East Midlands Gateway
Phase 2 (EMG2)

Document DCO 6.14F/MCO 6.14F (Part 5 of 6)

ENVIRONMENTAL STATEMENT

Technical Appendices

Appendix 14F

Preliminary Sources Study Affecting National Highways

October 2025

14

The East Midlands Gateway Phase 2
and Highway Order 202X and The East Midlands Gateway
Rail Freight and Highway (Amendment) Order 202X

SEGRO.COM/SLPEMG2

SEGRO

RECORD OF BOREHOLE B259

SCALE: 1 to 100

LOCATION:- BRIDGE 117 - M1 MOTORWAY BRIDGE WIDENING

Ground level: 7.45m above O.D.

Dia. of boring: 0.20m

SK 42 SC 86 478 22-1

Method of boring: Shell and Auger

Lining tubes: 0.20m to 9.00m

Daily Progress	Samples Depth	Samples Type	Change of Strata Legend	Change of Strata Depth	Change of Strata O.D. Level	Description of Strata
				0.20	68.25	TOPSOIL
	1.00 – 1.45	U(4)				
	1.45	D				
	2.50 – 2.95	U(4)				
	2.95	D				Stiff to very stiff dark red-brown sandy silty CLAY with fine to medium gravel, siltstone fragments and pockets of sand
	4.00 – 4.45	U(4)				
	4.45	D				
	5.50 – 5.95	U(4)				
	5.95	D				
21/2/73	7.00 – 7.45	U(4)		7.45	61.00	
	7.45	D				
	8.00 – 10.00	BD				Light green-grey silty fine to medium SANDSTONE with bands of siltstone
22/2/73				10.00	58.45	

Key to type of sample:

- U(4) — 102mm (4in.) dia. undisturbed sample
- D — disturbed sample
- BD — bulk disturbed sample
- V — vane test
- S ( ) — standard penetration test
- C ( ) — dynamic cone penetration test

Figure in brackets is No. of blows for penetration given in depth column (see Notes, page 1).

Remarks: (Observations on ground-water, etc.)

Before commencement of boring a pit was excavated to 1.00m depth to locate underground services. Water was added to assist boring throughout. Ground-water was not encountered during boring. The borehole was chiselled below 7.45m.

Lab. Ref. No. S/ 9372

M64 - DERBY SPUR

FIG. 267

British Geological Survey

Soil Mechanics

BOREHOLE No. 741

Sheet 1 of 2

Equipment & Methods
Cable tool boring, 150 mm diameter, from ground level to 7.17m.

Location No. 7382

Location SK42 SE 96

A42 CASTLE DONINGTON NORTH:
GROUND INVESTIGATION CONTRACT 4

Carried out for
Client: Department of Transport (E. Midlands Reg. Office)
Engineer: Scott Wilson Kirkpatrick & Partners

Ground Level
53.28 m A.O.D.

Coordinates
4 6721.0 mE
2 4338.0 mN

Date
12.01.88 to 13.01.88

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records
Clayey topsoil	53.28		(0.30)					
	52.98		0.30	0.40	D	1		
				0.50 – 0.95	U	2		33 blows
Firm becoming stiff red brown very closely fissured locally very silty CLAY with frequent up to coarse gravel sized lithorelics and occasional light green reduction spots				1.00	D	3	S	
				1.00 – 1.45	D	4	N=19	3,3/3,4,6,6
				1.20	WS	10A		
(KEUPER MARL 3/4a)			(3.20)					
				2.00 – 2.45	U	5		100 blows
				2.50	D	6		
thin to thickly laminated in parts				2.50 – 2.95	D	7	S N=35	5,10/11,9,7,8,
	49.78		3.50					
				3.50 – 3.90	U	8		150 blows for 400mm penetration
				3.95	D	9		
Very stiff (hard) red brown fissured very silty CLAY with bands of dark red brown thinly laminated mudstone, pockets and lenses of light grey silt locally cemented, and occasional light green reduction spots				3.95 – 4.40	D	10	S N=152	7,19/29,35,38,50
(KEUPER MARL 3)			(3.68 pen)	5.00 – 5.45	D	11	S N=80	5,7/11,20,22,27
friable				6.00 – 6.45	D	12	S N=100	10,17/15,21,29,35
								Chiselling from 6.70 to 7.00m 1.00 hour
				7.00 – 7.18	D	13	S 50	22,37/50 for 27mm
BOREHOLE ENDS AT 7.18 m.	46.10		7.18					

Remarks

Logged by: GNC

Scale: 1:50

Fig. 67

Notes:
Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

(c) Soil Mechanics
24.03.88/16.14 (Ver 3.1.0)

British Geological Survey

Soil Mechanics

BOREHOLE No. 741

Sheet 2 of 2

Equipment & Methods

As sheet 1

Location No. 7382

Location SK42SE96 46721.0 24338.0

A42 CASTLE DONINGTON NORTH: GROUND INVESTIGATION CONTRACT 4

Carried out for

Client: Department of Transport (E. Midlands Reg. Office)

Engineer: Scott Wilson Kirkpatrick & Partners

Ground Level | Coordinates | Date

As sheet 1

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample: Type	Sample: No.	Test	Field Records

Water Level Observations During Boring

Date	Time	Depth of Hole (m)	Depth of Casing (m)	Depth to Water (m)	Remarks
1988					
12.01	–	0.00	0.00		
12.01	1600	3.50	3.00	3.50	Water strike
12.01	1620			2.40	after 20 mins.
12.01	1700	4.50	4.50	1.40	End of shift
13.01	0800	4.50	4.50	1.20	
13.01	–	7.18	7.00	6.50	End of cable tool boring

Remarks

Logged by GAC

Scale 1:50

Fig. 67

Notes:

Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics 24.03.88/16.14 (Ver 3.1.0)

British Geological Survey

Soil Mechanics

BOREHOLE No. 741

Sheet 1 of 2

Equipment & Methods
Cable tool boring, 150 mm diameter, from ground level to 7.179m.

Location No. 7382
Location SK42 SE96
A42 CASTLE DONINGTON NORTH:
GROUND INVESTIGATION CONTRACT 4

Carried out for
Client: Department of Transport (E. Midlands Reg. Office)
Engineer: Scott Wilson Kirkpatrick & Partners

Ground Level
53.28 m A.O.D.

Coordinates
E 446721.0 mE
N 333338.0 mN

Date
12.01.88 to 13.01.88

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records
Clayey topsoil	53.28		(0.30)					
	52.98		0.30	0.40	D	1		
				0.50 - 0.95	U	2		33 blows
Firm becoming stiff red brown very closely fissured locally very silty CLAY with frequent up to coarse gravel sized lithorelics and occasional light green reduction spots				1.00	D	3		
				1.00 - 1.45	D	4	S N=19	3,3/3,4,6,6
				1.20	WS	10A		
(KEUPER MARL 3/4a)			(3.20)					
				2.00 - 2.45	U	5		100 blows
thin to thickly laminated in parts				2.50	D	6		
				2.50 - 2.95	D	7	S N=35	5,10/11,9,7,8,
	49.78		3.50					
				3.50 - 3.90	U	8		150 blows for 400mm penetration
Very stiff (hard) red brown fissured very silty CLAY with bands of dark red brown thinly laminated mudstone, pockets and lenses of light grey silt locally cemented, and occasional light green reduction spots				3.95	D	9		
				3.95 - 4.40	D	10	S N=152	7,19/29,35,38,50
(KEUPER MARL 3)				5.00 - 5.45	D	11	S N=80	5,7/11,20,22,27
			(3.68 part)					
friable				6.00 - 6.45	D	12	S N=100	10,17/15,21,29,35
								Chiselling from 6.70 to 7.00m 1.00 hour
				7.00 - 7.18	D	13	S 50	22,37/50 for 27mm
BOREHOLE ENDS AT 7.18 m.	46.10		7.18					

Remarks

Logged by GAC

Scale 1:50

Fig. 67

Notes:
Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 24.03.88/16.14 (Ver 3.1.0)

British Geological Survey

Soil Mechanics

BOREHOLE No. 741

Sheet 2 of 2

Equipment & Methods

As sheet 1

Location No. 7382

Location SK42SE96 46721.0 24338.0

A42 CASTLE DONINGTON NORTH:
GROUND INVESTIGATION CONTRACT 4

Carried out for

Client: Department of Transport (E. Midlands Reg. Office)
Engineer: Scott Wilson Kirkpatrick & Partners

Ground Level | Coordinates | Date

As sheet 1

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Samples/Tests: Sample Type	Samples/Tests: Sample No.	Samples/Tests: Test	Field Records

Water Level Observations During Boring

Date	Time	Depth of Hole (m)	Depth of Casing (m)	Depth to Water (m)	Remarks
1988					
12.01	–	0.00	0.00		
12.01	1600	3.50	3.00	3.50	Water strike
12.01	1620			2.60	after 20 mins.
12.01	1700	4.50	4.50	1.40	End of shift
13.01	0800	4.50	4.50	1.20	
13.01	–	7.18	7.00	6.50	End of cable tool boring

Remarks

Logged by: GAC

Scale: 1:50

Fig. 67

Notes:

Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 24.03.88/16.14 (Ver 3.1.0)

British Geological Survey

Soil Mechanics

BOREHOLE No. 742

Sheet 1 of 2

Equipment & Methods
Hand dug inspection pit to 1.00m. Cable tool boring, 150mm diameter, from 1.00m to 7.55m.

Location No. 7382 SK42SE97

Location
A42 CASTLE DONINGTON NORTH:
GROUND INVESTIGATION CONTRACT 4

Carried out for
Client: Department of Transport (E. Midlands Reg. Office)
Engineer: Scott Wilson Kirkpatrick & Partners

Ground Level	Coordinates	Date
57.60 m A.O.D.	446903.5 mE 323822.0 mN	28.01.88

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records
Rolled Hardcore (Foreman's description)	57.60		(0.70)					
	56.90		0.70					
Firm to stiff becoming locally very stiff red brown very silty CLAY with frequent coarse gravel sized lithorelics:locally with pockets and lenses of light grey green silt				1.00 – 1.45	U	1		26 blows
				1.60	D	2		
				1.60 – 2.05	D	3	S N=10	1,2/2,2,3,3
Below 1.60m with generally fine to medium locally coarse gravel sized lithorelics				2.50 – 2.95	U	4		24 blows
				3.10	D	5		
				3.10 – 3.55	D	6	S N=11	2,3/3,3,2,3
Below 4.60m becoming very stiff								
Below 6.10m becoming very stiff (hard) red brown CLAY with fine to medium gravel sized lithorelics and occasional medium to coarse gravel sized inclusions of dark brown silty clay with decayed rootlets			(6.85 part)	4.00 – 4.45	U	7		32 blows
				4.60	D	8		
(FILL)				4.60 – 5.05	D	9	S N=17	2,2/3,4,5,5
				5.50 – 5.95	U	10		43 blows
				6.10	D	11		
				6.10 – 6.55	D	12	S N=21	3,4/4,5,6,6
				7.10 – 7.55	D	13	S N=26	4,4/5,7,7,7
BOREHOLE ENDS AT 7.55 m.	50.05		7.55					

Remarks

Logged by: AAC

Scale: 1:50

Fig. 68

Notes:
Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 12.04.88/16.15 (Ver 3.1.0)

Soil Mechanics

BOREHOLE No. 742

Sheet 2 of 2

Equipment & Methods: As sheet 1

Location No. 7382 SK42SE97

Location: 46903.5 23822.0

A42 CASTLE DONINGTON NORTH: GROUND INVESTIGATION CONTRACT 4

Carried out for

Client: Department of Transport (E. Midlands Reg. Office)

Engineer: Scott Wilson Kirkpatrick & Partners

Ground Level | Coordinates | Date: As sheet 1

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records

Water Level Observations During Boring

Date	Time	Depth of Hole (m)	Depth of Casing (m)	Depth to Water (m)	Remarks
1988					
28.01	-	4.00	3.34	DRY	
28.01	-	7.55	3.34	DRY	End of cable tool boring

Remarks

Logged by: AAC

Scale: 1:50

Notes:

Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics 12.04.88/16.15 (Ver 3.1.0)

Fig. 68

British Geological Survey

Soil Mechanics

BOREHOLE No. 742

Sheet 1 of 2

Equipment & Methods

Hand dug inspection pit to 1.00m. Cable tool boring, 150mm diameter, from 1.00m to 7.55m.

Location No. 7382 SK42SE97

Location

A42 CASTLE DONINGTON NORTH:
GROUND INVESTIGATION CONTRACT 4

Carried out for

Client: Department of Transport (E. Midlands Reg. Office)
Engineer: Scott Wilson Kirkpatrick & Partners

Ground Level: 57.60 m A.O.D.

Coordinates: E 4903.5 mE, N 3822.0 mN

Date: 28.01.88

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records
Rolled Hardcore (Foreman's description)	57.60		(0.70)					
	56.90		0.70					
				1.00 - 1.45	U	1		26 blows
				1.60	D	2		
				1.60 - 2.05	D	3	S N=10	1,2/2,2,3,3
Firm to stiff becoming locally very stiff red brown very silty CLAY with frequent coarse gravel sized lithorelics:locally with pockets and lenses of light grey green silt								
				2.50 - 2.95	U	4		24 blows
Below 1.60m with generally fine to medium locally coarse gravel sized lithorelics				3.10	D	5		
				3.10 - 3.55	D	6	S N=11	2,3/3,3,2,3
Below 4.60m becoming very stiff								
Below 6.10m becoming very stiff (hard) red brown CLAY with fine to medium gravel sized lithorelics and occasional medium to coarse gravel sized inclusions of dark brown silty clay with decayed rootlets			(6.85 pen)	4.00 - 4.45	U	7		32 blows
				4.60	D	8		
(FILL)				4.60 - 5.05	D	9	S N=17	2,2/3,4,5,5
				5.50 - 5.95	U	10		43 blows
				6.10	D	11		
				6.10 - 6.55	D	12	S N=21	3,4/4,5,6,6
				7.10 - 7.55	D	13	S N=26	4,4/5,7,7,7
BOREHOLE ENDS AT 7.55 m.	50.05		7.55					

Remarks

Logged by: MAC

Scale: 1:50

Fig. 68

Notes:

Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics 12.04.88/16.15 (Ver 3.1.0)

All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

British Geological Survey

Soil Mechanics

BOREHOLE No. 742

Sheet 2 of 2

Equipment & Methods

As sheet 1

Location No. 7382 SK42SE97

Location 46903.5 23822.0

A42 CASTLE DONINGTON NORTH:
GROUND INVESTIGATION CONTRACT 4

Carried out for

Client: Department of Transport (E. Midlands Reg. Office)
Engineer: Scott Wilson Kirkpatrick & Partners

Ground Level | Coordinates | Date

As sheet 1

Description	Reduced Level	Legend	Depth (Thick)	Samples/Tests: Depth	Sample Type	Sample No.	Test	Field Records

Water Level Observations During Boring

Date	Time	Depth of Hole (m)	Depth of Casing (m)	Depth to Water (m)	Remarks
1988					
28.01	-	4.00	3.34	DRY	
28.01	-	7.55	3.34	DRY	End of cable tool boring

Remarks

Logged by: AAC

Scale: 1:50

Notes:

Materials are described in accordance with Appendices. For explanation of symbols and abbreviations see Fig. 1. (c) Soil Mechanics
All depths and reduced levels in metres. Thicknesses given in brackets in depth column. 12.04.88/16.15 (Ver 3.1.0)

Fig. 68

GEO – RESEARCH LTD SK 43 NE [redacted] 131 B/H No. 286

CONTRACT BIRMINGHAM-NOTTINGHAM MOTORWAY M42 | SHEET No. 1

LOCATION CASTLE DONINGTON SECTION IIB | No. of sheets 2

CLIENT M.R.C.U. DERBYSHIRE COUNTY COUNCIL SUB-UNIT | Ground Level 61.603 | Commenced 17/9/72 | Completed 10/11/72

Weather DRY

Percussion U D SPT B | Rotary Cored runs O/H | Legend 5

CASING Size 0.150 to 4.570 Size to

STRATUM. (Scale: 20mm to 1 metre) 1. Thickness	Depth 2. m	Sample No.	Blow Count (N) LL/PL/PI	M.C % Core Rec. % 6.	Type of Test 7.	Grading % Passing Sieve 8. Results of any other Tests: 75 mm / 40 mm / 20 mm / 10 mm / 2.40 mm	TRIAXIAL TEST: Bulk Density Kg/m³	Dev. Stress kN/m²	Lat. U.C.T. Pres. Stren. kN/m² kN/m² Shear/∠° kN/m²	WATER REMARKS 10.
Compact brown sandy TOPSOIL										
1.20	1.20									
Stiff red/brown and yellow/green sandy very silty CLAY	1.21	D1		18.4						
	1.44	U1	24.15.9. (CL) (18)	18.6			2040	241	100	
				20.3	TAQ		2000	147	200	
				21.1			2060	141	400	
	1.98	D2		20.2					88/0°	
(Keuper Waterstones) (i)										
	2.59	D3		23.0						
	2.89	U2	35.17.18.	21.7			1940			
1.80	3.00		(CL/CI) (40)							
Hard highly weathered light brown and green fine SANDSTONE (becoming harder and partly cemented as weathering lessens)	3.50	P1	8.8.8.15. (39)	15.6						
	3.96	B1		20.1						Water Added
(Keuper Waterstones) (iv)	4.57	P2	50 blows for 0.070 total							
	5.02	D4		9.2						
	5.33	P3	50 blows for 0.060 total							
2.38	5.38									OC of Boring @ 5.380 Cas @ 4.570 Water Nil Rotary Drilling commenced 10/11/72
Moderately weathered, medium/thickly bedded, with occasional laminae, buff, locally red or green at 5.00 - 8.00m, coarse grained, pebbly, poorly cemented with marl (laminae) 5.00 - 8.00m SANDSTONE (iv)				100						
				100						
3.12	8.50									
Continued on Sheet 2.										

REMARKS:

Sample	Depth	M.C. % D.W.		C. B. R. Air Voids	Type	TOP 0.1	TOP 0.2	BOTTOM 0.1	BOTTOM 0.2	Value	COMPACTION B.S. 1377 No.	Max. Dry Density	Optm. M.C.

For other symbols used see overleaf

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CONTRACT BIRMINGHAM-NOTTINGHAM MOTORWAY M42 | SHEET No. 2

LOCATION CASTLE DONINGTON SECTION IIB | No. of sheets 2

CLIENT M.R.C.U. DERBYSHIRE COUNTY COUNCIL SUB-UNIT

Percussion U D SPT B | Rotary Cored runs O/H | 5 Legend

CASING Size 0.150 to 4.570 Size to.

Ground Level 61.603

Commenced 17/9/72

Completed 10/11/72

Weather DRY

STRATUM. (Scale: 20mm to 1 metre) 1. Thickness	Depth 2. m	Sample No.	Blow Count (N) LL/PL/PI	M.C % Core Rec. % 6.	Type of Test 7.	Grading % Passing Sieve 8 Results of any other Tests	TRIAXIAL TEST Bulk Density Kg/m³	Dev. Stress kN/m²	Lat. U.C.T Pres. Stren. kN/m² kN/m² Shear/ϕ° kN/m²	WATER REMARKS 10.
						mm 75 mm 40 mm 20 mm 10 mm 5 μm 2.40 μm 600 μm 210 μm 150 μm 75				
Moderately weathered, medium/thickly bedded, with occasional laminae, buff, coarse grained, pebbly, poorly cemented SANDSTONE (iv)	8.50			100						
				100						
6.50	15.00			100						
Borehole Complete										

REMARKS:

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Sample	Depth	M.C. % D.W.	C. B. R. Air Voids	Type	TOP 0.1	TOP 0.2	BOTTOM 0.1	BOTTOM 0.2	Value	COMPACTION B.S. 1377 No.	Max. Dry Density	Optm M.C.

For other symbols used see overleaf

GEO – RESEARCH LTD SK 43 NE [redacted] 131 B/H No. 286

CONTRACT BIRMINGHAM-NOTTINGHAM MOTORWAY M42 SHEET No. 1

LOCATION CASTLE DONINGTON SECTION IIB No. of sheets 2

CLIENT M.R.C.U. DERBYSHIRE COUNTY COUNCIL SUB-UNIT

Percussion U D SPT B

CASING Size 0.150 to. 4.570 Size to.

Ground Level 61.603

Commenced 17/9/72

Completed 10/11/72

Weather DRY

Rotary Cored runs O/H

M.C % Core Rec. % of Test

Type

Grading % Passing Sieve: mm 75 | mm 40 | mm 20 | mm 10 | mm * | mm 2.40 | μm 600 | μm 210 | μm 150 | μm 75

TRIAXIAL TEST: Bulk Density Kg/m³ | Dev. Stress kN/m² | Lat. U.C.T. Pres. Stren. kN/m² kN/m² Shear/∠° kN/m²

WATER

STRATUM. (Scale: 20mm to 1 metre)

1. Thickness	Depth m	Sample No.	Blow Count (N) LL/PL/PI	5 Legend	6.	7.	8 Results of any other Tests	10. REMARKS
Compact brown sandy TOPSOIL								
1.20	1.20							
Stiff red/brown and yellow/green sandy very silty CLAY	1.21	D1			18.4			
	1.44	U1	24.15.9. (CL)		18.6		2040 241 100	
			(18)		20.3	TAQ	2000 147 200	
	1.98	D2			21.1		2060 141 400	
					20.2		88/0°	
(Keuper Waterstones)								
(i)	2.59	D3			23.0			
	2.89	U2	35.17.18.		21.7		1940	
1.80	3.00		(CL/CI) (40)					
Hard highly weathered light brown and green fine SANDSTONE (becoming harder and partly cemented as weathering lessens)	3.50	P1	8.8.8.15. (39)		15.6			
	3.96	B1			20.1			Water Added
(Keuper Waterstones)								
(iv)	4.57	P2	50 blows for 0.070 total					
	5.02	D4			9.2			
2.38	5.38	P3	50 blows for 0.060 total					
Moderately weathered, medium/thickly bedded, with occasional laminae, buff, locally red or green at 5.00 – 8.00m, coarse grained, pebbly, poorly cemented with marl (laminae 5.00 – 8.00m SANDSTONE					100			OC of Boring @ 5.380 Gas @ 4.570 Water Nil Rotary Drilling commenced 10/11/72
(iv)					100			
3.12	8.50							
Continued on Sheet 2.								

REMARKS:

Sample	Depth	M.C. % D.W.	Air Voids	Type	C. B. R. TOP 0.1	TOP 0.2	BOTTOM 0.1	BOTTOM 0.2	Value	COMPACTION B.S. 1377 No.	Max. Dry Density	Optm. M.C.

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For other symbols used see overleaf

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CONTRACT BIRMINGHAM-NOTTINGHAM MOTORWAY M42 | SHEET No. 2

LOCATION CASTLE DONINGTON SECTION 11B | No. of sheets 2

CLIENT M.R.C.U. DERBYSHIRE COUNTY COUNCIL SUB-UNIT | Ground Level 61.603 | Commenced 17/9/72 | Completed 10/11/72

Percussion U D SPT B

CASING Size 0.150 to. 4.570 Size to.

Weather DRY

Rotary Cored runs O/H Legend

STRATUM. (Scale: 20mm to 1 metre)

1. Thickness	Depth 2. m	Sample No.	Blow Count (N) LL/PL/PI
Moderately weathered, medium/thickly bedded, with occasional laminae, buff, coarse grained, pebbly, poorly cemented SANDSTONE (iv)	8.50		
	15.00		
Borehole Complete			

M.C % Core Rec. %	Type of Test	Grading % Passing Sieve mm	mm	mm	mm	mm	TRIAXIAL TEST Bulk Density Kg/m³	Dev. Stress kN/m²	Lat. U.C.T. Pres. Stress kN/m² kN/m² Shear/4 kN/m²	WATER REMARKS
		75	40	20	10	5				
		mm	µm	µm	µm	µm				
		2.40	600	210	150	75				
6.	7.	8 Results of any other Tests								10.
100										
100										
100										

REMARKS:

Sample	Depth	M.C. % D.W.	Air Voids	C. B. R. Type	TOP 0.1	TOP 0.2	BOTTOM 0.1	BOTTOM 0.2	Value	COMPACTION B.S. 1377 No.	Max. Dry Density	Optm M.C.

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GEO – RESEARCH LTD. SK 43 NE 141 B/H No. 298

CONTRACT BIRMINGHAM-NOTTINGHAM MOTORWAY M42 | SHEET No. 1

LOCATION CASTLE DONINGTON SECTION 11B | No. of sheets 1

CLIENT M.R.C.U. DERBYSHIRE COUNTY COUNCIL SUB-UNIT | Ground Level 54.727 | Commenced 15/9/72 | Completed 15/9/72

Weather FINE

Percussion: U / D / B

SPT

CASING: Size 0.200 to. 3.040 Size to.

Rotary: Cored runs / O/H

Legend

STRATUM. (Scale:20mm to 1 metre)	Depth	Sample No.	Blow Count (N) LL/PL/PI	M.C. % Core Rec. %	Type of Test	Grading % Passing Sieve: 75 mm / 40 mm / 20 mm / 10 mm / 5 mm / 2.40 mm / 600 µm / 210 µm / 150 µm / 75 µm	TRIAXIAL TEST: Bulk Density Kg/m³ / Dev. Stress kN/m² / Lat U.C.I. Pres. Strength kN/m² kN/m² / Shear/S kN/m²	WATER REMARKS
1. Thickness	2. m			5	6.	7.	8 Results of any other Tests	10.
Clay, sandy topsoil and sandstone FILL (ii) 0.90	0.90							
Compact, becoming very dense, sandstone gravel FILL (ii) 2.10	1.52 to 2.84 3.00	P1 B1 P2	7.4.4.5. (20) 12.8.23.30 (73)	14.3 17.0				WS @ 1.430 SWL 1.520 Water Added
Moderately weathered hard light brown and grey SANDSTONE (Lower Coal*) 0.84	3.04 to 3.75 3.84	P3 B2 P4	75 blows for 0.150 total 75 blows for 0.090 total	13.1 19.3				Water Added OCB @ 3.810 Cas @ 3.040 SWL 2.430 BH backfilled as casing withdrawn.
Borehole Complete								

REMARKS:

* Measures (ii)

Sample	Depth	M.C. % D.W.	Type	Air Voids	C. B. R. TOP 0.1	TOP 0.2	BOTTOM 0.1	BOTTOM 0.2	Value	COMPACTION B.S. 1377 No.	Max. Dry Density	Optm. M.C.

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For other symbols used see overleaf

Holst Soil Engineering Limited

BOREHOLE LOG

Borehole No. 2

SK 43 NE 217
4722 3646

Contract No. SI.2467/F.3243
Location Hart Avenue
Client Erewash Borough Council
Method of Boring Percussion
Diameter of Borehole 150mm

Sheet 1 of 1
Chainage
Ground Level 68.77m A.O.D.
Date 15.11.75

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.20	0.20						
Very stiff red brown silty CLAY with siltstone fragments		1.00	0.80	0.80 □	151	14	14.7	2155	
Completely weathered red brown MARL with bands of grey green siltstone				2.00 □	138	20	12.1	2250	
				3.00 □	66	17	15.4	2043	
		3.50	2.50						
Highly weathered red MARL and SILTSTONE		4.10	0.60	4.00 I					50for 100mm

Key

□ Undisturbed Sample
○ Disturbed Sample
△ Water Sample
I Penetration Test
Ø Angle of Friction
m.c. Moisture Content
γ Bulk Density
N S.P.T. Value
c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Borehole dry

Water levels are subject to seasonal or tidal variations and should not be taken as constant

Holst Soil Engineering Limited

BOREHOLE LOG

Borehole No. 3

SK 43 NE 218
4721 3652

Contract No. SI.2467/F.3243
Location Hart Avenue
Client Erewash Borough Council
Method of Boring Percussion
Diameter of Borehole 150mm

Sheet 1 of 1
Chainage
Ground Level 73.64m A.O.D.
Date 5.11.75

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.25	0.25						
Stiff red brown silty CLAY with occasional siltstone bands (weathered marl)				0.60 □	166	25	13.3	2185	
				1.50 □	175	20	23.1	2175	
		2.50	2.25	2.50 I					62
Highly weathered strong light grey green fine grained SILTSTONE		3.00	0.50						

Key

- □ Undisturbed Sample
- O Disturbed Sample
- △ Water Sample
- I Penetration Test
- Ø Angle of Friction
- m.c. Moisture Content
- γ Bulk Density
- N S.P.T. Value
- c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Borehole dry

Water levels are subject to seasonal or tidal variations and should not be taken as constant

Holst Soil Engineering Limited

BOREHOLE LOG

Borehole No. 4

SK43NE 219
4722 3661

Contract No. SI.2467/F.3243
Location Hart Avenue
Client Erewash Borough Council
Method of Boring Percussion
Diameter of Borehole 150mm

Sheet 1 of 1
Chainage
Ground Level 75.38m A.O.D.
Date 4.11.75

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	Ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.20	0.20						
Completely weathered red silty MARL with occasional thin green siltstone bands				0.50 U	83	15	15.7	2050	
				1.50 I					47
		1.90	1.70						
Highly weathered red sandy MARL with bands of strong hard green sandstone				2.80 I					50for 200mm
		3.00	1.10						

Key

- U Undisturbed Sample
- O Disturbed Sample
- △ Water Sample
- I Penetration Test
- Ø Angle of Friction
- m.c. Moisture Content
- γ Bulk Density
- N S.P.T. Value
- c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Borehole dry

Water levels are subject to seasonal or tidal variations and should not be taken as constant

Holst Soil Engineering Limited

BOREHOLE LOG

Borehole No. 6

SK 43 NE 22
4719 3678

Contract No. SI.2467/F.3243
Location Hart Avenue
Client Erewash Borough Council
Method of Boring Percussion
Diameter of Borehole 150mm

Sheet 1 of 1
Chainage
Ground Level 69.25m A.O.D.
Date 6.7.11.75

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	Ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.20	0.20						
Very stiff red silty CLAY (Weathered marl)				0.50 U	173	18	13.7	1810	
				1.50 U	110	7	19.0	1980	
				2.50 U	125	26	18.4	2170	
		3.20	3.00						
Highly weathered red and green interlaminated MARL and SILTSTONE				3.50 I					50for 150mm
		4.00	0.80						

Key

- U Undisturbed Sample
- O Disturbed Sample
- △ Water Sample
- I Penetration Test
- Ø Angle of Friction
- m.c. Moisture Content
- γ Bulk Density
- N S.P.T. Value
- c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Borehole dry

Water levels are subject to seasonal or tidal variations and should not be taken as constant

Holst Soil Engineering Limited

BOREHOLE LOG

Borehole No. TP 2

SK 43 NE 223
4719 3658

Contract No. SI.2467/F.3243
Location Hart Avenue
Client Erewash Borough Council
Method of Boring Excavator
Diameter of Borehole 1.5 m

Sheet 1 of 1
Chainage
Ground Level 76.55m A.O.D.
Date 20.11.75

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.30	0.30						
Firm red brown sandy stony CLAY		0.50	0.20						
Highly weathered red MARL with bands of siltstone		0.95	0.45						
Strong, hard grey, green SILTSTONE (excavator unable to break out the material)		1.30	0.35						

Key

- □ Undisturbed Sample
- O Disturbed Sample
- △ Water Sample
- I Penetration Test
- Ø Angle of Friction
- m.c. Moisture Content
- γ Bulk Density
- N S.P.T. Value
- c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Trial Pit dry

Water levels are subject to seasonal or tidal variations and should not be taken as constant

Holst Soil Engineering Limited

BOREHOLE LOG

Borehole No. TP 4

SK 43 NE #225
4717 3675

Contract No. SI.2467/F.3243
Location Hart Avenue
Client Erewash Borough Council
Method of Boring Excavator
Diameter of Borehole 1.5 m

Sheet 1 of 1
Chainage
Ground Level 75.38m A.O.D.
Date 20.11.75

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.30	0.30						
Firm red brown silty CLAY		0.70	0.40						
Highly weathered red brown silty MARL with occasional thin grey siltstone bands		2.00	1.30						

Key

- ▯ Undisturbed Sample
- O Disturbed Sample
- △ Water Sample
- I Penetration Test
- Ø Angle of Friction
- m.c. Moisture Content
- γ Bulk Density
- N S.P.T. Value

Remarks (Observations of Ground Water etc.)

Trial Pit dry

Holst Soil Engineering Limited

BOREHOLE LOG

SK 43 NE 226
4716 3682

Borehole No. TP 5

Contract No. SI.2467/F.3243
Location Hart Avenue
Client Erewash Borough Council
Method of Boring Excavator
Diameter of Borehole 1.5 m

Sheet 1 of 1
Chainage
Ground Level 67.16m A.O.D.
Date 20.11.75

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.30	0.30						
Stiff red sandy CLAY		0.60	0.30						
Highly weathered red silty MARL with occasional green siltstone bands		2.00	1.40						

Key

- ▯ Undisturbed Sample
- O Disturbed Sample
- △ Water Sample
- I Penetration Test
- Ø Angle of Friction
- m.c. Moisture Content
- γ Bulk Density
- N S.P.T. Value
- c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Trial Pit dry

Water levels are subject to seasonal or tidal variations and should not be taken as constant

Holst Soil Engineering Limited

BOREHOLE LOG

Borehole No. TP 6

SK43 NE 227
4725 3678

Contract No. SI.2467/F.3243
Location Hart Avenue
Client Erewash Borough Council
Method of Boring Excavator
Diameter of Borehole 1.5 m

Sheet 1 of 1
Chainage
Ground Level 62.10m A.O.D.
Date 20.01.75

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.30	0.30						
Stiff red sandy CLAY		0.55	0.25						
Completely weathered red MARL		0.95	0.40						
Strong hard grey SILTSTONE		1.20	0.25						
Highly weathered red brown silty MARL		2.00	0.80						

Key

- □ Undisturbed Sample
- O Disturbed Sample
- △ Water Sample
- I Penetration Test
- Ø Angle of Friction
- m.c. Moisture Content
- γ Bulk Density
- N S.P.T. Value
- c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Trial Pit dry

Holst Soil Engineering Limited

BOREHOLE LOG

Borehole No. TP 8

SK 43 NE 229
4725 3664

Contract No. SI.2467/F.3243
Location Hart Avenue
Client Erewash Borough Council
Method of Boring Excavator
Diameter of Borehole 1.5 m

Sheet 1 of 1
Chainage
Ground Level 72.30m A.O.D.
Date 21.11.75

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.30	0.30						
Weathered grey/green SILTSTONE		0.60	0.30						
Highly weathered red/brown MARL with occasional bands of grey/ green siltstone		2.00	1.40						

Key

- ▯ Undisturbed Sample
- O Disturbed Sample
- △ Water Sample
- I Penetration Test
- Ø Angle of Friction
- m.c. Moisture Content
- γ Bulk Density
- N S.P.T. Value
- c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Trial Pit dry

Water levels recorded are those at time of boring and may not be representative of other periods due to seasonal or tidal variations and should not be taken as constant.

Holst Soil Engineering Limited

BOREHOLE LOG

Borehole No. TP 14

SK 43 NE 234
4722 3638

Contract No. SL.2467/F.3243
Location Hart Avenue
Client Erewash Borough Council
Method of Boring Excavator
Diameter of Borehole 1.5 m

Sheet 1 of 1
Chainage
Ground Level 62.03m A.O.D.
Date 20.11.75

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	Ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.20	0.20						
Red brown sandy stony CLAY		0.40	0.20						
Grey green SILTSTONE		0.60	0.20						
Highly weathered red silty MARL		1.50	0.90						

Key

- ▯ Undisturbed Sample
- O Disturbed Sample
- △ Water Sample
- I Penetration Test
- Ø Angle of Friction
- m.c. Moisture Content
- γ Bulk Density
- N S.P.T. Value
- c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Trial Pit dry

Water levels are subject to seasonal or tidal variations and should not be taken as constant

Holst Soil Engineering Limited

BOREHOLE LOG

SK 43 NE 239

Borehole No. TP 2

Contract No. SI.2467/F.3243
Location Stanton Road
Client Erewash Borough Council
Method of Boring Excavator
Diameter of Borehole 1.5m

Sheet 1 of 1
Chainage
Ground Level 70.48m A.O.D.
Date 20.11.75

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.30	0.30						
Completely weathered red MARL		0.70	0.40						
Weathered grey green SILTSTONE		1.00	0.30						
Highly weathered red brown MARL		1.50	0.50						

Key

- □ Undisturbed Sample
- ○ Disturbed Sample
- △ Water Sample
- I Penetration Test
- ø Angle of Friction
- m.c. Moisture Content
- γ Bulk Density
- N S.P.T. Value
- c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Trial Pit dry

Water levels are subject to seasonal or tidal variations and should not be taken as constant

FOUNDATION ENGINEERING Ltd.

BOREHOLE LOG

LOCATION : NOTTINGHAM AQUEDUCT

BOREHOLE DIA. : 6"

DATE (Start) : 14 · 1 · 66

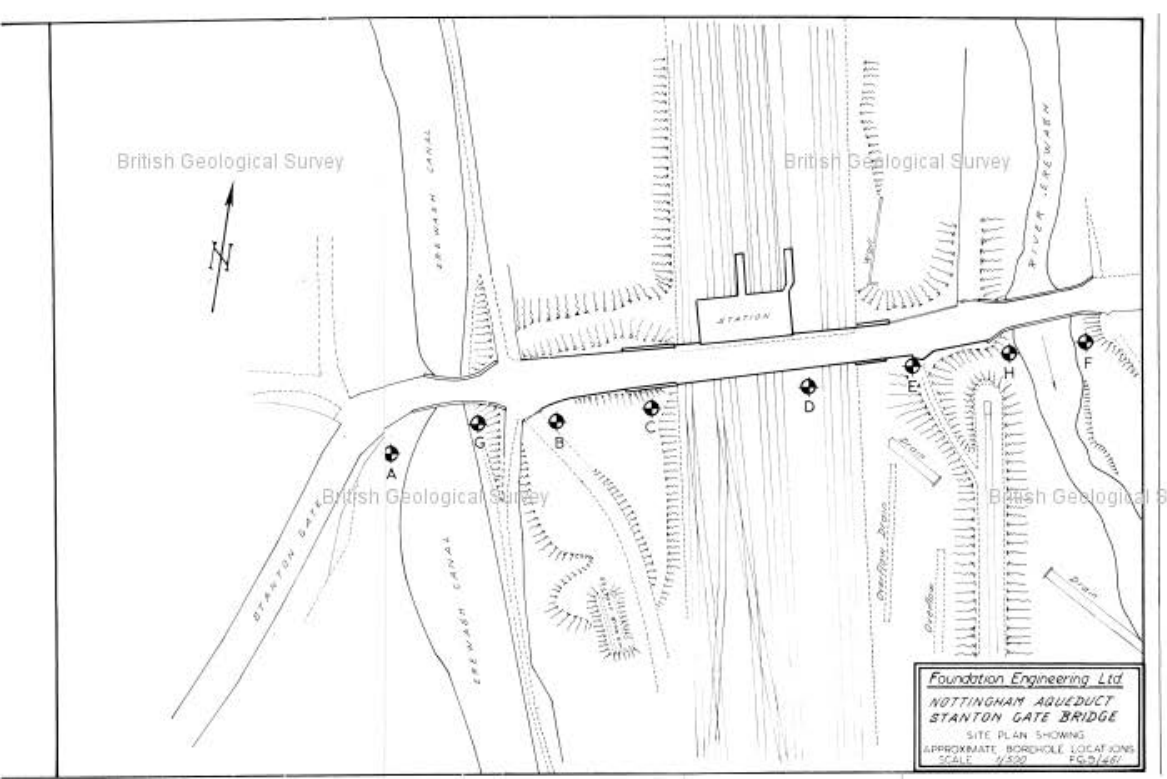
BOREHOLE No. : 12

GROUND LEVEL : 280 O.D.

WATER LEVEL : See note

Dates	Description	Thickness	Depth	Sample	Remarks
	TOPSOIL	1'-0"	0'-0" 1'-0"	1	
	Stiff red grey MARL	12'-0" +		2	
	Note: Borehole remained dry during boring		13'-0"	3	BOREHOLE COMPLETE

BOREHOLE SCALE : 1" 5' • : DISTURBED SAMPLE ▮ : UNDISTURBED SAMPLE + STANDARD PENETRATION TEST



British Geological Survey

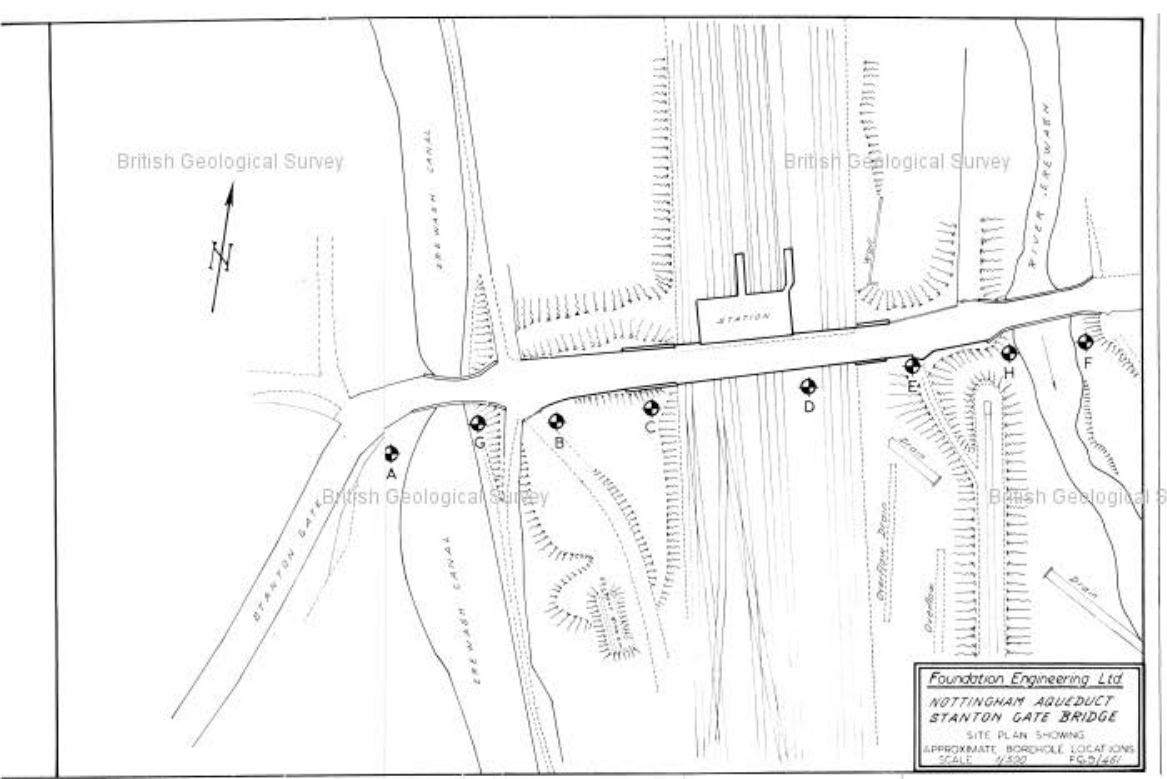
FOUNDATION ENGINEERING Ltd.

BOREHOLE LOG

LOCATION : NOTTINGHAM AQUEDUCT
BOREHOLE No. : 13
BOREHOLE DIA. : 6"
GROUND LEVEL : 280 ' O.D.
DATE (Start) : 14 · 1 · 66
WATER LEVEL : See note

Dates	Description	Thickness	Depth		Sample	Remarks
	TOPSOIL	1' - 0"	0'-0" 1' - 0"		1	
	Stiff red and grey MARL	13' - 0" +			2	
	Note: Boring remained dry during boring		14' - 0"		3	BOREHOLE COMPLETE

BOREHOLE SCALE : 1 5' • : DISTURBED SAMPLE ▮ : UNDISTURBED SAMPLE + STANDARD PENETRATION TEST



British Geological Survey

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	CP2011

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 1.50m	73.85	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447127 E 337066 N	03/08/2006	Arup	1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				Water strike(1) at 0.00m.	73.70	(0.15) 0.15	MADE GROUND. Grey slightly sandy slightly gravelly organic silt/clay. Gravel is subangular fine to coarse of sandstone and concrete with occasional plastic debris.		▽1
0.40	B101					(1.05)	Possible MADE GROUND. Stiff to very stiff friable red/brown locally mottled grey green clay. Gravel is subangular medium to coarse of sandstone with occasional sandstone cobbles.		
1.00	B102				72.65	1.20			
1.20	B2						MUDSTONE recovered as red brown subangular to angular gravel sized fragments with light grey laminae. Many cobbles of mudstone.		
1.20	C1					(0.80)			
1.20	K1								
1.50-1.56	SPT 25'/30 50/25			25/50					
1.50	D3				71.85	2.00			
1.50-2.00	B4			03/08/2006:1.00m					
2.00	D5			03/08/2006: 25/50 03/08/2006:			Complete at 2.03m		
2.00-2.03	SPT 25'/10 50/15								

Remarks

Scale (approx)	Logged By
1:50	RMS

Figure No.

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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	CP2012

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 1.20m	73.15	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447188 E 337155 N	15/08/2006	Arup	1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				Groundwater was not apparent during boring(1) at 0.00m.	73.00	(0.15) 0.15	Brown gravelly TOPSOIL with fragments of concrete.		▽1
0.15	B101						MUDSTONE: Recovered as red/brown gravel and sand sized fragments. With occasional rootlets to 0.50m.		
0.15	C2								
0.15	K2								
0.50	B102								
0.50	C4								
0.50	K4								
1.00	B103					(1.85)	From 1.00m; subangular to subrounded cobbles of moderately weak mudstone. At 1.20m; possible sandstone band recovered as gravelly fine sand.		
1.00	C6								
1.00	K6								
1.20-1.24	SPT 25'/20 35/15			25/35					
1.20	B104								
1.20	C2								
1.20	D1				71.15	2.00			
1.20-1.70	B3			15/08/2006:DRY					
2.00	D4						Complete at 2.10m		
2.00-2.10	SPT 25'/75 50/20			15/08/2006: 24,1/50 15/08/2006:					

Remarks

Scale (approx)	Logged By
1:50	RMS

Figure No.

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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	CP2018

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 4.00m	62.60	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447412 E 337685 N	27/07/2006-28/07/2006	Arup	1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				Groundwater was not apparent during boring(1) at 0.00m.	62.40	(0.20) 0.20	MADE GROUND. Grey brown friable gravelly slightly sandy slightly organic silt/clay. Gravel is subangular medium and coarse of limestone.		▽1
0.15	B8								
0.15	C201								
0.15	K201								
0.15	V201								
0.50	B1					(1.00)	MADE GROUND. Light grey brown very gravelly silty fine to coarse sand. Gravel is angular and subangular fine to coarse of limestone, concrete and granite with rare similar cobbles.		
0.50	C202								
0.50	K202								
0.50	V202								
					61.40	1.20			
1.20	C203								
1.20	D2						Probably MADE GROUND. Red brown locally mottled brown and grey green slightly sandy slightly gravelly silt/clay. Gravel is subangular medium of sandstone.		
1.20	K203								
1.20	V203								
1.50-1.95	U3			60 blows		(1.30)			
2.00	B5								
2.00	D4								
					60.10	2.50			
2.50-2.95	SPT N=20			5,5/5,5,5,5			Very weak yellow brown fine and medium SANDSTONE. (Recovered as very silty fine and medium sand).		
2.50	C204								
2.50	D6								
2.50	K204								
2.50	V204								
2.50-3.00	B7								
3.50-3.95	SPT N=39			7,8/8,10,10,11					
3.50	C205					(2.60)			
3.50	D9								
3.50	K205								
3.50	V205								
3.50-4.00	B10								
4.50	D11			27/07/2006:DRY			Below 4.65m; red brown.		
4.50-5.00	B12								
4.50-4.78	SPT 50/130			27/07/2006: 12,13/20,30 27/07/2006:					
					57.50	5.10			
5.10	D13			28/07/2006: 28/07/2006:DRY					
5.10-5.30	SPT 25'/90 50/105			28/07/2006: 20,5/35,15 28/07/2006:DRY			Complete at 5.30m		

Remarks

Scale (approx)	Logged By
1:50	TL

Figure No.

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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	CP2021

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	200mm cased to 6.00m	56.90	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447527 E 337812 N	21/08/2006-22/08/2006	Arup	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				Groundwater was not apparent during boring(1) at 0.00m.	56.80	(0.10) 0.10	MADE GROUND. Grass over grey slightly gravelly organic clay with occasional plastic debris. Gravel is subangular fine to coarse of concrete, sandstone and slag.		▽1
0.30	B101				56.50	(0.30) 0.40			
0.30	C101						MADE GROUND. Grey gravelly very clayey fine sand. Gravel is angular to subangular fine to coarse limestone, sandstone and slag with occasional cobbles of the same.		
0.30	K101					(0.90)			
0.80	B102						MADE GROUND. Dark grey brown slightly gravelly sandy silt locally very gravelly sand. Gravel is subangular fine to coarse concrete, clinker and limestone with occasional cobbles of slag. At 1.00m; slight hydrocarbon odour.		
0.80	K102								
1.00	K1								
1.20	B103				55.60	1.30			
1.20	C103								
1.20	K103								
1.20-1.65	U1			90 blows			MADE GROUND. Medium dense to dense dark brown gravelly angular sand. Gravel is subangular to subrounded fine to coarse of brick, concrete and slag.		
1.50	C3								
1.50	K3								
1.65	D2								
2.00	C4								
2.00	K4								
2.20-2.65	SPT N=20			3,5/5,4,5,6					
2.20	D5								
2.20-2.70	B6								
2.50	C7								
2.50	K7								
3.00-3.45	SPT N=41			4,5/9,11,11,10			Below 3.00m; becoming very gravelly.		
3.00	C8								
3.00	D9								
3.00	K8								
3.00-3.50	B10								
3.50	C11								
3.50	K11						At 3.80m; slag noted.		
						(5.20)			
4.00-4.45	SPT N=39			4,5/8,10,9,12			From 4.00m to 5.00m; very sandy gravel.		
4.00	C12								
4.00	D12								
4.00	D13								
4.00-4.50	B14								
4.50	C15								
4.50	K15								
5.00-5.45	SPT N=60			7,10/12,12,17,19					
5.00	C16								
5.00	D17								
5.00	K16								
5.00-5.50	B18								
5.50	C19								
5.50	K19								
6.00-6.45	SPT N=25			3,7/8,6,6,5					
6.00	C20								
6.00	D21								
6.00	K20				50.40	6.50			
6.00-6.50	B22						MADE GROUND. Light to medium brown slightly sandy clay with occasional rounded to angular gravel inclusions.		
6.50	C23								
6.50	D24								
6.50	K23								
7.00	C26								
7.00	K26					(1.40)			
7.00-7.50	U25			100 blows					
7.50	C27								
7.50	K27								
7.50-7.95	U28			84 blows	49.00	7.90			
7.95	D29						Dark brown organic very clayey SAND. Driller notes peat. Possibly [old]		
8.00	C30					(0.60)			
8.00	K30				48.40	8.50			
8.50-8.95	SPT N=23			1,2/6,6,5,6			Medium to dark brown slightly sandy CLAY with occasional rounded to angular coarse gravel.		
8.50	C31								
8.50	D32								
8.50	K31								
8.50-9.00	B33								
9.00	C34								
9.00	K34								
9.50	C35			21/08/2006:DRY		(2.20)			
9.50	K35								
9.50-9.95	U35			71 blows 21/08/2006:					

Remarks

Scale (approx)	Logged By
1:50	TL/DAL

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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	CP2021

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	200mm cased to 6.00m	56.90	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447527 E 337812 N	21/08/2006-22/08/2006	Arup	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
9.95 10.00 10.00	D36 C37 K37			21/08/2006: 22/08/2006:		(2.20)	CLAY (as previous sheet)		
10.70-10.80 10.70 10.70-11.10	SPT 25'/60 50/35 D38 B39			25/50 22/08/2006:DRY	46.20	10.70 (0.40)	SANDSTONE recovered as grey gravel and cobble sized fragments of slightly weathered orange stained fine grained fragments. Black veins observed throughout.		
11.10-11.15	SPT(C) 25'/30 50/20			22/08/2006: 25/50 22/08/2006:DRY	45.80	11.10	Complete at 11.15m		

Remarks

Scale (approx)	Logged By
1:50	TL/DAL

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Site	Borehole Number
M1 WIDENING J21-30	CP2022

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion		55.05	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447575 E 337801 N	02/08/2006	Arup	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.30)	TOPSOIL.		
0.30	B				54.75	0.30	MADE GROUND. Dense to very dense brown sand and gravel with occasional rootlets to 1.50m. Sand is fine to coarse, gravel is angular to rounded fine to coarse of mixed lithologies including sandstone, mudstone, chert, brick and slag. Occasional cobbles of sandstone, chert and clinker		
0.30	C101								
0.30	K101								
0.55	B								
0.55	C102								
0.55	K102								
1.20	B1								
1.50-1.95	SPT N=46			7,8/9,14,10,13					
1.50	C2								
1.50	D3								
1.50	K2								
1.50-2.00	B4								
2.00	C5								
2.00	K5								
2.50-2.95	SPT N=43			8,9/7,10,12,14					
2.50	C6								
2.50	D7					(5.00)			
2.50	K6								
2.50-3.00	B8								
3.00	C9								
3.00	K9								
3.50-3.91	SPT 25*/105 N=66			17,8/17,17,14,18					
3.50	C10								
3.50	D11								
3.50	K10								
3.50-4.00	B12								
4.00	C13								
4.00	K13								
4.50-4.95	SPT N=60			8,8/11,16,15,18					
4.50	C14								
4.50	D15								
4.50	K14								
4.50-5.00	B16								
4.70	W201								
4.70	W202				49.75	5.30			
5.30	C17					(0.40)	MADE GROUND. Dark green grey sandy clay. Sand is fine and medium.		
5.30	D18								
5.30	K17				49.35	5.70			
5.50-5.95	U19			50 blows			MADE GROUND. Orange brown mottled grey clayey sand with occasional gravel of sandstone. Sand is fine and medium.		
6.00	D20					(0.80)			
6.50-6.95	SPT N=21			3,3/4,5,5,7	48.55	6.50			
6.50	C21						Stiff dark blue grey CLAY mottled with light green grey fine and medium sand and red brown clay. Occasional fragments (approx 100mm long) of organic matter (decaying wood). With cobbles of weathered orange brown sandstone. Possible		
6.50	D22					(0.90)			
6.50	K21								
6.50-7.00	B23				47.65	7.40			
7.50	C24						Firm to stiff dark grey SILT/CLAY.		
7.50	K24								
7.50-7.95	U25			60 blows		(1.10)			
8.00	D26								
8.50	C27				46.55	8.50	Dark grey weathered MUDSTONE. Recovered as angular to subrounded gravel and cobble sized fragments of mudstone and silt/clay.		▼1
8.50	K27								
8.50-9.00	B28			Water strike(1) at 8.70m, no rise after 20 mins.					
8.90	W31								
9.00	D29								
9.00-9.45	SPT N=39			7,7/8,9,10,12					
9.00	P5								
9.00	V5								
9.00-9.50	B30					(2.80)			

Remarks

Scale (approx)	Logged By
1:50	RMS

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NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	CP2022

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion		55.05	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447575 E 337801 N	02/08/2006	Arup	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.50-10.78	SPT 25*/135 55/140			14,11/20,35		(2.80)	MUDSTONE (as previous sheet). Below 10.50m; hard with distinct laminae.		
10.50	D32								
10.50-11.00	B33								
11.30	D34			02/08/2006:8.00m	43.75	11.30			
				02/08/2006: 25/50					
11.30-11.38	SPT 25*/40 50/40			02/08/2006:			Complete at 11.38m		

Remarks

Scale (approx)	Logged By
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NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	RC2008

Machine:	Casing Diameter	Ground Level (mOD)	Client	Job Number
Flush :	140mm cased to 1.50m	83.75	Fugro Engineering Services Ltd	WAL060110A
Core Dia: mm				
Method :	Location	Dates	Engineer	Sheet
	447069 E 336740 N	16/10/2006-17/10/2006	Arup	1/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00			0	0	Groundwater was not apparent during boring(1) at 0.00m.			Inspection pit.		▽1
			0	0			(1.20)			
1.20	23	0	0	0	5,7/13,18,20,24 SPT N=75	82.55	1.20 (0.30)	OPEN HOLE.		
1.50-1.95										
1.50						82.25	1.50	NO RECOVERY		
	100	15	7	0			(1.35)			
3.00-3.45					5,14/17,29,34,20 SPT N=100	80.90	2.85	Very weak (locally stiff to weak) red brown MUDSTONE. With medium to widely spaced thin to medium beds of moderately strong light grey siltstone. Frequent dissolution pockets up to 4mm. Fractures are extremely closely to closely spaced subhorizontal rough and clean; subvertical to vertical rough clean 50-100mm long; 45-60 degrees rough generally clean occasionally with red brown clay infill <1mm thick.		
3.00			0	0						
3.65	85	53	19	0	2,7/9,12,26,37 SPT N=84					
4.50-4.95										
4.50							(3.65)	Between 4.50m and 4.80m; poor recovery probably due to SPT.		
5.53	41	0	0	0	P1					
6.50-6.95										
6.50					9,16/14,17,17,21 SPT N=69	77.25	6.50	NO RECOVERY		
	61	9	7	0			(0.89)			
8.00-8.45					10,15/17,19,16,21 SPT N=73	76.36	7.39	Very weak (locally stiff to weak) red brown MUDSTONE. With medium to widely spaced thin to medium beds of moderately strong light grey siltstone. Frequent dissolution pockets up to 4mm. Fractures are extremely closely to closely spaced subhorizontal rough and clean; subvertical to vertical rough clean 50-100mm long; 45-60 degrees rough generally clean occasionally with red brown clay infill <1mm thick.		
8.00								Between 8.00m and 8.59m; poor recovery possibly due to SPT.		
	83	63	12	0						
9.50					16,9/23,44,32,12 SPT N=111 16/10/2006:9.21m					
9.50-9.95					16/10/2006: 16/10/2006:		(4.51)	Between 9.50m and 9.76m; poor recovery probably due to SPT.		

Remarks
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;

Scale (approx)	Logged By
1:50	OP

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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	RC2008

Machine:	Casing Diameter	Ground Level (mOD)	Client	Job Number
Flush :	140mm cased to 1.50m	83.75	Fugro Engineering Services Ltd	WAL060110A
Core Dia: mm				
Method :	Location	Dates	Engineer	Sheet
	447069 E 336740 N	16/10/2006-17/10/2006	Arup	2/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
	52	28	7	0				MUDSTONE (as previous sheet)		
10.60					P2					
11.00 11.00-11.14			0	0	24/50 SPT 24'/75 50/69			Between 11.00m and 11.72m; poor recovery probably due to SPT.		
11.90	57	37	7	0		71.85	11.90	Very weak red brown MUDSTONE. Fractures are very closely to closely spaced horizontal to subhorizontal rough generally clean with occasional clay infill <1mm thick; subvertical to vertical persistance 50-100mm, rough with occasional clay infill <1mm; very closely to medium spaced 60-70 degrees rough with occasional clay infill <1mm. Between 12.50m and 13.15m; poor recovery probably due to SPT.		
12.50 12.50-12.60	95	70	20	0	25/50 SPT 25'/45 50/58		(3.70)			
13.90 14.00 14.00-14.21	97	95	36	0	P3 19,6/50 SPT 50/61			Between 14.00m and 14.07m; poor recovery probably due to SPT. Between 14.13m and 14.63m; moderately weak thinly and thickly interlaminated light green grey mudstone and siltstone.		
15.50 15.50-15.71			0	0	4,11/50 SPT 50/63	68.15	15.60 (0.25)	Moderately weak red brown MUDSTONE. Fractures are closely spaced subhorizontal rough with clay infill up to 8mm thick; very closely to closely spaced 60 degrees planar rough		
15.60 15.88	75	61	21	0	P4	67.90	15.85 (1.15)	Moderately strong red brown and orange brown SILTSTONE with occasional thin and thick laminae of red brown mudstone. Fractures are very closely to closely spaced horizontal rough generally clean with occasional orange silt and fine sand infill; closely to widely spaced 60 deg rough with some clay infill <1mm; subvertical <50mm rough with occasional clay and silt coating <1mm. Between 16.45m and 16.53m; occasional medium gravel sized dissolution voids.		
17.00 17.00-17.21			0	0	23,3/50 SPT 50/60	66.75	17.00			
17.38	95	79	0	0				Moderately strong (locally weak) red brown MUDSTONE thinly and thickly interlaminated with red brown and light grey SILTSTONE. With occasional gravel sized dissolution voids. Fractures are extremely closely to closely spaced horizontal smooth and rough occasionally with clay infill <1mm; subvertical to vertical <50mm long rough clean. Between 17.00m and 17.38m; poor recovery probably due to SPT.		
18.50 18.50-18.61					25/50 SPT 25'/53 50/55		(3.00)	From 18.50m and 18.58m; poor recovery probably due to SPT.		
19.50					P5 17/10/2006:14.21m			From 19.87m to 20.00m; Moderately strong red brown fine grained SANDSTONE slightly calcareous. Fractures are subvertical planar rough clean.		
					17/10/2006:	63.75	20.00			

Remarks

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1:50	OP

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NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	RC2011

Machine:	Casing Diameter	Ground Level (mOD)	Client	Job Number
Flush :	140mm cased to 1.50m	73.85	Fugro Engineering Services Ltd	WAL060110
Core Dia: mm				
Method :	Location	Dates	Engineer	Sheet
	447127 E 337066 N	07/08/2006-10/08/2006	Arup	1/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00			0	0	Groundwater was not apparent during boring(1) at 0.00m. C101			Refer to borehole CP2011 for likely material description.		▽1
0.40										
1.00	100	100	97	0	C102		(2.00)			
2.00						71.85	2.00	Weak to moderately weak thinly laminated dark red brown and light grey green MUDSTONE. With some very closely spaced thin to thick laminae of grey fine and medium grained sandstone. Fractures are subhorizontal medium to widely spaced undulating rough and open with some black staining to fracture surfaces, no penetration.		
	97	97	97	0						
					18/35 SPT 18'/75 07/08/2006:					
3.50							(3.05)			
3.50-3.60					07/08/2006: 35/25 D103					
3.50					07/08/2006:					
	100	97	33	0				Below 4.10m; becoming predominantly grey green with occasional dissolution voids up to 20mm.		
4.05-4.35					09/08/2006: C9					
5.00-5.18					8,18/35 SPT 35/32					
5.00						68.80	5.05			
5.00					D104			Weak to moderately weak very thinly to medium bedded dark red brown and light grey green fine and medium grained SANDSTONE. Fractures are horizontal very closely to medium spaced, planar, rough and open with rare black speckling on fracture surfaces. At 5.60m; 10mm band of grey fine grained sandstone. At 5.80m; 10mm band of grey fine grained sandstone.		
	90	90	48	0						
6.50-6.61					11/35 SPT 11'/75 35/36 D105					
6.50								At 6.55m; 10mm band of grey fine grained sandstone.		
6.50										
7.30-7.60	100	100	63	0	C10					
8.00-8.03					35/ SPT 35'/33					
8.00								Between 8.05m and 9.50m; with very closely spaced thick undulating laminae of dark red brown mudstone.		
	90	90	59	0						
9.25-9.47					C11 35/ SPT 35'/26		(8.05)			
9.50-9.53										
9.50										

Remarks
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;

Scale (approx)	Logged By
1:50	SM

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NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	RC2011

Machine:	Casing Diameter	Ground Level (mOD)	Client	Job Number
Flush :	140mm cased to 1.50m	73.85	Fugro Engineering Services Ltd	WAL060110
Core Dia: mm				
Method :	Location	Dates	Engineer	Sheet
	447127 E 337066 N	07/08/2006-10/08/2006	Arup	2/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
	100	100	31	0						
11.00 11.00-11.02 11.35-11.60	92	92	47	0	35/ SPT 35'/18 C12		(8.05)	Between 10.75m and 11.00m; becoming predominantly grey green.		
12.50	0	0	0	0	09/08/2006:9.00m 09/08/2006: 09/08/2006:DRY	60.75	13.10	Between 11.85m and 11.95m; with extremely closely spaced thin carbonaceous laminae. Below 12.50m; becoming moderately weak to moderately strong. With some extremely closely spaced thin laminae of mudstone.		
13.10	100	57	57	0	10/08/2006:		(0.90)	No recovery		
14.00 14.00-14.02	100	93	47	0	35/ SPT 35'/24	59.85	14.00	Weak to moderately weak very thinly to medium bedded dark red brown and light grey green fine and medium grained SANDSTONE. Fractures are horizontal very closely to medium spaced, planar, rough and open with rare black speckling on fracture surfaces. Below 14.00m; with many dissolution voids up to 50mm.		
15.10	Sample / Tests		Casing Depth (m)	Water Depth (m)			(2.85)	At 15.70m; horizontal fracture infilled up to 20mm with medium and coarse sandstone gravel.		
15.90-16.60	C13				10/08/2006:DRY 10/08/2006:	57.00	16.85	Complete at 16.85m		

Remarks

Scale (approx)	Logged By
1:50	SM

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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	RC2014

Machine: / Flush : / Core Dia: mm / Method :	Casing Diameter	Ground Level (mOD)	Client	Job Number
	146mm cased to 2.00m	80.05	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447284 E 337359 N	07/09/2006-11/09/2006	Arup	1/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00					Groundwater was not apparent during boring(1) at 0.00m.					
			0	0				OPEN HOLE		▽1
	57	33	0	0			(2.00)			
					07/09/2006:	78.05	2.00			
2.00								NO RECOVERY		
			0	0	07/09/2006:		(0.45)			
					07/09/2006:	77.60	2.45			
2.45										
2.35	89	71	0	0	08/09/2006: P1			Weak grey green and yellow brown thinly to thickly laminated fine and medium grained SANDSTONE. Fractures are horizontal, extremely closely and very closely spaced (15/30/60) rough, planar and undulating, very open, occasionally with slightly clayey sand and gravel infill up to 30mm. Gravel is angular, fine of sandstone.		
3.10								Between 3.10m and 3.20m; red brown.		
			0	0			(1.75)			
						75.85	4.20			
4.20	100	100	0	0				Weak and moderately weak occasionally moderately strong red brown fine and medium grained SANDSTONE with very closely widely spaced thin and thick laminae of very weak red brown MUDSTONE. Fractures are horizontal, very closely to medium spaced (25/60/350) rough, undulating, moderately open to very open.		
4.80					P2					
4.60	93	85	37	0				Between 5.30m and 6.00m; vertically rough, undulating, open with slightly silty fine to coarse sand infill.		
							(4.10)			
6.00										
	93	71	39	0				Between 6.45m and 6.60m; medium to coarse grained.		
7.05-7.25					C3			At 6.85m; well rounded void.		
7.50										
			0	0				Between 7.90m and 8.20m; medium to coarse grained, non-intact.		
8.25					P4					
8.30						71.75	8.30			
	95	93	13	0				Generally weak (variably, very weak and moderately weak) red brown thinly colour laminated, very thinly and thinly interbedded SILTSTONE and fine to medium grained SANDSTONE with medium spaced very thin and thin beds of moderate weak grey green medium to coarse grained sandstone. Fractures are horizontal, very closely to medium spaced (20/120/320) rough, undulating, occasional planar, moderately open to open.		
9.00										
	100	86	15	0						

Remarks
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was backfilled on completion with grout.;

Scale (approx)	Logged By
1:50	TL

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Site	Borehole Number
M1 WIDENING J21-30	RC2014

Machine:	Casing Diameter	Ground Level (mOD)	Client	Job Number
Flush :	146mm cased to 2.00m	80.05	Fugro Engineering Services Ltd	WAL060110
Core Dia: mm				
Method :	Location	Dates	Engineer	Sheet
	447284 E 337359 N	07/09/2006-11/09/2006	Arup	2/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.40					P5			Interbedded SILSTONE and SANDSTONE (as previous sheet)		
10.50										
11.20-11.42	100	88	29	0	C6					
12.00			0	0						
12.40								Between 12.20m and 12.40m; moderately weak medium to coarse grained sandstone.		
12.65	100	100	43	0	P7					
13.50										
13.95-14.17	100	100	45	0	C8		(10.47)	Between 14.50m and 14.80m; very weak, apparently leached.		
15.00										
15.95-16.20	100	100	69	0	C9					
16.50										
17.25-17.50			0	0	C10			Between 17.40m and 18.00m; moderately weak medium grained sandstone.		
17.50	51	33	0	0	/35					
18.00					08/09/2006:					
18.00-18.02			0	0	08/09/2006: SPT 0*/0 35/15 08/09/2006:DRY					
18.70						61.28	18.77	NO RECOVERY.		
18.45					11/09/2006: P11		(0.73)			
					11/09/2006:	60.55	19.50			
					11/09/2006:			Complete at 19.50m		

Remarks

Scale (approx)	Logged By
1:50	TL

Figure No.

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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	RC2016

Machine:	Casing Diameter	Ground Level (mOD)	Client	Job Number
Flush :	140mm cased to 2.00m	73.10	Fugro Engineering Services Ltd	WAL060110A
Core Dia: mm				
Method :	**Location**	**Dates**	**Engineer**	**Sheet**
	447290 E 337537 N	11/09/2006-12/09/2006	Arup	1/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00			0	0	Groundwater was not apparent during boring(1) at 0.00m.			Open Hole.		▽1
	100	87	33	0			(2.00)			
					11/09/2006:DRY	71.10	2.00			
2.00					11/09/2006:			Generally weak (variably very weak to moderately weak) red brown and green brown fine to medium grained micaceous SANDSTONE thinly interlaminated to medium interbedded with very weak red brown mudstone (variably siltstone) and weak green brown siltstone. Fractures horizontal, very closely and closely spaced, smooth, planar and undulating, occasionally with very soft red brown clay infill up to 2mm.		
	95	61	17	0	11/09/2006:					
2.15					12/09/2006: P1		(1.90)			
3.10			0	0				Between 3.20m and 3.45m; very weak and weak red brown mudstone (variably siltstone).		
3.90	90	83	51	0		69.20	3.90	Generally weak (variably moderately weak to moderately) thinly laminated to thinly interbedded fine grained red brown and fine to medium grained green brown micaceous SANDSTONE. Fractures are horizontal, closely and medium spaced, smooth, undulating, with up to 5mm firm red brown clay infill.		
4.55					P2					
4.75-5.04					C3					
4.60			0	0			(2.90)			
5.60	95	59	10	0				Between 5.60m and 5.85m; weak thinly and thickly laminated red brown mudstone.		
6.10			0	0						
6.80	92	92	18	0		66.30	6.80	Generally weak (variably very weak) red brown fine grained SANDSTONE (frequently grading to siltstone) closely very thinly interbedded with moderately weak green brown fine grained sandstone. Horizontal fractures are very closely to medium spaced, smooth, planar, occasionally irregular; other fractures are subvertical and vertical, irregular.		
7.60										
7.90	96	96	44	0	P4					
9.10							(5.10)			
9.75	100	63	14	0	P5					

Remarks
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;

Scale (approx)	Logged By
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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	RC2016

Machine:	Casing Diameter	Ground Level (mOD)	Client	Job Number
Flush :	140mm cased to 2.00m	73.10	Fugro Engineering Services Ltd	WAL060110A
Core Dia: mm				
Method :	Location	Dates	Engineer	Sheet
	447290 E 337537 N	11/09/2006-12/09/2006	Arup	2/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
								SANDSTONE (as previous sheet)		
10.60			0	0						
11.80					P6	61.20	11.90	At 11.85m; narrow calcite vein (12mm).		
11.85	100	65	14	0				Weak to moderately weak thickly laminated to thinly bedded yellow, green and brown fine grained SANDSTONE, thickly interbedded with weak to moderately weak thinly and thickly laminated siltstone. Sandstone contains frequent well rounded vugs (up to 3mm) and occasional rounded voids (up to 22mm). Between 11.90m and 12.85m; fractures: horizontal, very closely and closely spaced and open. Between 12.20m and 12.40m; dark green grey, fine and medium grained, non-intact. At 12.50m; very thin interbed (32mm) grey brown medium grained sandstone. Between 12.85m and 13.05m; recovered as uncompact very fine sandy silt. Between 13.05m and 14.20m; fractures are horizontal, closely spaced, smooth, planar and subvertical, irregular. Between 13.30m and 13.60m; non-intact.		
12.10			0	0						
12.45					P7		(2.30)			
12.85			0	0						
13.05	100	91	41	0						
13.60			0	0						
14.20	100	97	58	0		58.90	14.20			
14.79-15.10					C8			Moderately weak to moderately strong red brown and green thinly and thickly colour laminated SILTSTONE. Medium interbedded with moderately weak to moderately strong yellow brown fine and medium (becoming fine to coarse) grained sandstone. Fractures are horizontal, closely and medium spaced, smooth and rough, planar, occasionally undulating, open and occasionally with silt infill up to 2mm. Between 14.40m and 14.60m; very closely spaced, very narrow bands of fine grained gravel size clasts. At 15.20m; very narrow, irregular calcite veining with subrounded solution cavities (18mm). Between 15.30m and 15.70m; grading to fine grained sandstone. Between 15.80m and 15.85m; locally brecciated with subangular to rounded fine to coarse gravel size quartz clasts.		
15.10			0	0			(1.65)			
15.85						57.25	15.85			
16.12-16.42	100	94	35	0	C9			Very weak to weak grey brown coarse grained becoming red brown medium and coarse grained SANDSTONE with rare subrounded fine to coarse gravel size clasts. Fractures are horizontal, very closely to medium spaced, rough, planar and very open. Between 15.85m and 16.30m; grey brown; frequent subrounded to rounded, fine to coarse gravel size clasts. At 16.00m; horizontal fracture infilled with grey green silt (11mm).		
16.60	Sample / Tests		Casing Depth (m)	Water Depth (m)			(2.15)			
17.79-18.00	C10									
					12/09/2006:	55.10	18.00	Complete at 18.00m		
					12/09/2006:					

Remarks

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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	RC2017

Machine:	Casing Diameter	Ground Level (mOD)	Client	Job Number
Flush :	140mm cased to 3.00m	63.05	Fugro Engineering Services Ltd	WAL060110
Core Dia: mm				
Method :	Location	Dates	Engineer	Sheet
	447397 E 337601 N	20/09/2006	Arup	1/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00			0	0	Groundwater was not apparent during boring(1) at 0.00m.	62.90	(0.15) 0.15	TOPSOIL. Brown slightly gravelly fine sand. Gravel is subangular to subrounded fine to coarse of sandstone, limestone and brick. With many rootlets.		▽1
0.15	97	97	28	0	B101 C102 K102 K103		(0.65)	Red brown fine SAND with subangular to subrounded fine to coarse gravel sized fragments of sandstone.		
0.70					B104 C105 K105 K106	62.25	0.80	Between 0.70m and 1.40m; structure generally not evident.		
1.65	93	79	23	0	P1		(1.90)	Very weak to weak red brown weathered SILTSTONE (variably fine grained sandstone, rarely mudstone) with very closely to medium spaced very thin beds of weak yellow brown speckled black thinly to thickly laminated fine grained sandstone. Fractures: where evident subhorizontal and subvertical, extremely closely to closely spaced and irregular.		
2.20					P2					
2.25			0	0						
2.70						60.35	2.70			
3.20			0	0	P3		(0.75)	Weak to moderately weak yellow brown locally speckled black thinly and thickly laminated fine grained SANDSTONE with occasional thin laminations of light grey green siltstone. Fractures: horizontal, very closely and closely spaced, planar and open.		
3.45	98	98	61	0		59.60	3.45			
3.75								Generally weak (variably moderately weak) thinly interlaminated to very thinly interbedded red brown SILTSTONE, mudstone and grey green and yellow brown fine grained sandstone. Weathering: occasional black discolouration on fracture surfaces. Fractures: horizontal,		
4.40	93	90	54	0	P4		(2.00)	At 4.10m; 4mm irregular solution cavities with calcite mineralisation. very closely to closely spaced, smooth, planar and undulating; vertical, smooth and planar to irregular, 120mm persistence.		
4.85					P5					
5.05-5.33					C6					
5.25			0	0						
5.45						57.60	5.45			
6.80			0	0	P7		(1.05)	Moderately weak thickly laminated yellow brown fine and From 5.55m to 5.70m; irregular dissolution cavities with red brown staining and mineralisation up to 45mm. From 5.85m to 5.90m; locally medium to coarse grained. medium grained slightly calcareous SANDSTONE with occasional thin interlaminations of very weak grey green From 6.25m to 6.45m; frequent rounded vugs (1mm). siltstone; rare very thin bed of weak red brown siltstone. At 6.45m; frequent subrounded dissolution cavities (25mm) with occasional mineralisation.		
6.50	38	29	11	0		56.55	6.50			
6.75			0	0			(0.50)	Fractures: horizontal, closely and medium spaced, rough, planar with grey green silt infill up to 7mm, 1.no vertical, rough, undulating and open.		
7.00						56.05	7.00			
8.10	89	89	19	0	6/35 P8 SPT 6*/75 35/35		(1.25)	Moderately weak to moderately strong red brown and grey green thinly interlaminated SILTSTONE, frequently thinly and thickly interlaminated. Fractures: horizontal, very closely and closely spaced, smooth and undulating. Poor recovery. Recovered as subangular to rounded medium to coarse fragments of calcareous SANDSTONE. Possibly		
8.25-8.36										
8.25						54.80	8.25			
8.70	78	73	31	0	P9			Generally weak (variably moderately weak) light grey brown fine to coarse grained SANDSTONE with occasional subangular to subrounded fine gravel size quartz clasts. Fractures: horizontal (0 degrees to 10 degrees), very closely and closely spaced, rough, planar and open. Between 8.55m and 8.85m; locally mottled red brown.		
9.75-9.85					10/35 SPT 10*/75 35/25			Between 9.35m and 9.75m; frequent subrounded and rounded coarse gravel size pockets of green grey (glauconitic) silt.		
9.75							(3.00)	Below 9.75m: poor recovery.		

Remarks
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 0.70m depth and rescanned using the CAT to check for services. Services were not located. ;

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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	RC2017

Machine:	Casing Diameter	Ground Level (mOD)	Client	Job Number
Flush :	140mm cased to 3.00m	63.05	Fugro Engineering Services Ltd	WAL060110
Core Dia: mm				
Method :	Location	Dates	Engineer	Sheet
	447397 E 337601 N	20/09/2006	Arup	2/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
	0	0	0	0			(3.00)			
11.05					P10					
11.25					9/35	51.80	11.25	NO RECOVERY.		
11.25-11.36	0	0	0	0	SPT 9'/75 35/35					
12.75					35/		(2.70)			
12.75-12.80	0	0	0	0	SPT 35'/45					
12.95					D12					
13.25	62	62	20	0						
13.75			0	0		49.10	13.95 (0.30)			
13.95	0	0	0	0		48.80	14.25	Generally weak (variably moderately weak) light grey brown fine to coarse grained SANDSTONE with occasional subangular to subrounded fine gravel size quartz clasts. Fractures: horizontal (0 degrees to 10 degrees), very closely and closely spaced, rough, planar and open.		
14.15					P11		(0.75)			
14.25								NO RECOVERY.		
	Sample / Tests		Casing Depth (m)	Water Depth (m)		48.05	15.00			
14.25-14.28	SPT 35'/25				35/			Complete at 15.00m		
					20/09/2006:					
					20/09/2006:					

Remarks

Scale (approx)	Logged By
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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	RC2017

Machine:	Casing Diameter	Ground Level (mOD)	Client	Job Number
Flush :	140mm cased to 3.00m	63.05	Fugro Engineering Services Ltd	WAL060110
Core Dia: mm				
Method :	Location	Dates	Engineer	Sheet
	447397 E 337601 N	20/09/2006	Arup	1/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00			0	0	Groundwater was not apparent during boring(1) at 0.00m.	62.90	(0.15) 0.15	TOPSOIL. Brown slightly gravelly fine sand. Gravel is subangular to subrounded fine to coarse of sandstone, limestone and brick. With many rootlets.		▽1
0.15	97	97	28	0	B101 C102 K102 K103		(0.65)	Red brown fine SAND with subangular to subrounded fine to coarse gravel sized fragments of sandstone.		
0.70					B104 C105 K105 K106	62.25	0.80	Between 0.70m and 1.40m; structure generally not evident.		
1.65	93	79	23	0	P1		(1.90)	Very weak to weak red brown weathered SILTSTONE (variably fine grained sandstone, rarely mudstone) with very closely to medium spaced very thin beds of weak yellow brown speckled black thinly to thickly laminated fine grained sandstone. Fractures: where evident subhorizontal and subvertical, extremely closely to closely spaced and irregular.		
2.20					P2					
2.25			0	0						
2.70						60.35	2.70			
3.20			0	0	P3		(0.75)	Weak to moderately weak yellow brown locally speckled black thinly and thickly laminated fine grained SANDSTONE with occasional thin laminations of light grey green siltstone. Fractures: horizontal, very closely and closely spaced, planar and open.		
3.45	98	98	61	0		59.60	3.45			
3.75								Generally weak (variably moderately weak) thinly interlaminated to very thinly interbedded red brown SILTSTONE, mudstone and grey green and yellow brown fine grained sandstone. Weathering: occasional black discolouration on fracture surfaces. Fractures: horizontal,		
4.40	93	90	54	0	P4		(2.00)	At 4.10m; 4mm irregular solution cavities with calcite mineralisation. very closely to closely spaced, smooth, planar and undulating; vertical, smooth and planar to irregular, 120mm persistence.		
4.85					P5					
5.05-5.33					C6					
5.25			0	0						
5.45						57.60	5.45			
6.80			0	0	P7		(1.05)	Moderately weak thickly laminated yellow brown fine and From 5.55m to 5.70m; irregular dissolution cavities with red brown staining and mineralisation up to 45mm. From 5.85m to 5.90m; locally medium to coarse grained. medium grained slightly calcareous SANDSTONE with occasional thin interlaminations of very weak grey green From 6.25m to 6.45m; frequent rounded vugs (1mm). siltstone; rare very thin bed of weak red brown siltstone. At 6.45m; frequent subrounded dissolution cavities (25mm) with occasional mineralisation.		
6.50	38	29	11	0		56.55	6.50			
6.75			0	0			(0.50)	Fractures: horizontal, closely and medium spaced, rough, planar with grey green silt infill up to 7mm, 1.no vertical, rough, undulating and open.		
7.00						56.05	7.00			
8.10	89	89	19	0	6/35 P8 SPT 6*/75 35/35		(1.25)	Moderately weak to moderately strong red brown and grey green thinly interlaminated SILTSTONE, frequently thinly and thickly interlaminated. Fractures: horizontal, very closely and closely spaced, smooth and undulating. Poor recovery. Recovered as subangular to rounded medium to coarse fragments of calcareous SANDSTONE. Possibly		
8.25-8.36										
8.25						54.80	8.25			
8.70	78	73	31	0	P9			Generally weak (variably moderately weak) light grey brown fine to coarse grained SANDSTONE with occasional subangular to subrounded fine gravel size quartz clasts. Fractures: horizontal (0 degrees to 10 degrees), very closely and closely spaced, rough, planar and open. Between 8.55m and 8.85m; locally mottled red brown.		
9.75-9.85					10/35 SPT 10*/75 35/25			Between 9.35m and 9.75m; frequent subrounded and rounded coarse gravel size pockets of green grey (glauconitic) silt.		
9.75							(3.00)	Below 9.75m: poor recovery.		

Remarks
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 0.70m depth and rescanned using the CAT to check for services. Services were not located. ;

Scale (approx)	Logged By
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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	RC2017

Machine:	Casing Diameter	Ground Level (mOD)	Client	Job Number
Flush :	140mm cased to 3.00m	63.05	Fugro Engineering Services Ltd	WAL060110
Core Dia: mm				
Method :	Location	Dates	Engineer	Sheet
	447397 E 337601 N	20/09/2006	Arup	2/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
	0	0	0	0			(3.00)			
11.05					P10					
11.25					9/35	51.80	11.25	NO RECOVERY.		
11.25-11.36	0	0	0	0	SPT 9'/75 35/35					
12.75					35/		(2.70)			
12.75-12.80	0	0	0	0	SPT 35'/45					
12.95					D12					
13.25	62	62	20	0						
13.75			0	0		49.10	13.95 (0.30)			
13.95	0	0	0	0		48.80	14.25	Generally weak (variably moderately weak) light grey brown fine to coarse grained SANDSTONE with occasional subangular to subrounded fine gravel size quartz clasts. Fractures: horizontal (0 degrees to 10 degrees), very closely and closely spaced, rough, planar and open.		
14.15					P11		(0.75)			
14.25								NO RECOVERY.		
	Sample / Tests		Casing Depth (m)	Water Depth (m)		48.05	15.00			
14.25-14.28	SPT 35'/25				35/			Complete at 15.00m		
					20/09/2006:					
					20/09/2006:					

Remarks

Scale (approx)	Logged By
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G102
G2
G302

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	RC2022

Machine:	Casing Diameter	Ground Level (mOD)	Client	Job Number
Flush :	140mm cased to 8.00m	55.05	Fugro Engineering Services Ltd	WAL060110A
Core Dia: mm				
Method :	Location	Dates	Engineer	Sheet
	447575 E 337801 N	29/08/2006-30/08/2006	Arup	1/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00 0.00			0	0	Groundwater was not apparent during boring(1) at 0.00m. 103			OPEN HOLE.		▽1
4.61	NR		0	0	W401		(9.00)			
9.00 9.00 9.00-9.00 9.50-9.50	92	67	0	0	29/08/2006:7.10m 29/08/2006: W101 29/08/2006: 30/08/2006:	46.05	9.00	NO RECOVERY.		

Remarks

Scale (approx)	Logged By
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British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Borehole Number
M1 WIDENING J21-30	RC2022

Machine:	Casing Diameter	Ground Level (mOD)	Client	Job Number
Flush :	140mm cased to 8.00m	55.05	Fugro Engineering Services Ltd	WAL060110A
Core Dia: mm				
Method :	Location	Dates	Engineer	Sheet
	447575 E 337801 N	29/08/2006-30/08/2006	Arup	2/2

Depth (m)	TCR	SCR	RQD	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
							(2.00)			
10.30					10,12/14,21,30,35 SPT 100/244 D101			NO RECOVERY (as previous sheet)		
10.30-10.69										
10.30			0	0						
						44.05	11.00			
11.00			0	0			(0.15)	Brown and dark grey slightly sandy gravelly CLAY. Gravel is subangular to subrounded medium to coarse of sandstone.		
11.15			0	0		43.90	11.15			
							(0.20)			
11.35						43.70	11.35	Recovered non intact as dark grey slightly clayey angular fine to coarse gravel of SANDSTONE.		
11.40	92	67	0	0	P1		(0.55)			
11.80			0	0	26/35 SPT 26'/75 35/38 D102	43.15	11.90	Moderately strong light grey brown fine to medium grained SANDSTONE. Very closely to thickly interlaminated with very weak dark brown fine grained sandstone and siltstone. Light grey sandstone contains rare irregular pyritic veins <5mm thick. Fractures are horizontal (0-10 degrees) extremely closely to closely spaced (5/10/80) rough undulating and planar, occasionally infilled with up to 2mm brown fine sandy silt.		
11.80-11.91										
11.90										
11.80	100	100	35	0						
12.40					35/ SPT 35'/13 P2		(1.90)			
12.40-12.41										
12.55	73	67	35	0				Moderately strong light grey fine and medium grained SANDSTONE with frequent very thin black wispy interlaminae (<4mm). With rare pyritic veins up to 20mm and occasional rounded vugs <2mm. Fractures are horizontal (0-10 degrees) very closely to medium spaced (30/80/360) rough planar open to very open occasionally infilled with up to 2mm brown silty fine sand, rarely up to 15mm soft dark grey clay.		
13.40						41.25	13.80	Between 13.05m and 13.40m; 1 No vertical fracture - rough, undulating, very open, clean.		
13.55-13.75			0	0	C3					
13.80			0	0						
14.00			0	0				Moderately strong grey medium grained SANDSTONE extremely closely to closely thinly interlaminated to thinly interbedded with very weak and weak black MUDSTONE/SILTSTONE. Sandstone contains frequent dark grey and black non persistent wispy interlaminae. With occasional light brown surface discolouration on sandstone. Fractures are subhorizontal (5-15 degrees) extremely closely to closely spaced (5/50/120) smooth and rough, planar and undulating, tight to open, occasionally with up to 3mm very soft dark grey clay.		
14.40	95	77	19	0				From 14.00m to 14.40m; assumed zone of core loss. At 14.40m; very strong cobble of quartz, calcite and pyrite mineralisation.		
14.90					35/ SPT 35'/33		(2.30)			
14.90-14.93			0	0				Between 15.80m and 15.90m; recovered as very gravelly silt/clay.		
16.10	97	97	73	0		38.95	16.10			
16.40	98	90	67	0				Moderately strong and strong light grey medium and coarse grained SANDSTONE with frequent becoming occasional thin black wispy interlaminae and occasional rounded vugs up to 4mm. With rare very narrow <2mm pyritic veins. Occasional black discolouration on fracture surfaces. Fractures are horizontal (0-10 degrees) very closely to medium spaced (20/120/230) rough planar and undulating open rarely with <2mm soft black clay.		
17.90							(3.30)			
18.95-19.20					C5					
					30/08/2006:	35.65	19.40	Complete at 19.40m		
					30/08/2006: 30/08/2006:7.10m					

Remarks	Scale (approx)	Logged By
	1:50	TL
	Figure No.	

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NATURAL ENVIRONMENT RESEARCH COUNCIL

Site	Trial Pit Number
M1 WIDENING J21-30	OP2010

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Trial Pit		71.45	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447152 E 336932 N	27/09/2006	Arup	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.15	C1		Groundwater was not apparent during excavation(1) at 0.00m.	71.30	(0.15) 0.15	MADE GROUND. Red brown slightly gravelly clayey topsoil. Gravel is fine to coarse, subangular to subrounded of sandstone, coal, mudstone, quartz and plastic. Occasional rootlets to 0.40m. (Stratum I)		▽1
0.15	K1				(0.30)			
0.50	B2			71.00	0.45	MADE GROUND. Stiff brown slightly sandy slightly gravelly silt. Gravel is angular to subrounded sandstone, coal, quartz and occasional mudstone. Also occasional gravel size pockets of coal dust. (Stratum II)		
1.00	C3				(1.40)			
1.50	B4					Stiff red brown CLAY with occasional gravel of organic matter, coal, sandstone and friable weathered mudstone. (Possibly Made Ground). (Stratum III)		
				69.60	1.85			
2.00	C5					Stiff red brown CLAY with occasional subangular and subrounded fine to coarse gravel of weathered friable sandstone and mudstone. (Stratum IV)		
2.50	B6				(0.95)			
				68.65	2.80			
					(0.20)			
				68.45	3.00	Stiff light brown/grey gravelly CLAY/SILT. Gravel is subangular, fine to coarse of siltstone. (Stratum V)		
			27/09/2006:			At 3.00m; red brown weathered Mercia Mudstone on floor of pit.		
			27/09/2006:			Complete at 3.00m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:50	RMS	

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Site	Trial Pit Number
M1 WIDENING J21-30	TP2000

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Trial Pit		53.95	Fugro Engineering Services Ltd	WAL060110A
	Location	**Dates**	**Engineer**	**Sheet**
	447208 E 335961 N	21/09/2006	Arup	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
			Groundwater was not apparent during excavation(1) at 0.00m.		(0.50)	MADE GROUND. Stiff red brown fissile clayey gravel and cobbles of mudstone. (Stratum I) At 0.10m; TTRA10J 1992 two pair feeder cable and cable 2 TR 2031 issue A.		▽1
0.50	B1			53.45	0.50			
					(0.20)	Grey green SILTSTONE recovered as moderately weak gravel and cobble sized fragments. At 0.50m telecom marker tape. At 0.70m; telecom cable, broken during excavation.		
			21/09/2006:	53.25	0.70			
			21/09/2006: 21/09/2006:			Complete at 0.70m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:25	RMS	

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Site	Trial Pit Number
M1 WIDENING J21-30	TP2001

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Trial Pit		54.65	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447144 E 336018 N	16/08/2006	Arup	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
			Water strike(1) at 0.00m.	54.55	(0.10)	MADE GROUND. Dark brown sandy topsoil. Sand is fine and medium. (TOPSOIL I)		▽1
0.30	B1				0.10 (0.50)			
				54.05	0.60	Moderately weak red brown MUDSTONE. Extremely closely to very closely spaced randomly orientated joints. (Stratum II)		
0.70	B2							
0.70	D3				(0.80)	Firm and stiff slightly friable red brown and occasionally light grey CLAY. With fragments of subangular fine to coarse of mudstone. (Stratum III)		
1.40	B4			53.25	1.40			
			16/08/2006:	53.15	(0.10)	Moderately strong grey thinly laminated SILTSTONE. Recovered as tabular cobble to boulder sized fragments 5mm to 30mm thick. (Stratum IV)		
			16/08/2006:		1.50	Complete at 1.50m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:50	OP	

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Site	Trial Pit Number
M1 WIDENING J21-30	TP2002

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Trial Pit		58.65	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447184 E 336186 N	21/09/2006	Arup	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
			Groundwater was not apparent during excavation(1) at 0.00m.			MADE GROUND. Red brown gravel and cobbles of mudstone. Gravel is angular and coarse. (Stratum I)		▽1
0.50	B1				(1.50)			
1.50	B2			57.15	1.50	Grey laminated SILTSTONE. (Stratum II)		
					(0.60)			
				56.55	2.10			
			21/09/2006:					
			21/09/2006:			Complete at 2.10m		

Plan

Remarks

Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. Services were not encountered.;No visual or olfactory indication of contamination was observed.;On completion the trial pit was backfilled with compacted arisings. ;

Scale (approx)	Logged By	Figure No.
1:50	RMS	

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Site	Trial Pit Number
M1 WIDENING J21-30	TP2004

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Trial Pit		64.15	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447175 E 336386 N	21/09/2006	Arup	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
			Groundwater was not apparent during excavation(1) at 0.00m.	63.95	(0.20) 0.20	TOPSOIL. (TOPSOIL I)		▽1
0.50	B1			63.65	(0.30) 0.50	Red brown and light grey MUDSTONE and SILTSTONE. Hard and slightly weathered. (Stratum II)		
				63.40	(0.25) 0.75	Grey SILTSTONE. (Stratum III)		
				63.15	(0.25) 1.00	Red brown MUDSTONE. (Stratum IV)		
				62.85	(0.30) 1.30	Red brown MUDSTONE interbedded with grey SILTSTONE. (Stratum V)		
1.45	B2		21/09/2006:	62.70	(0.15) 1.45	Weak to moderately weak grey SILTSTONE. (Stratum VI)		
			21/09/2006:			Complete at 1.45m		

Plan

Remarks

Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. Services were not encountered.;No visual or olfactory indication of contamination was observed.;On completion the trial pit was backfilled with compacted arisings. ;

Scale (approx)	Logged By	Figure No.
1:50	RMS	

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Site	Trial Pit Number
M1 WIDENING J21-30	TP2005

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Trial Pit		62.80	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447127 E 336392 N	16/08/2006	Arup	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
			Groundwater was not apparent during excavation(1) at 0.00m.	62.70	(0.10) 0.10	MADE GROUND. Dark brown sandy topsoil with many rootlets. (TOPSOIL I)		▽1
0.50	B1				(0.80)	Red brown gravelly cobbles of MUDSTONE. Gravel is angular and subangular fine to coarse of mudstone. Between 0.60m and 0.75m; lenses of light grey mudstone and siltstone.		
0.90	B2			61.90	0.90	(Stratum II)		
1.40	D3		16/08/2006:		(0.60)	Weak becoming stronger with depth thinly laminated red brown MUDSTONE. Weakness probably due to weathering. With occasional boulder sized lenses of moderately weak		
			16/08/2006:	61.30	1.50	At base; moderately strong. light grey mudstone and siltstone. (Stratum III)		
						Complete at 1.50m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:50	OP	

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Site	Trial Pit Number
M1 WIDENING J21-30	TP2007

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Trial Pit		71.00	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447104 E 336751 N	16/08/2006	Arup	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
			Groundwater was not apparent during excavation(1) at 0.00m.	70.85	(0.15) 0.15	MADE GROUND. Topsoil with many roots and rootlets. (TOPSOIL I)		▽1
0.50 0.50	B1 D2				(1.45)	Very weak and weak becoming stronger with depth dark orange/brown SILTSTONE/SANDSTONE. With some gravel sized pockets and thin laminae of red brown mudstone. Recovered as friable clay with many cobbles of very weak silty sandstone. Extremely to very closely spaced randomly orientated discontinuities. Often with very thin (<1mm) blue mineral coating. (Stratum II)		
1.00	D3							
1.50	B4		16/08/2006:	69.40	1.60	Below 1.40m; moderately weak and dark red brown siltstone.		
			16/08/2006:			Complete at 1.60m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:50	OP	

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Site	Trial Pit Number
M1 WIDENING J21-30	TP2013

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Trial Pit		74.30	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447168 E 337240 N	16/08/2006	Arup	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.15	C2		Groundwater was not apparent during excavation(1) at 0.00m.	74.15	(0.15)	TOPSOIL (I)		▽1
0.15	K1				0.15	Possibly MADE GROUND. Light brown clayey sandy gravel and cobbles. Sand is fine. Gravel is angular and subangular fine to coarse of sandstone, mudstone and interlaminated sandstone and mudstone. Cobbles are angular to subangular of sandstone and siltstone with mudstone laminae. With occasional angular boulders of sandstone. (450mm x 320mm x 120mm). (Stratum II)		
0.15	K2				(0.85)			
0.50	B3			73.30	1.00			
0.50	C5			73.20	(0.10)	Moderately weak red brown SILTSTONE. (Stratum III)		
0.50	K4		16/08/2006:		1.10			
0.50	K5		16/08/2006:			Complete at 1.10m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:50	OP	

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Site	Trial Pit Number
M1 WIDENING J21-30	TP2019

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Trial Pit		57.65	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447535 E 337760 N	21/09/2006	Arup	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30	B1		Groundwater was not apparent during excavation(1) at 0.00m.		(0.80)	MADE GROUND. Red brown sandy gravel. Gravel is coarse of flint. With angular fragments of metal. Becoming silty with depth. (Stratum I)		▽1
0.50 0.50 0.70 0.70	C2 K2 B2 C2			56.85	0.80 (0.80)	MADE GROUND. Brown sandy silt with occasional fragments of vitreous slag, clinker and cobbles of slag. (Stratum II)		
				56.05	1.60 (1.10)	MADE GROUND. Red brown and mottled black clayey sand. (Stratum III)		
2.70	B3			54.95	2.70 (1.50)	Probably MADE GROUND. Firm sandy clay/silt. (Stratum IV)		
				53.45	4.20 (0.30)	Probably MADE GROUND. Slightly clayey yellow brown fine sand. (Stratum V)		
4.50	B4		21/09/2006:	53.15	4.50	Complete at 4.50m		
			21/09/2006:					

Plan

Remarks

Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. Services were not encountered.;No visual or olfactory indication of contamination was observed.;On completion the trial pit was backfilled with compacted arisings. ;

Scale (approx)	Logged By	Figure No.
1:50	RMS	

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Site	Trial Pit Number
M1 WIDENING J21-30	TP2020

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Trial Pit		50.95	Fugro Engineering Services Ltd	WAL060110
	Location	**Dates**	**Engineer**	**Sheet**
	447506 E 337820 N	28/09/2006	Arup	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
			Water strike(1) at 0.00m.	50.65	(0.30) 0.30	Vegetation over silty/clayey TOPSOIL with some rootlets and occasional roots, rare fragments of metal and frequent limestone ballast. (Stratum I)		▽1
0.50	B1				(0.50)	MADE GROUND. Stiff to firm grey brown mottled orange slightly sandy clay. (Stratum II)		
0.50	C2			50.15	0.80			
0.50	C3					MADE GROUND. Soft to firm grey orange brown sandy to very sandy silt. (Stratum III)		
0.50	K2				(0.50)			
0.50	K4			49.65	1.30			
0.90	B5			49.50	(0.15)			
0.90	C6					Old TOPSOIL. Dark grey/black soft silt with some to frequent amorphous plant remains and rare cobbles of sandstone. (Stratum IV) Old		
0.90	C7			49.35	1.45			
0.90	K6				(0.15)			
0.90	K8				1.60			
1.40	B9					MADE GROUND. Pale grey locally white grey very sandy silt to a silty sand. Locally a slightly silty sand with occasionally cobbles of mudstone, subangular gravel of white grey sandstone and some plant remains/roots. (Stratum V). Possible archaeological feature.		
1.40	C10							
1.40	C11							
1.40	K10							
1.40	K12							
1.50	D13							
1.70	B14							
1.70	C15							
1.70	C16				(2.40)	MADE GROUND. Very soft dark blue grey slightly sandy slightly gravelly clay with frequent plant remains and some cobbles of sandstone. Becomes firmer with depth (soft to firm). With occasional plant roots. (Stratum VI). Possible archaeological feature. Possible		
1.70	K15							
1.70	K17							
2.20	D18							
2.70	B19					At 3.50m; friable silt/clay with some mudstone and subangular sandstone gravel, slightly sandy.		
2.70	C20							
2.70	C21							
2.70	K22							
3.20	D23							
3.70	B24			46.95	4.00			
3.70	C25			46.85	(0.10)	Very weak thinly laminated dark grey weathered MUDSTONE.		
3.70	C26		28/09/2006:		4.10			
3.70	K25							
3.70	K27		28/09/2006:			Complete at 4.10m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:50	MW	

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Site	Number
Nottinghamshire/ Derbyshire COA NMCS2 Upgrade	D21A

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Drive-in Window Sampler		67.00	Highways Agency	F11451
	Location	**Dates**	**Engineer**	**Sheet**
	447116.71 E 336605.85 N	20/08/1999	WSP Environmental Ltd	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				66.80	(0.20) 0.20	TOPSOIL.		
0.20-0.90	D01		0 blows		(1.00)	MADE GROUND: Reddish brown mottled grey sandy clay with some fine to coarse angular gravel sized fragments of mudstone and sandstone.		
				65.80	1.20 (0.20)			
1.40-1.80	D02		0 blows	65.60	1.40	Stiff, greenish grey slightly sandy CLAY with some fine to coarse angular gravel of mudstone.		
			20/08/1999:0.00m		(0.40)	Stiff to very stiff reddish brown slightly sandy CLAY with much fine to coarse angular gravel of mudstone. (Highly Weathered Mudstone)		
			20/08/1999: 20/08/1999:0.00m	65.20	1.80	Complete at 1.80m		

Remarks
1. Inspection pit GL to 0.90m (0.50m x 0.50m). 2. Hole terminated at 1.80m. 3. Hole backfilled with grout. 4. Borehole dry. 5. MarkerPost Ref 194/5 +30. 6. Hole backfilled with grout.

Scale (approx)	Logged By
1:50	NBR

Figure No.

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CONTRACT BIRMINGHAM-NOTTINGHAM MOTORWAY M42 | SHEET No. 1

LOCATION CASTLE DONINGTON SECTION IIB | No. of sheets 2

CLIENT M.R.C.U DERBYSHIRE COUNTY COUNCIL SUB-UNIT | Ground Level 77.553 | Commenced 1/12/72 | Completed 20/12/72

Percussion: D / SPT / B

CASING: Size to. Size to. Nil

Rotary: Cored runs / O/H

M.C % Core Rec. % of Test

Type

Grading % Passing Sieve: mm 75 / mm 2.40 | μm 40 / μm 600 | mm 20 / μm 210 | mm 10 / μm 150 | mm ⅜ / μm 75

TRIAXIAL TEST: Bulk Density Kg/m³ | Dev. Stress kN/m² | Lat. U.C.T. Pres. Stress kN/m² kN/m² Shear/2c kN/m²

Weather RAIN/DRY

WATER

STRATUM. (Scale:20mm to 1 metre)

1. Thickness	Depth 2 m	Sample No.	Blow Count (N) LL/PL/PI	5 Legend	6.	7.	8 Results of any other Tests	10 REMARKS
Dark brown sandy TOPSOIL 0.35	0.35							
Stiff brown/yellow sandy silty CLAY with siltstone fragments (Weathered Keuper Waterstones) 1.15	0.50	D1						
	1.00	B1						Water Added
	1.50							
Hard moderately weathered green/yellow SILTSTONE/fine* (iv) 0.65	2.00	CP1 D2	75 blows for 0.240 total					
	2.15							OC of Boring at 2.150 Cas Nil Water Nil Rotary Drillir commenced 12/12/72 WS @ 2.000 whilst open-holing.
Moderately weathered, slightly weathered at 8.00 – 10.00m, thinly interbedded, green, locally buff or grey becoming at 8.00m green and red coarse grained silty, fine sandy, locally muddy, SILTSTONES and SANDSTONE (iv)					100			
					100			
					100			
					100			
6.85	9.00							

Continued on Sheet 2.

REMARKS:

- SANDSTONE with a trace of marl. (Keuper Waterstones)

Sample	Depth	M.C. % D.W.	Air Voids	Type	C. B. R. TOP 0.1	TOP 0.2	BOTTOM 0.1	BOTTOM 0.2	Value	COMPACTION B.S. 1377 No.	Max. Dry Density	Optm. M.C.

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CONTRACT BIRMINGHAM-NOTTINGHAM MOTORWAY M42 SHEET No. 2

LOCATION CASTLE DONINGTON SECTION IIB No. of sheets 2

CLIENT M.R.C.U. DERBYSHIRE COUNTY COUNCIL SUB-UNIT

Percussion U D SPT B

CASING Size to. Size to. Nil

Ground Level 77.553

Commenced 1/12/72

Completed 20/12/72

Weather RAIN/DRY

Rotary Cored runs O/H

M.C % Core Rec. %

Type of Test

Grading % Passing Sieve: 75 mm | 40 mm | 20 mm | 10 mm | 5 mm; 2.40 mm | 600 µm | 210 µm | 150 µm | 75 µm

TRIAXIAL TEST: Bulk Density Kg/m³ | Dev. Stress kN/m² | Lat. U.C.T. Pres. Stren. kN/m² kN/m² Shear% kN/m²

WATER

STRATUM. (Scale: 20mm to 1 metre)

1. Thickness	Depth 2 m	Sample No.	Blow Count (N) LL/PL/PI	5 Legend	6.	7.	8 Results of any other Tests	10. REMARKS
Moderately weathered, slightly weathered at 8.00 – 10.00m, thinly interbedded, green * 1.00	9.00 10.00							
Borehole Complete								

REMARKS:

* and red coarse grained silty, fine sandy, locally muddy, SILTSTONES and SANDSTONE. (iv)

Sample	Depth	M.C. % D.W.	Air Voids	C. B. R. Type	TOP 0.1	TOP 0.2	BOTTOM 0.1	BOTTOM 0.2	Value	COMPACTION B.S. 1377 No.	Max. Dry Density	Optm. M.C.

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CONTRACT BIRMINGHAM-NOTTINGHAM MOTORWAY M42 SHEET No. 1

LOCATION CASTLE DONINGTON SECTION IIB No. of sheets 1

CLIENT M.R.C.U. DERBYSHIRE COUNTY COUNCIL SUB-UNIT

Percussion U D SPT B

CASING Size to. Size to. Nil

Ground Level 75.847

Commenced 30/11/72

Completed 15/12/72

Weather DRY

Rotary Cored runs / O/H

M.C. % Core Rec. % of 6.

Type of Test 7.

Grading % Passing Sieve: mm 75 | mm 40 | mm 20 | mm 10 | mm 5 ; μm 600 | μm 210 | μm 150 | μm 75

TRIAXIAL TEST: Bulk. Density Kg/m³ | Dev. Stress kN/m² | Lat. M.C.T. Pres. Stress kN/m² kN/m² Shear f.s. kN/m²

WATER REMARKS

STRATUM. (Scale: 20mm to 1 metre)

1. Thickness	Depth 2. m	Sample No.	Blow Count (N) LL/PL/PI	5. Legend	8. Results of any other Tests	10.
Turf overlying dark brown TOPSOIL. 0.30	0.30					
Firm, becoming hard, interbedded at 1.00m, highly weathered (weathering lessening with depth) green slightly * 1.20	0.50	D1 U1	30.21.9. (CL) (56)		17.2 17.5 TAQ; 2090 144 100; (100 x 200mm result) 72/0°	Dry
	1.00	D2 P1	75 blows for 0.080			Dry
	1.50	D3	total			
Highly weathered, becoming moderately weathered at 7.00m, thinly bedded, buff/grey, fine sandy and coarse silty, poorly to moderately cemented, locally micaceous SANDSTONE (iv)					100 100 100 100	OC of Boring @ 1.500 Gas Nil Water Nil Rotary Drilling commenced 15/12/72 WS @ 1.500 whilst open-holing
7.50	9.00					

Borehole Complete

REMARKS:

* micaceous SILTSTONE and fine SANDSTONE. (Keuper Waterstones) (ii)/(iv)

Sample	Depth m	% D.W.	S.G.	Air Voids	Type	C.B.R. TOP 0.1	TOP 0.2	BOTTOM 0.1	BOTTOM 0.2	Value	COMPACTION B.S. 1377 No.	Max. Dry Density	Optm. M.C.
U1	0.50		2.65	6%	Static	2	2	2	2				
				7%								1600	14.0%

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For other symbols used see overleaf

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46616-30448

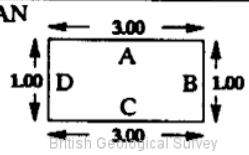
TRIAL PIT LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4						TRIAL PIT No
Job No	8 1 1 3 0	Date	Ground Level (m AOD)	Co-Ordinates (Local)			967
		14-8-90	30.10	E 66,641.9 N 100,485.4			
Contractor	Soil Mechanics Limited						Sheet 1 of 1

SAMPLES AND TESTS			SKETCH OF FACES SHOWING DEPTH			
Type	Depth	Strength	A	B	C	D
			1			
B1	1.10		2			
J1A	1.10					
B2	2.10		3			
J2A	2.10					
			4			

No.	Depth	STRATA DESCRIPTION
1	0.00-0.30	TOPSOIL
2	0.30-1.60	Loose brown and orange brown sandy SILT with occasional pockets of yellow silt and occasional up to cobble sized pieces of weakly cemented gravel. (MADE GROUND)
3	1.60-2.60	Dense reddish brown slightly sandy subangular to subrounded medium to coarse GRAVEL of predominantly quartzite. (FLUVIAL DEPOSITS)
4	2.60-3.00	Dense brown sandy subrounded to subangular fine to coarse GRAVEL of predominantly quartzite with subangular to subrounded cobbles. (FLUVIAL DEPOSITS)

PLAN



Bearing 130°

Shoring / Stability
No shoring used / Unstable below 1.60m

Groundwater
Water seepage at 1.20m

All dimensions in metres Scale 1:50	Client Department of Transport	Plant Cat 428	Logged By IGP

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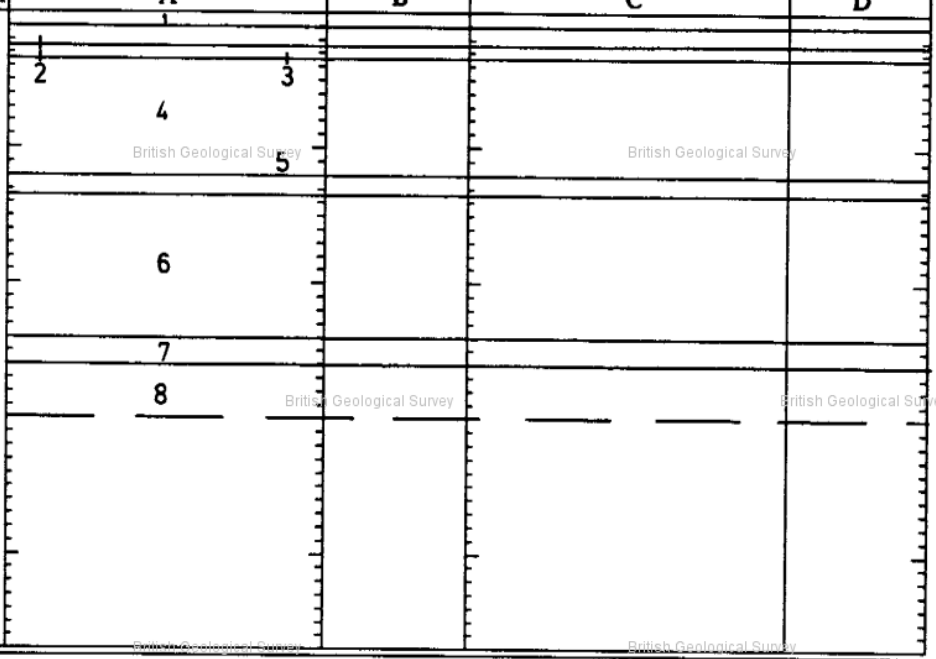
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SK43SE 127
46798-30619

TRIAL PIT LOG

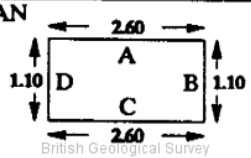
Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4			TRIAL PIT No
Job No 8 1 1 3 0	Date 9-8-90	Ground Level (m AOD) 30.50	Co-Ordinates (Local) E 66,825.4 N 100,654.5	973
Contractor **Soil Mechanics Limited**				Sheet 1 of 1

SAMPLES AND TESTS			SKETCH OF FACES SHOWING DEPTH
Type	Depth	Strength	A / B / C / D
B1	0.90		
J1A	0.90		
B2	1.70		
J2A	1.70		
B3	2.50		
J3A	2.50		



No.	Depth	STRATA DESCRIPTION
1	0.00-0.10	TOPSOIL and concrete slab.
2	0.10-0.25	Firm light brown clayey SILT. (MADE GROUND)
3	0.25-0.35	Loose brown rounded fine to coarse GRAVEL of predominantly quartzite with some sand. (MADE GROUND)
4	0.35-1.20	Loose brown mottled yellow silty fine to coarse SAND with occasional rounded to subrounded fine to coarse gravel. (MADE GROUND)
5	1.20-1.35	Dense yellow brown very sandy subangular to subrounded fine to medium GRAVEL of predominantly quartzite. (POSSIBLE MADE GROUND)
6	1.35-2.40	Loose dark brown fine to coarse SAND with much subangular to subrounded fine to medium gravel. (FLUVIAL DEPOSITS)
7	2.40-2.60	Dense dark grey fine to coarse SAND with much subangular to subrounded fine to coarse gravel and occasional cobbles. (FLUVIAL DEPOSITS)
8	2.60-3.00	Dense brown thinly bedded sandy subangular to subrounded GRAVEL of predominantly quartzite and fine to coarse SAND. (FLUVIAL DEPOSITS)

PLAN



Bearing 50°

Shoring / Stability
No shoring used / Unstable below 2.60m

Groundwater
Water strike at 2.80m

All dimensions in metres Scale 1:50	Client **Department of Transport**	Plant **Cat 428**	Logged By **IGP**

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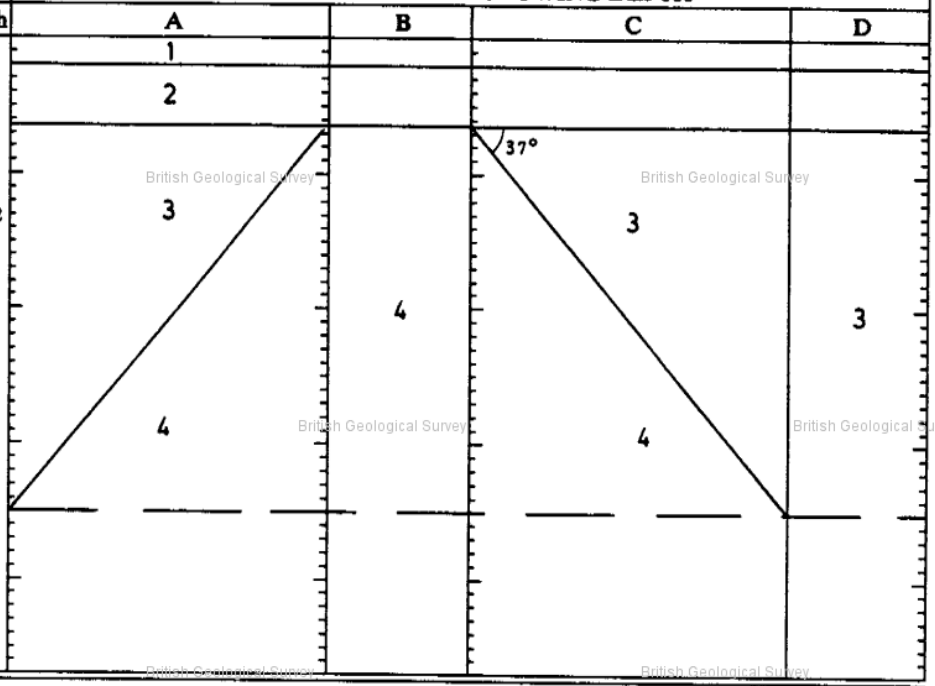
SK43SE B1
46938-30363

TRIAL PIT LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4						TRIAL PIT No
Job No	8 1 1 3 0	Date	Ground Level (m AOD)	Co-Ordinates (Local)			981
		11-9-90	31.10	E 100,399.4 N 66,964.2			
Contractor	Soil Mechanics Limited						Sheet 1 of 1

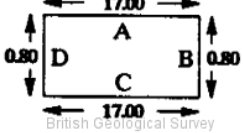
SAMPLES AND TESTS		
Type	Depth	Strength
J1	0.10	
J2	0.50	
B3	0.50	
B4	0.75	
J5	0.75	
V	1.30	33kN/m2
B6	3.40	
J7	3.40	

SKETCH OF FACES SHOWING DEPTH



No.	Depth	STRATA DESCRIPTION
1	0.00-0.20	Loose grey SILT with some angular to rounded fine to coarse gravel and with occasional cobbles and bricks. (MADE GROUND)
2	0.20-0.65	Firm orange brown silty fine SAND with occasional brick fragments. (MADE GROUND)
3	0.65-3.00	Firm grey very clayey SILT. (MADE GROUND) between 0.65 and 0.75m, mixed with spongy dark brown decaying plant material.
4	0.65-3.50	Dense brown sandy angular to rounded fine to coarse GRAVEL of predominantly quartzite. (FLUVIAL DEPOSITS) Contact between strata 3 and 4 dipping at 37 deg to 125 deg.

PLAN



Bearing 30 °

Shoring / Stability: No shoring used / Stable

Groundwater: Slight seepage at 3.00m

All dimensions in metres Scale 1:50	Client Department of Transport	Plant Cat 428	Logged By IGP

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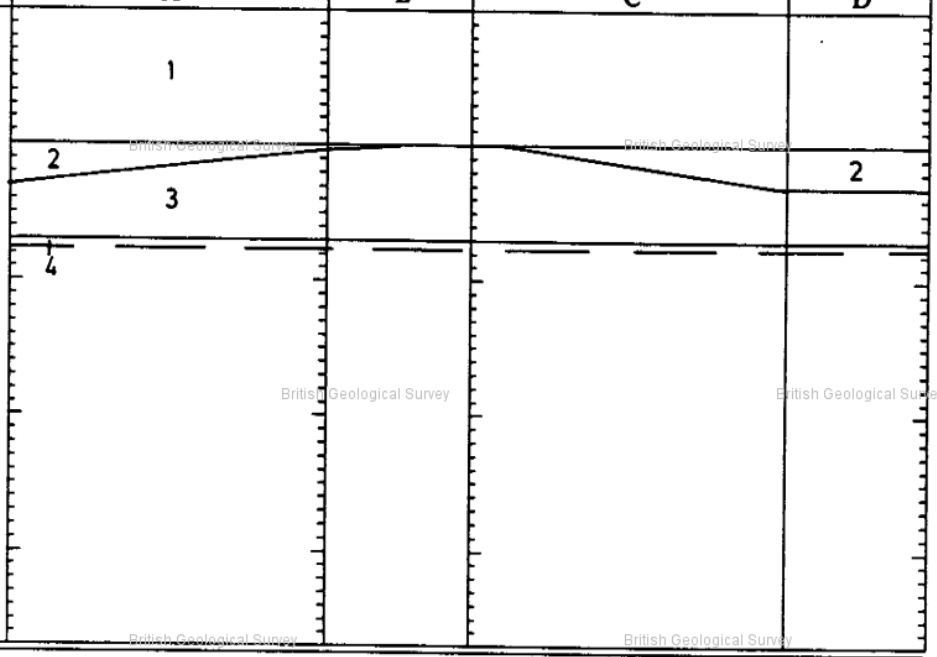
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SK43SE 132
46939-30333

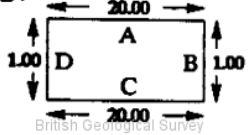
TRIAL PIT LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4			TRIAL PIT No
Job No 8 1 1 3 0	Date 11-9-90	Ground Level (m AOD) 30.80	Co-Ordinates (Local) E 66,964.6 N 100,370.0	981A
Contractor Soil Mechanics Limited				Sheet 1 of 1

SAMPLES AND TESTS			SKETCH OF FACES SHOWING DEPTH			
Type	Depth	Strength	A	B	C	D
						

No.	Depth	STRATA DESCRIPTION
1	0.00-1.00	Firm brown mottled grey sandy CLAY with some angular to rounded fine to coarse gravel, occasional bricks and occasional organic remains. (MADE GROUND)
2	1.00-1.30	Firm grey SILT. (MADE GROUND)
3	1.30-1.70	Soft to firm brown sandy CLAY with some angular to rounded fine to coarse gravel. (ALLUVIUM)
4	1.70-1.75	Loose dark grey sandy organic SILT with some organic remains and occasional subangular to rounded fine gravel. (ALLUVIUM)
		Contact between strata 2 and 3 dipping at 65 deg to 130 deg.

PLAN



Bearing 280°

Shoring / Stability: No shoring used / Stable

Groundwater: Dry

All dimensions in metres Scale 1:50	Client Department of Transport	Plant Cat 428	Logged By IGP

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SK43SE 134
46912-30376

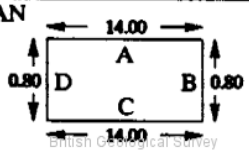
TRIAL PIT LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4			TRIAL PIT No
Job No 8 1 1 3 0	Date 11-9-90	Ground Level (m AOD) 31.10	Co-Ordinates (Local) E 66,937.8 N 100,412.4	982
Contractor Soil Mechanics Limited				Sheet 1 of 1

SAMPLES AND TESTS			SKETCH OF FACES SHOWING DEPTH			
Type	Depth	Strength	A	B	C	D
J1	0.00		1			
J6	0.40		2			
B2	0.45					
J3	0.45					
B4	1.10		3			
J5	1.10		4			
J7	1.70					
B8	1.70		5			
J9	1.90					
B10	1.90					
J11	2.30		6			
B12	2.40					
J13	2.40					

No.	Depth	STRATA DESCRIPTION
1	0.00-0.30	Dense grey brown very clayey SAND with much angular to rounded fine to coarse gravel of quartzite, ash and coal with occasional bricks and pieces of concrete. (MADE GROUND)
2	0.30-1.00	Dense reddish brown silty fine to coarse SAND with some subangular to subrounded fine to coarse gravel. Intermixed with dense grey silt. (MADE GROUND)
		At 0.50m, 38mm diameter armoured cable (declared dead by EMEB)
3	1.00-1.20	Firm dark grey sandy CLAY with some angular to rounded fine to coarse gravel and with some organic material, with occasional up to cobble size pockets of sand and gravel. With rare pieces of bamboo cane. (MADE GROUND)
4	1.20-1.80	Firm grey mottled orange brown very silty sandy CLAY. (ALLUVIUM)
5	1.80-2.30	Dense brown very sandy angular to rounded fine to coarse GRAVEL of predominantly quartzite. (FLUVIAL DEPOSITS)
6	2.30-2.60	Dense brown sandy angular to rounded fine to coarse GRAVEL of predominantly quartzite. (FLUVIAL DEPOSITS) Between 2.30 and 2.35m, stained black.

PLAN



Bearing 125°

Shoring / Stability: No shoring used / Stable

Groundwater: Dry

All dimensions in metres Scale 1:50	Client Department of Transport	Plant Cat 428	Logged By IGP

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SK43SE 135
46839-30310

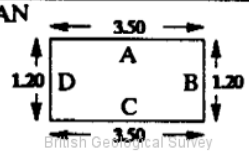
TRIAL PIT LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4			TRIAL PIT No
Job No 8 1 1 3 0	Date 8-8-90	Ground Level (m AOD) 30.10	Co-Ordinates (Local) E 66,864.8 N 100,347.0	985
Contractor Soil Mechanics Limited				Sheet 1 of 1

SAMPLES AND TESTS			SKETCH OF FACES SHOWING DEPTH			
Type	Depth	Strength	A	B	C	D
B1	0.60		1			
J1A	0.60		2			
B2	1.50		3			
J2A	1.50		4			
V	1.75	22kN/m2				
B3	1.95		5			
V	1.95	22kN/m2	6			
J3A	1.95		7			
V	2.18	24kN/m2	8			
B4	2.50					
J4A	2.50		9			

No.	Depth	STRATA DESCRIPTION
1	0.00-0.30	TOPSOIL
2	0.30-0.90	Loose light brown silty fine to coarse SAND with some fine to medium gravel sized brick fragments and many rootlets. (MADE GROUND)
3	0.90-1.70	Firm brown very silty CLAY with some fine sand and occasional subangular to subrounded fine to coarse gravel. (MADE GROUND)
4	1.70-1.80	Soft grey CLAY with some reddish brown fine to coarse sand and rare limestone cobbles. (MADE GROUND)
5	1.80-2.15	Soft black slightly sandy CLAY. (ALLUVIUM)
6	2.15-2.20	Soft light grey sandy CLAY with some black organic material. (ALLUVIUM)
7	2.20-2.25	Dense yellow rounded to subangular fine to coarse GRAVEL of predominantly quartzite. (FLUVIAL DEPOSITS)
8	2.25-2.70	Dense reddish brown medium SAND with occasional subangular to subrounded fine to coarse gravel. (FLUVIAL DEPOSITS)
9	2.70-3.10	Dense reddish brown slightly sandy subrounded to subangular fine to medium GRAVEL of predominantly quartzite with occasional cobbles. (FLUVIAL DEPOSITS)

PLAN



Bearing 220°

Shoring / Stability
No shoring used / Unstable below 2.25m

Groundwater
Rapid seepage at 2.25

All dimensions in metres Scale 1:50	Client Department of Transport	Plant Cat 428	Logged By IGP

Form A3

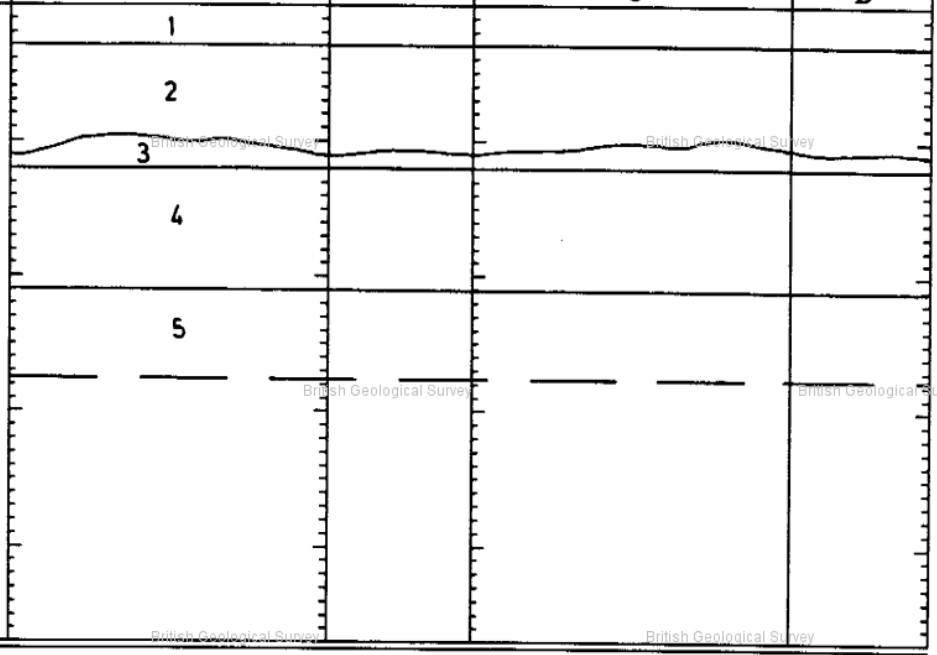
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46809-30405

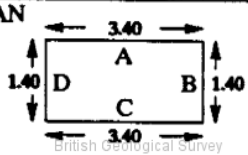
TRIAL PIT LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4							TRIAL PIT No
Job No	8	1	1	3	0	Date 8-8-90	Ground Level (m AOD) 30.40	Co-Ordinates (Local) E 66,834.2 N 100,442.4	987
Contractor	Soil Mechanics Limited							Sheet 1 of 1

SAMPLES AND TESTS			SKETCH OF FACES SHOWING DEPTH			
Type	Depth	Strength	A	B	C	D
B2	0.70					
J2A	0.70					
B3	1.50					
J3A	1.50					
B4	2.50					
J4A	2.50					

No.	Depth	STRATA DESCRIPTION
1	0.00-0.30	TOPSOIL
2	0.30-1.10	Loose reddish brown silty fine to coarse SAND with some red and black staining, occasional rootlets and ceramic fragments. (MADE GROUND)
3	1.10-1.20	Dense reddish brown fine to coarse SAND and subrounded to rounded fine to coarse GRAVEL of predominantly quartzite. (FLUVIAL DEPOSITS)
4	1.20-2.10	Dense brown medium to coarse SAND with some subangular to subrounded fine to coarse gravel. (FLUVIAL DEPOSITS)
5	2.10-2.75	Dense brown medium bedded sandy subangular to rounded fine to coarse GRAVEL and COBBLES of predominantly quartzite. (FLUVIAL DEPOSITS)

PLAN



Bearing 160°

Shoring / Stability
No shoring used / Very unstable below 2.10m

Groundwater
Water strike at 2.60m

All dimensions in metres Scale 1:50	Client Department of Transport	Plant Cat 428	Logged By IGP

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46782-30495

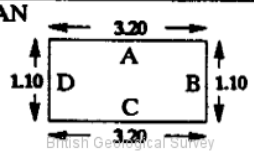
TRIAL PIT LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4							TRIAL PIT No
Job No	8	1	1	3	0	Date 14-8-90	Ground Level (m AOD) 30.40	Co-Ordinates (Local) E 66,806.3 N 100,532.7	989
Contractor	Soil Mechanics Limited								Sheet 1 of 1

SAMPLES AND TESTS			SKETCH OF FACES SHOWING DEPTH			
Type	Depth	Strength	A	B	C	D
B1	0.90		1			
J1A	0.90		2			
			3			
B2	2.00		4			
J2A	2.00					

No.	Depth	STRATA DESCRIPTION
1	0.00-0.20	TOPSOIL
2	0.20-0.50	Loose light brown silty SAND with occasional rootlets. (MADE GROUND)
3	0.50-1.50	Dense orange brown silty fine to medium SAND with black and orange staining below 0.80m. (MADE GROUND)
		at 0.70m, 1 number brick
4	1.50-2.70	Dense light yellow medium to coarse SAND with some rounded fine to coarse gravel. (ALLUVIUM)

PLAN



Bearing 170°

Shoring / Stability
No shoring used / Unstable below 1.50m

Groundwater
Water strike at 2.00

All dimensions in metres Scale 1:50	Client Department of Transport	Plant Cat 428	Logged By IGP

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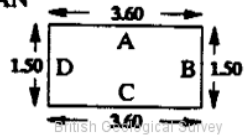
TRIAL PIT LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4			TRIAL PIT No
Job No 8 1 1 3 0	Date 9-8-90	Ground Level (m AOD) 30.60	Co-Ordinates (Local) E 66,719.7 N 100,466.9	990
Contractor Soil Mechanics Limited				Sheet 1 of 1

SAMPLES AND TESTS			SKETCH OF FACES SHOWING DEPTH			
Type	Depth	Strength	A	B	C	D
B1	1.00		1			
J1A	1.00		2			
B2	1.40		3			
J2A	1.40		4			
			5			
B3	2.30		6			
J3A	2.30		7			

No.	Depth	STRATA DESCRIPTION
1	0.00-0.20	TOPSOIL
2	0.20-0.70	Loose multicoloured silty fine to coarse SAND with occasional angular fine to coarse gravel and rare pieces of plastic. (MADE GROUND)
3	0.70-1.05	Loose brown silty fine to coarse SAND with occasional subrounded fine to coarse gravel, with some up to cobble sized pockets of black organic material. (MADE GROUND)
4	1.05-1.70	Loose yellow brown mottled black and orange fine to coarse SAND with some rounded fine to medium gravel. (possible MADE GROUND)
5	1.70-2.30	Loose yellow and light brown fine to coarse SAND with rounded to subangular fine to coarse gravel. (FLUVIAL DEPOSITS)
6	2.30-3.10	Dense yellow and light brown sandy subangular to subrounded fine to coarse GRAVEL of predominantly quartzite and occasional clay lenses. (FLUVIAL DEPOSITS)
7	3.10-3.30	Dense yellow and light brown very sandy subangular to subrounded fine to medium GRAVEL of predominantly quartzite. (FLUVIAL DEPOSITS)

PLAN



Bearing 40°

Shoring / Stability
No shoring used / Unstable below 2.30m

Groundwater
Water strike at 2.30m

All dimensions in metres Scale 1:50	Client Department of Transport	Plant Cat 428	Logged By IGP

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46709-30376

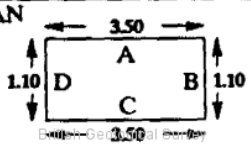
TRIAL PIT LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4			TRIAL PIT No
Job No 8 1 1 3 0	Date 9-8-90	Ground Level (m AOD) 30.90	Co-Ordinates (Local) E 66,735.1 N 100,417.2	991
Contractor Soil Mechanics Limited				Sheet 1 of 1

SAMPLES AND TESTS			SKETCH OF FACES SHOWING DEPTH			
Type	Depth	Strength	A	B	C	D
B1	0.35		1			
J1A	0.35		2			
			3			
B2	1.50		4			
J2A	1.50		5			
			6			
			7			

No.	Depth	STRATA DESCRIPTION
1	0.00-0.10	TOPSOIL
2	0.10-0.95	Dense reddish brown silty fine to coarse SAND with some angular to subrounded gravel and cobbles of concrete, quartzite and limestone and with occasional pieces of metal. (MADE GROUND) at 0.60m, concrete, at 0.85m, layer of broken bricks
3	0.95-1.60	Dense brown fine to coarse SAND with angular to subrounded fine to coarse gravel of concrete and brick and occasional black organic remains. (MADE GROUND)
4	1.60-1.80	Loose brown mottled yellow brown fine to coarse SAND. (FLUVIAL DEPOSITS)
5	1.80-1.90	Dense reddish brown mottled yellow sandy subangular to subrounded fine to coarse GRAVEL of predominantly quartzite with occasional cobbles. (FLUVIAL DEPOSITS)
6	1.90-2.40	Dense yellow brown very sandy subangular to subrounded fine to coarse GRAVEL of predominantly quartzite with occasional cobbles. (FLUVIAL DEPOSITS)
7	2.40-3.00	Dense yellow brown fine to coarse SAND with much subangular to subrounded fine to coarse gravel and occasional cobbles. Below 2.70m, light brown with decreasing sand content. (FLUVIAL DEPOSITS)

PLAN



Bearing 50°

Shoring / Stability
No shoring used / Unstable below 1.90m

Groundwater
Water at base of pit

All dimensions in metres Scale 1:50	Client Department of Transport	Plant Cat 428	Logged By IGP

Form A3

BGS ID: 220535 : BGS Reference: SK43SE140
British National Grid (27700) : 446737,330308

Report an issue with this borehole

British Geological Survey

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SK43SE 143
46698-30504

BOREHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4					BOREHOLE No
Job No	8 1 1 3 0	Date 9-9-90	Ground Level (m AOD) 31.00	Co-Ordinates (Local) E 66,724.5 N 100,542.9		968
Contractor	Soil Mechanics Limited					Sheet 1 of 2

SAMPLES & TESTS			Water	STRATA					
Depth	Type No	Test Result		Reduced Level	Legend	Depth Thickness	DESCRIPTION	Geology	Instrument Backfill
				30.60		(0.40) 0.40	TARMAC	MG	
				30.35		(0.25) 0.65	GRAVEL and COBBLE. (sub base)	MG	
0.65-1.20	B1			30.20		(0.15) 0.80	Grey sandy gravelly CLAY. (MADE GROUND)	MG	
						(0.90)	Stiff brown sandy CLAY. (MADE GROUND)		
1.50-1.95	U2	24		29.30		1.70		MG	
2.05	J3	N20				(0.60)	Soft to firm brown mottled black and orange brown sandy CLAY. (ALLUVIUM)		
2.10-2.55	SJ4			28.70		2.30	below 1.90m, with much sand and some to much subrounded fine to coarse gravel	A	
2.20-2.80	B5		1 1				Medium dense brown sandy to very sandy subangular to rounded fine to coarse GRAVEL of predominantly quartzite. (FLUVIAL DEPOSITS)		
3.10	W6	N28							
3.15-3.60	CB7								
4.15-4.60	C	N28							
4.30-5.00	B8					(5.00)			
5.20-5.65	CB9	N20							
6.00-6.45	SJ10	N22							
6.01-6.81	B11								
7.00-7.45	C	N15		23.70		7.30		F	
7.60-7.96	SJ12	(82 for 205mm)				(1.15)	Stiff greenish grey and reddish brown very silty CLAY with some gypsum veining and occasional greenish grey alteration spots. (MERCIA MUDSTONE GROUP)	MMG	

Boring Progress and Water Observations

Date	Time	Depth	Casing	Casing Dia	Water Dpt
9-9-90		3.20	2.75	150mm	2.75
9-9-90		3.20	2.75	150mm	2.68
9-9-90	1800	5.80	5.80	150mm	3.30
10-9-90	0800	5.80	5.80	150mm	2.60
10-9-90		8.45	7.80	150mm	

Chiselling

From	To	Hours
7.80	8.15	1.0

Water Added

From	To
2.00	8.15

GENERAL REMARKS

Inspection pit to 1.25m, 250mm iron water main located at 1.10m depth 1.25m from kerb.

All dimensions in metres Scale 1:50	Client Department of Transport	Method Cable Percussion	Logged By IRC

Form A1

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

SK43SE 143

BOREHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4								BOREHOLE No	968
Job No	8	1	1	3	0	Date 9-9-90	Ground Level (m AOD) 31.00	Co-Ordinates (Local) E 66,724.5 N 100,542.9		
Contractor	Soil Mechanics Limited								Sheet	2 of 2

SAMPLES & TESTS			Water	STRATA				Geology	Instrument Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth Thickness	DESCRIPTION		
8.15-8.43	SJ13	(56 for 130mm)		22.55		8.45	CLAY (as sheet 1) below 8.10m, recovered as up to fine gravel sized pieces of greenish grey siltstone and white gypsum	MMG	
							Borehole complete at 8.45m		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing	Casing Dia	Water Dpt	From	To	Hours	From	To	
9-9-90		3.20	2.75	150mm	2.75	7.80	8.15	1.0	2.00	8.15	Inspection pit to 1.25m, 250mm iron water main located at 1.10m depth 1.25m from kerb.
9-9-90		3.20	2.75	150mm	2.68						
9-9-90	1800	5.80	5.80	150mm	3.30						
10-9-90	0800	5.80	5.80	150mm	2.60						
10-9-90		8.45	7.80	150mm							

All dimensions in metres Scale 1:50	Client Department of Transport	Method Cable Percussion	Logged By IRC

Form A1

British Geological Survey

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CONSULTING ENGINEERS

SK43SE 145
46714-30535

DRILLHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4						DRILLHOLE No
Job No	8 1 1 3 0	Date 30-8-90	Ground Level (m AOD) 31.10	Co-Ordinates (Local) E 66,727.8 N 100,572.8			970/R
Contractor	Soil Mechanics Limited						Sheet 1 of 4

SK 46714 30535

RUN DETAILS			STRATA						Geology	Instrument Backfill
Date Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'd Level	Legend	Depth (Thickness)	DESCRIPTION				
						Discontinuities	Detail	Main		
30-8-90					(8.15)			CABLE PERCUSSION OPEN HOLE		
								Cable percussion open hole to 8.15m		

Drilling Progress and Water Observations

Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	Flush Type	Flush Returns
1-9-90	0800	8.15	8.10	89mm		2.80	Air/Mist	100%
1-9-90	1600	19.70	8.70	89mm		11.80		
2-9-90	0800	19.70	8.70	89mm		2.90		

GENERAL REMARKS

Mylar core barrel liner used.

All dimensions in metres Scale 1:50	Client Department of Transport	Method Rotary Core Drilling	Logged By HW

Form A2

British Geological Survey

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SK43SE 145

DRILLHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4			DRILLHOLE No
Job No 8 1 1 3 0	Date 30-8-90	Ground Level (m AOD) 31.10	Co-Ordinates (Local) E 66,727.8 N 100,572.8	970/R
Contractor Soil Mechanics Limited				Sheet 2 of 4

RUN DETAILS			STRATA						
						DESCRIPTION			
Date Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'd Level	Legend	Depth (Thickness)	Discontinuities	Detail	Main	Geology / Instrument Backfill
30-8-90			22.95		8.15				
1-9-90	50 (14) 0					....8.15-8.50m, assessed zone of core loss		Light reddish brown highly weathered sandy MUDSTONE very weak to weak. (MERCIA MUDSTONE GROUP)	
8.85						....8.50-10.00m, non intact			
	13 (0) 0	NI/NI/40			(2.15)	....8.85-9.50m, assessed zone of core loss			
9.60									
	100 (60) 0		20.80		10.30				MMG
10.60								Reddish brown mottled greenish grey highly weathered MUDSTONE weak with closely spaced gypsum veins and nodules (<3mm). (MERCIA MUDSTONE GROUP)	
	88 (75) 43	30/100/200			(1.30)				MMG
			19.50		11.60				
						....11.60m, subhorizontal gypsum vein (40mm)		Reddish brown mottled grey green moderately weathered very silty MUDSTONE weak with closely spaced gypsum veins (<30mm). (MERCIA MUDSTONE GROUP)	
12.20									
	100 (70) 22	(35° for 75mm) NI/20/150			(2.20)	....12.40m, subhorizontal gypsum vein (15mm) ....12.75-13.80m, very closely spaced gypsum veins (<30mm)			
13.70						....13.40-13.70m, grey			
			17.30		13.80				MMG
	100 (87) 24	NI/60/130			(1.40)			Reddish brown mottled grey moderately weathered MUDSTONE weak with very closely to closely spaced gypsum veins (<20mm). (MERCIA MUDSTONE GROUP)	
15.20			15.90		15.20	....14.80-14.87m, greenish grey siltstone			MMG
	100 (100) 50				(1.40)			Reddish brown slightly weathered MUDSTONE moderately weak with very closely to medium spaced gypsum veins (<3mm).	MMG

Drilling Progress and Water Observations

Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	Flush Type	Flush Returns
1-9-90	0800	8.15	8.10	89mm		2.80	Air/Mist	100%
1-9-90	1600	19.70	8.70	89mm		11.80		
2-9-90	0800	19.70	8.70	89mm		2.90		

GENERAL REMARKS

Mylar core barrel liner used.

All dimensions in metres Scale 1:50	Client Department of Transport	Method Rotary Core Drilling	Logged By HW

Form A2

British Geological Survey

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CONSULTING ENGINEERS

SK43SE 145

DRILLHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4					DRILLHOLE No
Job No	8 1 1 3 0	Date 30-8-90	Ground Level (m AOD) 31.10	Co-Ordinates (Local) E 66,727.8 N 100,572.8		970/R
Contractor	Soil Mechanics Limited					Sheet 3 of 4

RUN DETAILS			STRATA						
Date Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'd Level	Legend	Depth (Thickness)	DESCRIPTION Discontinuities / Detail	DESCRIPTION Main	Geology	Instrument backfill
		20/80/190				....16.10-16.35m, mottled greenish grey	(MERCIA MUDSTONE GROUP) MUDSTONE (as sheet 2)		
16.70			14.50		16.60			MMG	
	100 (50) 15	(35° for 72mm)				....16.60-17.00m, non intact	Reddish brown moderately weathered MUDSTONE very weak to weak with closely spaced gypsum veins (<3mm). (MERCIA MUDSTONE GROUP)		
		NI/40/120			(1.60)	....17.60-18.20m, friable very weak			
18.20			12.90		18.20			MMG	
	93 (75) 30						Reddish brown slightly weathered very silty MUDSTONE moderately weak with very closely spaced horizontal to subhorizontal gypsum veins (<5mm). (MERCIA MUDSTONE GROUP)		
		40/80/150			(1.75)				
1-9-90 19.70									
2-9-90	100 (17) 17		11.15		19.95	....19.70-19.95m, subvertical irregular rough fracture		MMG	
		NI/NI/60			(0.75)	....19.95-20.70m, intersecting subvertical fractures	Reddish brown moderately weathered MUDSTONE weak with closely spaced intersecting subvertical and inclined joints and subhorizontal partings. (MERCIA MUDSTONE GROUP)		
			10.40		20.70	....20.40-20.70m, mottled greenish grey		MMG	
21.00		NI/NI/230 (57° for 140mm)			(0.45)				
	100 (43) 18		9.95		21.15	....20.90-21.15m, non intact	Grey green fine grained slightly to moderately weathered SANDSTONE moderately weak with occasional gypsum veins and nodules. (MERCIA MUDSTONE GROUP)	MMG	
						....21.30-21.40m, mottled greenish grey			
22.50		NI/100/270			(2.20)		Reddish brown slightly weathered MUDSTONE weak to moderately weak with closely spaced gypsum veins (<5mm). (MERCIA MUDSTONE GROUP)		
	100 (73) 57					....22.50m, 50 deg smooth planar fracture			
			7.75		23.35			MMG	
24.00					(1.00)	....23.75-24.00m, non intact	Light grey slightly weathered slightly sandy SILTSTONE moderately weak to moderately strong with closely spaced gypsum veins (<3mm).	MMG	

Drilling Progress and Water Observations

Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	Flush Type	Flush Returns
1-9-90	0800	8.15	8.10	89mm		2.80	Air/Mist	100%
1-9-90	1600	19.70	8.70	89mm		11.80		
2-9-90	0800	19.70	8.70	89mm		2.90		

GENERAL REMARKS

Mylar core barrel liner used.

All dimensions in metres Scale 1:50	Client Department of Transport	Method Rotary Core Drilling	Logged By HW

Form A2

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

SK43SE 145

DRILLHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4					DRILLHOLE No
Job No	8 1 1 3 0	Date 30-8-90	Ground Level (m AOD) 31.10	Co-Ordinates (Local) E 66,727.8 N 100,572.8		970/R
Contractor	Soil Mechanics Limited					Sheet 4 of 4

RUN DETAILS			STRATA						
						DESCRIPTION			
Date Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'd Level	Legend	Depth (Thick-ness)	Discontinuities	Detail	Main	Geology
	97 (90) 41	NI/70/240	6.75		24.35			(MERCIA MUDSTONE GROUP) SILTSTONE (as sheet 3)	MMG
25.50		30/80/320			(1.75)	....24.81m, subhorizontal gypsum vein (40mm) ....24.81-25.19m, weak mudstone		Reddish brown mottled grey slightly weathered sandy SILTSTONE moderately weak to moderately strong with very closely spaced subhorizontal gypsum veins (<3mm). (MERCIA MUDSTONE GROUP)	
	83 (42) 17		5.00		26.10				MMG
2-9-90 27.00		NI/NI/NI	4.10		(0.90) 27.00			Reddish brown slightly weathered slightly sandy MUDSTONE moderately weak with very closely spaced gypsum veins (<4mm). (MERCIA MUDSTONE GROUP)	MMG
		(35 for 70mm)						Drillhole complete at 27.22m.	

Drilling Progress and Water Observations

Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	Flush Type	Flush Returns
1-9-90	0800	8.15	8.10	89mm		2.80	Air/Mist	100%
1-9-90	1600	19.70	8.70	89mm		11.80		
2-9-90	0800	19.70	8.70	89mm		2.90		

GENERAL REMARKS

Mylar core barrel liner used.

All dimensions in metres Scale 1:50	Client Department of Transport	Method Rotary Core Drilling	Logged By HW

Form A2

British Geological Survey

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SK43SE 146
46742·30539

DRILLHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4						DRILLHOLE No
Job No	8	1	1	3	0	Date 11-8-90	Ground Level (m AOD) 31.20	Co-Ordinates (Local) E 66,765.2 N 100,575.8	971/R
Contractor	Soil Mechanics Limited								Sheet 1 of 4

RUN DETAILS			STRATA							
						DESCRIPTION				
Date Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'd Level	Legend	Depth (Thick-ness)	Discontinuities	Detail	Main	Geology	Instru-ment/ Backfill
11-9-90					(8.50)			CABLE PERCUSSION OPEN HOLE		

Drilling Progress and Water Observations

Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	Flush Type	Flush Returns
16-9-90	0930	8.50	8.50	89mm		9.90	Air/Mist	100%
16-9-90		11.50	8.95	89mm	11.50			
16-9-90		14.85	8.95	89mm	14.85			
16-9-90	1800	19.45	8.95	89mm		2.90		
17-9-90	0800	19.45	8.95	89mm		2.90		
17-9-90	1330	30.55	8.95	89mm		2.90		

GENERAL REMARKS

Core liner core barrel liner used.

All dimensions in metres Scale 1:50	Client Department of Transport	Method Rotary Core Drilling	Logged By EJS-S

Form A2

British Geological Survey

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CONSULTING ENGINEERS

SK43SE 146

DRILLHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4					DRILLHOLE No
Job No	8 1 1 3 0	Date 11-8-90	Ground Level (m AOD) 31.20	Co-Ordinates (Local) E 66,765.2 N 100,575.8		971/R
Contractor	Soil Mechanics Limited					Sheet 2 of 4

RUN DETAILS			STRATA						
Date Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'd Level	Legend	Depth (Thick-ness)	DESCRIPTION Discontinuities Detail	DESCRIPTION Main	Geology	Instrument Backfill
11-9-90			22.70		8.50		Cable percussion open hole to 8.50m		
16-9-90 8.85		(0 (0) 0)				....8.50-9.47m, no recovery	Reddish brown mottled greenish grey moderately weathered MUDSTONE weak in parts very silty. (MERCIA MUDSTONE GROUP)		
	38 (28) 26					....9.47-9.54m, non intact			
9.85					(2.80)	....9.77-9.80m, non intact			
	0 (0) 0	NI/50/140				....9.85-10.40m, no recovery			
10.40									
	43 (24) 0					....10.40-10.87m, no recovery			
						....10.87-11.11m, generally non intact			
11.30			19.90		11.30			MMG	
11.50		(0 (0) 0)				....11.30-11.70m, no recovery	Reddish brown in parts mottled greenish grey slightly weathered MUDSTONE weak to moderately weak with very closely spaced randomly orientated gypsum veins (<15mm). (MERCIA MUDSTONE GROUP)		
	85 (69) 19					....11.85-11.89m, non intact			
						....11.94m, irregular gypsum vein (40mm)			
						....11.98-12.05m, non intact			
12.85						....12.20-12.23m, non intact			
	96 (90) 48	NI/90/210 (57° for 140mm)			(3.15)	....12.23m, gypsum vein (20mm)			
						....12.25-12.29m, non intact			
						....12.61-12.73m, 5No subhorizontal gypsum veins			
						....12.69-12.73m, non intact			
						....12.85-12.91m, no recovery			
						....12.91-13.95m, greenish grey			
						....13.26m, gypsum vein (30mm)			
						....13.31m, gypsum vein (20mm)			
14.45			16.75		14.45	....13.84m, gypsum vein (50mm)		MMG	
	100 (91) 60					....14.12-14.14m, non intact			
						....14.14-14.19m, 3No gypsum veins (<10mm)	Reddish brown slightly weathered MUDSTONE weak to moderately weak with extremely closely spaced generally subhorizontal gypsum veins (<5mm). (MERCIA MUDSTONE GROUP)		
						....14.19-14.26m, non intact			
					(2.50)				
						....15.76-16.92m, in parts non intact		MMG	

Drilling Progress and Water Observations

Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	Flush Type	Flush Returns
16-9-90	0930	8.50	8.50	89mm		9.90	Air/Mist	100%
16-9-90		11.50	8.95	89mm	11.50			
16-9-90		14.85	8.95	89mm	14.85			
16-9-90	1800	19.45	8.95	89mm		2.90		
17-9-90	0800	19.45	8.95	89mm		2.90		
17-9-90	1330	30.55	8.95	89mm		2.90		

GENERAL REMARKS

Core liner core barrel liner used.

All dimensions in metres Scale 1:50	Client Department of Transport	Method Rotary Core Drilling	Logged By EJS-S

Form A2

British Geological Survey

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CONSULTING ENGINEERS

SK43SE 146

DRILLHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4						DRILLHOLE No
Job No	8 1 1 3 0	Date 11-8-90	Ground Level (m AOD) 31.20	Co-Ordinates (Local) E 66,765.2 N 100,575.8			971/R
Contractor	Soil Mechanics Limited						Sheet 3 of 4

RUN DETAILS			STRATA						
						DESCRIPTION			
Date Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'd Level	Legend	Depth (Thick-ness)	Discontinuities	Detail	Main	Geology
								MUDSTONE (As sheet 2)	
16.95			14.25		16.95				MMG
	46 (34) 6					....16.95-18.31m, no recovery		Reddish brown slightly weathered MUDSTONE weak with extremely closely spaced generally subhorizontal gypsum veins (<5mm). (MERCIA MUDSTONE GROUP)	
						....18.31-20.56m, weak			
					(3.60)	....18.51m, gypsum vein (25mm)			
16-9-90		NI/80/330				....18.86-18.88m, non intact			
19.45						....19.06-19.24m, non intact			
17-9-90	96 (84) 41					....19.36-19.45m, non intact			
						....19.45-19.51m, no recovery			
						....20.11-20.20m, non intact			
			10.65		20.55	....20.20m, gypsum vein (30mm)			MMG
					(0.45)			Greenish grey mottled reddish brown slightly weathered SILTSTONE moderately weak to weak. (MERCIA MUDSTONE GROUP)	
21.00			10.20		21.00	....20.83-20.93m, non intact			MMG
	97 (53) 35	(60° for 110mm)				....21.00-21.51m, non intact			
						....21.00-21.76m, occasional green grey alteration spots (<30mm)		Reddish brown slightly weathered MUDSTONE weak with extremely closely spaced generally subhorizontal gypsum veins (<5mm). (MERCIA MUDSTONE GROUP)	
						....21.91-22.10m, non intact			
						....22.10m, gypsum vein (30mm)			
22.50					(2.85)				
	97 (73) 34					....22.54-22.67m, mottled greenish grey			
						....22.60-22.65m, non intact			
						....23.29-23.49m, non intact			
						....23.65-23.74m, mottled greenish grey			MMG
23.90			7.35		23.85	....23.74-23.83m, non intact			MMG

Drilling Progress and Water Observations

Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	Flush Type	Flush Returns
16-9-90	0930	8.50	8.50	89mm		9.90	Air/Mist	100%
16-9-90		11.50	8.95	89mm	11.50			
16-9-90		14.85	8.95	89mm	14.85			
16-9-90	1800	19.45	8.95	89mm		2.90		
17-9-90	0800	19.45	8.95	89mm		2.90		
17-9-90	1330	30.55	8.95	89mm		2.90		

GENERAL REMARKS

Core liner core barrel liner used.

All dimensions in metres Scale 1:50	Client Department of Transport	Method Rotary Core Drilling	Logged By EJS-S

Form A2

British Geological Survey

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

SK43SE 146

DRILLHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4			DRILLHOLE No
Job No 8 1 1 3 0	Date 11-8-90	Ground Level (m AOD) 31.20	Co-Ordinates (Local) E 66,765.2 N 100,575.8	971/R
Contractor Soil Mechanics Limited				Sheet 4 of 4

RUN DETAILS			STRATA						
Date Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'd Level	Legend	Depth (Thick-ness)	DESCRIPTION Discontinuities Detail	DESCRIPTION Main	Geology	Instru-ment/ Backfill
	100 (100) 66	(35° for 60mm) 30/60/200	6.75		(0.60) 24.45	....23.75-23.83m, greenish grey ....23.83m, gypsum vein (30mm)	Bluish grey slightly weathered SILTSTONE moderately strong with extremely closely spaced subhorizontal gypsum veins (>0.5mm). (MERCIA MUDSTONE GROUP)	MMG	
26.05						....24.85-25.01m, greenish grey ....25.01m, gypsum vein (30mm) ....25.44-25.50m, very silty ....25.62-25.80m, greenish grey	Reddish brown slightly weathered MUDSTONE weak to moderately weak with extremely closely spaced generally subhorizontal gypsum veins (<5mm). (MERCIA MUDSTONE GROUP)		
	100 (87) 41	NI/95/400			(6.10)	....26.21-26.41m, non intact ....26.83-26.91m, 45 deg planar smooth fracture			
27.55						....27.46-27.60m, greenish grey ....27.79-27.82m, greenish grey			
	100 (100) 89								
29.15						....28.94-29.01m, greenish grey			
	97 (87) 28					....29.38-29.41m, non intact ....29.41-29.87m, greenish grey ....29.87-29.91m, non intact ....29.19-30.03m, greenish grey ....30.12-30.19m, non intact			
17-9-90 30.55			0.65		30.55	....30.19m gypsum vein (20mm)		MMG	
		(58° for 135mm)					Drillhole complete at 30.69m		

Drilling Progress and Water Observations

Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	Flush Type	Flush Returns
16-9-90	0930	8.50	8.50	89mm		9.90	Air/Mist	100%
16-9-90		11.50	8.95	89mm	11.50			
16-9-90		14.85	8.95	89mm	14.85			
16-9-90	1800	19.45	8.95	89mm		2.90		
17-9-90	0800	19.45	8.95	89mm		2.90		
17-9-90	1330	30.55	8.95	89mm		2.90		

GENERAL REMARKS

Core liner core barrel liner used.

All dimensions in metres Scale 1:50	Client Department of Transport	Method Rotary Core Drilling	Logged By EJS-S

Form A2

British Geological Survey

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

SK43SE 147
46738-30564

DRILLHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4			DRILLHOLE No
Job No 8 1 1 3 0	Date 15-8-90	Ground Level (m AOD) 31.10	Co-Ordinates (Local) E 66,757.7 N 100,603.8	972/R
Contractor Soil Mechanics Limited				Sheet 1 of 4

RUN DETAILS			STRATA						
Date Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'd Level	Legend	Depth (Thick-ness)	DESCRIPTION Discontinuities	Detail	Main	Geology / Instrument Backfill
15-8-90					(7.20)			CABLE PERCUSSION OPEN HOLE	
15-8-90			23.90		7.20			Cable percussion open hole to 7.20m.	
16-8-90	6 (3) 0					....7.20-8.55m, assessed zone of core loss		MUDSTONE (as sheet 2)	MMG

Drilling Progress and Water Observations

Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	Flush Type	Flush Returns
16-8-90	0800	7.20	7.20	89mm		2.20	Air/Mist	100%
16-8-90	1800	11.37	8.63	89mm		8.90		
17-8-90	0800	11.37	8.63	89mm		2.70		

GENERAL REMARKS

Mylar core barrel liner used.

All dimensions in metres Scale 1:50	Client Department of Transport	Method Rotary Core Drilling	Logged By IRC

Form A2

British Geological Survey

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

SK43SE 147

DRILLHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4						DRILLHOLE No
Job No	8 1 1 3 0	Date 15-8-90	Ground Level (m AOD) 31.10	Co-Ordinates (Local) E 66,757.7 N 100,603.8			972/R
Contractor	Soil Mechanics Limited						Sheet 2 of 4

RUN DETAILS			STRATA						
Date Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'd Level	Legend	Depth (Thick-ness)	DESCRIPTION: Discontinuities / Detail	DESCRIPTION: Main	Geology	Instrument Backfill
8.63							Reddish brown mottled greenish grey highly weathered very silty MUDSTONE weak to very weak with extremely to very closely spaced gypsum veins (<5mm). (MERCIA MUDSTONE GROUP)		
	64 (35) 17	(56 for 150mm)			(4.20)	....8.63-9.41m, assessed zone of core loss			
9.85									
	70 (36) 0	NI/70/150				....9.85-10.31m, assessed zone of core loss			
16-8-90 11.37			19.70		11.40	....10.88-11.30m, 3 No subhorizontal gypsum veins (<39mm)		MMG	
17-8-90	85 (74) 24	(47° for 150mm)				....11.37-11.59m, assessed zone of core loss	Reddish brown mottled greenish grey highly to moderately weathered MUDSTONE weak with very closely to medium spaced gypsum veins (<6mm). (MERCIA MUDSTONE GROUP)		
12.85						....11.75-12.65m, 7 No subhorizontal gypsum veins (<50mm)			
	99 (80) 39				(3.15)	....12.70-12.90m, greenish grey			
14.37						....13.04-14.72m, 4 No subhorizontal gypsum veins (<35mm)			
	100 (68) 24	(35° for 50mm)	16.55		14.55			MMG	
15.45							Reddish brown moderately weathered MUDSTONE weak with closely spaced subhorizontal gypsum veins (<5mm) and occasional greenish grey alteration spots. (MERCIA MUDSTONE GROUP)		
	100 (62) 18					....15.75-16.34m, subvertical irregular rough fracture		MMG	

Drilling Progress and Water Observations

Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	Flush Type	Flush Returns
16-8-90	0800	7.20	7.20	89mm		2.20	Air/Mist	100%
16-8-90	1800	11.37	8.63	89mm		8.90		
17-8-90	0800	11.37	8.63	89mm		2.70		

GENERAL REMARKS

Mylar core barrel liner used.

All dimensions in metres Scale 1:50	Client Department of Transport	Method Rotary Core Drilling	Logged By IRC

Form A2

British Geological Survey

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CONSULTING ENGINEERS

SK43SE 147

DRILLHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4									DRILLHOLE No
Job No	8	1	1	3	0	Date 15-8-90	Ground Level (m AOD) 31.10	Co-Ordinates (Local) E 66,757.7 N 100,603.8		972/R
Contractor	Soil Mechanics Limited									Sheet 3 of 4

RUN DETAILS			STRATA						
Date Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'd Level	Legend	Depth (Thick-ness)	DESCRIPTION Discontinuities	Detail	Main	Geology
		NI/80/170			(3.15)			MUDSTONE (as sheet 2)	
						....17.00-17.25m, non intact			
						....17.27-17.31m, 2 No subhorizontal gypsum veins (<16mm)			
			13.40		17.70	....17.38-17.70m, moderately weathered with many 40-70 deg fractures			MMG
18.45								Reddish brown moderately to slightly weathered MUDSTONE moderately weak with very closely to medium spaced gypsum veins (<5mm) and occasional greenish grey alteration spots. (MERCIA MUDSTONE GROUP)	
	90 (82) 57	(35° for 25mm)							
						....20.00-20.60m, mottled greenish grey			
21.50		(35° for 25mm)							
	100 (84) 38	NI/150/280			(7.75)	....21.80m, 70 deg planar smooth fracture			
						....20.20-22.40m, greenish grey			
						....22.40m, 30 deg gypsum vein			
						....23.11-24.09m, greenish grey			
						....23.41m, subhorizontal gypsum vein (27mm)			MMG

Drilling Progress and Water Observations

Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	Flush Type	Flush Returns
16-8-90	0800	7.20	7.20	89mm		2.20	Air/Mist	100%
16-8-90	1800	11.37	8.63	89mm		8.90		
17-8-90	0800	11.37	8.63	89mm		2.70		

GENERAL REMARKS

Mylar core barrel liner used.

All dimensions in metres Scale 1:50	Client Department of Transport	Method Rotary Core Drilling	Logged By IRC

Form A2

British Geological Survey

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

SK43SE 147

DRILLHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4					DRILLHOLE No
Job No	8 1 1 3 0	Date	Ground Level (m AOD)	Co-Ordinates (Local)		972/R
		15-8-90	31.10	E 66,757.7 N 100,603.8		
Contractor	Soil Mechanics Limited					Sheet 4 of 4

RUN DETAILS			STRATA						
Date Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'd Level	Legend	Depth (Thick-ness)	DESCRIPTION: Discontinuities / Detail	DESCRIPTION: Main	Geology	Instrument / Backfill
24.20		(35° for 10mm)					MUDSTONE (as sheet 3)		
	100 (63) 26					....24.56m, subhorizontal gypsum vein (33mm) ....24.90-25.00m, non intact ....25.16-25.30m, greenish grey			
			5.65		25.45			MMG	
		NI/70/100			(1.55)	....25.70-27.00m, very closely spaced 50-70 deg planar smooth fractures and gypsum veins	Reddish brown slightly to moderately weathered MUDSTONE moderately weak to weak with closely to medium spaced gypsum veins (<12mm). (MERCIA MUDSTONE GROUP)		
17-8-90 27.00			4.10		27.00			MMG	
		(35° for 15mm)					Drillhole complete at 27.02m.		

Drilling Progress and Water Observations

Date	Time	Depth	Casing	Core Dia mm	Water: Strike	Water: Standing	Flush: Type	Flush: Returns
16-8-90	0800	7.20	7.20	89mm		2.20	Air/Mist	100%
16-8-90	1800	11.37	8.63	89mm		8.90		
17-8-90	0800	11.37	8.63	89mm		2.70		

GENERAL REMARKS

Mylar core barrel liner used.

All dimensions in metres Scale 1:50	Client Department of Transport	Method Rotary Core Drilling	Logged By IRC

Form A2

British Geological Survey

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CONSULTING ENGINEERS

SK43SE 150
46819-30367

BOREHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4							BOREHOLE No
Job No	8	1	1	3	0	Date 9-8-90	Ground Level (m AOD) 30.10	Co-Ordinates (Local) E 66,844.3 N 100,406.5	986
Contractor	Soil Mechanics Limited								Sheet 1 of 2

SAMPLES & TESTS			Water	STRATA					
Depth	Type No	Test Result		Reduced Level	Legend	Depth Thickness	DESCRIPTION	Geology	Instrument Backfill
0.00-0.80	B1			29.90		(0.20) 0.20	TOPSOIL	T	
						(0.40)	Firm to stiff brown and grey mottled orange CLAY with occasional rootlets and dark brown silt nodules.		
0.50-0.95	SJ2	N15		29.50		0.60	(ALLUVIUM)	A	
0.95	B3					(1.40)	Medium dense orangish brown very silty fine to coarse SAND with occasional subangular to subrounded fine to coarse gravel. (FLUVIAL DEPOSITS)		
1.50-1.95	SJ4	N21	1						
1.95	B5			28.10		2.00		F	
2.60-3.05	CB6	N21					Medium dense brown slightly sandy to sandy subrounded to rounded fine to coarse GRAVEL of predominantly quartzite with occasional subrounded cobbles. (FLUVIAL DEPOSITS)		
2.61	K	9E-06							
3.60-4.05	CB7	N30				(4.20)			
4.60-5.05	CB8	N26							
5.60-6.05	CB9	N28					below 5.60m, with much sand		
				23.90		6.20		F	
6.60-6.96	SJ10	(79 for 210mm)					Firm reddish brown slightly sandy CLAY with occasional angular up to fine gravel sized mudstone lithorelicts, occasional grey green alteration spots and extremely closely spaced sub-horizontal gypsum veins (up to 1mm). (MERCIA MUDSTONE GROUP)		
6.95	B11								
7.60-8.05	SJ12	N16				(3.20)		MMG	

Boring Progress and Water Observations

Date	Time	Depth	Casing	Casing Dia	Water Dpt
9-8-90		1.60	1.50	150mm	1.60
9-8-90		1.60	1.50	150mm	1.53
9-8-90	1800	2.00	2.00	150mm	1.60
10-8-90	0800	2.00	2.00	150mm	Dry
10-8-90	1800	5.00	4.60	150mm	
13-8-90	0800	5.00	4.60	150mm	2.00
13-8-90		9.40	8.20	150mm	3.40

Chiselling

From	To	Hours
7.60	8.60	1.00
8.60	9.10	1.00

Water Added

From	To
2.00	9.40

GENERAL REMARKS

Permeability test carried out at 2.60m

All dimensions in metres Scale 1:50	Client Department of Transport	Method Cable Percussion	Logged By IRC

Form A1

British Geological Survey

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

SK43SE 160

BOREHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4			BOREHOLE No
Job No 8 1 1 3 0	Date 9-8-90	Ground Level (m AOD) 30.10	Co-Ordinates (Local) E 66,844.3 N 100,406.5	986
Contractor Soil Mechanics Limited				Sheet 2 of 2

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth Thickness	DESCRIPTION		
8.06	B13						CLAY (as sheet 1)		
8.60-8.81	SJ14	(35 for 62mm)							
8.90	B15								
9.10-9.37	SJ16	(59 for 121mm)		20.70		9.40		MMG	
							Borehole complete at 9.40m		

Boring Progress and Water Observations

Date	Time	Depth	Casing	Casing Dia	Water Dpt
9-8-90		1.60	1.50	150mm	1.60
9-8-90		1.60	1.50	150mm	1.53
9-8-90	1800	2.00	2.00	150mm	1.60
10-8-90	0800	2.00	2.00	150mm	Dry
10-8-90	1800	5.00	4.60	150mm	
13-8-90	0800	5.00	4.60	150mm	2.00
13-8-90		9.40	8.20	150mm	3.40

Chiselling

From	To	Hours
7.60	8.60	1.00
8.60	9.10	1.00

Water Added

From	To
2.00	9.40

GENERAL REMARKS

Permeability test carried out at 2.60m

All dimensions in metres Scale 1:50	Client Department of Transport	Method Cable Percussion	Logged By IRC

Form A1

British Geological Survey

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

SK43SE 151
46730-30357

BOREHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4					BOREHOLE No
Job No	8 1 1 3 0	Date 10-9-90	Ground Level (m AOD) 31.00	Co-Ordinates (Local) E 66,755.5 N 100,396.9		992
Contractor	Soil Mechanics Limited					Sheet 1 of 2

SAMPLES & TESTS			Water	STRATA				Geology	Instrumentation/Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth Thickness	DESCRIPTION		
0.00-0.50	B1						Very stiff reddish brown sandy CLAY with occasional rootlets. (MADE GROUND)		
0.50-0.95	U2	76				(1.50)			
1.00	J3						below 1.10m, with occasional subrounded fine to medium gravel		
1.10-1.55	SJ4	N15							
1.11-1.56	B5			29.50		1.50		MG	
1.55-2.00	CB6	N37					Dense brown slightly sandy to sandy subangular to subrounded fine to coarse GRAVEL of predominantly quartzite. (FLUVIAL DEPOSITS)		
2.55-3.00	CB7	N38							
3.55-4.00	CB8	N44							
4.55-5.00	CB9	N44				(6.10)			
5.55-6.00	CB10	N56							
7.00-7.45	CB11	N54							
				23.40		7.60		F	
7.60-7.68	SJ12	(35* for 75mm)					CLAY (as sheet 2)	MMG	

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing	Casing Dia	Water Dpt	From	To	Hours	From	To	
10-9-90	1800	8.60	4.00	150mm		7.60	8.60	1.0	1.70	8.60	
11-9-90	0800	8.60	4.00	150mm	3.10	8.60	9.20	1.0			
11-9-90	1800	11.25	10.50	150mm	6.10	10.50	11.00	1.0			

All dimensions in metres Scale 1:50	Client Department of Transport	Method Cable Percussion	Logged By IRC

Form A1

British Geological Survey

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

SK43SE 151

BOREHOLE LOG

Project	DERBY SOUTHERN BYPASS GROUND INVESTIGATION CONTRACT 4						BOREHOLE No
Job No	8 1 1 3 0	Date 10-9-90	Ground Level (m AOD) 31.00	Co-Ordinates (Local) E 66,755.5 N 100,396.9			992
Contractor	Soil Mechanics Limited						Sheet 2 of 2

SAMPLES & TESTS			Water	STRATA				Geology	Instrument backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth Thickness	DESCRIPTION		
8.50-8.95	SJ13	N61					Firm greenish grey and reddish brown very silty CLAY. (MERCIA MUDSTONE GROUP) between 7.60 and 8.00m, with occasional angular up to fine gravel sized lithorelicts between 8.60 and 10.50m, with occasional angular up to fine gravel sized mudstone lithorelicts		
8.51-8.96	B14					(2.70)			
9.20-9.65	SJ15	N29							
9.21-9.66	B16			20.70		10.30		MMG	
10.50-10.70	SJ17	(35 for 50mm)				(0.95)	Stiff reddish brown mottled greenish grey very silty CLAY with occasional gypsum veins. (MERCIA MUDSTONE GROUP)		
11.00-11.21	SJ18	(35 for 60mm)		19.75		11.25		MMG	
							Borehole complete at 11.25m		

Boring Progress and Water Observations

Date	Time	Depth	Casing	Casing Dia	Water Dpt
10-9-90	1800	8.60	4.00	150mm	
11-9-90	0800	8.60	4.00	150mm	3.10
11-9-90	1800	11.25	10.50	150mm	6.10

Chiselling

From	To	Hours
7.60	8.60	1.0
8.60	9.20	1.0
10.50	11.00	1.0

Water Added

From	To
1.70	8.60

GENERAL REMARKS

All dimensions in metres Scale 1:50	Client Department of Transport	Method Cable Percussion	Logged By IRC

Form A1

Holst Soil Engineering Limited

BOREHOLE LOG

Borehole No. 1

SK 43 SE 284
4723 3453

Contract No. SI.2467/F.3243
Location Petersham Road
Client Erewash Borough Council
Method of Boring Percussion
Diameter of Borehole 150mm

Sheet 1 of 1
Chainage
Ground Level 37.46m A.O.D.
Date 16.11.75

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	Ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.40	0.40						
Stiff grey brown sandy stony CLAY		1.10	0.70	0.50 □	62	15	15.3	1995	
Medium dense SAND and GRAVEL		4.90	3.80	1.50 I 2.50 I 4.00 I					16 14 16
Highly weathered red silty MARL		9.50	4.60	5.50 □ 7.00 □ 8.50 □	98 90 21	0 5 7	22.9 25.3 27.6	2155 2155 2005	
Moderately weathered hard red MARL		10.00	0.50	9.80 I					50for 150mm

Key

□ Undisturbed Sample
O Disturbed Sample
△ Water Sample
I Penetration Test
Ø Angle of Friction
m.c. Moisture Content
γ Bulk Density
N S.P.T. Value
c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Water struck at 1.70m
Water standing level 1.70m

Water levels are subject to seasonal or tidal variations and should not be taken as constant

British Geological Survey

Holst Soil Engineering Limited

Borehole No. 3

BOREHOLE LOG

SK 43 SE 286
4730 3419

Contract No. ..SI.2467/F.3243.....
Location .....Perersham Road.....
Client....Erewash Borough Council.....
Method of Boring.....Percussion.....
Diameter of Borehole .....150mm.....

Sheet ..1..of ...1.....
Chainage.....
Ground Level ..36.27m A.O.D...
Date....18.11.75.....

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	ø deg	m.c. %	y Kg/cu.m	N
TOPSOIL		0.30	0.30						
Grey brown very stony sandy CLAY		1.20	0.90						
Medium compact medium grained SAND and GRAVEL				1.50 I					19
				2.50 I					16
				3.50 I					21
		4.60	3.40						
Highly weathered red/brown silty MARL with occasional bands of green marl				5.00 U	41	7	19.3	2040	
				6.50 U	124	0	28.2	2205	
				8.00 U	131	6	26.3	2235	
				9.50 U	142	8	22.7	2260	
		10.30	5.70						
Moderately weathered hard MARL		11.00	0.70	10.50 I					50for 100mm

Key

- U Undisturbed Sample
- O Disturbed Sample
- Δ Water Sample
- I Penetration Test
- Ø Angle of Friction
- m.c. Moisture Content
- y Bulk Density
- N S.P.T. Value
- c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Water struck at 2.50m
Water standing level 2.50m

Water levels are subject to seasonal or tidal variations and should not be taken as constant

British Geological Survey

Holst Soil Engineering Limited

BOREHOLE LOG

Borehole No. 3

SK 43 SE 286 4730 3419

Contract No. ...SI.2467/F.3243.....
Location .....Pareysham Road.....
Client....Erewash Borough Council.....
Method of Boring.....Percussion.....
Diameter of Borehole .....150mm.....

Sheet .1..of ...1.....
Chainage.....
Ground Level ..36.27m A.O.D...
Date....18.11.75.....

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.30	0.30						
Grey brown very stony sandy CLAY		1.20	0.90						
Medium compact medium grained SAND and GRAVEL				1.50 I					19
				2.50 I					16
				3.50 I					21
		4.60	3.40						
Highly weathered red/brown silty MARL with occasional bands of green marl				5.00 ▯	41	7	19.3	2040	
				6.50 ▯	124	0	28.2	2205	
				8.00 ▯	131	6	26.3	2235	
				9.50 ▯	142	8	22.7	2260	
		10.30	5.70						
Moderately weathered hard MARL		11.00	0.70	10.50 I					50for 100mm

Key

- ▯ Undisturbed Sample
- O Disturbed Sample
- △ Water Sample
- I Penetration Test
- Ø Angle of Friction
- m.c. Moisture Content
- γ Bulk Density
- N S.P.T. Value
- c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Water struck at 2.50m
Water standing level 2.50m

Water levels are subject to seasonal or tidal variations and should not be taken as constant

Holst Soil Engineering Limited

BOREHOLE LOG

Borehole No. 7

SK 43 SE 290
4739 3383

Contract No. SI.2467/F.3243
Location Petersham Road
Client Erewash Borough Council
Method of Boring Percussion
Diameter of Borehole 150mm

Sheet 1 of 1
Chainage
Ground Level 34.50m. A.O.D.
Date 21.11.75

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.40	0.40						
Medium dense grey brown very sandy GRAVEL with bands of sand				1.00 I					27
				2.00 I					22
				3.00 I					15
		3.50	3.10						
Completely weathered red and light grey green silty MARL				4.50 □	76	0	20.1	2090	
				6.00 □	89	6	20.2	2085	
				7.50 □	76	6	18.2	1965	
		8.20	4.70						
Moderately weathered hard red MARL				8.90 I					50for 70mm
		9.00	0.80						

Key

□ Undisturbed Sample
O Disturbed Sample
△ Water Sample
I Penetration Test
Ø Angle of Friction
m.c. Moisture Content
γ Bulk Density
N S.P.T. Value
c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Water struck at 2.40m
Final standing level 2.40m

Water levels are subject to seasonal or tidal variations and should not be taken as constant

British Geological Survey

Holst Soil Engineering Limited

Borehole No. 7

BOREHOLE LOG

SK 43 SE 290 4739 3383

Contract No. SI.2467/F.3243
Location ..... Petersham Road .....
Client ..... Erewash Borough Council ..
Method of Boring ..... Percussion .....
Diameter of Borehole 150mm .....

Sheet ... 1 of ..... 1 .....
Chainage .....
Ground Level ..... 34.50m. A.O.D.
Date ... 21.11.75 .....

Description of Strata	Legend	Depth Below G.L.(m)	Thickness of Strata(m)	Type of Sample	c KN/sq.m	ø deg	m.c. %	γ Kg/cu.m	N
TOPSOIL		0.40	0.40						
Medium dense grey brown very sandy GRAVEL with bands of sand				1.00					27
				2.00					22
				3.00					15
		3.50	3.10						
Completely weathered red and light grey green silty MARL				4.50	76	0	20.1	2090	
				6.00	89	6	20.2	2085	
				7.50	76	6	18.2	1965	
		8.20	4.70						
Moderately weathered hard red MARL		9.00	0.80	8.90					50for 70mm

Key

- □ Undisturbed Sample
- O Disturbed Sample
- △ Water Sample
- I Penetration Test
- ø Angle of Friction
- m.c. Moisture Content
- γ Bulk Density
- N S.P.T. Value
- c Apparent Cohesion

Remarks (Observations of Ground Water etc.)

Water struck at 2.40m
Final standing level 2.40m

Water levels are subject to seasonal or tidal variations and should not be taken as constant

British Geological Survey

N.G.R. 443M. 3475

141 SK43SE 131

Sandiacre.

Well at Wilsthorpe (Derbyshire), about 1 mile south of Sandiacre.

One-inch Map (N.S.) 141. Six-inch Map 51 SW.

Date of sinking, 1889–1890.

Height above O.D. about 140 feet.

From J. SHIPMAN, 'Geology of Stapleford and Sandiacre,' *Trans Notts. Nat. Soc.*, 1891.

		Thickness. Ft.	Ins.	Depth. Ft.	Ins.
Glacial Drift? (*see* note at foot).	Soil	2	0	2	0
	Stiff clay (brick-earth)	2	0	4	0
	Gravel, sand, and small bits of Keuper shale, with quartzite pebbles	4	0	8	0
	Red and blue marl, with quartzite pebbles	31	0	39	0
	Stiff red clay, with small lumps of blue shale, and fewer pebbles	23	0	62	0
Keuper Marl.	Stiff clay	8	0	70	0
	Red marl	3	0	73	0
	Red marl and blue shale	23	0	96	0
	Thin seams of sandstone and blue marl	3	6	99	6
	Hard sandstone in thin beds, with shale partings and thin veins of gypsum ...	19	6	119	0
	Hard grey marl, with thin bands of sandstone	34	0	153	0
	Hard calcareous sandstone	1	6	154	6
	Red marl	1	6	156	0
	Sandstone	6	0	162	0
	Red and green marl and shale	68	0	230	0
	Red and bluish marl	15	0	245	0
Waterstones (*see* note at foot).	Red sandy marlstone	6	0	251	0
	Red marl	6	0	257	0
	Conglomerate composed of small pebbles	6		257	6
	Red marl	20	6	278	0
	Hard shale	1	6	279	6
	Red sandy marl	9	0	288	0
	Coarse red sandstone with subangular pebbles			[288	6]
Bunter.	Coarse red and white sandstone, with subangular pebbles	2	0	290	0
	Bluish grey sandstone, with subangular pebbles	10	0	300	0
	Stiff pale greenish-blue sandy marl, highly calcareous	40	0	340	0
	Light reddish coarse sandrock (calcareous)	3	0	343	0
		28	0	371	0

Shipman classed the uppermost 60 ft. of clay as Boulder Clay, because of th supposed admixture of pebbles with Keuper Marl to this depth; but, from the loca conditions, it is more likely that these were introduced accidentally during borin operations. His classification of the Keuper and Bunter has been altered in accord ance with our interpretation of the district.

Shipman states that the boring "was abandoned at a total depth of 371 feet owing to the extreme hardness of the water—about 143°—which rendered it quite unfit for domestic purposes." [I was then asked to select another site, and a boring was made in the Inverse plain by the side of the new Methodist Chapel on the Derby road. Here a copious supply of excellent water was reached at a depth of 45 feet from the surface, in the Bunter sandstone. So abundant was the supply, in fact, that the water was pumped up at a rate of 240,000 gallons a day, for several days in succession, without any perceptible diminution of the supply. A large well has been sunk here and waterworks have now been established."

Average daily supply from the second well (May, 1911) 120,000 gallons (J. B. H., *see* footnote on p. 47). Analysis, p. 140.

3. 15.—Sandiacre: Stapleford and Sandiacre Water Company. (*See* p. 111.)

(Communicated by Mr. J. B. HILL of H.M. Local Government Board.)

Converted into parts per 100,000.

Total dissolved solid matter	44·44
Ammoniacal matter... ...	·01
Albuminoid organic matter..	·04
Nitrates	1·71
Nitrites	·00
Chlorides	2·85
Hardness, total	33·28
" temporary ...	23·57
" permanent ...	9·35
Oxygen consumed in 3 hours	·01

Physical examination satisfactory.

141/131.

SK 43 SE
SK 4719 3475.
c140 ft AOD.

SK43/2

Site now under motorway embankment.
Never used due to hardness, filled.

Wellat Wilsthorpe,
Sandiacre
Derbyshire.

10.12.79 IL

K43SE/33
141/151

Long Eaton—Map 141.

42. WILSTHORPE, bore at. Map 51 S.W. Height above O.D. about 150 ft. (c 152m)

Glacial Deposits (See note below)	Soil	2	0	2	0
	Stiff clay (brick-earth)	2	0	4	0
	Gravel, sand, and small bits of Keuper shale, with quartzite pebbles	4	0	8	0
	Red and blue marl with quartzite pebbles	31	0	39	0
	Stiff red clay with small lumps of blue shale and fewer pebbles	23	0	62	0
Keuper Marl	Stiff clay	8	0	70	0
	Red marl	3	0	73	0
	Red marl and blue shale	23	0	96	0
	Thin seams of sandstone and blue marl	3	6	99	6
	Hard sandstone in thin beds, with shale partings and thin veins of gypsum	19	6	119	0
	Hard grey marl with thin bands of sandstone	34	0	153	0
	Hard calcareous sandstone	1	6	154	6
	Red marl	1	6	156	0
	Sandstone	6	0	162	0
	Red and green marl and shale	68	0	230	0
	Red and bluish marl	15	0	245	0
Waterstones	Red sandy marlstone	6	0	251	0
	Red marl	6	0	257	0
	Conglomerate composed of small pebbles	0	6	257	6
	Red marl	20	6	278	0
	Hard shale	1	6	279	6
	Red sandy marl	[9	0]	288	0
Bunter	Coarse red sandstone with sub-angular pebbles	2	0	290	0
	Coarse red and white sandstone, angular pebbles	10	0	300	0
	Bluish grey sandstone with sub-angular pebbles	40	0	340	0
	Stiff pale greenish-blue sandy marl, highly calcareous	3	0	343	0
	Light reddish coarse sand-rock (calcareous)	28	0	373	0

Should be 371 acc. Shipman

Shipman classed the uppermost 60 ft. of clay as Boulder Clay because of the supposed mixture of pebbles with Keuper Marl to this depth; but, from local conditions, it is more likely that these were introduced accidentally during boring operations. His classification of the Keuper and Bunter has been altered in accordance with our interpretation of the district.

Shipman states that the boring "was abandoned at a total depth of 371 ft., owing to the extreme hardness of the water—about 143°, which rendered it quite unfit for domestic purposes." "I was then asked to select another site, and a boring was made in the alluvial plain by the side of the new Methodist Chapel on the Derby Road. Here a copious supply of excellent water was reached at a depth of 45 ft. from the surface, in the Bunter Sandstone."

'The Water Supply of Nottinghamshire' (*Mem. Geol. Surv.*), 1914, p. 111.

Published in
'Wells & Springs
of Derbyshire'
page 100, 101

SK43SE/33

WELL BORING at WILSTHORPE County Derby

Geol. map 1 in. map New Series ~~1 in.~~ 141 6 in. map

Made by Date 1889-1890

Sunk feet. Bored 371 feet.

Communicated by From J. Shipman, 'Geology of Stapleford and Sandiacre' Trans Notts. Nat. Hist. Soc., 1891

Height above Ordnance Datum Rest level of water

Yield

Quality (with copy of analysis on separate sheet) Too hard. Abandoned

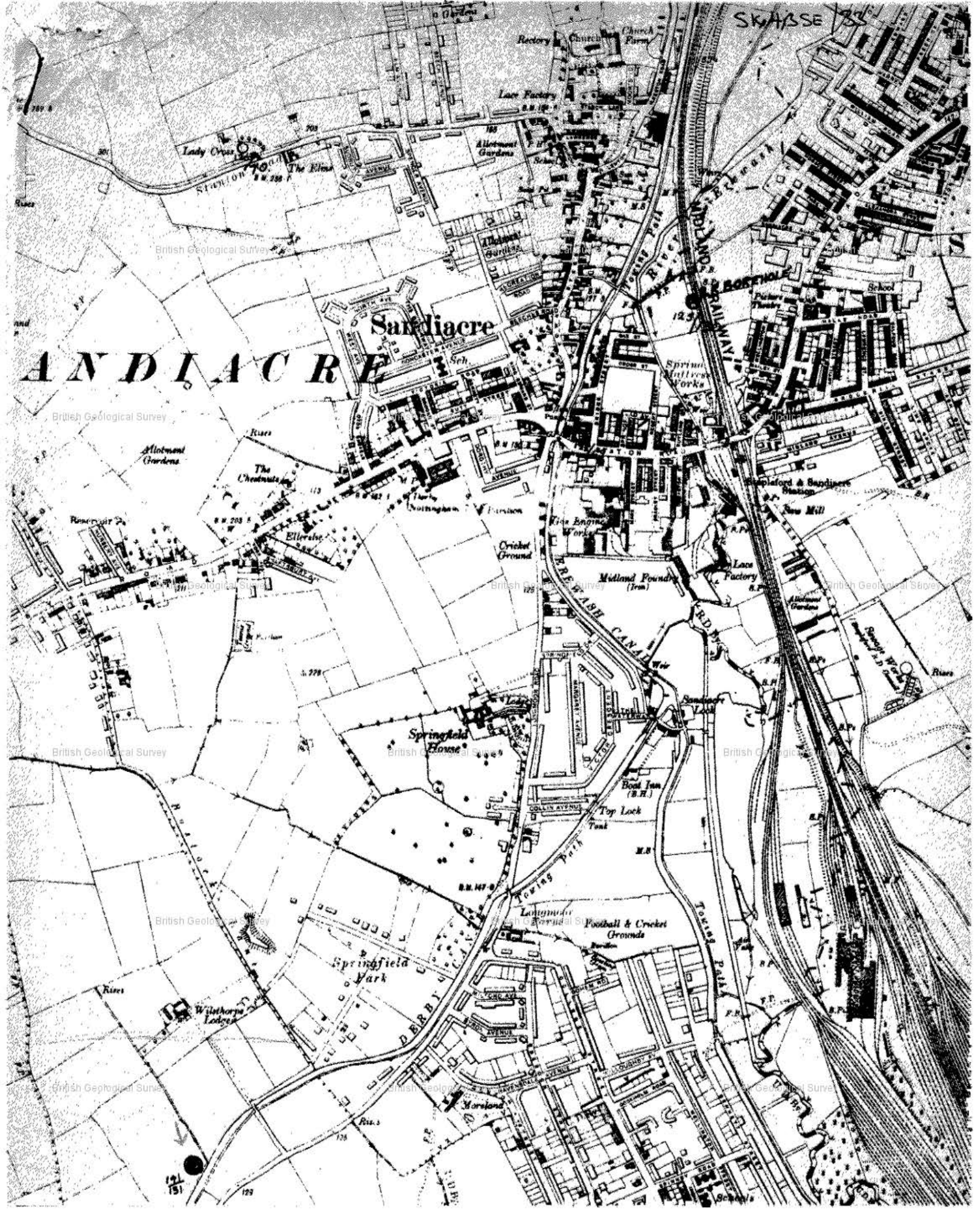
GEOLOGICAL FORMATION.	NATURE OF STRATA.	THICKNESS. Feet.	THICKNESS. Inches.	DEPTH. Feet.	DEPTH. Inches.
	Soil	2	-	2	-
Glacial Drift	Stiff clay (brick-earth)	2	-	4	-
	Gravel, sand and small bits of Keuper shale, with quartzite pebbles	4	-	8	-
	Red and blue marl, with quartzite pebbs.	31	-	39	-
	Stiff red clay, with small lumps of blue shale, and fewer pebbles	23	-	62	-
Keuper Marl	Stiff clay	8	-	70	-
	Red marl	3	-	73	-
	Red marl and blue shale	23	-	96	-
	Thin seams of sandstone and blue marl	3	6	99	6
	Hard sst. in thin beds, with shale partings and thin veins of gypsum	19	6	119	-
	Hard grey marl, with thin bands of sst.	34	-	153	-
	Hard calcareous sst.	1	6	154	6
	Red marl	1	6	156	-
	Sandstone	6	-	162	-
	Red and green marl and shale	68	-	230	-
	Red and bluish marl	15	-	245	-
Waterstones	Red sandy marlstone	6	-	251	-
	Red marl	6	-	257	-
	Conglomerate composed of small pebbs.	-	6	257	6
	Red marl	20	6	278	-
	Hard shale	1	6	279	6
	Red sandy marl	9	-	288	-
	Coarse red sst. with subangular pebbs.	2	-	290	-
Bunter	Cse. red and white sst., with subangular pebbles	~~10~~ 10	-	~~300~~ 300	-
	Bluish grey sst. with subangular pebbs.	46	-	346	-
	Stiff pale greenish-blue sandy marl highly calcareous.	3	-	343	-
	Light reddish coarse sand-rock (calcs.)	28	-	371	-

Shipman classed the uppermost 60ft. of clay as Boulder Clay, because of the supposed mixture of pebbles with Keuper Marl to this depth; but, from local conditions, it is more likely that these were introduced accidentally during boring operations. His classification of the Keuper and Bunter has been altered in accordance with our interpretation of the district.

P T.O.

GEOLOGICAL SURVEY AND MUSEUM,
JERMYN STREET, LONDON. S.W. 1.

(B10619). Wt. 15824—S123. 2500. 11/25. Gp. 160. O.A.


Sandiacre
ANDIACRE
Rectory
Church
Church Farm
Lace Factory
Lady Cross
Allotment Gardens
The Elms
Station
Midland Railway
River Erewash
Borehole
School
Picture Theatre
Sandiacre Bottle Works
Allotment Gardens
The Chestnuts
Reservoir
Ellerslie
Nottingham
Cricket Ground
Fire Engine Works
Stapleford & Sandiacre Station
New Mill
Midland Foundry (Iron)
Lace Factory
Erewash Canal
Weir
Springfield House
Lodge
Boat Inn (P.H.)
Top Lock
Tank
Towing Path
Longmeadow Recreation Ground
Football & Cricket Grounds
Springfield Park
Derby
Rd.
Willthorpe Lodges
Horsland
Schools

BOREHOLE RECORD - Cable Percussion

SK43SE439 Sheet 1 of 1

Project CHURCH WILNE - RIVER TRENT

Engineer CHARLES HASWELL & PARTNERS

Borehole BH41

Coordinates 46547 32100

Client SEVERN TRENT WATER LIMITED

Project No 96-8957

Sampling				Properties			Strata			
Depth	Sample Type	Depth Cased	Depth to Water	Strength kN/m²	W %	SPT N	Description	Depth	Legend	Level OD
0.00 - 1.20	B						TOPSOIL.	0.20		
							Stiff brown and red brown friable silty sandy gravelly CLAY. Very gravelly in parts. Gravel fraction is fine to coarse sized and rounded to angular. MADE GROUND.	0.90		
1.20 - 1.65	U27	1.20					Soft yellow brown very sandy gravelly CLAY. Gravel fraction is fine to coarse sized and rounded to subangular. ALLUVIUM.			
1.65 - 2.10	B									
2.10 - 2.55	U40	1.50						2.40		
2.55 - 3.10	B						Medium dense light brown sandy GRAVEL. ALLUVIUM.	3.10		
3.10 - 4.10	B						Soft to firm brown and red brown very sandy gravelly CLAY. ALLUVIUM.			
3.10 - 3.55	C	3.00				19		4.10		
4.10 - 4.55	SJ	4.00	3.30			40	Medium dense to dense brown slightly sandy GRAVEL. Gravel is fine to coarse sized and rounded to subangular. RIVER TERRACE DEPOSITS.			
4.55 - 5.00	B					28				
5.10	JWX4									
5.00 - 5.45	C	NR	NR			28				
5.45 - 5.80	B									
5.80 - 5.90	J							5.80		
6.00 - 6.45	U53	6.00	5.00				Firm to stiff red brown friable very silty CLAY with some fine to medium gravel sized angular weak mudstone lithorelict fragments within the matrix. MERCIA MUDSTONE GROUP ZONES IVA/III.			
6.45	J									
6.45 - 6.60	J									
6.60 - 7.05	SJ	6.00	6.00			64	Becoming very stiff with depth.	7.05		

Boring				Progress				Groundwater				
Depth	Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	am (A) pm (P) Date	Depth Struck	Depth Cased	Depth after 20 mins	Depth Sealed	Remarks on Groundwater
7.05	150mm	Cable Percussion.	KS/TS	Start 7.05 End	6.00	6.00	12/12/96 P12/12/96 12/12/96	4.10	4.10	3.30	*	Medium inflow. * Partial at 6.00m.

Remarks

Inspection pit dug to 1.20m.
Falling head permeability test carried out.
Water added to assist boring from 1.90m to 4.10m.
Standpipe installed as follows:
Bentonite seal 6.00m to 7.00m.
19mm diameter slotted standpipe and pea gravel surround 6.00m to 1.00m.

geotechnics

Logged by: DMB

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres.

Scale: 1:50

BOREHOLE RECORD - Cable Percussion

SK43SE439 Sheet 1 of 1

Project CHURCH WILNE - RIVER TRENT

Engineer CHARLES HASWELL & PARTNERS

Borehole BH41

Coordinates 446547 32100

Client SEVERN TRENT WATER LIMITED

Project No 96-8957

Sampling

Depth	Sample Type	Depth Cased	Depth to Water
0.00 - 1.20	B		
1.20 - 1.65	U27	1.20	
1.65 - 2.10	B		
2.10 - 2.55	U40	1.50	
2.55 - 3.10	B		
3.10 - 4.10	B		
3.10 - 3.55	C	3.00	
4.10 - 4.55	SJ	4.00	3.30
4.55 - 5.00	B		
5.10	JWX4		
5.00 - 5.45	C	NR	NR
5.45 - 5.80	B		
5.80 - 5.90	J		
6.00 - 6.45	U53	6.00	5.00
6.45	J		
6.45 - 6.60	J		
6.60 - 7.05	SJ	6.00	6.00

Properties

Strength kN/m²	W %	SPT N
		19
		40
		28
		28
		64

Strata

Description	Depth	Legend	Level OD
TOPSOIL.	0.20		
Stiff brown and red brown friable silty sandy gravelly CLAY. Very gravelly in parts. Gravel fraction is fine to coarse sized and rounded to angular. MADE GROUND.	0.90		
Soft yellow brown very sandy gravelly CLAY. Gravel fraction is fine to coarse sized and rounded to subangular. ALLUVIUM.	2.40		
Medium dense light brown sandy GRAVEL. ALLUVIUM.	3.10		
Soft to firm brown and red brown very sandy gravelly CLAY. ALLUVIUM.	4.10		
Medium dense to dense brown slightly sandy GRAVEL. Gravel is fine to coarse sized and rounded to subangular. RIVER TERRACE DEPOSITS.	5.80		
Firm to stiff red brown friable very silty CLAY with some fine to medium gravel sized angular weak mudstone lithorelict fragments within the matrix. MERCIA MUDSTONE GROUP ZONES IVA/III. Becoming very stiff with depth.	7.05		

Boring

Depth	Dia	Technique	Crew
7.05	150mm	Cable Percussion.	KS/TS

Progress

Depth of Hole	Depth Cased	Depth to Water	am (A) pm (P)	Date
Start				12/12/96
7.05	6.00	6.00	P	12/12/96
End				12/12/96

Groundwater

Depth Struck	Depth Cased	Depth after 20 mins	Depth Sealed	Remarks on Groundwater
4.10	4.10	3.30	*	Medium inflow. * Partial at 6.00m.

Remarks

Inspection pit dug to 1.20m.
Failing head permeability test carried out.
Water added to assist boring from 1.90m to 4.10m.
Standpipe installed as follows:
Bentonite seal 6.00m to 7.00m.
19mm diameter slotted standpipe and pea gravel surround 6.00m to 1.00m.

geotechnics

Logged by: DMB

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres.

Scale: 1:50

TRIAL PIT RECORD

SK43SE 457

Project CHURCH WILNE - RIVER TRENT

Engineer CHARLES HASWELL & PARTNERS

Trial Pit TP147

Coordinates 446514 331993

Client SEVERN TRENT WATER LIMITED

Project No 96-8957

Face	A	B	C	D
	Depth		Level	

Ground Level



Elevation of Pit Faces

Trial Pit Logged by JT

Vertical Scale 1:50

Samples and Tests			Strata			
Depth	Type	Strength kN/m²	Face B Depth	Stratum Number	Description	Geological Classification
			1.20	1	See Hand Dug Pit log.	
1.30	B		1.40	2	Medium dense brown very silty sandy CLAY with some well graded gravel.	ALLUVIUM.

Excavation			
Date Excavated	17/12/96	Date Backfilled	17/12/96
Plant	JCB 3CX		
Shoring	NONE		
Stability	Stable.		

Dimensions



Groundwater

None encountered during excavation.

Remarks Pit abandoned at 1.40m due to encountering a large cast iron water pipe (pipe not damaged). Electric cable prevented pit being moved closer to the Severn Trent works.

geotechnics

Symbols and abbreviations are explained on the accompanying key. All linear dimensions are in metres.

FOUNDATION ENGINEERING Ltd.

BOREHOLE LOG

LOCATION : NOTTINGHAM AQUEDUCT

BOREHOLE No. : 1

BOREHOLE DIA. : 8"

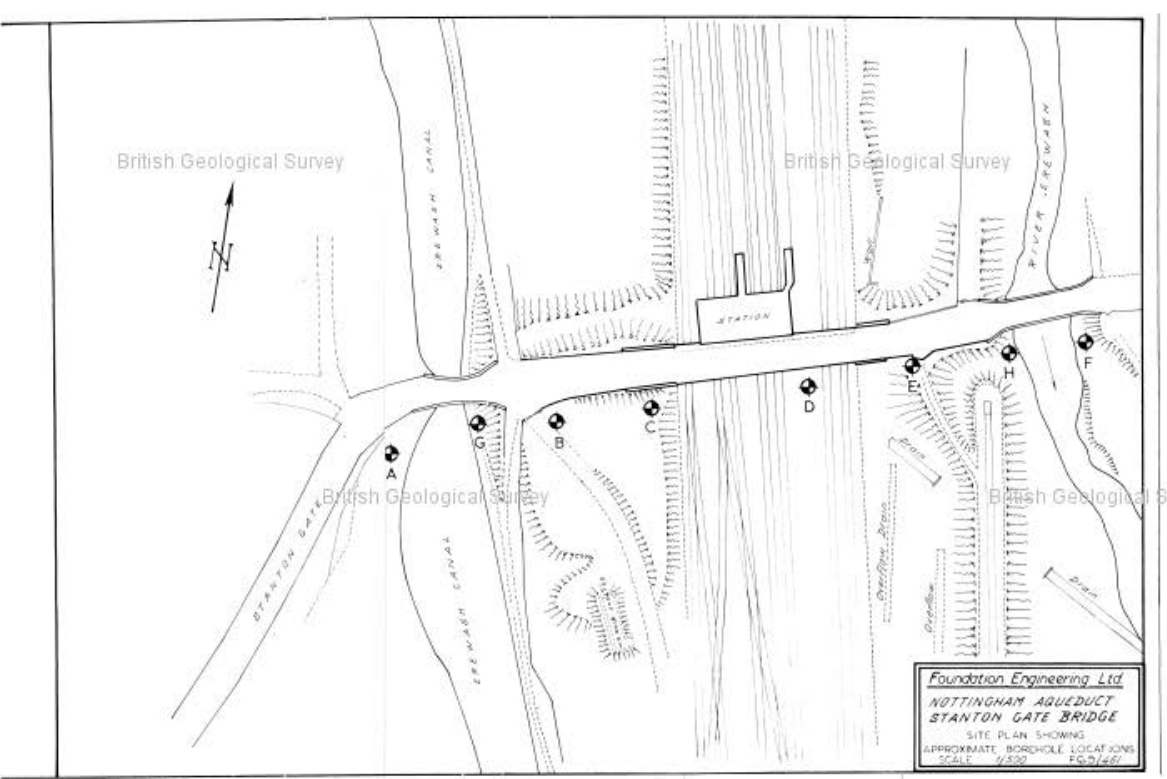
GROUND LEVEL : 102' O.D.

DATE (Start) : 9 · 1 · 66

WATER LEVEL : See notes

Dates	Description	Thickness	Depth	Sample	Remarks
	MADE GROUND - red marl	4'-0"	0'-0"		
	Firm mottled brown & grey CLAY	4'-0"	4'-0"	1	
	Compact grey sandy c.m.f. GRAVEL	7'-0" +	8'-0"	2	
			15'-0"	3	
	Note: With borehole cased & cleaned out to 15'-0" water rose from 6'-6" to 4'-6" during lunch break.			4	BOREHOLE COMPLETE

BOREHOLE SCALE : 1" = 5' • : DISTURBED SAMPLE ▮ : UNDISTURBED SAMPLE + STANDARD PENETRATION TEST



British Geological Survey

BGS Field Slip
SK 45 SE 83

DEPARTMENT OF THE ENVIRONMENT — RECORD OF BOREHOLE No. 43 SE 3

CONTRACT PECD 7/1/112 : RESEARCH PROGRAMME TO ASSESS THE POTENTIALLY WORKABLE SAND AND GRAVEL RESOURCES IN THE SOAR VALLEY LEICESTERSHIRE.

Sheet No. 1 of 1

DRILLING CONTRACTOR
FOUNDATION ENGINEERING LTD.

COORDINATES
446590E 330548N

DATE
18.9.84

DRILLING METHOD/MACHINE
Cable Tool Percussion/Pilcon Wayfarrer

GROUND LEVEL
29.7m OD

HOLE DIAMETER
200 mm

SAMPLE DEPTH (m)	PARTICLE SIZE SUMMARY % (mm) BS 5930 : 1981 cobbles >60	Gravel 60–2	Sand 2–0.06	Fines <0.06	BS 882 : 1983 >40	40–5	5–0.075	<0.075	STRATA DESCRIPTION (According to BS 5930 : 1981)	DEPTH & THICKNESS (m)	RAISED LEVEL (M.O.D.)	SYMBOLIC LOG
									Stiff, brown, slightly sandy, slightly gravelly CLAY			
									Stiff, green brown mottled light brown, silty CLAY with scattered coal fragments	0.75	28.95	
									Soft, light grey, very sandy CLAY	1.20	28.50	
1.60 – 2.00	–	13	75	12	–	10	77	13	Very soft, light brown, gravelly, clayey, medium SAND	1.60 (0.40)	28.10	
2.00 – 3.00	4	78	17	1	20	48	31	1	Brown, subangular to rounded, sandy fine to coarse GRAVEL with cobbles	2.00 (2.10)	27.70	
3.50 – 4.10	14	71	14	1	28	51	20	1		4.10	25.60	
4.10 – 6.50	–	74	25	1	8	60	31	1	Light yellow brown, subangular to rounded, very sandy, fine to coarse GRAVEL	(2.70)		
									Hard to very weak, red brown mottled green grey, very clayey SILTSTONE with gypsum veining	6.80 7.30	22.90 22.40	
									END OF BOREHOLE 7.30 m.			

REMARKS:–
Water struck at 1.60 m.
Water level after drilling 1.40 m.

Overburden thickness 1.60 m.
Mineral thickness 5.30 m.
Overburden ratio 0.31

ENGINEERING GEOLOGY LTD.
in association with
GEOMORPHOLOGICAL SERVICES LTD.

SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

SK 43 SE 85

A564 DERBY SOUTHERN BYPASS AND DERBY SPUR PRELIMINARY GROUND INVESTIGATION

BOREHOLE No. 143
SHEET 1 OF 5
COORDINATES 446738.6 E, 330561.3 N
GROUND LEVEL 31.19 mOD

Field Work by: Soil Mechanics Limited
Method: Cable tool boring
Dates: 21.4.88
Hole Dimensions: 150mm
Casing Dimensions: 150mm

Date	Casing Depth (m)	Water Depth (m)	Samples/Insitu Tests: Depth (m)	Type No.	Test Result	Change of Strata: Legend	Depth (m)	Reduced Level	Description of Strata	Piezo/ S'pipe
							(0.80)		Firm brown sandy CLAY with some gravel (Foreman's description) (MADE GROUND)	
			0.60 - 1.20	B1			0.80	30.39		
							(0.25)		Stiff blue grey sandy silty CLAY (Foreman's description) (MADE GROUND)	
							1.05	30.14		
							(1.25)		Yellow brown very clayey SAND with occasional pockets of dark grey organic sand and rare rounded gravel (ALLUVIUM)	
	2.00	1.95	1.55 - 2.00	U2	'18'					
		20	2.10 - 2.55	J3	S (10)		2.30	28.89		
		2.30	2.40 - 2.90	B4						
	3.00		3.05 - 3.50	B5	C (21)				Medium dense brown SAND and subrounded to subangular GRAVEL with occasional cobbles (RIVER SANDS AND GRAVELS)	
			3.10 - 3.70							
	4.00									
			4.50 - 4.95	B6	C (25)		(5.00)			
	5.00		4.60 - 5.20							
	6.00									
			6.05 - 6.50	B7	C (10)					
			6.20 - 6.70							
				W8						
							7.30	23.99	Red brown moderately to highly weathered MUDSTONE very weak to weak with frequent gypsum veining and with much CLAY KEUPER MARL : ZONE III)	
			7.70	J9	S		(0.70 pen)			
21.4.88	7.80	3.20	7.80 - 8.00	J10	50 for 72mm		8.00	23.19		
									BORING COMPLETE AT 8.00m ROTARY FOLLOW ON	

Remarks
1. Hand excavated inpsection pit to 1.50m
2. Water added to assist boring 2.30 to 4.50m

SCALE 1:50

Disturbed Samples W = Groundwater; J = Jar; B = Bulk
Undisturbed Samples Soil Sample
Insitu Tests Depth groundwater struck(m)and depth water rose to in X minutes; V (30) = Vane Shear Strength in KN/m²; C or S = SPT cone or spoon (25) = N value; R = Penetration for seating blows

FIGURE A1

British Geological Survey

SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

SK 43 SE 85

A564 DERBY SOUTHERN BYPASS AND DERBY SPUR PRELIMINARY GROUND INVESTIGATION

DRILLHOLE No 143

SHEET 2 OF 5

COORDINATES E N

GROUND LEVEL m OD

Fieldwork by: Soil Mechanics Limited
Method: Rotary core drilling (air flush)
Dates: 26 to 28.4.88
Core Diameter: 90mm
Casing Diameter: 121mm

Drilling						Change of Strata			Description of Strata		Installation
Date	Depth (m)	Run	TCR %	RQD %	Test or I_f (mm)	Legend	Depth (m)	Reduced Level	Detail	Main	S'pipe
									CABLE TOOL BORING (As sheet 1)		a
	8.10						8.10	23.09			c
			87	26	NI 60 160		(3.40)			Red brown mottled light greenish grey thinly laminated extremely closely fractured slightly to moderately weathered MUDSTONE weak. With much gypsum veining. And with very closely to closely spaced subhorizontal irregular rough fractures (KEUPER MARL : ZONE II – III)	e
	9.10		10	0							

Remarks (Ground water seepages, Morning water levels, flush returns)

SCALE 1:50

Disturbed Samples
W – Groundwater
J – Jar

Core Runs
50 / 100
core recovery %

Insitu Tests
Depth groundwater struck (m)
CorS – SPT cone or spoon
[25] – N value
* – Penetration for seating blows

FIGURE A2

British Geological Survey

SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

SK 43 SE 85

A564 DERBY SOUTHERN BYPASS AND DERBY SPUR PRELIMINARY GROUND INVESTIGATION

DRILLHOLE No 143

SHEET 3 OF 5

COORDINATES E N

GROUND LEVEL m OD

Fieldwork by: As sheet 2
Method:
Dates:
Core Diameter:
Casing Diameter:

Drilling						Change of Strata			Description of Strata		Piezo/ S'pipe
Date	Depth (m)	Run	T CR %	RQD %	Test or I_f (mm)	Legend	Depth (m)	Reduced Level	Detail	Main	
	10.10		10	0	NI 60 160		(3.40)			KEUPER MARL (As sheet 1)	
	11.10		42	10			11.50	19.69			
	12.00		50	12	S 50 for 50mm NI 90 240		(2.00)			Red brown and light greenish grey moderately to slightly weathered MUDSTONE weak to moderately weak with some to much gypsum veins and inclusions. And with closely spaced subhorizontal to 40° irregular rough fractures (KEUPER MARL : ZONE II – III)	
	13.00		95	53	CS 1		13.50	17.69	50mm fibrous gypsum vein		
			82	23	NI 60 130		(2.00)		Red brown moderately to slightly weathered MUDSTONE weak to moderately weak. With occasional medium to closely spaced 5 to 10mm fibrous gypsum veins. And with occasional to some light greenish grey reduction spots. And with medium to closely spaced highly fractured and highly weathered zones generally non-intact. (KEUPER MARL : ZONE II – III)		e
26.4.88	15.00										
27.4.88			66	19			15.50	15.69			
	16.50		99	49	NI 90 190		(4.00)			Red brown slightly weathered MUDSTONE moderately weak to moderately strong with gypsum veins and with occasional light greenish grey reduction spots. (KEUPER MARL : ZONE II)	
	18.00		66	33			19.50	11.69			
	20.00				NI 120 370					KEUPER MARL (As sheet 3)	

Remarks (Ground water seepages, Morning water levels, flush returns)

SCALE 1:50

Disturbed Samples
W – Groundwater
J – Jar

Core Runs
50 / 100 core recovery %

Insitu Tests
Depth groundwater struck (m)
C or S – SPT cone or spoon
(25) – N value
* – Penetration for seating blows

FIGURE A2

British Geological Survey

SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

SK 43 SE 85

A564 DERBY SOUTHERN BYPASS AND DERBY SPUR PRELIMINARY GROUND INVESTIGATION

DRILLHOLE No 143
SHEET 4 OF 5
COORDINATES E N
GROUND LEVEL m OD

Fieldwork by: As sheet 2
Method:
Dates:
Core Diameter:
Casing Diameter:

Drilling: Date	Depth (m)	Run	TCR %	RQD %	Test or If (mm)	Change of Strata: Legend	Depth (m)	Reduced Level	Description of Strata: Detail	Description of Strata: Main	Piezo S'pipe
			90	24	NI 120 370		(1.40)			Red brown fresh to slightly weathered SANDSTONE moderately strong with occasional light greenish grey reduction spots and some gypsum veins (KEUPER MARL : ZONE I – II)	
	20.50				CS 2		20.90	10.29			
			98	86	30 160 290		(1.70)			Red brown fresh to slightly weathered MUDSTONE moderately weak with occasional light greenish grey reduction spots and some gypsum veins. (KEUPER MARL : ZONE I – II)	
	22.00						22.60	8.59			
			99	49	NI 90 240		(1.40)		Red brown. Very closely spaced subhorizontal planar rough fractures	Generally light greenish grey fresh to slightly weathered SILTSTONE moderately weak to moderately strong with some gypsum veins (KEUPER MARL : ZONE I – II)	
	24.00						24.00	7.19			
			22	0	NI 30 80				Poor quality core due to bolt falling down hole and advancing in front of core barrel.	Red brown fresh to slightly weathered MUDSTONE moderately weak in parts weak, with occasional light greenish grey reduction spots. With extremely to very closely spaced gypsum veins. And with very closely to closely spaced subhorizontal irregular rough fractures. (KEUPER MARL : ZONE I – II)	e
27.4.88 28.4.88	26.65						(6.05 pen)		Light greenish grey		
			99	50	NI 95 220				Non-intact.		
	28.05								Light greenish grey		
			97	65							

Remarks (Ground water seepages, Morning water levels, flush returns)

SCALE 1:50

Disturbed Samples: W – Groundwater; J – Jar
Core Runs: 50 core recovery 100 %
Insitu Tests: Depth groundwater struck (m); C or S – SPT cone or spoon [25] – N value; ⋇ – Penetration for seating blows

FIGURE A2

SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

SK 43 SE 86

A564 DERBY SOUTHERN BYPASS
AND DERBY SPUR
PRELIMINARY GROUND
INVESTIGATION

BOREHOLE No. 144
SHEET 1 OF 1
COORDINATES
446682.1 E
330507.8 N
GROUND LEVEL
31.10 mOD

Field Work by: Soil Mechanics Limited
Method: Cable tool boring
Dates: 22.4.88
Hole Dimensions: 150mm
Casing Dimensions: 150mm

Date	Casing Depth (m)	Water Depth (m)	Samples/Insitu Tests: Depth (m)	Type No.	Test Result	Change of Strata: Legend	Depth (m)	Reduced Level	Description of Strata	Piezo/ Spipe
			0.30 - 0.60	B1			0.20	30.90	TOPSOIL	
							(0.40)		Brown clayey SAND with much up to cobble size pieces of brick (MADE GROUND)	
							0.60	30.50		
			0.60 - 1.20	B2					Soft to firm orange brown sandy becoming very sandy CLAY with a little fine and medium gravel	
							(1.10)			
	1.50	1.40							(ALLUVIUM)	
		20								
		1.70	1.55 - 2.00	U3	'20'		1.70	29.40		
			2.10 - 2.55	B4	S (7)				Loose becoming medium dense brown SAND and subrounded GRAVEL with occasional pockets of brown clay	
			2.10 - 2.70							
									(RIVER SANDS AND GRAVELS)	
	3.00									
			3.00 - 3.45	B5	C (19)					
			3.20 - 3.70							
							(4.10)			
	4.00									
			4.60 - 5.05	B6	C (25)					
	5.00		4.70 - 5.30							
							5.80	25.30		
	6.00								Medium dense brown SAND with some to much subangular to subrounded gravel	
			6.10 - 6.55	B7	C (11)		(1.10)			
			6.20 - 6.70						(RIVER SANDS AND GRAVELS)	
	7.00						6.90	24.20		
							(0.30)		SAND and GRAVEL (Foreman's description)	
							7.20	23.90	(RIVER SANDS AND GRAVELS)	
			7.30	J8			(0.20)			
					S		7.40	23.70	Stiff red brown very silty CLAY with rare subrounded fine and medium quartz gravel	
			7.60 - 7.89	J9	72 for 139mm				(REWORKED KEUPER MARL)	
				W10						
							(1.50)		Very stiff red brown very silty CLAY with occasional fine gravel size lithorelicts and relict structure. And with occasional bands of red brown thinly laminated MUDSTONE very weak	
			8.40 - 8.60	J11						
22.4.88	7.50	5.40	8.70 - 8.89	J12	S 50 for 38mm		8.90	22.20	KEUPER MARL : ZONE IV - III	
									BOREHOLE COMPLETE AT 8.90m	

Remarks

1. Hand excavated inspection pit from G.L. to 1.50m
2. Water added to assist boring, 1.70 to 4.00m
3. Hole grouted to 3.00m, backfilled with arisings to G.L.

SCALE 1:50

Disturbed Samples: J = Jar; B = Bulk
W = Groundwater
Undisturbed Samples: Soil Sample
Insitu Tests: Depth groundwater struck/stand depth water rose to in X minutes
V (30) = Vane Shear Strength in KN/m²
C or S = SPT cone or spoon
(25) = N value
P = Penetration for seating blows

FIGURE A1

British Geological Survey

SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

SK 43 SE 87

A564 DERBY SOUTHERN BYPASS AND DERBY SPUR PRELIMINARY GROUND INVESTIGATION

BOREHOLE No. 145
SHEET 1 OF 1
COORDINATES
446715.5 E
330227.2 N
GROUND LEVEL
30.60 mOD

Field Work by: Soil Mechanics Limited
Method: Cable tool boring
Dates: 13 to 14.5.88
Hole Dimensions: 150mm
Casing Dimensions: 150mm

Date	Casing Depth (m)	Water Depth (m)	Samples/Insitu Tests: Depth (m)	Type No.	Test Result	Change of Strata: Legend	Depth (m)	Reduced Level	Description of Strata	Piezo/ Stand pipe
			0.50	J1					Grey SILT (Pulverised fuel ash)	a
							(2.00)		(MADE GROUND)	
			1.50		V [10]					f
			1.50 - 2.00	B2	V [7]					
			2.00		V-unable to penetrate		2.00	28.60		
			2.30	J3			(0.50)		Grey silt with occasional brown clay pockets	
							2.50	28.10	(MADE GROUND)	
			2.50 - 2.95	J4	S (7)					
									Firm brown slightly sandy CLAY with some subrounded gravel and occasional plant debris	
			3.00 - 3.80	B5					(MADE GROUND)	d
			3.90	J6						
			4.00 - 4.45	U7	'10'		(3.75)			b
			4.50	J8						
			4.60 - 5.50	B9						
			5.60	J10						
			5.70 - 6.15	U11	'9'					d
			6.20	J12			6.25	24.35		
			6.30 - 7.00	B13					Brown clayey SAND and GRAVEL	
							(1.05)		(POSSIBLY MADE GROUND)	
							7.30	23.30		
			7.40 - 7.85	U14	'150'		(0.45)		Very stiff red brown very silty CLAY with occasional lithorelicts	
			7.90	J15			7.75	22.85	(KEUPER MARL : ZONE IVa)	e
			8.00 - 8.60	B16					Red brown thinly laminated extremely closely fractured moderately to highly weathered MUDSTONE very weak with some gypsum veins	
			8.70	J17			(1.50 pen)			
			8.80 - 9.25	J18	S (101)				(KEUPER MARL : ZONE III)	
							9.25	21.35		
									BOREHOLE COMPLETE AT 9.25m	

Remarks

SCALE 1:50

FIGURE A1

Disturbed Samples: J = Jar; B = Bulk; W = Groundwater
Undisturbed Samples: Soil Sample
Insitu Tests: Depth groundwater struck(m)and depth water rose to in X minutes; V [30] = Vane Shear Strength in KN/m²; C or S = SPT cone or spoon (25) = N value; P = Penetration for seating blows

British Geological Survey

SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

SK 43 SE 88

A564 DERBY SOUTHERN BYPASS AND DERBY SPUR PRELIMINARY GROUND INVESTIGATION

BOREHOLE No. 146
SHEET 1 OF 1
COORDINATES 446853.9 E, 330334.5 N
GROUND LEVEL 30.21 mOD

Field Work by: Soil Mechanics Limited
Method: Cable tool boring
Dates: 12 to 13.5.88
Hole Dimensions: 150mm
Casing Dimensions: 150mm

Date	Casing Depth (m)	Water Depth (m)	Samples/Insitu Tests: Depth (m)	Type No.	Test Result	Change of Strata: Legend	Depth (m)	Reduced Level	Description of Strata	Piezo/ Spipe
							(0.30) 0.30	29.91	TOPSOIL	
			0.50	J1			(1.15)		Firm brown slightly sandy CLAY (ALLUVIUM)	
		1.00	0.70 - 1.15	B2	'35'					
		20	1.40	J3			1.45	28.76		
		1.50	1.50	J4			(0.55)		Soft dark grey clayey SILT (ALLUVIUM)	
			1.55 - 2.00	U5			2.00	28.21		
			2.05	J6	'10'				Clayey	
			2.10 - 2.55	B7	C (14)					
			2.70	J8					Medium dense becoming dense brown SAND and subangular to subrounded GRAVEL (RIVER SANDS AND GRAVELS)	
			3.10 - 3.55	B9	C (20)					
			4.30	J10			(4.90)			
			4.50 - 4.95		C (21)					
			4.50 - 5.50	B11						
			5.80	J12						
			6.00 - 6.45		C (49)					
			6.00 - 7.00	B13						
			7.00	J14			6.90 (0.30)	23.31	Firm red brown sandy CLAY with occasional subangular to subrounded gravel and cobbles (REWORKED KEUPER MARL)	
			7.30 - 7.75	J15 W16	S (18)		7.20 (1.05)	23.01	Stiff red brown very silty CLAY with occasional fine gravel size lithorelicts and relic structure (KEUPER MARL : ZONE IVa)	
12.5.88	7.30	Added								
13.5.88	7.30	1.10	7.90	J17						
			8.00 - 8.45	U18	'180'		8.25 (1.20 pen)	21.96	Red brown in parts light greenish grey thinly laminated and extremely closely fractured moderately to highly weathered MUDSTONE very weak friable, with occasional gypsum veins and some clay (KEUPER MARL : ZONE III)	
			8.50	J19						
			8.50 - 8.80	B20						
			9.00	J21						
			9.10 - 9.44	J22	S 112 for 190mm					
13.5.88	8.80	3.00					9.45	20.76		
									BOREHOLE COMPLETE AT 9.45m	

Remarks
1. Water added to assist boring
2. Hole backfilled with arisings to G.L.

SCALE 1:50

Disturbed Samples: W = Groundwater; J = Jar; B = Bulk
Undisturbed Samples: Soil Sample
Insitu Tests: Depth groundwater struck(m)and depth water rose to in X minutes; V (30) = Vane Shear Strength in KN/m²; C or S = SPT cone or spoon; (25) = N value; R = Penetration for seating blows

FIGURE A1

SCOTT WILSON KIRKPATRICK & PARTNERS
Consulting Engineers & Transportation Planners

SK 43 SE 92

A564 DERBY SOUTHERN BYPASS
AND DERBY SPUR
PRELIMINARY GROUND INVESTIGATION

Fieldwork By Soil Mechanics Limited

Dates : 9.5.88

TRIAL PIT LOG

Co-ordinates E. 446952.4 N 330357.0

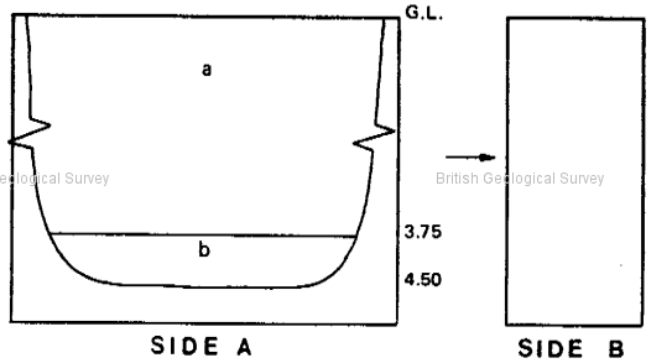
Ground Level 30.70 m A.O.D.

Dimensions (l x b x h) 3.50 x 0.70 x 4.50

Excavation Plant JCB 3CX

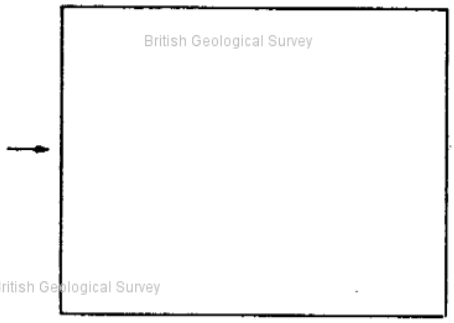
Trial Pit No. 237

ELEVATIONS : All faces similar

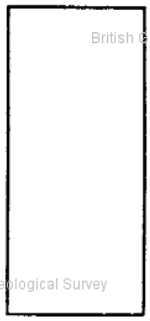


SIDE A

SIDE B

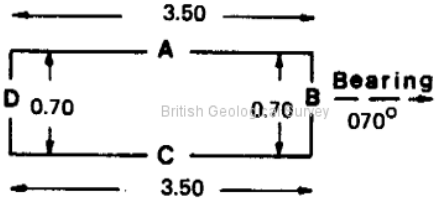


SIDE C



SIDE D

PLAN (Not to Scale)



SAMPLES

No. & Type	Depth m
W1	1.00
D2	3.00
B3	3.75
D4	3.75

No.	Depth m	STRATA DESCRIPTION	Cv/Cp kN/m²
a.	0.00 – 3.75	Loose grey silt (Pulverised fuel ash) (MADE GROUND) Heavy seepage of water at 1.00m, ash flowing slightly where wet At 1.60m, becoming dense and dry	
b.	3.75 – 4.50	Firm greyish brown and brown very sandy CLAY / clayey SAND with some fine to coarse subrounded gravel (RIVER SANDS AND GRAVELS)	

NOTES Cv/Cp Approx. value of undrained shear strength from hand vane/penetrometer
Groundwater: Heavy seepage 1.00 – 1.60m
Pumping: –
Supports/stability: P.F.A. flowing slightly where wet

FIGURE A3

Working on behalf of highways england

Contact name
Amey Arup Joint Venture

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See Bookmarks for contents of this report.

highways england

amey ARUP

06 Product Development & Production

Preconstruction and Construction services

Smart Motorways Programme

M1 Junction 23a to 25

Geotechnical Design Report

HAGDMS Report No. 29152

June 2017

Notice

This document and its contents have been prepared and are intended solely for Highways England's information and use in relation to the Smart Motorways Programme.

Document history

Amey Arup assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

This document has 2060 pages including the cover.

Revision history

Job number: 244508/COCDFL1SMP01			**Document ref: HA549342-AMAR-HGT-SWI-RP-CE-000003**			
Revision	Purpose description	Originated	Checked	Reviewed	Approved	Date
P01	Design Fix 4	SB	SG	TB	TB	01/07/2016
P02	Design Fix 5, addition of minor structures, gabion wall philosophy (SEAF) and King Sheet Piles. Incorporation of HE comments.	SB/RM	AMTB	SG	GS	07/06/2017

Document control

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Executive summary

This Geotechnical Design Report (GDR) relates to the Smart Motorway scheme on the M1 motorway between Junctions 23a (East Midlands Airport) and 25 (A52 Nottingham).

This report has been prepared by AmeyArup (AMAR) in accordance with the guidance set out in HD22/08 for a GDR and design has been undertaken in accordance with Eurocode 7. The report text describes the approach taken in producing detailed geotechnical design solutions for the Smart Motorway works. The appendices to this report contain details of the application of the design methodology to individual structures, earthworks and other geotechnical features throughout the scheme. This report is a Design Fix 5 deliverable and is a revision of the GDR produced at Design Fix 4.

Generalised material properties and parameters were derived as part of the AMAR Ground Investigation Report (GIR); these are refined based on local data from nearby historical ground investigation data for major structure and earthwork widening locations. These are presented within Geotechnical Summary Sheets appended to this Geotechnical Design Report. Scheme specific Ground Investigation has not yet been completed at this time. A 'Just in Time' validation Ground Investigation has been proposed to take place during the construction phase to verify ground conditions and allow design validation, where considered necessary.

Highways structures and design locations for this scheme include:

- Gantry foundations (major structures);
- CCTV mast, large traffic signs, environmental barriers, radar masts, EAV poles and Remotely Operable Temporary Traffic Management sign foundations (minor structures);
- Emergency Refuge Areas;
- Cross Carriageway Ducts;
- Mainline verge widening to accommodate drainage and communication ducting.

To determine the preferred widening solution for a given location based on its particular topography, the decision flow chart developed within the Peer 2 Peer community and re-produced in the AMAR Lateral Solutions Options Report (2016) was used.

Where a slope regrade was required a numerical model using the slope stability modelling software program SLOPE/W was used. Retaining walls were required along some of the verge widening extents, as well as at some major structure locations. Where retained heights were to be of greater than 1.5m in height, an Approval in Principle was produced. Embedded retaining solutions were modelled for suitability using the program WALLAP.

Foundations for minor structures are to comprise either a planted foundation (where applicable), bored piles or pad foundations, depending on structure type and associated loadings.

Five different types of gantries were proposed for the scheme; these were MS3 cantilever, MS4 cantilever, ADS cantilever, super cantilever and superspan portal.

All gantries will be constructed on pile caps and group piled foundations.

A separate GDR has been produced relating to Cross Carriageway ducts.

Earthworks and retaining wall specifications (Series 600 and 1600) are appended to this report, along with a specification for the proposed 'Just in Time' validation Ground Investigation.

The geotechnical risk register from the AMAR Geotechnical Design Report, Rev P01 (Design Fix 4) was updated as part of this Geotechnical Design Report. The significant hazards highlighted were:

- Insufficient land space for widening solution chosen;
- Proximity of adjacent structures (i.e. buried culverts);
- Unknown/variable ground and groundwater conditions;
- Delay in undertaking 'Just in time' validation ground investigation; and
- Localised flooding and reduction in floodplain area due to earthwork widening.
- Incomplete and inaccurate topographical survey data.

1. Introduction

1.1. General

This report relates to the Smart Motorway scheme on the M1 motorway between Junctions 23a (East Midlands Airport) and 25 (A52 Nottingham).

The M1 in the East Midlands is a key strategic route that carries high volumes of heavy goods and other vehicles between the conurbations in Leicestershire, Nottinghamshire, Derbyshire and beyond to South and West Yorkshire, with key links to the West Midlands and the South.

The proposed SMP scheme for M1 Junctions 23a to 25 includes the following elements:

- Smart Motorway infrastructure to enable hard shoulder running;
- Emergency Refuge Areas (ERAs);
- Lane specific signals and gateway gantries;
- Rigid concrete barrier in central reserve;
- Lighting;
- Pavement and drainage renewals;
- Environmental barrier;
- Tie-in to development of the proposed strategic rail freight terminal between Junctions 24 and 24a.

Where verge widening is located on an embankment or in a cutting, earthworks and/or retaining structures will be needed.

This Geotechnical Design Report (GDR) describes the philosophy behind the geotechnical design solutions for structure foundations, earthworks and retaining structures for the Smart Motorway works. For each major structure and major earthwork widening location a stand-alone Geotechnical Summary Sheet was produced that outlines the ground model, material parameters and geotechnical design at the specific location. These are included as Appendix A to this GDR.

Geotechnical design solutions include:

- Piled foundations for major structures;
- Cutting regrade at 1vertical(v):3horizontal(h) or 1v:2.5h;
- Full height embankment widening with granular fill at 1v:2h;
- Granular wedge at crest of embankment at 1v:2h;
- Localised re-profiling (Minor cut/fill <500mm);
- Steel sheet piles and King Sheet Pile (KSP) walls
- Low height retaining walls;
- Gabion walls.

Scheme specific Ground Investigation (GI) has not been carried out, with the geotechnical design completed on the basis of ground modelling undertaken utilising historical GI information as outlined in the Ground Investigation Report, Rev P01 [Ref 1] and driven LiDAR survey information. A ‘Just in Time’ validation GI has been proposed to be undertaken during the construction phase to validate ground conditions and design, where considered necessary.

This report has been produced by Amey Arup Joint Venture (AMAR) in accordance with the requirements of HD22/08 [Ref 2] and is a deliverable for Design Fix 5 (Detailed Design). This GDR is a revision of the GDR, Rev P01 completed at Design Fix 4 for Target Cost. A further revision to this GDR may be issued to incorporate significant changes in the design following the ‘Just in Time’ validation GI. Minor changes during the construction phases shall be incorporated in a Geotechnical Feedback Report (GFR).

The following geotechnical reports have been produced previously for this scheme:

- AMAR, M1 J23a - J25, Statement of Intent, Ref. HA549342-AMAR-HGT-SWI-RP-CE-000001, HAGDMS Ref. 28704, Rev P01, October 2015 [Ref 4];
- AMAR, M1 Junction 23a to 25, Ground Investigation Report, Report Ref. HA549342-AMAR-HGT-SWI-RP-CE-000002, HAGDMS Ref. 28929, Rev P01, February 2016 [Ref 1];
- AMAR, M1 Junction 23a to 25, Geotechnical Design Report, Report Ref. HA549342-AMARHGT-SWI-RP-CE-000003, Rev P01, July 2016

A scheme specific Preliminary Sources Study Report (PSSR) was not deemed necessary as all historic information and data sources were included in a PSSR previously produced by Ove Arup & Partners for M1 widening works between Junctions 21 & 30. [Ref.3].

1.2. Ground Summary, Ground Conditions and Material Properties

The ground conditions, material properties and parameters are presented in full in the reports referenced above however they are summarised in Tables 1-1 and 1-2 below respectively. The material properties and parameters are refined based on local data from nearby historical GI for each major structure, retaining structure and earthworks regrade location and presented on the individual Geotechnical Summary Sheets included as Appendix A to this GDR. Geological Long Sections for the scheme are presented as Drawing Sequence HA549342-AMAR-HGT-SWI-DR-CE-000016 to HA549342-AMAR-HGT-SWI-DR-CE-000042, in the AMAR GIR [Ref 1].

The ground conditions encountered comprise bedrock of Mercia Mudstone of varying degrees of weathering which comprises interbedded layers of mudstone, siltstone and sandstone. The bedrock is overlain by Glacial Till towards the south of the scheme extents. The central area of the site is dominated by the River Trent floodplain and therefore fluvial, glaciofluvial and mass movement deposits overlie bedrock within this area. The north of the scheme extents has limited superficial deposits recorded.

Embankments generally comprise locally sourced fine-grained fill (re-worked weathered Mercia Mudstone), sometimes underlain by coarse-grained fill (various rock types).

Groundwater was not often recorded within historical exploratory holes, but can be assumed to be at projected flood levels at localities within the River Trent floodplain as a conservative assumption. At locations within a cutting with no groundwater data, groundwater is assumed to be 1m below ground level. At locations within an embankment, which are outside the floodplain extents, groundwater is assumed to be present at 1m below the toe of the embankment.

A ‘Just in Time’ validation GI will be required to confirm ground model assumptions at site specific locations where existing local historical GI data is insufficient. The requirements for this GI is outlined in the Validation GI Specification, included as Appendix B to this GDR.

Table 1-1 – Characteristic Material Properties Summary

Stratum	γ (kN/m^3)	NMC (%)	LL (%)	PL (%)	PI (%)	SPT N
Embankment Fill	21	2-31 (15)	21-49 (33)	10-28 (16)	8-31 (17)	10-40 (15-20)
Alluvium	20	8-49 (23)	34-62 (51)	15-37 (27)	19-32 (20)	28-36 (32)
River Terrace Deposits	20	4-14 (10)	-	-	-	10-50 (30)
Head Deposits	20	8-24 (16)	26-57 (41)	13-25 (17)	12-32 (23)	10-23 (20)
Glaciofluvial Deposits (fine-grained materials)	21	2-39 (13)	20-65 (36)	11-33 (19)	5-32 (17)	5+5z
Glaciofluvial Deposits (coarse-grained materials)			-	-	-	10-40
Glacial Till	21	8-25 (15)	23-48 (36)	9-21 (16)	14-29 (20)	5+7z
Mercia Mudstone – III/IV	21	6-41 (18)	18-55 (34)	14-35 (20)	2-37 (14)	30 (0-10m bgl) 50 (>10m bgl)
Mercia Mudstone – I/II	22	6-24 (13)	-	-	-	-
Mercia Mudstone – Siltstone	22	8-34 (15)	-	-	-	-
Mercia Mudstone – Sandstone	21	13-21 (17)	-	-	-	-

Notes
1. Typical ranges are given with characteristic values in brackets.
2. z = metres below top of stratum.
3. This table is to be read in conjunction with the AMAR GIR [Ref 1] and should not be used in isolation.
4. Characteristic properties are re-assessed on a site-specific basis for Geotechnical Summary Sheets.
5. γ = bulk density; NMC = natural moisture content; LL = liquid limit; PL = plastic limit; PI = plasticity index; SPT = Standard Penetration Test.
6. Some strata had limited data available; in particular Alluvium, Head Deposits and unweathered Mercia Mudstone.

Table 1-2 – Characteristic Geotechnical Parameters Summary

Stratum	c_u (kN/m^2)	c' (kN/m^2)	ϕ' (°)	m_v (m^2/MN)	c_v (m^2/yr)	E_u (MN/m^2)	E' (MN/m^2)	E	v_u	v'	v	UCS (MN/m^2)	BRE Class
Embankment Fill	30-240 (100)	0	25-42 (27)	0.01-0.25 (0.08)	3.6-22.0 (10.7)	10-20 (7.8)	5-15 (6.2)	-	0.50	0.10-0.30 (0.20)	-	-	DS-2 AC-2
Alluvium	22-180 (30-50)	0	24-26 (25)	0.16-2.15	*	2.0-6.0 (4.0)	1.0-4.0 (3.0)	-	0.50	0.10-0.30 (0.20)	-	-	DS-1 AC-1s
River Terrace Deposits	-	-	28-44 (38)	-	-	-	30-100 (43)	-	-	0.30-0.40 (0.35)	-	-	DS-3 AC-3
Head Deposits	50-121 (100)	0	24-28 (27)	0.09-0.20 (0.10)	*	4.8-20.0 (7.8)	3-15 (6.2)	-	0.50	0.10-0.30 (0.20)	-	-	DS-1 AC-1
Glaciofluvial Deposits (fine-grained materials)	28-355	0	24-27 (26)	0.03-0.36	2.8-25.4 (12.8)	3.3-20.0	2.6-15.0	-	0.50	0.10-0.30 (0.20)	-	-	DS-3 AC-3
Glaciofluvial Deposits (coarse-grained materials)	-	-	38	-	-	-	19.2-55.2	-	-	0.15-0.30 (0.25)	-		
Glacial Till	50-300	0	24-27 (26)	0.02-0.36	*	3.3-5.4	2.6-4.3	-	0.50	0.10-0.30 (0.20)	-	-	DC-1 AC-1s
Mercia Mudstone – III/IV (0-10m bgl)	50-200	2	25-42 (30)	0.01-0.31 (0.06)	0.62-44.23 (15.9)	5-20 (10.8)	3-15 (8.6)	-	0.50	0.10-0.30 (0.20)	-	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10m bgl)				0.01-0.31 (0.04)		5-20 (16.8)	3-15 (13.4)	-			-		
Mercia Mudstone – I/II	-	-	-	-	-	-	-	100-2830 (250)	-	-	0.20	1.9-16.5 (4.0)	DS-2 AC-2
Mercia Mudstone – Siltstone	-	-	-	-	-	-	-	75-2830 (75)	-	-	0.20	0.16-109.9 (5.0)	DS-1 AC-1s
Mercia Mudstone – Sandstone	-	-	-	-	-	-	-	180	-	-	0.20	3.40-19.81 (10.0)	DS-3 AC-3

Notes
1. Typical ranges are given with characteristic values in brackets.
2. * = No historical consolidation test data was available for this stratum.
3. z = metres below top of stratum.
4. This table is to be read in conjunction with the AMAR GIR [Ref 1] and should not be used in isolation. The above characteristic parameters are an interpretation of the findings from historical GI data (where data was available) for the scheme extents.
5. Characteristic parameters are re-assessed on a site-specific basis for Geotechnical Summary Sheets at proposed structure locations.
6. c_u = undrained shear strength; c' = drained cohesion; ϕ' = drained angle of friction; m_v = coefficient of compressibility; c_v = coefficient of consolidation; E_u = undrained Young's modulus; E' = drained Young's modulus; E = Young's modulus for rock; v_u = undrained Poisson's ratio; v' = drained Poisson's ratio; v = Poisson's ratio for rock; UCS = unconfined compressive strength; and BRE Class = derived from BRE SD1 [Ref 5].

1.3. Geotechnical Category

Anticipated earthworks and retaining structures for the scheme were reassessed following the submission of the AMAR GIR [Ref 3] as part of this GDR. It was determined that the proposed earthworks, retaining solutions and foundations remain ‘Geotechnical Category 2’.

2. Earthworks

2.1. General

This section relates to all areas of the scheme where widening is to be achieved by earthworks comprising cut and fill operations carried out without the use of earth retaining or strengthened earthwork elements.

The earthwork solutions are as follows:

- Cutting regrade at 1v:3h or 1v:2.5h;
- Embankment widening with granular fill at 1v:2h;
- Embankment widening with granular wedge at crest at 1v:2h.

Typical details for the above solutions are shown in Drawing No HA549342-AMAR-HGT-SWI-DR-CE-000601 in Appendix C. A Series 600 Schedule is included as Appendix D of this GDR and a Series 1600 Schedule is included as Appendix E.

For areas of significant verge widening, (e.g. at major structures), site-specific design parameters were chosen using a combination of proximal historical GI data and taking account the indicative design parameters given in the AMAR GIR, Rev P01 [Ref 1]. Ground conditions used in each design case can be found in the Geotechnical Summary Sheets for each earthwork widening location included as Appendix A of this GDR.

There are areas where 'Just in Time' validation GI is necessary to confirm the parameters used in design. These are noted in the Geotechnical Summary Sheets (included as Appendix A) and the GI specification (included as Appendix B).

The purpose of the 'Just in Time' validation GI is to verify ground data and allow validation of geotechnical design. Should there be any significant discrepancies between the 'Just in Time' validation GI results and the ground conditions adopted in the design, revision of the design shall take place and any major changes shall be submitted in a revised GDR. Minor changes during the construction phases shall be incorporated in a GFR.

The design of all earthworks was performed in accordance with BS 6031:2009 – Code of practice for earthworks [Ref 9], BS EN 1997-1:2004+A1:2013 (Eurocode 7) [Ref 6] and NA+A1:2014 to BS EN 1997-1:2004+A1:2013 [Ref 7].

Ground profiles were modelled on location specific cross sections derived from the driven LiDAR survey information. Coverage of this survey is limited in parts; particularly at locations where large embankments are present; this is a risk to the overall design and is included in the risk register at the end of this GDR.

2.2. Cutting Stability

Regrading of cuttings is required for some areas of mainline verge widening and at the location of gantries and ERAs. Generalised cutting heights and angles are presented in the AMAR GIR, [Ref 1], Regrading as a consequence of verge widening may increase cutting slope angles, with a maximum of 1v:2.5h (vertical:horizontal) where ground conditions allow.

2.2.1. Method of analysis

Where a slope regrade was required a numerical model using the slope stability modelling software SLOPE/W [Ref 8] was used. The Morgenstern-Price method of analysis was used along with the Piezometric Line option for pore water pressure conditions, utilising the Eurocode 7 Design Approach 1, Combination 1 and Combination 2 set of partial factors [Ref 6]. The entry and exit slip surface option was used with a minimum slip surface depth geometry set at 0.3m.

In accordance with Eurocode 7 [Ref 6], slope geometries were considered stable when the minimum reported Degree of Utilisation was ≤100%. In areas where there is increased uncertainty with regard to the ground model a reduced utilisation of <90% has been adopted.

2.2.2. Groundwater

Following review of groundwater data, varying groundwater levels were noted therefore groundwater was modelled at 1m below ground surface level as a moderately conservative design assumption.

2.2.3. Ground Conditions

Specific ground conditions were determined at each location of significant earthworks widening. These are presented in the Geotechnical Summary Sheets included as Appendix A.

2.2.4. Eurocode 7 Partial Factors

Partial factors utilised for actions soil parameters and resistance are summarised in Tables 2-1 and 2-2 respectively below:

Table 2-1 – Partial Factors on Actions

Load or Action			Set	
			A1	A2
Permanent Actions (G)	Unfavourable	γ_G	1.35	1.0
	Favourable	$(\gamma_{G,fav})$	1.0	1.0
Variable Actions (Q)	Unfavourable	γ_Q	1.5	1.3
	Favourable	-	0	0

Table 2-2 – Partial Factors for Soil Parameters

Soil Parameter		Set	
		M1	M2
Angle of Shearing Resistance (tan φ)	$\gamma_{\varphi'}$	1.0	1.25
Drained Cohesion (c')	$\gamma_{c'}$	1.0	1.25
Undrained Shear Strength (c_u)	γ_{cu}	1.0	1.4
Unconfined Strength (q_u)	γ_{qu}	1.0	1.4
Weight Density (γ)	γ_γ	1.0	1.0

Surcharge loads to replicate highways were incorporated as follows:

- 20kN/m^2 variable load for the running lanes of the main carriageway and slip roads in accordance with BS6031:2009 [Ref 9];
- 10kN/m^2 variable load for ERA locations in accordance with BS6031:2009 [Ref 9];
- 5kN/m^2 variable load for verge areas in accordance with BD37/01 [Ref 10].

The above were factored as per partial factors outlined in Table 2-1 in accordance with Eurocode 7 [Ref 6].

2.2.5. Results

Design results based on the above analysis are presented for each earthworks widening location in stand-alone Geotechnical Summary Sheets presented as Appendix A to this GDR.

2.3. Embankment Stability

Embankment widening is required for some areas of mainline verge widening and at major structure locations. Generalised embankment heights and angles are presented in the AMAR GIR [Ref 1], and local embankment heights and angles for areas of earthworks widening are presented in the Geotechnical Summary Sheets included in Appendix A of this GDR.

Build-out as a result of verge widening would increase the slope angles to a maximum 1v:2h.

The widening of embankments will be achieved by the placement of granular, Class 6N, fill. The following geotechnical parameters where assumed for design:

- Unit weight = 20kN/m^3;
- Angle of friction ϕ' = 36°;
- Young's Modulus E' = 20,000kN/m^3.

2.3.1. Method of Analysis

Where a slope regrade was required a numerical model using the slope stability modelling software SLOPE/W [Ref 8] was used. The Morgenstern-Price method was used along with the Piezometric Line for porewater pressure conditions, utilising the Eurocode 7 set of partial factors [Ref 6]. The entry and exit slip surface option was used with a minimum slip surface depth geometry set at 0.3m.

In accordance with Eurocode 7 [Ref 5], slope geometries were considered stable when the degree of utilisation is<100%. In areas where there is increased uncertainty with regard to the ground model a reduced utilisation of <90% has been adopted.

2.3.2. Groundwater

Groundwater was modelled to start at toe drainage level and rise up to the flood level through the Embankment Fill and become uniform within the embankment at the flood level. This is considered to represent worst credible conditions within the embankment. Where flood levels were not present, groundwater was modelled at 1m below the toe of the embankment as a moderately conservative design measure.

Rapid drawdown was not considered, as floodwater is not expected to be present at these locations for a significant period of time, hence the embankment is not expected to be fully saturated. Partially saturated embankments are not expected to immediately become unsaturated hence the effect of rapid drawdown is not anticipated.

2.3.3. Ground Conditions

Specific ground conditions were assessed at each earthwork widening location, as presented in the Geotechnical Summary Sheets included as Appendix A of this GDR.

2.3.4. Eurocode 7 Partial Factors

Refer to Tables 2-1 and 2-2 in Section 2.2.4. of this GDR for the partial factors adopted for slope stability analysis.

Surcharge loads to replicate highways were incorporated as follows:

- 20kN/m^2 variable load for the running lanes of the main carriageway and slip roads in accordance with BS6031:2009 [Ref 9];
- 10kN/m^2 variable load for ERA locations in accordance with BS6031:2009 [Ref 9];
- 5kN/m^2 variable load for verge areas in accordance with BD37/01 [Ref 10].

The above were factored as per partial factors outlined in Table 2-1 in accordance with Eurocode 7 [Ref 6].

2.3.5. Results

Design results using the above methodology are presented for each earthworks widening location in stand-alone Geotechnical Summary Sheets presented as Appendix A of this GDR.

2.4. Reuse of Materials

The earthworks solutions proposed for the scheme require imported Class 6N granular fill; the mixed and variable materials anticipated from cutting excavations are not expected to be suitable for re-use in the widened embankments. In addition, as the majority of the site comprises embankments rather than cuttings, it is anticipated that there will not be large volumes of ‘site won’ materials through excavation of existing cuttings. Therefore, the reuse of ‘site won’ materials is not anticipated for this scheme.

3. Highway Structures

3.1. Introduction

The main types of highway structures proposed for the scheme are as follows:

- Embedded retaining walls (sheet piles and KSP);
- Gravity gabion retaining walls;
- Low height retaining solutions;
- Pile foundations; both single and group;
- Pad foundations;
- Planted foundations (where applicable).

The proposed embedded retaining walls are to generate the necessary verge width required for Smart Motorway infrastructure. Section 3.2 below outlines the design methodology adopted for retaining walls. The Series 600 and Series 1600 Schedules are included as Appendix D and E.

All structures with a retained height of ≥1.5m require an Approval in Principle (AIP) submission in accordance with the requirements of BD2/12 Technical Approval of Highway Structures [Ref 11]. These are presented as a separate document from this GDR.

3.2. Retaining Walls

3.2.1. Geotechnical Design Methodology for Retaining Walls

Retaining walls are required along some of the verge widening extents and at some major structure locations. Details of retaining wall locations are included as Geotechnical Summary Sheets in Appendix A of this GDR.

Low height retaining solutions will also be required at discrete locations to allow maintenance access to minor structures. Options considered, to date, include:

- Plastic Sheet pile walls
- Slab on edge
- Self-retaining A-chambers
- Extended pile cap design

Typical retaining wall solutions are presented as Drawing No HA549342-AMAR-HGT-SWI-DR-CE-001601, Rev P04 included in Appendix C of this GDR. The verge widening retaining wall details are included in Drawing Sequence HA549342-AMAR-HGT-MLC-DR-CE-000001 to HA549342-AMAR-HGT-SWI-DR-CE-000013, Rev P08 included in Appendix C of this GDR.

Series 600 and 1600 Schedules, included as Appendix D and E of this GDR respectively, show the locations, depths and extents of retaining walls.

3.2.2. Embedded Retaining Walls

Embedded retaining solutions have been specified as sheet piled walls and King Sheet Pile walls for this scheme and is design is based on limit state analysis in accordance to BS EN 1997:2004 [Ref 6], BS EN 1993-5 2007 and BS 8002:2015 – Code of practice for earth retaining structures [Ref 33].

Sheet Pile Wall

The design of the sheet pile wall sections adopted the principles of limit state analysis to determine wall displacements and bending moments to satisfy utilisation and deflection criteria using the software WALLAP [Ref 12]. Design was in accordance with Eurocode 7 [Ref 6], Design Approach 1 combination 1 and combination 2 adopting the partial factor method with a requirement to achieve a maximum reported utilisation of <100% and with the requirement to satisfy serviceability limit state criteria (SLS). In areas where there is increased uncertainty with regard to the ground model a reduced utilisation of <90% has been adopted.

The following considerations and criteria were adopted in the assessment:

- Toe in depth to provide passive resistance against rigid wall rotation failure and overall global stability.
- Structural capacity of the wall which will determine the wall type and dimensions;
- Unplanned excavation of 0.5m for walls located at the toe of cuttings. For walls located mid-slope no allowance has been made for unplanned excavation;
- No deflection greater than 50mm based on values used on other SMP schemes provided by Geotechnical SES (PTS);
- Combined moment of inertia = 12870cm^4/m, 42370cm^4/m, 72322cm^4/m (depending on selected section type);
- Section modulus = 830cm^3/m, 2020cm^3/m, 3200cm^3/m (depending on selected section type);
- Steel grade = S355GP;
- Class 6N granular fill is proposed as backfill to retaining walls

The corrosion rate has been taken from BS EN 1993-5 2007: Eurocode 3 Design of Steel Structures - Part 5 Piling [Ref 13] and for a 120 year design has been assumed to be 1.5mm per side. All sections used in design were deemed to have sufficient sacrificial thickness for a 120 year design life.

King Sheet Pile Walls (KSP)

The design of King Sheet pile walls adopted the principles of limit state analysis to determine wall deflections and bending moments to satisfy utilisation using the software WALLAP [Ref 12]. Design was in accordance to Eurocode 7 [Ref 6], Design Approach 1, combinations 1 and 2 adopting the partial factor method with a requirement to achieve a maximum reported utilisation of <100% and with the requirement to satisfy serviceability limit state criteria (SLS). In areas where there is increased uncertainty with regard to the ground model a reduced utilisation of <90% has been adopted.

King Sheet Piles design methodology was based on that of a Traditional King Post Wall design, where pair of sheet piles is driven to achieve full depth (King Piles) with a pair of intermediate piles in between two King Piles, which are not driven to full depth.

The following considerations were made following King Sheet Pile Design:

- Use of a pair of 700mm Z pile sections (U piles cannot be used for KSP design);
- Pair of 770mm intermediate Z pile sections;
- Soldier Pile Width = 1400mm;
- Soldier Pile Spacing Centre to Centre = 2940mm;
- As per the KSP Technical guidance, the moment of inertia of the King Pile per metre run is divided by 2.1, as it is assumed the intermediates have no moment / stiffness capacity for design [Ref 32].
- Grade of steel for King Piles is S390GP;
- Grade of steel for intermediate piles is S270GP.
- Unplanned excavation of 0.5m for walls located at the toe of cuttings. For walls located mid-slope no allowance has been made for unplanned excavation.
- Toe in depth to provide passive resistance against rigid wall rotation failure and overall global stability;
- Structural capacity of the wall which will determine the wall type and dimensions;
- Class 6N granular fill is proposed as backfill to retaining walls.

Due to KSP design being relatively new additional analysis was completed using a traditional king post wall design methodology, where the moment of inertia of the double Z section, is divided by the centre to centre spacing between the King Sheet Piles. This analysis was used a verification check on the King Sheet Pile design described earlier and yielded similar results.

The corrosion rate has been taken from BS EN 1993-5 2007: Eurocode 3 Design of Steel Structures - Part 5 Piling [Ref 13] and for a 120 year design has been assumed to be 1.5mm per side. All sections used in design were deemed to have sufficient sacrificial thickness for a 120 year design life.

3.2.3. Gravity Retaining Walls

Gravity retaining walls were designed using limit state analysis in accordance with BE EN 1997:2004 [Ref 6], BS 8002 – Code of practice of earth retaining structures [Ref 33] ensuring ULS (Overturning, Sliding, Bearing and Global Stability) and SLS limits are not exceeded. Details of proposed gabion gravity retaining walls are given in the Series 600 Specification, Rev P04 and the Strengthened Earthwork Appraisal Form (SEAF); which are included as Appendix D and F respectively.

3.3. Foundations

3.3.1. Minor Structures

Foundations have been designed for the following minor structures:

- CCTV camera masts
- Radar poles
- EAV masts
- Large Traffic Signs
- ROTTMs
- Environmental Barriers

Foundation options considered were:

- Planted foundations;
- Pad foundations;
- Piled Foundations.

3.3.2. Gantries

Five different types of gantries are proposed for the scheme; these are MS3 cantilever, MS4 cantilever, ADS cantilever, super cantilever and superspan portal. Figures 3-1 to 3-5 below show typical photographs of these gantry types:

Figure 3-1 MS3 Cantilever Gantry



Figure 3-2 MS4 Cantilever Gantry



Figure 3-3 ADS Cantilever Gantry



Figure 3-4 Super Cantilever Gantry



Figure 3-5 Superspan Portal Gantry



Pile group foundations have been adopted for gantry locations.

Group pile foundations options were as follows:

- Four piles, 2x2 configuration, 750mm diameter, pile cap 4mx4m and 1.8m height;
- Four piles, 2x2 configuration, 900mm diameter, pile cap 4.5mx4.5m and 1.8m height; and
- Three piles, 1x3 configuration, 900mm diameter, pile cap 2mx7m and 1.8m height.

All piles were assumed to be bored and the design methodology was in accordance with Eurocode 7 [Ref 5] and NA+A1:2014 to BS EN 1997-1:2004+A1:2013 [Ref 7].

The ground models adopted for detailed design of foundations at each major structure are included in the Geotechnical Summary Sheets included as Appendix A of this GDR. Ground models were based on the generalised ground model in the AMAR GIR, [Ref 1] and made location specific by assessing localised ground conditions recorded in historical GI data.

3.4. Design Standards and Partial Factors

The design of planted foundations was carried out in accordance with BD94/07 Design of minor structures [Ref 14]. Planted foundations are only proposed for traffic signs and Radar masts not located adjacent to earthworks slopes in accordance with the recommendations of the standard.

The geotechnical design of both pad and pile foundations is based on limit state design and was carried out in accordance with Eurocode 7 [Ref 6] and BS 8004:2015 – Code of practice for foundations [Ref 35] adopting the partial factor method for Design Approach 1, combinations 1 and 2, with a view of achieving a utilisation of <100%.

The factoring of actions for each case was undertaken in accordance with NA+A1:2014 to BS EN 1997-1:2004+A1:2013 [Ref 7] and NA to BS EN 1990:2002+A1:2005 [Ref 15] (for accidental loads), as shown below in Table 3-1:

Table 3-1 – Partial Factors for Actions

Load or Action		SLS	ULS-C1	ULS-C2
Permanent (G)	Unfavourable (γ_G)	1.0	1.35	1.0
	Favourable ($\gamma_{G,fav}$)	1.0	1.0	1.0
Variable (Q)	Unfavourable (γ_Q)	1.0	1.5	1.3
	Favourable ($\gamma_{Q,fav}$)	1.0	0.0	0.0
Accidental (A)	Unfavourable (γ_A)	1.0	1.0	1.0
	Favourable ($\gamma_{A,fav}$)	1.0	1.0	1.0

Partial factors for soil parameters were in accordance with NA+A1:2014 to BS EN 1997-1:2004+A1:2013 [Ref 7], as shown in Table 3-2 below:

Table 3-2 – Partial Factors for Materials

Soil Parameter	**Set**	
	M1	M2
Weight Density (γ_γ)	1.0	1.0
Undrained Shear Strength (γ_{cu})	1.0	1.4
Cohesion ($\gamma_{c'}$)	1.0	1.25
Angle of Shearing Resistance (γ_ϕ)	1.0	1.25
Unconfined Strength (γ_{qu})	1.0	1.4

The partial factors for reactions were taken as per the recommendations in NA+A1:2014 to BS EN 1997-1:2004+A1:2013 [Ref 7] for bored piles; these are presented in Table 3-3 below:

Table 3-3 – Partial Resistance Factors for Bored Piles

Resistance	Set		
	R1	R4 without explicit verification of SLS	R4 with explicit verification of SLS
Base (γ_b)	1.0	2.0	1.7
Shaft (compression) (γ_s)	1.0	1.6	1.4
Total/combined (compression) (γ_t)	1.0	2.0	1.7
Shaft in tension (γ_{st})	1.0	2.0	1.7

3.5. Loading

Loading conditions and associated values for each major structure type were provided by the AMAR structural design team based on typical structure types and are included in Appendix G.

Loading conditions and associated load values for each gantry type were provided by the gantry superstructure designer, Ramboll, and are included as Appendix G of this GDR. The loads provided at DF4 were generalised forces and moments for typical gantry types. However during DF5 revised loadings were received from Ramboll which were significantly higher than the loads adopted at DF4 design. This increase was due to a number of factors including:

- Increased span length for portal structures;
- Increased cantilever length;
- Adoption of man access gantries

3.5.1. Minor Structures

Loading conditions and associated values for each minor structure type was provided the AMAR structural design team and is presented in the tables below:

3.5.1.1. CCTV Loading

Table 3-4 – CCTV Characteristic Loading

Loading Type	Load	Unfactored Loads		
		F_x (kN)	F_z (kN)	M_y (kNm)
Permanent	Dead Load (CCTV Mast)	-	11	-
Permanent	Dead Load (CCTV Equipment)	-	1.2	-
Permanent	Dead Load (Pile Cap)	-	21.38	-
Variable	Wind	4.79	-	15.57

3.5.1.2. ROTTM Loading

Table 3-5 – ROTTM Characteristic Loading

Loading Type	Load	Unfactored Loads		
		F_x (kN)	F_z (kN)	M_x (kNm)
Permanent	Dead Load (ROTTM Post & Sign)	-	3.66	-
Variable	Dead Load (CCTV Equipment)	-	-	-
Variable	Wind (Longitudinal Wind Load)	8.19	-	29.86
Variable	Wind (Shear Force)	8.2	-	-

3.5.1.3. RADAR & EAV Loading

Table 3-6 – RADAR & EAV Characteristic Loading

Loading Type	Load	Unfactored Loads		
		F_x (kN)	F_z (kN)	M_y (kNm)
Permanent	Dead Load (Mast)	-	1.79	-
Permanent	Dead Load (Equipment)	-	0.12	-
Variable	Wind	1.67	-	9.90

3.5.1.4. Environmental Barrier Loading

The loading on the environmental barrier foundations varied due to the different barrier heights and is presented in table 3-7.

Table 3-7 – RADAR & EAV Characteristic Loading

Height of panel (m)	Post Weight (kN) (Permanent)	Uniform Distributed load from Panels (kN/m^2) (Permanent)	Shear Force (kN) (Variable)	Bending Moment (kNm) (Variable)
2	0.382	4.768	28.61	33.75
3	0.574	5.904	53.13	79.70
4	1.421	7.698	92.37	184.75

3.5.1.5. Traffic Signs

Table 3-8 – Large Traffic Signs Characteristic Loading

Sign Face Area Group (m^2)	Sign Chosen for Analysis	Sign Weight (kN) (Permanent)	Shear Force (kN) (Variable)	Bending Moment (kNm) (Variable)
0-7	NB11	37.74	4.27	12.61
7-11	SB96	51.48	16.12	65.48
11-17	NB31	80.45	24.54	93.48
35-39 Embankment	SB48	193.01	17.37	103.98
35-39 Cutting	TS3	178.49	46.26	227.04
55-56	TS1	278.25	75.13	409.44

Table 3-9 –Single Post Traffic Signs Characteristic Loading

Sign Face Area Group (m^2)	Sign Chosen for Analysis	Sign Weight (kN) (Permanent)	Shear Force (kN) (Variable)	Bending Moment (kNm) (Variable)
0-1	SB64	4.20	1.10	2.79
1-3	SBS08	12.73	3.88	10.46
6-9	NB01	41.55	12.86	47.40

3.6. Geotechnical Design Methodology of Planted foundations

Planted foundations have been adopted for Radar poles and traffic signs where ground conditions and topography allow. The design of planted foundations has been carried out in accordance with BD94/07 Design of Minor Structures [Ref 14]. Planted foundations have not been considered for structures such as CCTV or in situations where embankment stability considerations preclude their use in accordance with BD94.

3.7. Geotechnical Design Methodology of Pad foundations

Pad foundations have been proposed for minor structures where ground conditions, loading values and topography allow. However where the use of a pad foundation would lead to a requirement for significant additional verge width and therefore require earthworks widening, piled foundations have been proposed.

Pad foundations have been adopted as follows:

- Single post traffic signs 2.0mx3.2mx1.5m
- Multi post traffic signs; 2.6m wide and 2.0m deep with the length varying depending on the size of the sign face
- ROTTM signs: 2.3mx2.0mx1.5m

The design of the pad foundations adopted the principles of limit state analysis to determine the degree of utilisation when considering overturning, forward sliding and bearing failure using in-house spreadsheets to Eurocode 7 [Ref 6] with a view of achieving a utilisation <100% to ensure the design is adequate.

3.8. Geotechnical Design Methodology of Piled Foundations

3.8.1. Single Piles

Single bored piles of either 450mm diameter or 750mm diameter have been adopted for CCTV masts, Environmental Barriers (single pile beneath each post), Radar poles, EAV masts and for two post traffic signs (single pile beneath each post).

Generally, the design methodology for single piles was as follows:

1. Pile lengths and axial capacity of the pile were calculated using the in-house single pile capacity spreadsheet based upon the maximum axial loads on a single pile for all three cases;
2. Numerical modelling of the single pile was then undertaking using WALLAP [Ref 12] to check the bending moments (lateral capacity) (Ultimate Limit State Combination 1 and 2) and deflections (Serviceability limit state);
3. Iteration was carried out as appropriate following the Steps 1 and 2 above to determine a suitable design pile length;
4. Calculated maximum pile moment outputs were provided to the Structural Engineers for design of structural reinforcement.

The following considerations and criteria were adopted in the assessment:

- Maximum deflection of 20mm for signs and Environmental barriers and of 10mm for CCTV masts, EAV masts and Radar poles as advised by AMAR Structures team;
- Maximum bending moment of 261kNm for 450mm diameter bored piles and 1000kNm for 750mm bored piles.

Following consultation with the delivery partner (Costain Galliford Try) the use of driven piles was not considered due to concerns over drivability and the potential impact on programme as pile driving would require night time working due to proximity of residential properties to sections of the scheme.

Single Pile Analysis

Axial pile capacity calculations were carried out using an in-house spreadsheet for static single pile capacity. The calculations determined the pile length to Eurocode 7 [Ref 6] and in accordance with the design philosophy described below:

The total characteristic action on a pile included the applied load, self-weight and negative skin friction (where applicable). The design action was calculated by applying appropriate partial factors for actions (as stated in Table 3-1 of Section 3.3.3. of this GDR) to the characteristic actions.

Total bearing resistance of a pile is the combination of Shaft Friction (S_F) and End Bearing (E_B).

For fine-grained (cohesive) soils, a total stress approach was adopted:

$$S_F = \alpha\, c_u$$
$$E_B = N_c\, c_u$$

Where, 'c_u' was the undrained shear strength of the soil, 'α' was the shaft adhesion factor and 'N_C' was a bearing capacity factor after Berezantev (1961) [Ref 17].

For coarse-grained (granular) soils, an effective stress approach was adopted:

$$S_F = K_S\, \sigma'_V \tan\delta$$
$$E_B = N_q\, \sigma_v'$$

Where, 'K_S' was the coefficient of horizontal soil stress, 'σ'_V' was the effective vertical stress and 'δ' was the angle of friction between pile and soil. 'N_q' was calculated as a function of the angle of friction (ϕ') of the stratum and the length to diameter ratio (L/D) of the pile (Berezantzev, 1961) [Ref 17].

Design resistance was calculated by applying appropriate partial and model factors for resistance (as stated in Table 3-3 of Section 3.3.3. of this GDR) to the ultimate bearing resistance in accordance with Eurocode 7 [Ref 6] guidelines.

Design pile length was calculated based on the pile length at which the design resistance is equal to or greater than the design action.

Lateral capacity of the piles is analysed in WALLAP, using the subgrade reaction model to determine the bending moment and displacement in the pile. WALLAP considers the failure mechanism of short rigid pile due to rotation and the long flexible pile due to bending.

Based on the above, the length of the pile can be determined to satisfy the lateral capacity of the pile.

3.8.2. Pile Groups

Pile groups have been adopted for gantry foundations and for the foundations for large traffic signs and ROTTM signs located at the crest of embankments or on earthwork slopes.

Generally, the pile group design methodology for pile groups was as follows:

1. Based upon the gross loading and initial pile length, pile group analysis was carried out using PIGLET software [Ref 16] (see Section 3.8.2.1.) to determine the axial load, lateral load and moment distribution amongst piles for Serviceability Limit State (SLS), Ultimate Limit State-Combination 1 (ULS-C1 or STR) and Ultimate Limit State-Combination 1(ULS-C2 or GEO) cases; whereas, the lateral and vertical deflections are calculated for SLS case only.
2. In-house single pile capacity spreadsheet (see section 3.5.1.1) was used to check the pile length based upon the maximum axial loads on a single pile for all cases as per the results of Step 1 above.
3. Iteration was carried out as appropriate following the Steps 1 and 2 above to determine a suitable design pile length.
4. Pile moment outputs were provided to the Structural Engineers for design of structural reinforcement.

Pile Group Analysis

Piles were sufficiently spaced (minimum 3x the pile diameter therefore interaction between piles is considered negligible) so that the axial bearing capacity of the pile group would be higher than the sum of the end bearing capacity of the total piles in the group. It can be shown that the capacity of the group was no less than that of individual piles as follows:

Base area of single square pile = πR^2

Therefore, total base area of 'N' number of piles in a group = $N(\pi R^2)$

Base area of the block = LxB

Here, R = Radius of circular pile, L = Length of pile block, B = Width of pile block

Therefore, for a unit end bearing Q kN/m^2

End bearing capacity of N number of piles = $QxN(\pi R^2)$ kN

End bearing capacity of the block = Qx(LxB) kN

Pile group analyses using PIGLET software [Ref 16] was undertaken to determine the axial load, lateral load and moment distribution in piles along with the lateral and vertical deflections of pile heads.

The computer programme, PIGLET [Ref 16], analyses the load deformation response of pile groups under loading conditions. The program was based on a number of approximate solutions for the response of single piles to axial, torsional and lateral loading, with allowance made for the effects of interaction between piles in the group.

In the PIGLET models, piles were assumed to deform elastically. The soil was modelled as a material whose stiffness varies linearly with depth; as such a suitable average stiffness increasing with depth for the strata penetrated by the piles was taken. In addition, for end-bearing, a soil of increased stiffness was specified below the level of the pile bases. The stiffness was characterised by a shear modulus (G) and Poisson's ratio (ν). The shear modulus is related to the Young's modulus (E) as:

$$G = E/(2*(1+\nu))$$

The soil was effectively considered in two layers – above and below the pile base. The upper layer, above the pile base, was considered to deform solely by the shear stresses acting down the pile shaft; whereas, the lower layer was deformed by the load transmitted to the pile base. In the analysis, the pile group was assumed to be capped by a rigid pile cap.

The following was assumed in the analysis:

- The pile was given an axial and lateral Young's Modulus (E') of 25MN/m^2 for both the free-standing and embedded lengths;
- Pile cap was modelled as being rigid;
- Loads provided at the time of writing were treated as a point load in the middle of the pile cap;
- A free-standing length of 0.5m was modelled within the embankment fill material (no stiffness provided).

3.9. Aggressive Environment for Buried Concrete

There were few occasions where suitable local chemical testing was available to inform Design Sulphate and Aggressive Chemical Environment Concrete classifications at major structure locations. Where local test data was available (i.e. ≤10m from proposed gantry foundations), these were considered in the relevant Geotechnical Summary Sheets included as Appendix A of this GDR. Where sufficient local chemical test data was absent, 'Just in Time' validation GI will be required to determine concrete classification for relevant gantry locations. Concrete classification will be in accordance with BRE Special Digest 1 (2005) [Ref 5].

4. Strengthened Earthworks

4.1. General

Refer to Strengthened Earthworks Appraisal Form included in Appendix F.

5. Drainage

5.1. General

The drainage strategy for the scheme was developed in accordance with the requirements of IAN 161/15 – Smart Motorways [Ref 23] and the Design Manual for Roads and Bridges (Volume 4, Section 2) [Ref 24]. The Drainage Strategy Report, Rev P02 by AMAR (2016) [Ref 25] sets out the general principles on which the design has been developed as well as highlighting specific assumptions and risks.

The scheme will have a significant impact on the existing pipe network in some areas and very little impact in others. Cross-carriageway drainage will be retained and re-used wherever possible to minimise the requirement to construct new drainage, subject to them being in acceptable condition. The drainage strategy is to replace those drainage pipes that were identified in the survey as having Grade 4 or Grade 5 defects, but this is to be confirmed. Grade 4 defects are identified as assets which have either 'major defects' or their 'performance severely reduced'. Grade 5 defects are identified as assets which are either 'not fit for purpose or unsafe' or that are 'blocked or in unsafe condition'.

The proposed drainage design will interface with existing earthworks drainage, which predominantly takes the form of an interceptor ditch at the toe of the earthworks. The ditches themselves will be retained and in some locations diverted where it is proposed to widen existing earthworks. It is also proposed to clear the existing ditches of any debris and remove any overgrown vegetation as part of the site clearance works, which will ensure that the ditches are returned to their original capacity. In the existing situation there are numerous outfalls from the mainline drainage system on the M1 which discharge directly into these ditches. These outfalls are to be retained as part of the proposed drainage design and the existing headwalls retained also. Where the existing outfalls have been identified as having Grade 4 or defects, these will be replaced on a like-for-like basis, Once the scope of outfall design is known (i.e. during Construction), slope stability analysis will be undertaken to assess existing earthworks in the temporary and permanent condition and measures as deemed necessary will be proposed to ensure there is no reduction in the stability of the existing earthworks whilst drainage repairs are undertaken.

No slope drainage has been identified in the drainage survey information received, however, should any be encountered on site these will be retained or re-instated as necessary.

General groundwater conditions based on historical groundwater data for the scheme extents was presented in the AMAR GIR [Ref 1]. Groundwater conditions at each major structure or widening location are presented in the Geotechnical Summary Sheets included as Appendix A of this GDR. In general, groundwater is assumed to be at flood level or 1m below toe of slope for embankments (whichever is most conservative), and for cuttings it is assumed to be at 1m below ground surface level unless local groundwater data suggests otherwise. In some locations the flood levels have defined the verge widening solution to avoid construction into the floodplain. Groundwater conditions for geotechnical design were outlined in Sections 2.2.2. and 2.3.2. of this GDR.

Drainage has been specified behind retaining walls and at embankments and cuttings. Details of the type of drainage system specified and the location is presented in Specification Appendices Series 500 – Drainage and Service Ducts.

6. Pavement Design, Subgrade and Capping

6.1. General

The pavement foundations along the scheme extents are anticipated to experience the following changes:

- Improvement of existing hard shoulder for use as full-time running lane;
- New pavement constructed on imported fill where build-out of embankments is required;
- Construction of new pavements on existing ground where locations are placed in areas of cuttings.

6.2. Assessment

The minimum CBR for pavement construction is 2.5%, in accordance with IAN 73/06 [Ref 26]; therefore a CBR <2.5% requires the ground to be improved (or replaced) so that the minimum 2.5% CBR is achieved prior to placement of capping or sub-base. Given the anticipated ground conditions for the site, it is anticipated that the CBR for pavement construction will be sufficiently in excess of 2.5%, however locations where a CBR of 2.5% is not achieved, additional capping may be required.

7. Assessment of Potential Contamination

7.1. General

This section presents details of risk assessment sources, pathways and receptors with regards to contamination that may be present during the proposed work. Existing chemical data will be reviewed, and the risk posed by this to human health during works is assessed. Additionally, material deemed unsuitable for re-use will be assessed where available for appropriate disposal routes.

Details of dealing with unacceptable material or suspected unacceptable material are included in Specification Series 600 Appendices 6/2, 6/14 and 6/15, included in Appendix D of this GDR.

A number of historical disused landfills are located adjacent to and within the scheme extents in this area, as identified in the AMAR GIR, Rev P01 [Ref 1]. Some excavation works are proposed within the highway boundary in this area for the purpose of verge widening in cutting and for drainage and/or other works. While it is considered unlikely that significant contamination will be encountered, the extents of the former landfill areas have been identified within Geotechnical Hazard Plans (included in the AMAR GIR, Rev P01 [Ref 1]) and instructions given to undertake additional contamination testing if suspected contaminated material is encountered. Additional detail for discovery of unexpected contamination is provided with section 7.7. of this GDR.

Given the nature of the site and likely heterogeneity of the Made Ground that has been deposited there is potential for localised contamination to be encountered during excavation works. This is likely resulting from historical spills or more general contamination of topsoil due to exhaust emissions or de-icing salts. For this reason, and for material classification purposes, contamination testing of all excavated materials is included in the Specification, with a requirement to undertake further investigation in locations where there is any indication that material may be contaminated.

7.2. Sources of information on contamination testing

All available historical ground reports were reviewed to identify existing information on contamination and a summary of the available information is shown below. The sources of information used are listed within this section.

7.2.1. Existing geo-environmental data

The available data in AGS format was interrogated. A total of 4 No. solid, 4 No. water and 4 No. leachate samples were available and considered suitable for analysis by this study.

Table 7-1 – Relevant geo-environmental samples taken to date

Sample	Location	Solid	Water	Leachate
TP1063	South of Junction 23A; Ch181635	✓		✓
CP1096	North of Junction 24A; Ch187290	✓	✓	✓
TP1095	North of Junction 24A; Ch187775	✓		✓
CP1097	North of Junction 24A; Ch188015	✓	✓	✓
CP1103	Between Junction 24A and 25; Ch189499		✓	

Sample	Location	Solid	Water	Leachate
RC1112	Between Junction 24A and 25; Ch191678		✓	

Water samples were tested for the inorganic analytes including heavy metals and sulphate. Additionally, organic analytes including PAHs, TPH and BTEX were tested.

Soil samples were tested for a range of analytes including those shown in Table 7-2.

Table 7-2 – Soil chemical testing

Borehole ref	Analyte tested					
	Inorganics Inc. heavy metals	Phenols	BTEX	CWGTPH	PCBs	Asbestos
TP1063	✓	✓	✓	✓	✓	✓
CP1096	✓	✓	✓	✓	✓	✓
TP1095	✓	✓	✓	✓	✓	✓
CP1097	✓	✓	✓	✓	✓	✓

7.3. Human Health Assessment of available data

Due to the low number of soil data available (4 No.) for analytes pertinent to human health across a large area, this does not constitute a full human health risk assessment for the scheme extents.

The results of the four soil samples tested were compared against commonly used screening values/assessment criteria detailed in Limiting Values for Harm to Human Health and the Environment detailed in Appendix 6/15 of the Series 600 Specification, included in Appendix D of this GDR. The generic assessment criteria (GACs) chosen were Environment Agency (EA)/Defra Category 4 Screening Levels (C4SLs) and LQM/CIEH Suitable 4 Use Levels (S4ULs) where C4SLs were unavailable [Ref 26 & 27].

Of the available testing results no GACs for commercial/industrial usage were exceeded. It is therefore possible to say that of the samples tested there is unlikely to be a possibility of significant harm to human health or the wider environment. However this testing is extremely limited and is unlikely to be representative of the site entirely. As such recommendations are given within the following sections for personal protective equipment and sections for unexpected contamination discovery.

Additional samples and associated analysis must be completed to confirm these conditions. It is highly likely additional currently undetected contamination exists between the limited locations with available chemical testing results. It is recommended that additional testing be undertaken as part of the 'Just in Time' validation GI.

7.4. Controlled waters

A preliminary generic quantitative risk assessment (Tier 2) of groundwater data was undertaken in accordance with the GP3 methodology [Ref 28]. The assessment criteria are contained within Limiting Values for Harm to Human Health and the Environment detailed in Appendix 6/15, included in Series 600 Specification in Appendix D of this GDR. Analysis was undertaken on 4 No. samples: CP1096, CP1097, CP1103 and RC1112.

Several analytes are assumed to have detection limits above the generic assessment criteria including total cyanide, benzo(ghi)perylene and indeno(1,2,3)pyrene. Minor exceedances of PAHs benzo(b,k)fluoranthene, benzo(ghi)perylene and indeno(1,2,3)pyrene were recorded in CP1103. Ammoniacal nitrogen showed exceedances in CP1097 and CP1103. Several metals showed slight exceedances in several samples including cadmium, boron, copper, lead, nickel, selenium and zinc.

As several analytes were measured above assessment criteria, this poses a potential risk to the receptor (in this case the groundwater, controlled waters). However as only 4 No. samples were assessed over the length of the site this does not constitute a full assessment. This number of samples gives a limited assessment, and it can be considered likely that the results are not representative of the entire site.

7.5. PPE Recommendations

A full human health risk assessment has not been undertaken for the full extents of the scheme. Several potential sources of contamination have been identified, although sufficient GI and chemical testing has not been undertaken to assess the locations, nature and extents of these.

Site operatives should be advised that the site has the potential to be contaminated. It is recommended that standard Personal Protective Equipment (PPE) is used and site health and safety best practise is followed. Additionally, eye protection, safety gloves and nitrile gloves should be used when handling soil samples. Washing and cleaning facilities should be located onsite and available to staff during the site investigation. These should be used if direct dermal contact is made with the soil. Should olfactory, visual, or gross contamination be encountered on site it should be deemed as contaminated and a Geo-Environmental Specialist should be consulted. The use of these measures will mitigate the potential risk posed by potential contamination to the primary receptors.

Site operatives should be made aware that asbestos may be present in motorway structures, Made Ground and excavated material removed from exploratory holes, and should be put on a asbestos awareness course prior to the GI work. If asbestos is detected works should cease and a Geo-Environmental Engineer or Asbestos Specialist should be consulted.

7.6. Waste Hazard Classification and waste acceptance criteria

This waste categorisation exercise was undertaken under the assumption that offsite disposal will occur. If possible it is preferable that the proposed construction is designed to minimise volumes of waste, or that material can be re-used in preference to landfill disposal. To determine the likely waste class of excavated soils a waste categorisation exercise was undertaken on the limited data.

Soil quality data from the available investigation data was entered into a hazard assessment tool, HazWasteOnline. The tool uses the current EA WM3 [Ref 29] guidance to determine whether the substances contained in the soils tested exceed any risk phrases that would render the materials as ‘hazardous’ waste.

The tool includes a number of options for using the different valences (chemical species) or compounds that may be present, e.g. whether the chromium found is chromium III or the less common but more toxic chromium VI. Where options were available these were set at the default (worst case assessment) for the model in accordance with the guidance set out in WM3.

The results of hazard assessment show that of the four samples entered into the tool, each were classified as non-hazardous wastes. The full hazard classification report can be viewed within Appendix K of this GDR.

The samples tested were TP1063, CP1096, TP1095 and CP1097. Each of the 4 No. samples were deemed to be non-hazardous and will likely have a EWC (European Waste Catalogue) code of 17 05 04 (Soil and stones other than those mentioned in 17 05 03). The four samples were tested for inert WAC tests, and did not exceed any of the inert landfill criteria.

The testing on a limited total of 4 No. viable samples does not constitute a full assessment for the scheme length. There is the potential for Made Ground and arisings from exploratory holes to contain hazardous material. As such additional testing of materials destined for offsite disposal is necessary. This includes

assessment of total soils for waste hazard classification and waste acceptance criteria testing to confirm the correct disposal route and to provide required supporting documentation.

The criteria for unacceptable material or suspected unacceptable material are included in Specification Series 600 Appendices 6/2, 6/14 and 6/15, included in Appendix D of this GDR

7.7. Recommendations on further testing

It is recommended that total solids testing is undertaken to allow waste hazard classification of materials prior to construction. A suite of determinants is also recommended to be undertaken prior to construction to assess risk to human health for construction workers and longer term end users (maintenance crews) if necessary.

It is recommended that the exploratory holes are located within the areas of the most significant sources of contamination identified as part of the 'Just in Time' validation GI. In particular, within these areas the exploratory holes should be placed near to gantry's and message boards where considerable construction and future maintenance work is to be undertaken. Key areas identified are:

- Lockington Quarry and Hemington Gravel Pits, Ch186600-188300;
- Church Wilne Water Treatment Works landfill, Ch189500-189900;
- The reinstated landfills South of Junction 25, Ch191400-192000.

The proposed boreholes for geotechnical investigation can be used to obtain geo-environmental samples. The recommended sampling strategy and placement is contained within: Addendum to Specification Appendix 1/5 – Validation GI Specification, included as Appendix B to this GDR.

The following structures and areas should be assessed prior to construction.

Asset	SMP Reference	Chainage	Carriageway	NEW/ REMAINING	Environmental Contamination Data taken Within 100m	Environmental Contamination Sampling required
Gantry	101	181950	NB	NEW	No	No
Gantry	112	185180	SB	NEW	No	No
Gantry	202	186240	NB	NEW	No	No
Gantry	202	186240	SB	NEW	No	No
Gantry	203	186400	SB	NEW	No	No
Gantry	204	186526	NB	NEW	No	Yes
Gantry	301	186847	NB	NEW	No	Yes
Gantry	301	186847	SB	NEW	No	Yes
Gantry	302	187073	SB	NEW	No	Yes
Gantry	326	187300	SB	NEW	Yes	Yes
Gantry	303	187608	SB	NEW	No	Yes
Gantry	304	187650	NB	NEW	No	Yes
Gantry	305	187818	SB	NEW	Yes	Yes
Gantry	307	188529	NB	NEW	No	No
Gantry	308	188760	SB	NEW	No	No
Gantry	309	188947	SB	NEW	No	No
Gantry	310	189160	SB	NEW	No	No
Gantry	311	189780	NB	NEW	No	Yes
Gantry	311	189780	SB	NEW	No	Yes

Asset	SMP Reference	Chainage	Carriageway	NEW/ REMAINING	Environmental Contamination Data taken Within 100m	Environmental Contamination Sampling required
Gantry	313	190771	NB	NEW	No	No
Gantry	314	191096	NB	NEW	No	No
Gantry	315	191296	NB	NEW	No	No
Gantry	316	191430	SB	NEW	No	Yes
Gantry	318	191801	NB	NEW	No	Yes
Gantry	319	192101	NB	NEW	No	No
Gantry	320	192290	SB	NEW	No	No
Gantry	321	192476	NB	NEW	No	No
Gantry	322	192906	NB	NEW	No	No
Gantry	323	193300	SB	NEW	No	No
Gantry	324	193331	NB	NEW	No	No
ERA	E1-A1	185195-185305	NB	NEW	No	No
ERA	E2-A1	186645-186755	NB	NEW	No	Yes
ERA	E3-B1	188425-188525	SB	NEW	No	No
ERA	E3-A1	188765-188865	NB	NEW	No	No
ERA	E3-B2	190465-190565	SB	NEW	No	No
ERA	E3-A2	190800-190900	NB	NEW	No	No
ERA	E3-B3	191845-191955	SB	NEW	No	Yes

Contamination testing should be undertaken and compared against U1B threshold values contained within the Specification Series 600 Appendices 6/2, 6/14 and 6/15, included in Appendix D of this GDR.

7.8. Discovery Strategy for Unexpected Contamination

The following procedure should be adopted at the construction phase to address the discovery of olfactory or visual evidence of contaminated ground:

1. Visual monitoring of excavation works should be undertaken by the Contractor under the guidance of an Environmental Specialist and Asbestos Specialist to check for unexpected or unusual materials with a contaminative potential. Such material could consist of buried drums, tanks or containers, soil, groundwater or liquids with an unusual colour or odour, or other evidence of contamination.
2. Halt work in affected area and consult an Environmental Specialist if such material is encountered - work in that area will be stopped until the material has been properly identified and suitable precautions taken.
3. Have the suspect material tested and characterised - where safe and reasonable to do so, any suspected contaminated material should be left in-situ and subjected to testing by an Environmental Specialist.

4. Assess options for dealing with the observed contamination - on the basis of the test results, the contamination must be appropriately dealt with in one of the following ways, in sequence:
    i. Additional risk assessment by an Environmental Specialist to determine whether the material poses any risk, and if it may be suitable for an alternative use on-site;
    ii. On-site treatment, subject to degree of contamination, available facilities, licences and space. Re-testing would be necessary before suitability for re-use could be confirmed;
    iii. The material may need to be removed for disposal or recycling off-site. This should be considered a last resort.

Regardless of which route above is taken, at the earliest stage the overseeing body should determine whether the Local Planning Authority must be consulted, and all decision making and actions must be recorded in the site file.

8. Ground Treatment

8.1. General

No ground treatment is proposed.

9. Specification Appendices

9.1. General

Specification appendices for Series 600 and 1600 are included as Appendix L and M to this GDR respectively. The specification for the 'Just in Time' validation GI is presented as Appendix B of this GDR.

The general scheme assumptions are as detailed below:

- Earthworks have been assessed to limit impact on flood plain;
- Earthworks have been assessed to limit impact on 'Red' environmental slopes;
- Earthworks widening and transitions for culverts to be refined during site mobilisation and verification surveys;
- In some locations fill is shown in cuttings to reduce verge width; this has been assumed to be not required;
- Cross sections and earthworks widening solutions and transitions in vicinity of bridge / underpass locations will need to be refined during site mobilisation and verification surveys;
- Geotechnical design has been undertaken based on historical GI data. Scheme specific 'Just in Time' validation GI will be required in some locations;

The appendices used are as follows:

- Appendix 1/5: Testing to be Carried Out by the Contractor;
- Appendix 6/1: Requirements for Acceptability and Testing etc. of Earthworks Materials;
- Appendix 6/2: (11/04) Requirements for Dealing with Clause U1B and Class U2 Unacceptable Materials;
- Appendix 6/3: Requirements for Excavation, Deposition, Compaction (Other than Dynamic Compaction);
- Appendix 6/5: Geotextiles Used to Separate Earthworks Materials;
- Appendix 6/6: Fill to structures and fill above structural Foundations;
- Appendix 6/7: Sub- formation and Capping and Preparation and Surface Treatment of Formation;
- Appendix 6/8: (05/01) Topsoiling;
- Appendix 6/9: Earthwork Environmental Bunds, Landscape Areas, Strengthened Embankments;
- Appendix 6/10 Ground Anchorages, Crib Walling and Gabions;
- Appendix 6/12: Instrumentation and monitoring;
- Appendix 6/14: (11/04) Limiting Values for Pollution of Controlled Waters;
- Appendix 6/15: (11/04) Limiting Values for Harm to Human Health and the Environment;
- Appendix 16/1: General Requirements for Piling and Embedded Retaining Walls;
- Appendix 16/3: Bored Cast-In-Place Piles;
- Appendix 16/8: Non-Destructive Methods for Testing Piles;
- Appendix 16/9: Static Load Testing of Piles;
- Appendix 16/15: Steel Sheet Piles;
- Appendix 16/18: Support Fluid.

10. Instrumentation and Monitoring

10.1. Proposed Instrumentation and Monitoring

None.

10.2. Instrumentation and Monitoring Methods

None.

10.3. Pile Testing

For pile testing details refer to the Specification appendix for Series 1600 included as Appendix E to this GDR.

10.4. 'Just in Time' Validation Ground Investigation

10.4.1. General

A 'Just in Time' validation GI has been specified to verify the ground conditions and validate the proposed design solutions, where required, prior to construction due to current design being based on non-scheme specific GI data.

Any major change in design on the basis of the validation GI shall be incorporated in a revision of this GDR. Any minor changes to design shall be recorded in the GFR.

The specification for the 'Just in Time' validation GI is presented as Appendix B of this GDR.

10.4.2. Supervision of works

The 'Just in Time' validation GI, will be procured by the Principal Contractor as part of the construction works and will be supervised by suitably qualified Geotechnical Engineer(s)/Engineering Geologist(s) from AMAR.

There will be a full time AMAR geotechnical presence on site during the construction to enable ongoing geotechnical design validation during the works.

11. Geotechnical Risk Register

A review of the geotechnical and environmental risks associated with the proposed works has been undertaken. The risks have been evaluated using a risk evaluation matrix as presented below in Table 11-1. Reference has been made to Part 3 of HD 41/15 'Maintenance of Highway Geotechnical Assets' [Ref 31] as part of the risk assessment process.

Table 11-1 – Risk Rating Criteria

Likelihood (L)		Severity (S)			=	Risk (R)					
% Likelihood							Likelihood				
		Time, Cost, SHE, Reputation					1	2	3	4	5
Almost Certain	5	Negligible Impact	1	E.g. Programme, budget, commercial sensitivity, SHE risks and reputation	Severity	5	5	10	15	20	25
Probable	4	Client and Contract strained	2			4	4	8	12	16	20
Possible	3	Client dissatisfaction and damage to relationships, reputation. Increased costs for the project and possible delay in completion of works.	3			3	3	6	9	12	15
Unlikely	2	Threat to future schemes and Client/business relationships, increased project costs and delays of works.	4			2	2	4	6	8	10
Negligible	1	Threat to contract credibility, Significant delays in program/construction works and increase in overall project costs.	5			1	1	2	3	4	5

Risk Ratings

1 to 5 Green Risk is negligible or of otherwise low severity (green) and shall be set aside for further consideration.
6 to 10 Amber Risk is unacceptable (red or amber) and shall be subject to further analysis and evaluation.
12 to 25 Red Risk is unacceptable (red or amber) and shall be subject to further analysis and evaluation.

The risk register, detailed below in Table 11-2, lists the anticipated geotechnical and environmental hazards associated with the works and the potential consequences of those hazards. The risk before control of the hazard has been assessed quantitatively as has the anticipated risk following the proposed response to each hazard.

Table 11-2 – Geotechnical Risk Register

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
A – Slopes and Earthworks									
A1	Existing steep slopes on or adjacent to scheme leading to slope failure.	Instability, surface deformation, structural damage.	3	4	12	Construction design includes specification and implementation of stabilisation methods where required.	1	4	4
A2	Gradient on site – insufficient land available for widening – retaining walls or earthworks required.	Increased cost of scheme, impact on structure layout.	5	4	20	Complete topographical survey at locations where required. Review structure locations and land required. Design of suitable retaining structures where space is limited.	2	4	8
A3	Slope instability instigated by temporary works and loading the crest of existing highway embankments.	Damage to structures, highway, infrastructure and adjoining properties.	3	4	12	Assess stability of all slopes likely to be affected by the works and design the structures accordingly.	1	4	4
A4	Incomplete / inaccurate topographical survey information.	Use of inaccurate topographical survey data may lead to a redesign during construction phase, which will have a negative impact on the program, increase costs of the works as well as having significant impact on other disciplines.	4	4	16	Complete Topographical Survey at locations where required for completeness of data. This will result in a more accurate design and less risk during the construction phase.	2	4	8
B – Foundations and Substructures (Major and Minor Structures)									
B1	Loose or compressible soils at shallow depth – unstable ground unsuitable for shallow foundations.	Instability of excavations. Excessive settlements/bearing capacity failure. Requirement for deep foundations. Increased cost of scheme.	3	4	12	Undertake ‘Just in time’ validation GI, in situ testing at structure location if insufficient data currently available. Design appropriate foundation solutions for ground conditions present.	3	1	3

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
B2	Hard ground at shallow depth – difficulty in achieving adequate depth for foundation construction.	Requirement for heavy duty machinery to excavate shallow bedrock to enable foundation construction. Potential change of piling method with delays in program. Potential requirement for re-design during construction.	4	3	12	Undertake 'Just in time' validation GI and laboratory testing to determine ground conditions if insufficient data currently available. Design appropriate foundation solutions for ground conditions present.	2	3	6
B3	Adjacent Structures – works affecting existing foundations, services, off-site structures.	Damage to existing foundations. Damage to services and endangering road users. Damage to adjacent structures. Increased cost of scheme.	3	5	15	Locate all services prior to commencement of works. Design to avoid impact on existing foundations, services and adjacent structures.	2	5	10
B4	Aggressive ground chemistry – attack on buried concrete leading to reduced strength of foundations.	Failure of foundations, damage to structures. Risk to road users. Increased cost to scheme to repair/replace.	4	3	12	Undertake additional chemical testing in accordance with BRE-SD1 [Ref 5] during 'Just in Time' validation GI. Use appropriate concrete design in construction.	2	3	6
B5	Orientations of discontinuities/joints/faults etc. in bedrock not favourable to shallow foundation design and temporary works slopes.	Stability of temporary works compromised. Founding stratum failure or deformation in excess of structure serviceability limits resulting in structure/infrastructure damage. Disruption to construction owing to unforeseen ground conditions. Delays to programme and increased costs.	3	4	12	A site specific 'Just in Time' validation GI will be undertaken to determine bedrock description.	2	4	8
C – Pavement Construction									
C1	Soft and compressible near surface soil – low CBR due to soft formation. Settlement of buried services infrastructure.	Pavement deformation. Damage to services. Increased cost to repair.	3	3	9	Design pavement accordingly. Consider alternative solutions/routes for services.	2	3	6
C2	Hard ground at shallow depth – difficulty in excavation of service trenches.	Requirement for heavy duty machinery to excavate service trenches. Increase cost to scheme.	3	3	9	Consider contingency solution/alternative routes for services where this is thought likely.	2	3	6

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
C3	Frost susceptible soils resulting in frost heave.	Pavement deformation / damage to buried services.	3	2	6	Undertake design appropriate to ground conditions present.	2	2	4
D – Drainage and Flooding									
D1	Shallow groundwater.	Dewatering required during construction. Risks to foundations due to uplift.	2	3	6	Conservative groundwater conditions assumptions where there is a lack of data present.	1	3	3
D2	Low ground and local watercourses resulting in localised flooding.	Requirement for flood protection. Increased cost to development.	3	4	12	Undertake appropriate design based on surface water conditions. Undertake slope design considering flood conditions.	2	4	8
D3	Motorway crosses major river or watercourse and/or aquifer.	Pollution of major river or watercourse or aquifer during works.	3	4	12	AMAR Landscape and Environment completed Environment Study Report. Pertinent watercourses identified and contingency measures to be specified by the Environment team.	1	4	4
D4	Reduction in floodplain area due to earthwork widening.	Earthwork changes have the potential of affecting the hydraulic characteristics within the floodplain associated with the River Trent and its tributaries. Floodplain compensation may be required. Increased cost and programme for liaison with EA.	4	4	16	Earthwork changes assessed in comparison to known flood levels and alternative solutions considered. Build-out into flood plain unavoidable in certain areas.	2	4	8
D5	Locations within areas of high flooding risk.	Flooding of sites affecting temporary works. Disruption to construction owing to flood events. Delays to programme and increased costs.	4	3	12	Contractor to be aware of weather conditions and EA adverse weather warnings. Contractor to plan temporary works to avoid working in adverse weather conditions. Contractor to plan emergency procedures for flooding events. Residual risks for management by the contractor and site staff to be notified via Designer's Risk Assessment.	2	3	6

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
D6	Proximity to surface water features (watercourses and water pools).	Falls in the water, risk of drowning/injury/death to site workers.	4	5	20	Contractor to design works area to restrict access of site staff to watercourses. Emergency procedures in place for falls in water. Residual risks for management by the contractor and site staff to be notified via Designer's Risk Assessment.	2	5	10
E – Temporary Works/Construction Issues									
E1	Buried Services encountered during excavations.	Health and safety risk – harm to workers/road users. Suspension of road signage. Increased cost to repair.	3	5	15	Obtain all services plans for the route and ensure all services are identified and marked out prior to commencement of any intrusive site works. Inspection pits to be dug before commencement of any exploratory holes.	2	5	10
E2	Contaminated Ground.	Health and safety risk to site workers/road users. Increased cost to dispose of material off site. Delay and increase in cost to development.	3	4	12	Contaminated land risk assessment and waste acceptance assessment completed as part of this GDR.	2	4	8
E3	Environmental Barrier.	Lack of available verge width for new barriers resulting in verge build-out and embankment widening. Cost and programme implications.	3	4	12	Obtained required barrier locations at early stage and assessed requirements for embankment widening.	2	4	8
F – Cross Carriageway Ducts									
F1	Limited knowledge of ground conditions.	Selection of inappropriate trenchless technique causing unacceptable settlement and/or heave and delays.	3	3	9	Select appropriate technique and design based on the findings of the 'Just in Time' validation GI. AMAR to undertake design and provide separate GDR for this element.	1	3	3

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
F2	Possible drill deviation during drilling due to increasing stiffness of stratum.	Selection of inappropriate trenchless technique causing possible delays in programme.	3	3	9	Select appropriate technique and design based on the findings of the 'Just in Time' validation GI.	2	3	6
F3	Ground deformation resulting from installation.	Unacceptable settlement trough develops in road pavement or heave occurs.	3	4	12	Selection of appropriate technique and dimensions of the bore and duct. Allow cuttings to remain around the annulus. Consider bentonite flush if bore unstable. Use experienced operatives only. Install crossing deeper. Monitor road surface level before and after installation.	2	4	8
F4	'Frac-outs' (blowouts of drilling mud – if used).	Drilling mud disrupts the pavement and is a safety issue for road users. Damage to highways drainage assets from drilling mud ingress.	2	3	6	Careful monitoring and control of drilling flush pressures. Observation during drilling. Use experienced operatives only.	1	3	3
G – Insufficient Geotechnical Data									
G1	Insufficient GI and/or laboratory testing for design.	Stratigraphy and materials not as anticipated. Unforeseen ground conditions. Inappropriate design solutions. Re-design may be required with cost and programme implications.	5	3	15	Plan to undertake 'Just in time' validation GI where required at specified locations. The results of the 'Just in Time' validation GI will be reviewed against this GDR and resources pre-allocated for any re-design needed. The Geotechnical Site Team is to be suitably qualified to manage risk on site.	3	3	9
G2	Delay in undertaking 'Just in time' validation GI.	GI is required and design may need to be revised following its findings. GI to be undertaken as per the Validation GI Specification included as Appendix B of this GDR. Cost and programme delays due to delays in verification of design.	3	4	12	'Just in Time' validation GI will be undertaken before construction works. To prevent delays, comprehensive planning will be undertaken to ensure sufficient resources are available for the GI.	2	4	8

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
H – Construction Phase									
H1	Unknown/variable ground and groundwater conditions that may be worse than those assumed for design.	Founding stratum failure or deformation in excess of structure serviceability limits resulting in structure/infrastructure damage. Disruption to construction owing to unforeseen ground conditions.	4	4	16	'Just in Time' validation GI to be undertaken. Evaluation and confirmation of design, where necessary redesign.	2	4	8
H2	Services.	Conflict with proposed new construction, damage during construction works, delays to construction and additional costs, risk of injury/death to construction personnel.	5	5	25	Existing services have been identified. Inspection pits and slit trenches in high risk areas should be undertaken to locate and identify known services.	1	5	5
H3	Highway traffic.	Injury/death to site workers/members of the public.	5	5	25	Traffic management will be implemented during 'Just in Time' validation GI and construction. All site personnel to be briefed on the residual risks.	2	5	10
H4	Narrow verge width at the embankment crests.	Difficult/restricted access for plant/machinery. Increased risk of slips/falls. Increased risk of damage to equipment and risk to human health.	5	3	15	The potential for minor variations in locations to avoid areas of restricted access/working area.	4	3	12
H5	Driving sheet piles through very dense gravel and mudstone.	Risk of damage to equipment and personnel during driving. High associated costs to rectify equipment if damaged.	4	4	16	Contractor to assess ground through in-situ test data from 'Just In Time' validation GI and determine/consider alternative method of installing sheet pile.	4	3	12
H6	Excavation of material	Risk of injury to personal during excavation. Possibility of material being displaced into live carriageway, which can lead to injury to the users of the network.	4	4	16	Contractor to assess area of excavation and use appropriate safety measures to ensure material is stored or placed away from the running lanes. Excavator operators to have a banksman to prevent the risk of injury to personnel on site.	4	3	12

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk		
			L	S	R		L	S	R
H7	Encountering, disposal and handling of hazardous material	Health and safety implications for site personnel. Additional handling and disposal costs, delays to the program.	4	4	16	Contractor to ensure appropriate PPE worn at all times and site won material and hazardous materials to be stored separately on site to avoid mixture. Contractor to complete appropriate testing on material and appropriate disposal measures to be taken on site. Hazardous materials to be stored with clear signs present warning all site personnel of hazards.	2	4	8

12. References

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2. Design Manual for Roads and Bridges, Volume 4, Section 1, Part 2, HD22/08, Managing Geotechnical Risk;
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5. BRE Special Digest 1:2005, Concrete in Aggressive Ground. 2005;
6. BS EN 1997-1:2004+A1:2013, Eurocode 7: Geotechnical Design - Part 1: General Rules;
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8. Geo-Slope International, Geo Studio 2012 (August 2015 Release), SLOPE/W Slope Stability Analysis;
9. BS 6031:2009, Code of Practice for Earthworks;
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13. BS EN 1993-5 2007: Eurocode 3: Design of Steel Structures Part 5: Piling;
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15. BD94/07 Design of Minor Structures;
16. Randolf, M.F., Piglet: Analysis and Design of Pile Groups, Version 5.1, July 2006;
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20. Valmont Stainton, Appendix 13/2, Specification for Highways Works, Column and Bracket Data Sheet, 12M RADAR COLUMN (CC7942), April 2015;
21. Design Manual for Roads and Bridges, Volume 2, Section 2, Part 1, BD95/07, Design of Minor Structures, February 2007;
22. AMAR, M1 Junction 23a to 25, Geotechnical Design Report – Cross Carriageway Ducts, Report Ref: HA549342-AMAR-HGT-SWI-RP-CE-000006, Rev P01, HAGDMS Ref: 29378, February 2017;
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25. AMAR, M1 Junction 23a to Junction 25, Drainage Strategy Report, Report Ref. HA549342-AMAR-HDG-SWI-RP-CD-000001, Rev P02, February 2016;
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30. Environment Agency. Waste Classification. Guidance on the classification and assessment of waste, Technical Guidance WM3, Bristol: Environment Agency, Scottish Environment, 1st edition, 2015;
31. HD 41/15, Design Manual for Roads and Bridges, Volume 4 Geotechnics and Drainage, Section 1 Earthworks, Part 3 Maintenance of Highway Geotechnical Assets, 2015;
32. King Sheet Piling – Technical Guidance, V 1.2/15.4.14, obtained from www.ksp-piling.co.uk.
33. BS 8002:2015 – Code of practice for earth retaining structures
34. BS 8004:2015 – Code of practice for foundations

Appendix A. Geotechnical Summary Sheets

Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-188500-188500NB-GSS-000001		
Earthworks Widening Solution	Granular Wedge at Embankment Crest (1:2.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	188500-188500		
Carriageway	Northbound		
Marker Post	188/5A+00 – 188/5A+00		
National Grid Reference	E 446628, N 330743		
Existing Ground Level at Location	Carriageway	38.69mAOD	
	Toe of embankment	29.82mAOD	
Earthwork Type	NB: N/A	SB: Embankment	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: N/A	SB:	HAGDMS designation
Earthwork Height	NB: N/A	SB:	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 19°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Roheel Masrat	19/04/2017	[redacted]
Checked	Alice Bazen	20/04/2017	
Reviewed	Gary Summerfield	21/04/2017	
Approved	Tom Bulteel	06/06/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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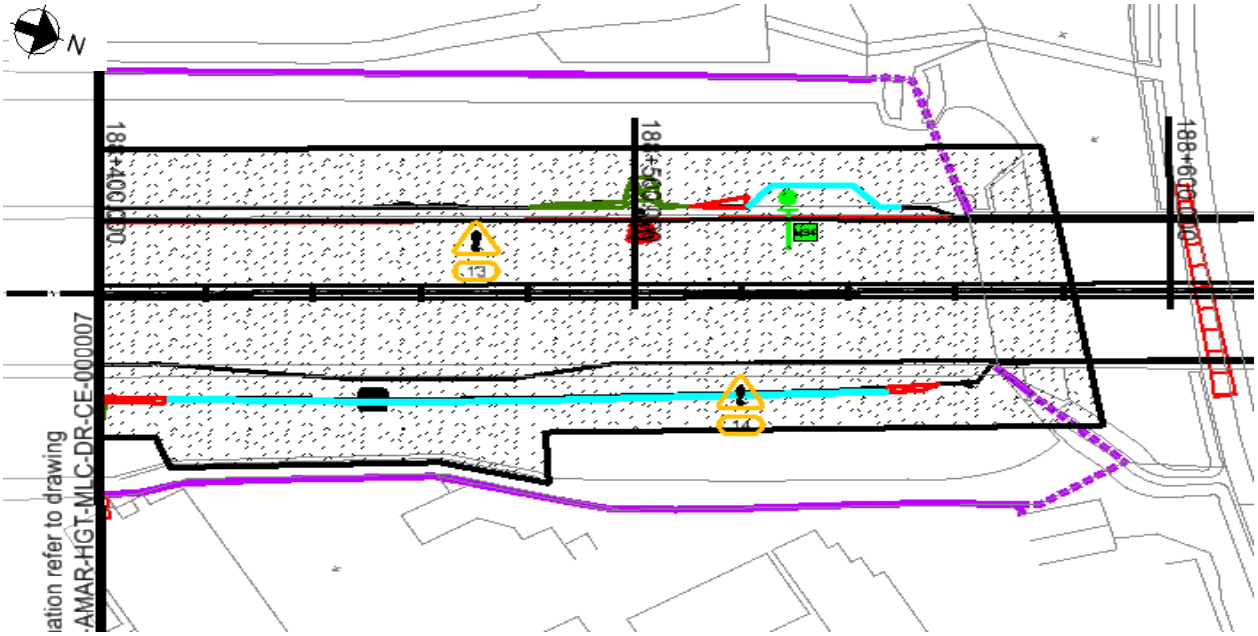


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Granular Wedge at Embankment Crest (1:2.0)

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that location comprises and embankment with height of 8.62m and slope angle of 19 degrees.

The critical cross section is based on the section with the greatest earthwork height at chainage 188500.

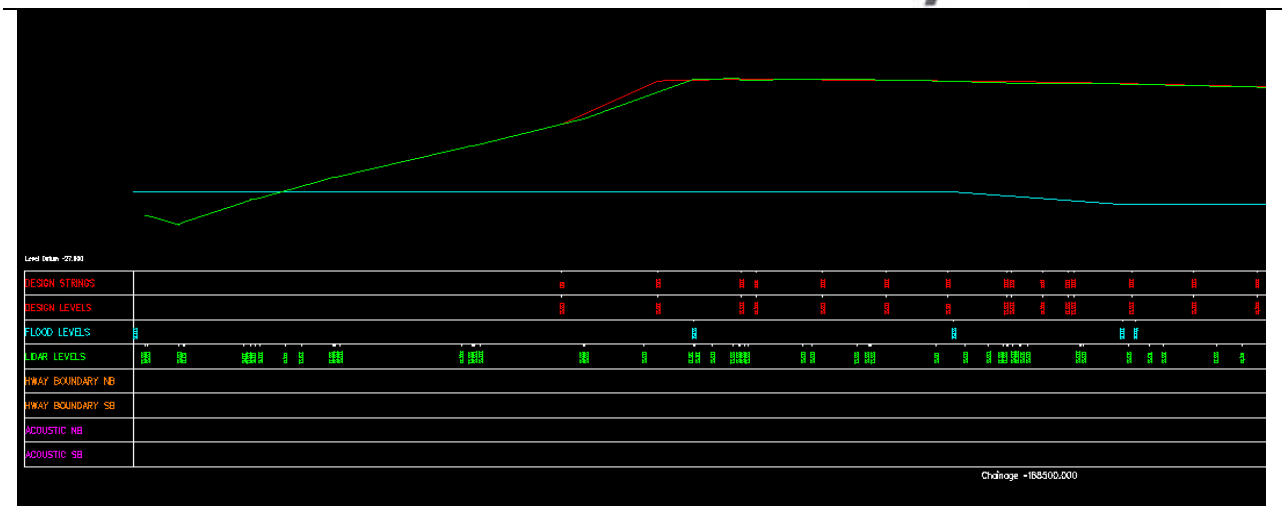


Figure 2 Topographic Critical Cross Section Chainage 188500

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough, indicates that the site is underlain by:

Superficial Deposits: Hemington Member - Silt And Gravel

Solid Deposits: Edwalton Member - Mudstone

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however 2 no. relevant exploratory holes considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000031, Rev P01.

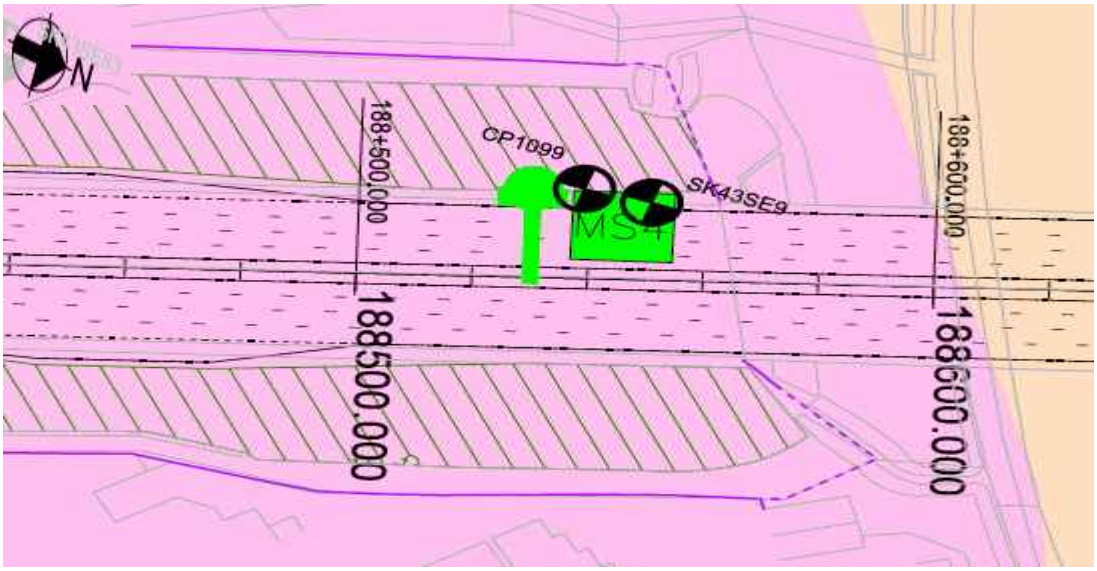


Figure 3: Borehole Location Plan

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Flood Risk:

The design flood level is 31.83mAOD. Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	CP1099
Borehole Chainage	188539
Borehole Location	Northbound
National Grid Reference	E 446611, N 330778
Ground Level at Exploratory Hole	38.60mAOD
RAG Analysis	Green
Date Drilled	24/10/2006-25/10/2006
Termination Depth	19.05 metres below ground level
Other suitable holes	SK43SE9

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (m bgl)	Depth to Base (m AOD)	SPT 'N' Value Range[3]
Embankment Fill	9.19	29.50	17-32 (32)
River Terrace Deposits	16.69	22.00	38-83 (38)
Mercia Mudstone – III/IV	>16.69	<22.00	29>150

(1) Ground level is assumed to be at carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within historical exploratory holes CP1099 and SK43SE9.

Groundwater:

Groundwater was encountered in borehole SK43SE9 at 1.22mbgl (29.78mAOD) and rose to 0.61mbgl (30.39mAOD).

Groundwater Design Level:

No Local groundwater is available therefore design groundwater level of 31.83mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

3 No. Atterberg Limit Test and 3 No. Natural Moisture Content tests were undertaken within the Embankment Fill and Mercia Mudstone with the following results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	4.0	9.0	25.0	12.0	13.0	CL
Embankment Fill	7.7	6.0	25.0	12.0	13.0	CL
Mercia Mudstone	18.4	15.0	29.0	20.0	9.0	CL

Lab Test Data – BRE Classification:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
River Terrace Deposits	pH	Water	2	7.50	-

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Assumed Ground Model For Design:

Ground model is based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-000034, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01.

The below table outline the assumed anticipated ground model:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment fill	0.00-9.19	38.69-29.50	9.19	21	27	0	85	6.90	5.52	-	0.50	0.20	-	DS-2 AC-2
River Terrace Deposits	9.20-16.69	29.50-22.0	7.49	21	38	-	-	-	52.80	-	-	0.25	-	DS-3 AC-2
Mercia Mudstone – III/IV	>16.69	<22.00	-	21	30	2	150	16.80	13.40	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) c_u of Embankment Fill can be determined using SPT N values and the Stroud correlation; typical f1 value of 5.0 and SPT 'N' Value of 17 gives C_u of
(4) ϕ' of Embankment Fill can be determined using Table 2 in BS8002:2015 using a typical PI of 13% gives 27°.
(5) E' of Embankment Fill can be determined using Bowles relationship Eu = 300 (N + 6) = 300 (17 + 6) = 6.9MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 5.5MN/m^2.
(6) ϕ' of River Terrace Deposits can be determined using correlation with SPT (Peck 1974) N values (typical N value of 38) gives an angle of 38°.
(7) E' of River Terrace Deposits can be determined using Bowles correlation E' = 1200 (N + 6) which (using typical N value of 38) gives a value of 52.80MN/m^2.
(8) c_u of Mercia Mudstone – III/IV can be derived using the Stroud correlation. A characteristic PI of 14% was used to derive an f1 value of 5.0; combined with a conservative SPT N value of 23, this gives a cu of 115kN/m^2.
(9) Due to lack of reliable data available for Mercia Mudstone-III/IV, geotechnical parameters derived in the AMAR GIR have been adopted.
(10) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

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Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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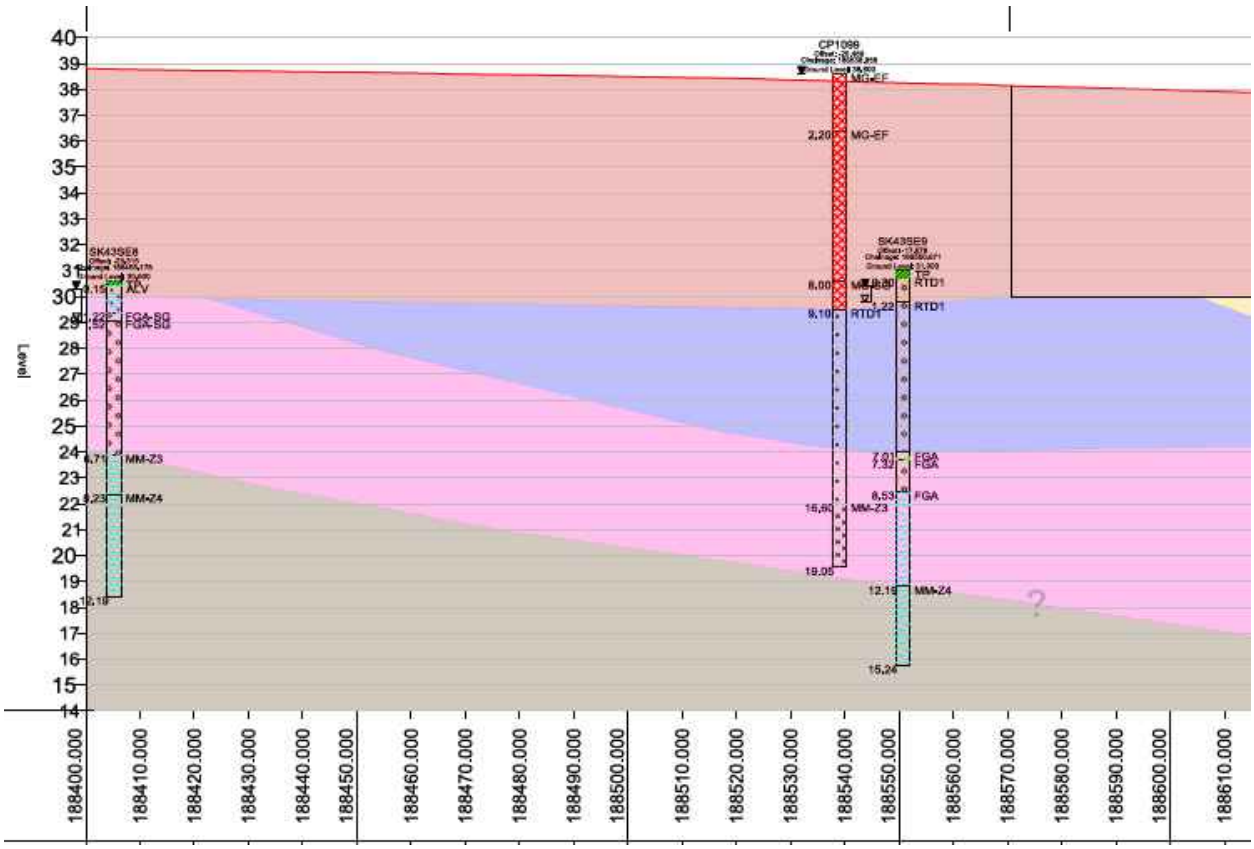


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
188500	188500	Granular Wedge at Embankment Crest (1:2.0)	3.0	26.6 (1V:2H)

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FURTHER GROUND INVESTIGATION

No further Ground Investigation has been proposed.

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HISTORICAL EXPLORATORY HOLES

Borehole Log

Borehole No. **CP1099** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446611.00 - 330778.00	Hole Type CP
Location:		Level: 38.60mbgl	Scale 1:50
Client: Highways England		Dates: 24/10/2006 - 25/10/2006	Logged By RMS/JS

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		1.20 - 1.65	2U	49blows					MADE GROUND: Brown slightly silty sand. Sand is fine to coarse. With occasional gravel of subangular fine to coarse weathered weak sandstone. MG-EF
		1.70	3D						
		2.20	SPT (S)	N=17 (2,2/4,4,4,5)	Water=DRY	2.20	36.40		MADE GROUND: Stiff brown mottled green slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is subangular to subrounded coarse of sandstone, siltstone, mudstone and coal. With occasional rootlets and gypsum. Slight organic odour. MG-EF
		2.20 - 2.65	4D						
		2.20 - 2.70	5B						
		3.20 - 3.65	6U	71blows					
		3.70	7D						
		4.20	SPT (S)	N=26 (4,5/5,7,7,7)	Casing=3.20m Water=DRY				
		4.20 - 4.65	8D						
		4.20 - 4.70	9B						
		5.20 - 5.65	10U	100blows					
		5.70	11D						
		6.20	SPT (S)	N=32 (3,6/8,8,8,8)	Casing=6.20m Water=DRY				
		6.20 - 6.65	12D						
		6.20 - 6.70	13B						
		7.20 - 7.65	14U	100blows					
		7.70	15D						
		8.00	SPT (C)	50 (25 for 30mm/50 for 0mm)	Casing=8.00m Water=DRY	8.00	30.60		MADE GROUND: Very dense brown clayey sand with gravel of angular to subrounded fine to coarse mudstone, limestone and sandstone. Occasional subrounded cobbles of the same. MG-SG
		8.00 - 8.50	16B						
		9.30	SPT (C)	N=38 (2,5/6,9,11,12)	Casing=9.30m Water=ADDED	9.10	29.50		Dense brown SAND and GRAVEL. Sand is mainly medium to coarse, gravel is angular to subrounded fine to coarse of mixed lithologies. Occasional to some subrounded cobbles.
		9.30 - 9.80	17B						
		9.80	24W						

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 8.00m to 9.00m (2.5 hours), 11.00m to 11.30m (0.5 hours) and 18.50m to 18.90m (1 hour).;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 9.30m to 16.60m.;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **CP1099** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446611.00 - 330778.00	Hole Type CP
Location:		Level: 38.60mbgl	Scale 1:50
Client: Highways England		Dates: 24/10/2006 - 25/10/2006	Logged By RMS/JS

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									RTD1 *SAND and GRAVEL (as previous sheet)*
		10.80	SPT (C)	50 (2,6/50 for 180mm)	Casing=10.80m Water=ADDED				
		10.80 - 11.30	18B						
		12.30	SPT (C)	N=49 (3,6/9,11,14,15)	Casing=12.30m Water=ADDED				
		12.30 - 12.70	19B						
		13.80	SPT (C)	50 (6,9/50 for 200mm)	Casing=13.80m Water=ADDED				
		13.80 - 14.30	20B						
		15.30	SPT (C)	49 (2,5/49 for 245mm)	Casing=15.30m Water=ADDED				
		15.30 - 15.80	21B						
		16.60	22D			16.60	22.00		
		16.70	SPT (S)	N=29 (3,4/6,6,8,9)	Casing=16.70m Water=ADDED				Stiff to very stiff brown slightly sandy SILT with occasional angular to subangular fine to coarse lithorelics of weathered siltstone and sandstone. MM-Z3
		16.70 - 17.15	23D						
		16.70 - 17.20	25B						
		18.20 - 18.40	26U	100blows					
		18.40	27D						
		18.45	28D						
		18.45	SPT (S)	50 (25 for 70mm/50 for 60mm)	Casing=18.20m Water=10.30m				*Below 18.40m; recovered as brown slightly sandy fine to coarse angular to subangular gravel sized fragments of finely laminated weathered SILTSTONE. With occasional laminae of gypsum (<2mm).*
		18.45 - 18.90	29B			19.05	19.55		End of borehole at 19.05 m
		18.90	30D						
		18.90	SPT (S)	50 (25 for 75mm/50 for 75mm)	Casing=18.50m Water=10.10m				

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 8.00m to 9.00m (2.5 hours), 11.00m to 11.30m (0.5 hours) and 18.50m to 18.90m (1 hour).;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 9.30m to 16.60m.;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **SK43SE9** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446610.00 - 330790.00	Hole Type CP
Location:		Level: 31.00mbgl	Scale 1:50
Client: Highways England		Dates: 15/02/1962 - 23/02/1962	Logged By

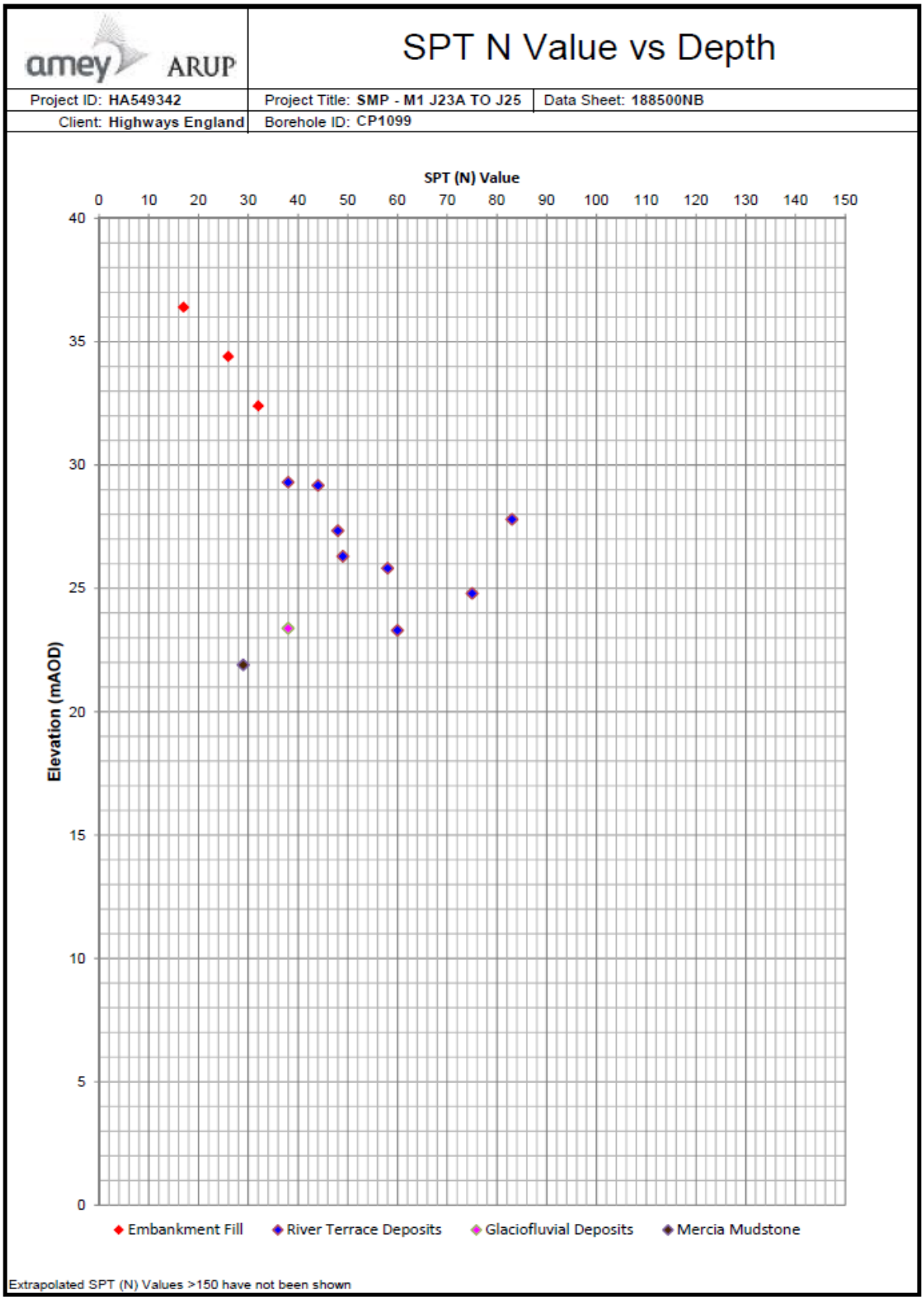
Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	1D			0.30	30.70		Top soil TP
		0.61	2D						Sandy subsoil RTD1
						1.22	29.78		Gravel & sand RTD1
		1.52	3D						
		1.83	SPT (S)	N=44 (75,6/6,8,14,16)	Water=-				
		1.83 - 2.29	15B						
		1.83 - 2.29	23SP TLS						
		3.05	4D						
		3.66	SPT (S)	N=48 (75,8/6,10,14,18)	Water=-				
		3.66 - 4.11	16B						
		3.66 - 4.11	24SP TLS						
		4.57	5D						
		5.18	SPT (S)	N=58 (75,6/10,12,16,20)	Water=-				
		5.18 - 5.64	17B						
		5.18 - 5.64	25SP TLS						
		6.10	6D						
						7.01	23.99		Organic material FGA
		7.16	7D			7.32	23.68		Silt & gravel FGA
		7.62	8D						
		7.62	SPT (S)	N=38 (75,4/8,8,10,12)	Water=-				
		7.62 - 8.08	18B						
		7.62 - 8.08	26SP TLS						
		8.53	9D			8.53	22.47		Red & grey marl FGA
		8.84 - 9.30	19U	128blows					
									Continued on next sheet

Remarks
No core possible in Marl & Gypsum

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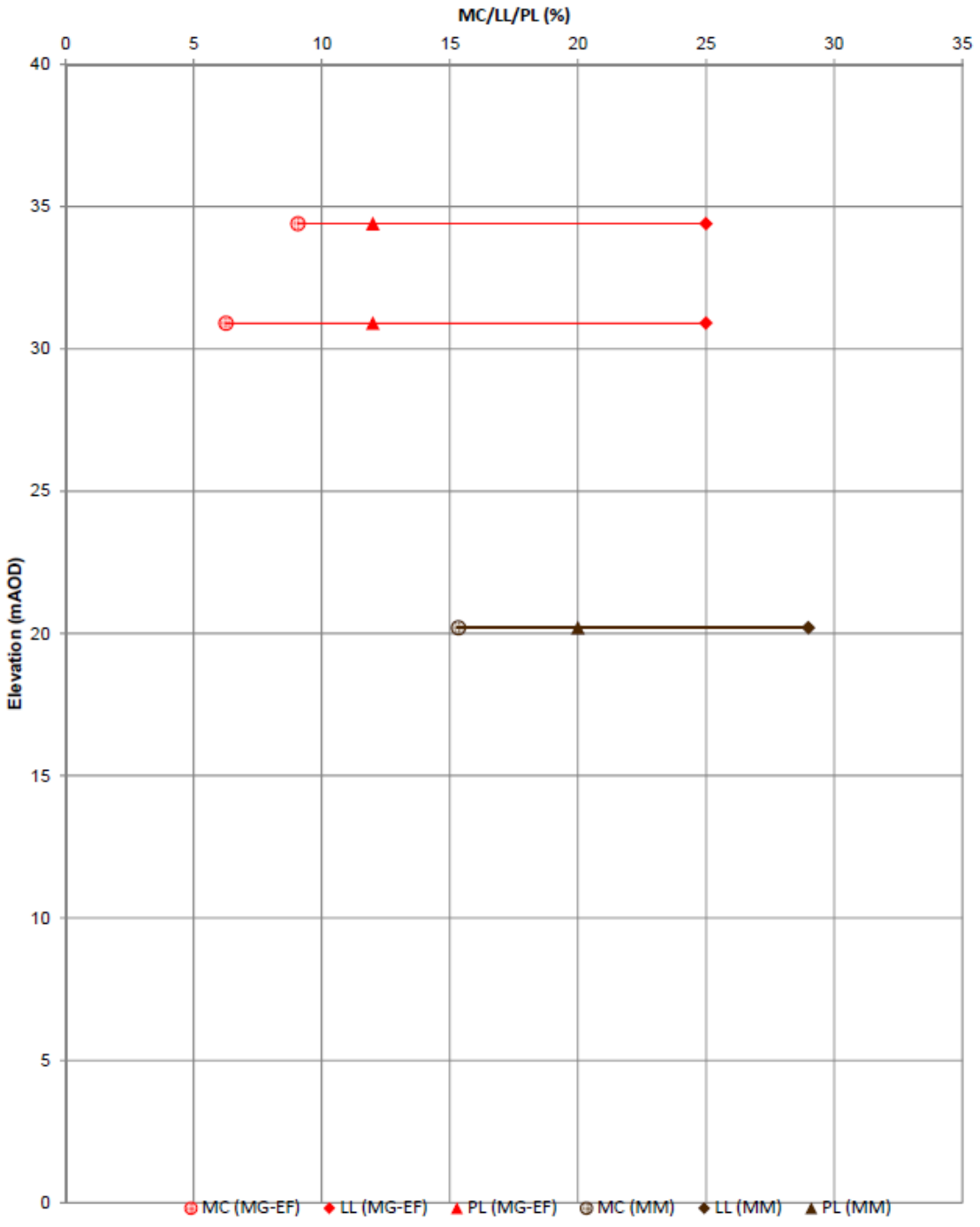
PLOTS



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Moisture Content/Atterberg Limits

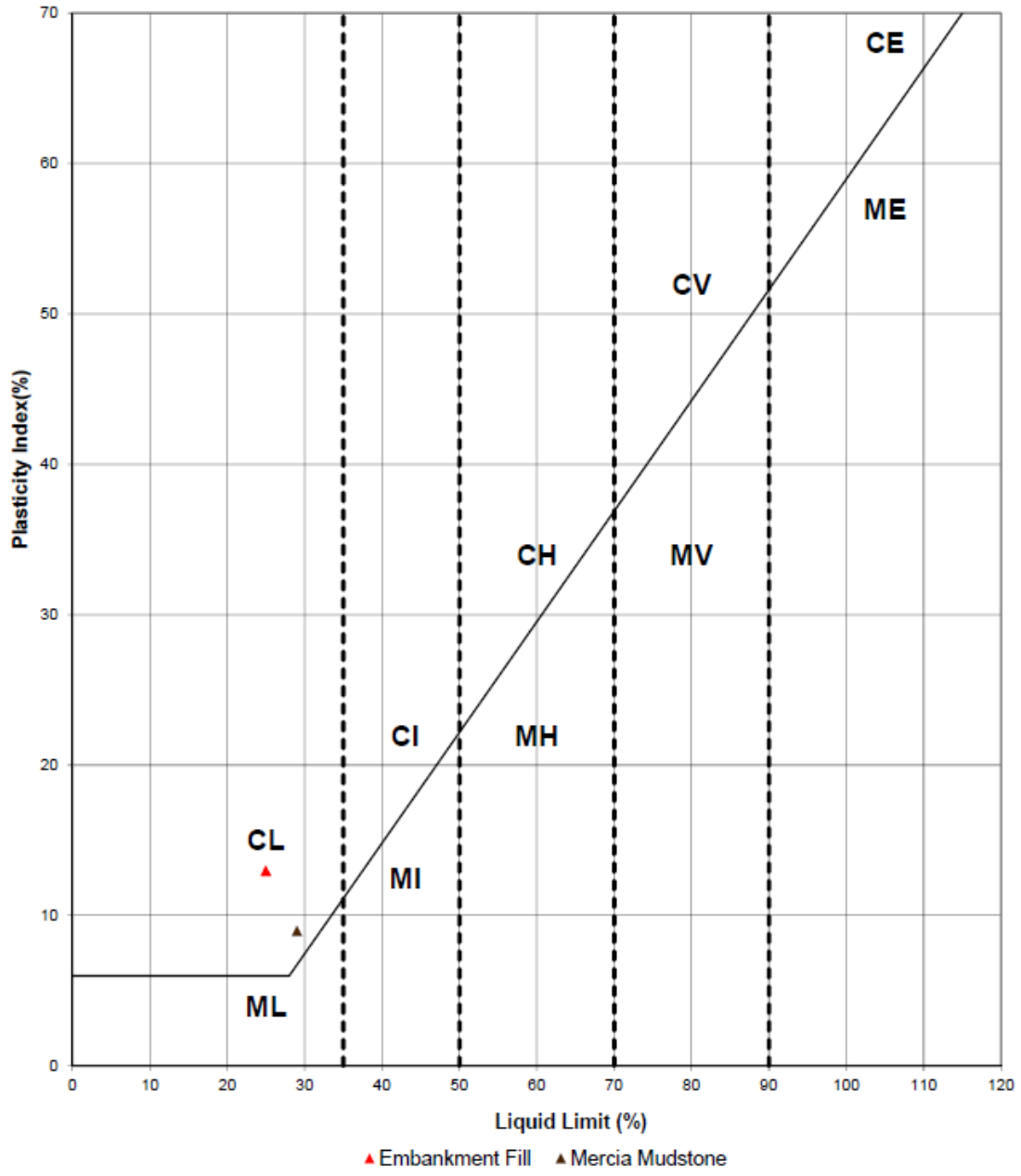
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188500NB**
Client: **Highways England**	Borehole ID: **CP1099**	



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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188500NB**
Client: **Highways England**	Borehole ID: CP1099	



Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-188130-188190NB-GSS-000001		
Earthworks Widening Solution	Granular Wedge at Embankment Crest (1:2.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	188130-188190		
Carriageway	Northbound		
Marker Post	MP188/1A+30 – MP188/1A+90		
National Grid Reference	E 446747, N 330385 – E 446726, N 330451		
Existing Ground Level at Location	Carriageway	37.55-38.17mAOD	
	Toe of embankment	31.01-30.27mAOD	
Earthwork Type	NB: Embankment	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: 7_M1_24389	SB: N/A	HAGDMS designation
Earthwork Height	NB: 7.5-7.9m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 26°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Simon Arinze	02/05/2017	[redacted]
Checked	Roheel Masrat	03/05/2017	
Reviewed	Gary Summerfield	04/05/2017	
Approved	Tom Bulteel	06/06/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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DESK STUDY

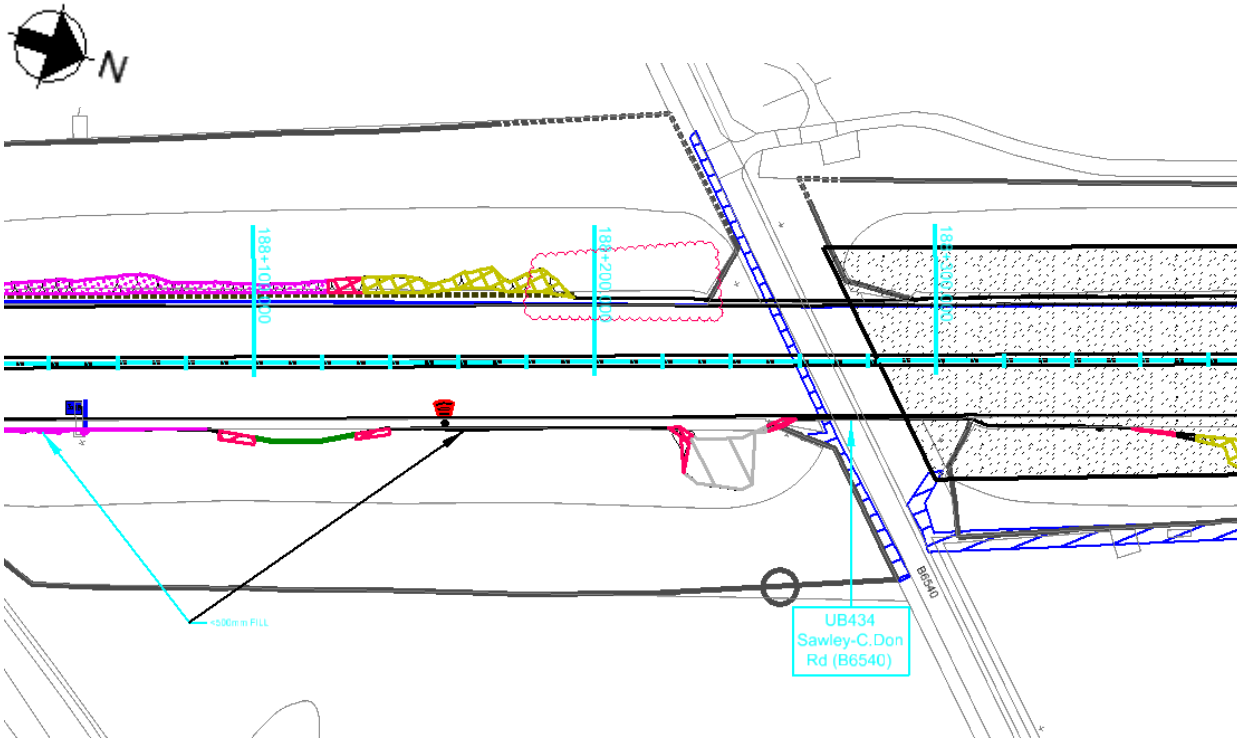


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- 188130-188190 – Granular Wedge at Embankment Crest (1:2.0)

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment with a height ranging between 7.5-7.9m and a typical slope angle of 26 degrees.

The critical cross section at chainage 188170 is based on the section with the greatest earthwork height.

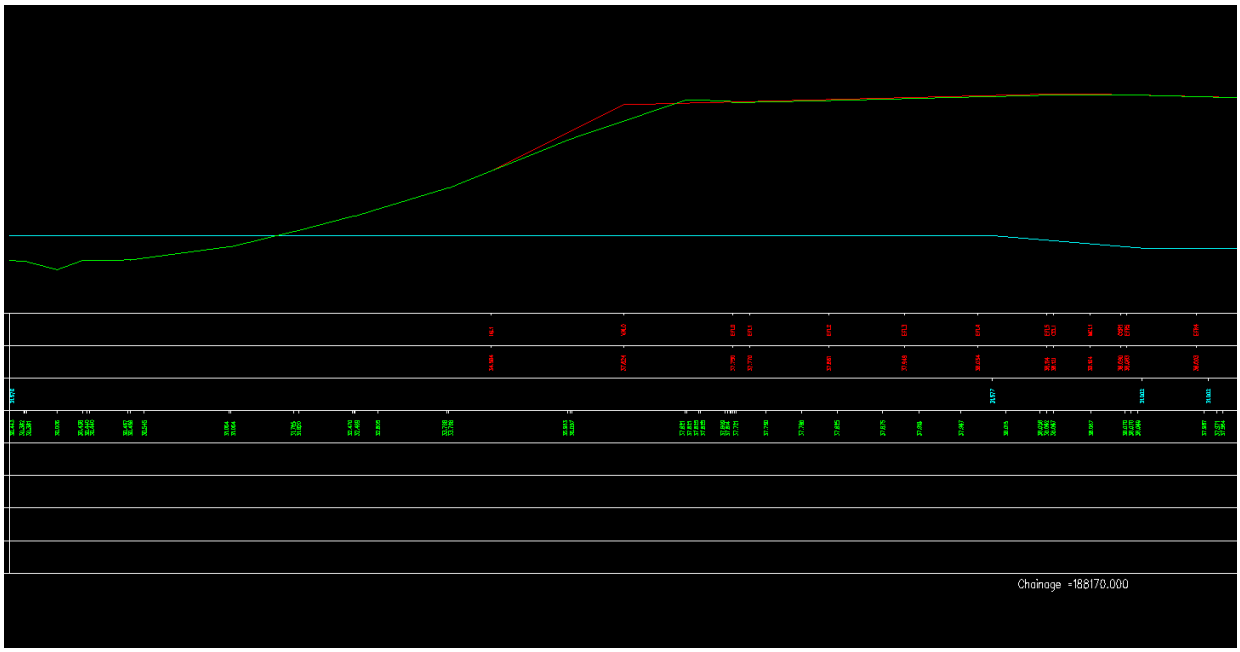


Figure 2 - Topographic Critical Cross Section Chainage 188170

Utilities:

Western power low voltage supply meter connection running along the northbound verge.

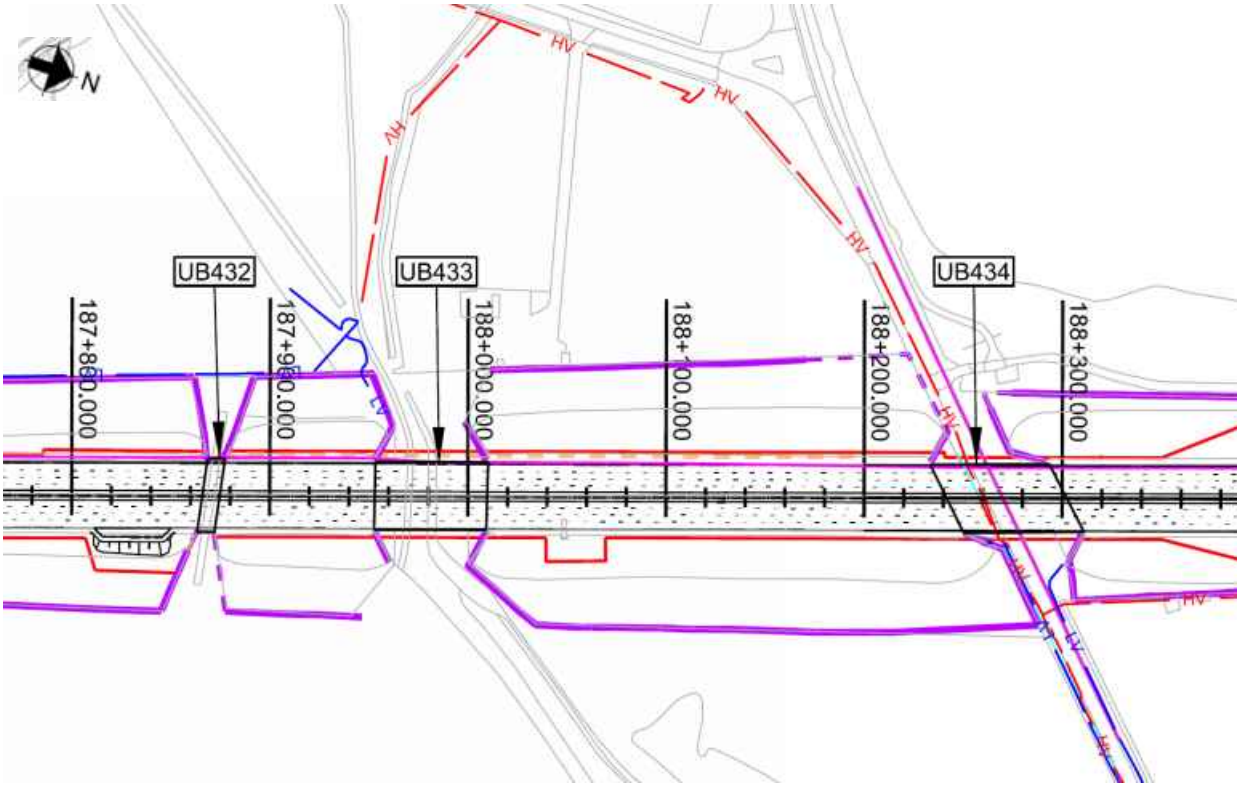


Figure 3 - Utilities Location Plan

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Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Hemington Member - Silt And Gravel

Solid Deposits: Edwalton Member - Mudstone

Ground Investigation:

There are 2 No. historical exploratory holes recorded within the design chainage, with an additional 4 no. relevant exploratory holes outside the design chainage considered as shown on Geological Long Section, Drawing No. HA549342-AMAR-HCT-SWI-DR-CE-000028, Rev P01.

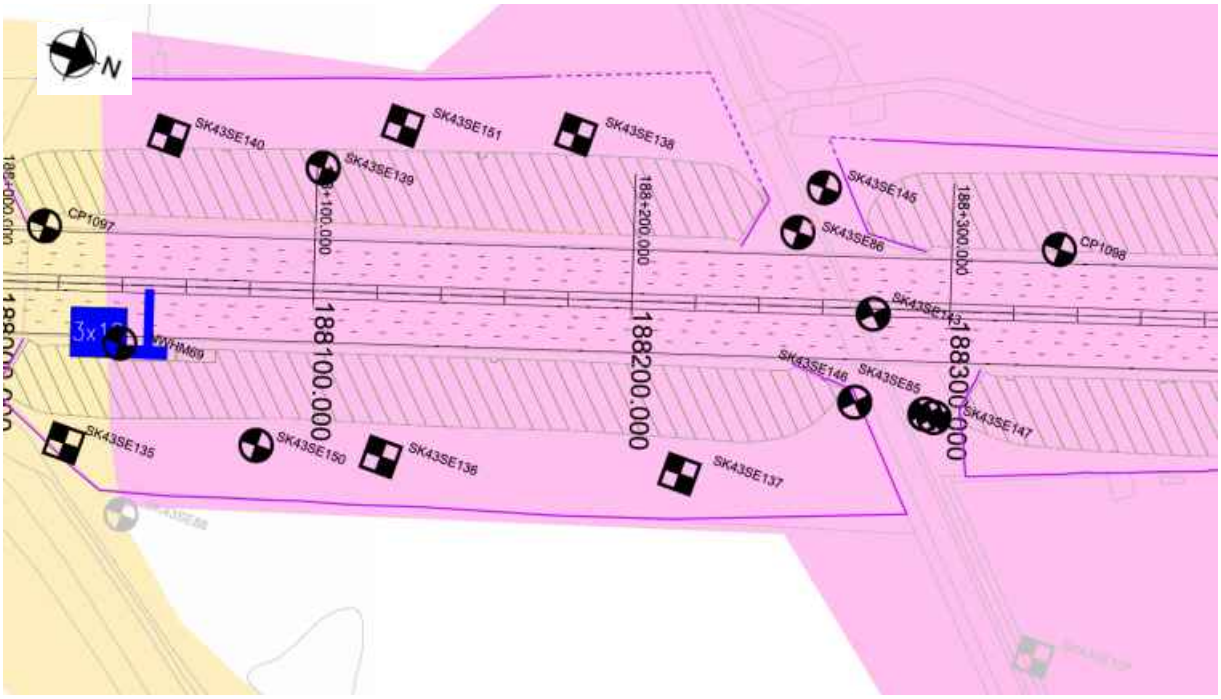


Figure 4: Borehole Location Plan

Flood Risk:

The design flood level is 31.58mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	SK43SE151	SK43SE138	SK43SE86
Borehole Chainage	188120	188175	188250

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Borehole Location	Northbound	Northbound	Northbound
National Grid Reference	E 446730, N 330357	E 446693, N 330428	E 446682, N 330507
Ground Level at Exploratory Hole	31.00mAOD	30.60mAOD	31.10mAOD
RAG Analysis	Green	Amber	Green
Date Drilled	10/09/1990 – 11/09/1990	09/08/1990	22/04/1988
Termination Depth	11.25 meters below ground level (mbgl)	2.30 metres below ground level (mbgl)	8.60 metres below ground level (mbgl)
Other suitable holes	CP1098, SK43SE145, SK43SE137		

Existing Ground Conditions:

The following ground conditions have been assumed based on the GI and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*	Hand Vane Strength Range (kN/m^2)
Embankment Fill	7.92	30.5	15-41 (15)	-
Glaciofluvial Deposits (Coarse Grained)	14.42	24.0	7-130 (37)	-
Mercia Mudstone – III/IV	>14.42	<24.0	29->150 (29)	-

(1) Ground level is assumed to be at the carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within historical exploratory holes SK43SE151, SK43SE86 and CP1098.

Groundwater:

Groundwater was encountered in 4 No. Exploratory boreholes and are presented in the table below:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		mbgl	mAOD	Time	mbgl	mAOD
SK43SE137	Glaciofluvial Deposits	2.0	28.40	N/A	N/A	N/A
SK43SE86	Glaciofluvial Deposits	2.0	29.10	-	1.55	29.55
SK43SE151	Mercia Mudstone	8.50	22.50	-	-	-
SK43SE138	Glaciofluvial Deposits	2.30	28.30	-	-	-

Groundwater Design Level:

Limited groundwater data is available therefore a design groundwater level of 31.58mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

No geotechnical laboratory tests were undertaken within the historical exploratory boreholes.

Lab Test Data – BRE Classification:

No environmental laboratory tests were undertaken within the historical exploratory boreholes.

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Assumed Ground Model For Design:

Ground model is based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-000034 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01.

The below table outline the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0.00 – 7.92	38.42 – 30.50	7.92	21	27	0	96	6.3	5.0	-	0.5	0.20	-	DS-2 AC-2
Glaciofluvial Deposits (Coarse Grained)	7.92 – 14.42	30.50 – 24.00	6.50	21	37	-	-	-	51.6	-	-	0.25	-	DS-3 AC-3
Mercia Mudstone – III/IV (>10mbgl)	>14.42	<24.00	-	21	30	2	145	10.5	8.4	-	0.5	0.2	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) c_u of Embankment Fill can be determined using SPT N values and the Stroud correlation, using an average PI of 14%, f1 correlation factor is 6.4. Using an average SPT 'N' Value of 15, Cu is 96.0 kN/m^2.
(4) ϕ' of Embankment Fill can be determined using Table 2 in BS8002:2015 using a typical PI of 14% gives 27°.
(5) E' of Embankment Fill can be determined using Bowles relationship Eu = 300 (N + 6) = 300 (15 + 6) = 6.3MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 5.5MN/m^2.
(6) ϕ' of Glaciofluvial Deposits can be determined using correlation with SPT (Peck 1974) N values (typical N value of 37) gives an angle of 37°.
(7) E' of River Terrace Deposits can be determined using Bowles correlation E' = 1200 (N + 6) which (using typical N value of 37) gives a value of 51.6MN/m^2.

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(8) c_u of Mercia Mudstone – III/IV can be derived using the Stroud correlation. A f1 value of 5.0 is used based on CIRIA C570; combined with a conservative SPT N value of 29, this gives a cu of 145kN/m^2.

(9) ϕ' of Mercia Mudstone III/IV (>10mbgl) is based on values determined in the AMAR GIR due to limited local GI data.

(10) Eu for Mercia Mudstone – III/IV can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 29 gives Eu = 10.5MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu =8.4MN/m^2.

(11) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata, the classification used for the strata in the AMAR GIR has been adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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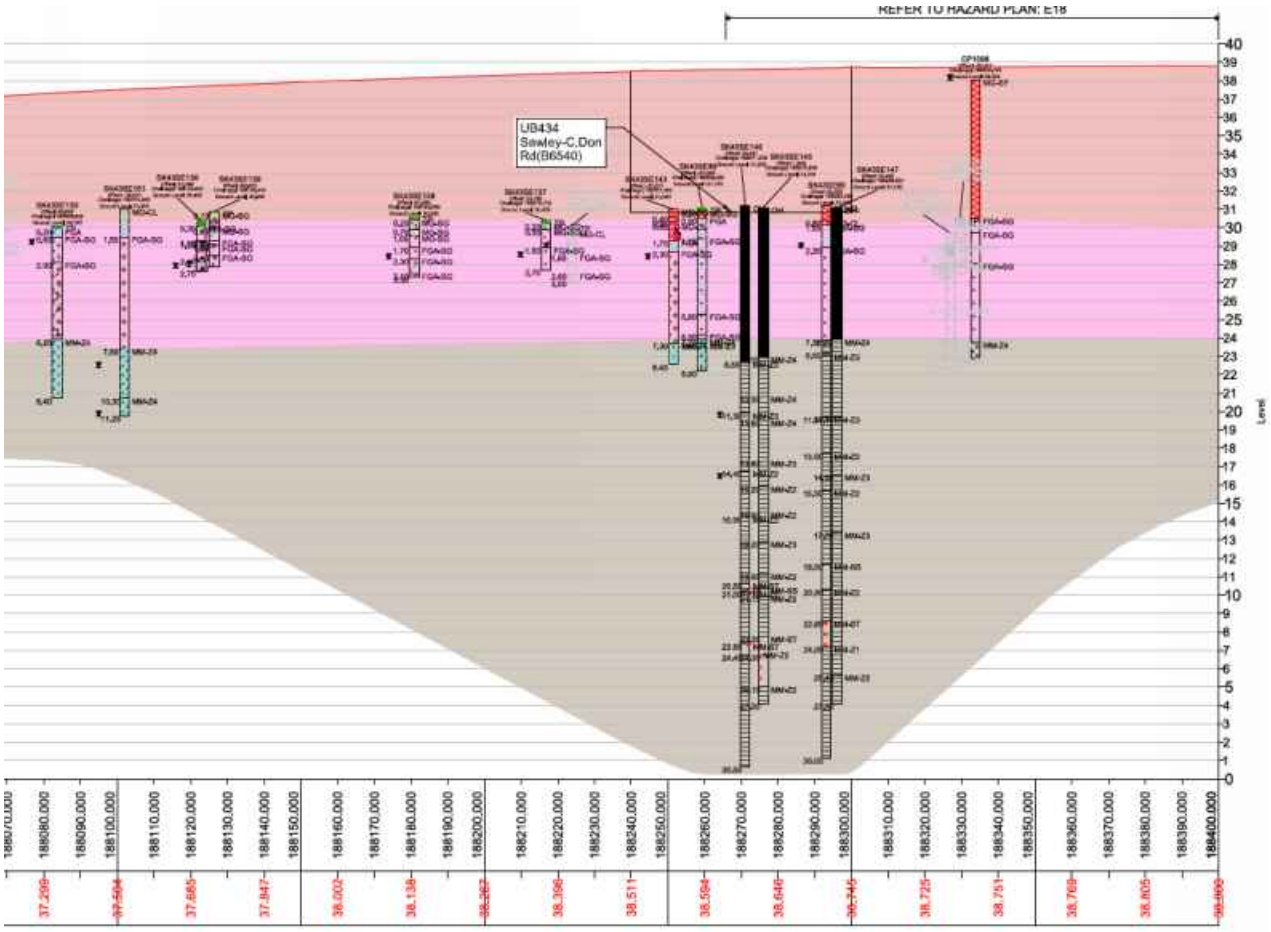


Figure 5: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
188130	188190	Granular Wedge at Embankment Crest (1:2.0)	3.5	26.6 (1V:2H)

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FURTHER GROUND INVESTIGATION

Further geotechnical investigation is not required between chainage 188130 and 188190.

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HISTORICAL EXPLORATORY HOLES

amey

Borehole Log

Borehole No.
SK43SE86
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446682.00 - 330507.00	Hole Type CP
Location:		Level: 31.10mbgl	Scale 1:50
Client: Highways England		Dates: 22/04/1988 - 22/04/1988	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 0.60	B1B			0.20	30.90		TOPSOIL TP
		0.60 - 1.20	B2B			0.60	30.50		Brown clayey SAND with much up to cobble size pieces of brick (MADE GROUND) MG-SG
									Soft to firm orange brown sandy becoming very sandy CLAY with a little fine and medium gravel (ALLUVIUM) FGA
	▼	1.55 - 2.00	U3U	20blows		1.70	29.40		
		2.10	SPT (S)	7 (0 for 0mm/7,..)	Water=7.00m				Loose becoming medium dense brown SAND and subrounded GRAVEL with occasional pockets of brown clay (RIVER SANDS AND GRAVELS) FGA-SG
		2.10 - 2.70	B4B						
		3.00	SPT (C)	19 (0 for 0mm/19,..)	Water=19.00m				
		3.20 - 3.70	B5B						
		4.70 - 5.30	B6B						
						5.80	25.30		Medium dense brown SAND with some to much subangular to subrounded gravel (RIVER SANDS AND GRAVELS) FGA-SG
		6.10	SPT (C)	11 (0 for 0mm/11,..)	Water=11.00m				
		6.20 - 6.70	B7B						
						6.90	24.20		SAND and GRAVEL (Foreman's description) (RIVER SANDS AND GRAVELS) FGA-SG
		7.30	J8J			7.20	23.90		
		7.60 - 7.89	J9J			7.40	23.70		Stiff red brown very silty CLAY with rare subrounded fine and medium quartz gravel (REWORKED KEUPER MARL) MM-Z4
		7.89	W10 W						Very stiff red brown very silty CLAY with occasional fine gravel size lithorelicts and relict structure. And with occasional bands of red brown thinly laminated MUDSTONE very weak (KEUPER MARL: ZONE IV - III) MM-Z3
		8.40 - 8.60	J11J						
		8.70	SPT (S)	50 (0 for 0mm/50 for 38mm)	Water=395.00m				
		8.70 - 8.89	J12J			8.90	22.20		End of borehole at 8.90m

Remarks
Hand excavated inspection pit from G.L. to 1.50m. Water added to assist boring, 1.70 to 4.00m. Hole grouted to 3.00m, backfilled with arisings to G.L.

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Trial Pit Log

Trialpit No: SK43SE138 HISTORIC Sheet 1 of 1

Project Name:	SMP - M1 J23A TO J25	Project No.: COCDFL1SMP01	Co-ords: 446693.00 - 330428.00
Location:			Level: 30.60mbgl
Client:	Highways England		Dimensions: 3.60m x 1.50m; Inclination: 90°; Orientation: 40°; Depth: 2.30m
			Date: 09/08/1990; Scale: 1:50; Logged

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
					0.20	30.40		TOPSOIL TP
					0.70	29.90		Loose multicoloured silty fine to coarse SAND with occasional angular fine to coarse gravel and rare pieces of plastic. (MADE GROUND) MG-SG
	1.00 1.00	B1B J1AJ			1.05	29.55		Loose brown silty fine to coarse SAND with occasional subrounded fine to coarse gravel, with some up to cobble sized pockets of black organic material. (MADE GROUND) MG-SG
	1.40 1.40	B2B J2AJ			1.70	28.90		Loose yellow brown mottled black and orange fine to coarse SAND with some rounded fine to medium gravel. (possible MADE GROUND) MG-SG
▼	2.30 2.30	B3B J3AJ			2.30	28.30		Loose yellow and light brown fine to coarse SAND with rounded to subangular fine to coarse gravel. (FLUVIAL DEPOSITS) FGA-SG
					3.10	27.50		Dense yellow and light brown sandy subangular to subrounded fine to coarse GRAVEL of predominantly quartzite and occasional clay lenses. (FLUVIAL DEPOSITS) FGA-SG
					3.30	27.30		Dense yellow and light brown very sandy subangular to subrounded fine to medium GRAVEL of predominantly quartzite. (FLUVIAL DEPOSITS) FGA-SG End of pit at 2.30 m

Shift Information: Date & Time	Depth	Water	Remarks	Backfill: Top	Base	Description	Water Strike: Struck	Rose to	Date	Time	Sealed	Remarks	Depth Related Remarks: Top	Base	Remarks

Remarks:

Stability: Unstable below 2.30m

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Trial Pit Log

Trialpit No: SK43SE139 HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446709.00 - 330376.00 Level: 30.90mbgl	Date 09/08/1990
Location:		Dimensions: 3.50m x 1.10m Inclination: ° Orientation: ° Depth: 3.00m	Scale 1:50 Logged
Client: Highways England			

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
	0.35 0.35	B1B J1AJ			0.10	30.80		TOPSOIL TP Dense reddish brown silty fine to coarse SAND with some angular to subrounded gravel and cobbles of concrete, quartzite and limestone and with occasional pieces of metal. (MADE GROUND) MG-SG concrete layer of broken bricks
					0.95	29.95		
	1.50 1.50	B2B J2AJ			1.60	29.30		Dense brown fine to coarse SAND with angular to subrounded fine to coarse gravel of concrete and brick and occasional black organic remains (MAKE GROUND) MG-SG
					1.80	29.10		
					1.90	29.00		Loose brown mottled yellow brown fine to coarse SAND (FLUVIAL DEPOSITS) FGA-SG
▼					2.40	28.50		Dense reddish brown mottled yellow sandy subangular to subrounded fine to coarse GRAVEL of predominantly quartzite with occasional cobbles (FLUVIAL DEPOSITS) FGA-SG
					3.00	27.90		Dense yellow brown very sandy subangular to subrounded fine to coarse GRAVEL of predominantly quartzite with occasional cobbles. (FLUVIAL DEPOSITS) FGA-SG
								Dense yellow brown fine to coarse SAND with much subangular to subrounded fine to coarse gravel and occasional cobbles. Below 2.70m, light brown with decreasing sand content. (FLUVIAL DEPOSITS) FGA-SG
								End of pit at 3.00 m

Shift Information: Date & Time	Depth	Water	Remarks	Backfill: Top	Base	Description	Water Strike: Struck	Rose to	Date	Time	Sealed	Remarks	Depth Related Remarks: Top	Base	Remarks

Remarks:

Stability:

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Trial Pit Log

Trialpit No: SK43SE140
HISTORIC
Sheet 1 of 1

Project Name:	SMP - M1 J23A TO J25	Project No.: COCDFL1SMP01	Co-ords: 446737.00 - 330308.00 Level: 30.80mbgl
Location:			Dimensions: 3.80m Inclination: ° Orientation: ° Depth: 3.10m
Client:	Highways England		

Date: 09/08/1990
Scale: 1:50
Logged:

1.20m

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
	0.50 0.50	B1B J1AJ			0.55 0.60	30.25 30.20		Loose reddish brown silty fine to coarse SAND with some hardcore, tarmac, gravel and a little clay (MADE GROUND) MG-SG
					1.10	29.70		Loose light brown SAND with occasional subrounded fine to coarse gravel (MADE GROUND) MG-SG
	1.30 1.30	B2B J2AJ						Dense dark grey sandy SILT with occasional fine to medium subrounded gravel and occasional organic remains, organic odour (PROBABLY MADE GROUND) FGA
	1.70 1.70	B3J J3AJ			1.90	28.90		Dense orange brown SAND with occasional rounded to subrounded fine to coarse gravel with some organic material (POSSIBLE MADE GROUND) FGA-SG
▼					3.10	27.70		Dense brown grey fine to coarse SAND with some angular to subrounded fine to coarse GRAVEL of predominantly quartzite (FLUVIAL DEPOSITS) FGA-SG
								End of pit at 3.10 m

Shift Information				Backfill			Water Strike						Depth Related Remarks		
Date & Time	Depth	Water	Remarks	Top	Base	Description	Struck	Rose to	Date	Time	Sealed	Remarks	Top	Base	Remarks

Remarks:

Stability:

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Borehole Log

Borehole No. **SK43SE151**
HISTORIC
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446730.00 - 330357.00	Hole Type CP
Location:		Level: 31.00mbgl	Scale 1:50
Client: Highways England		Dates: 10/09/1990 - 11/09/1990	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.00 - 0.50	B1B						Very stiff reddish brown sandy CLAY with occasional rootlets. (MADE GROUND) below 1.10m jwith occasional subrounded fine to medium gravel. MG-CL
		0.50 - 0.95	U2U						
		1.00	J3J						
		1.10	SPT (C)	15 (0 for 0mm/15,..)	Water=15.00m				
		1.10 - 1.55	J4J			1.50	29.50		
		1.11 - 1.56	B5B						Dense brown slightly sandy to sandy subangular to subrounded fine to coarse GRAVEL of predominantly quartzite. (FLUVIAL DEPOSITS) FGA-SG
		1.55	SPT (C)	37 (0 for 0mm/37,..)	Water=37.00m				
		1.55 - 2.00	B6B						
		2.55	SPT (C)	38 (0 for 0mm/38,..)	Water=38.00m				
		2.55 - 3.00	B7B						
		3.55	SPT (C)	44 (0 for 0mm/44,..)	Water=44.00m				
		3.55 - 4.00	B8B						
		4.55	SPT (C)	44 (0 for 0mm/44,..)	Water=44.00m				
		4.55 - 5.00	B9B						
		5.55	SPT (C)	56 (0 for 0mm/56,..)	Water=56.00m				
		5.55 - 6.00	B10B						
		7.00	SPT (C)	54 (0 for 0mm/54,..)	Water=54.00m				
		7.00 - 7.45	B11B						
		7.60	SPT (S)	35 (0 for 0mm/35 for 75mm)	Water=140.00m	7.60	23.40		Firm greenish grey and reddish brown very silty CLAY (MERCIA MUDSTONE GROUP) MM-Z4
		7.60 - 7.68	J12J						with occasional angular up to fine gravel sized lithorelicts
	▼	8.50	SPT (S)	61 (0 for 0mm/61,..)	Water=61.00m				with occasional angular up to fine gravel sized mudstone lithorelicts
		8.50 - 8.95	J13J						
		8.51 - 8.96	B14B						
		9.20	SPT (S)	29 (0 for 0mm/29,..)	Water=29.00m				
		9.20 - 9.65	J15J						
		9.21 - 9.66	B16B						

Continued on next sheet

Remarks

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Borehole Log

Borehole No.
SK43SE151
HISTORIC
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446730.00 - 330357.00	Hole Type CP
Location:		Level: 31.00mbgl	Scale 1:50
Client: Highways England		Dates: 10/09/1990 - 11/09/1990	Logged By

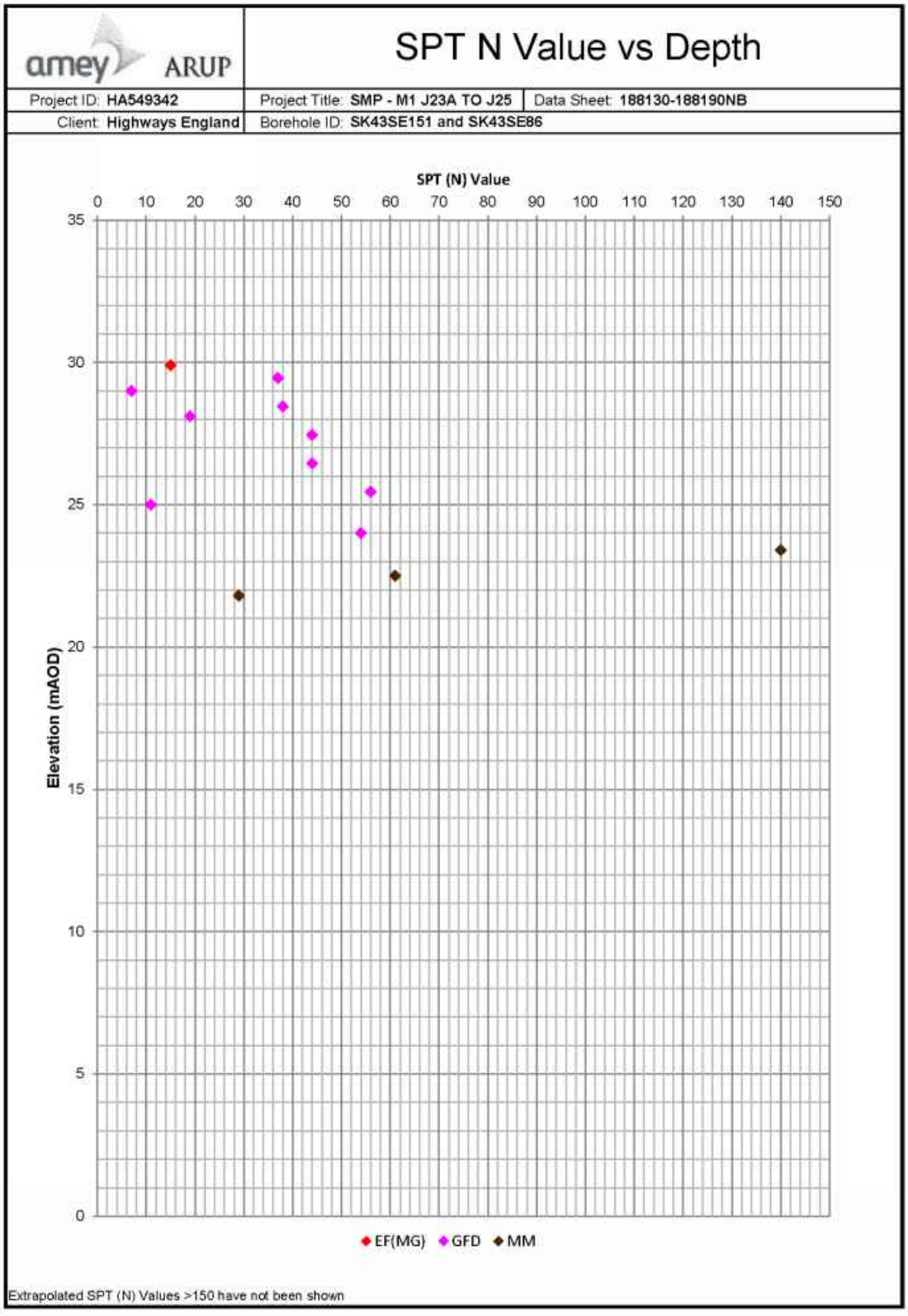
Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		10.50 10.50 - 10.70	SPT (S) J17J	35 (0 for 0mm/35 for 50mm)	Water=210.00m	10.30	20.70		Stiff reddish brown mottled greenish grey very silty CLAY with occasional gypsum veins. (MERCIA MUDSTONE GROUP) MM-Z4
	▼	11.00 11.00 - 11.21	SPT (S) J18J	35 (0 for 0mm/35 for 60mm)	Water=175.00m	11.25	19.75		End of borehole at 11.25 m

Remarks

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PLOTS



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-182800-182890NB-GSS-000001		
Earthworks Widening Solution	Gabion Wall, Plastic Sheet Pile Retaining Wall		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	182800-182890		
Carriageway	Northbound		
Marker Post	MP182/8A – MP182/8A +90		
National Grid Reference	E 447001 , N 325259 – E 447031 , N 325343		
Existing Ground Level at Location	Crest of cutting	80.8mAOD	
	Carriageway	75.7mAOD	
Earthwork Type	NB: Cutting	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_42111	SB: N/A	HAGDMS designation
Earthwork Height	NB: 2.1-5.1m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 22^{o}	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	01/04/2017	[redacted]
Checked	Roheel Masrat	12/04/2017	
Reviewed	Gary Summerfield	25/04/2017	
Approved	Thomas Bulteel	02/05/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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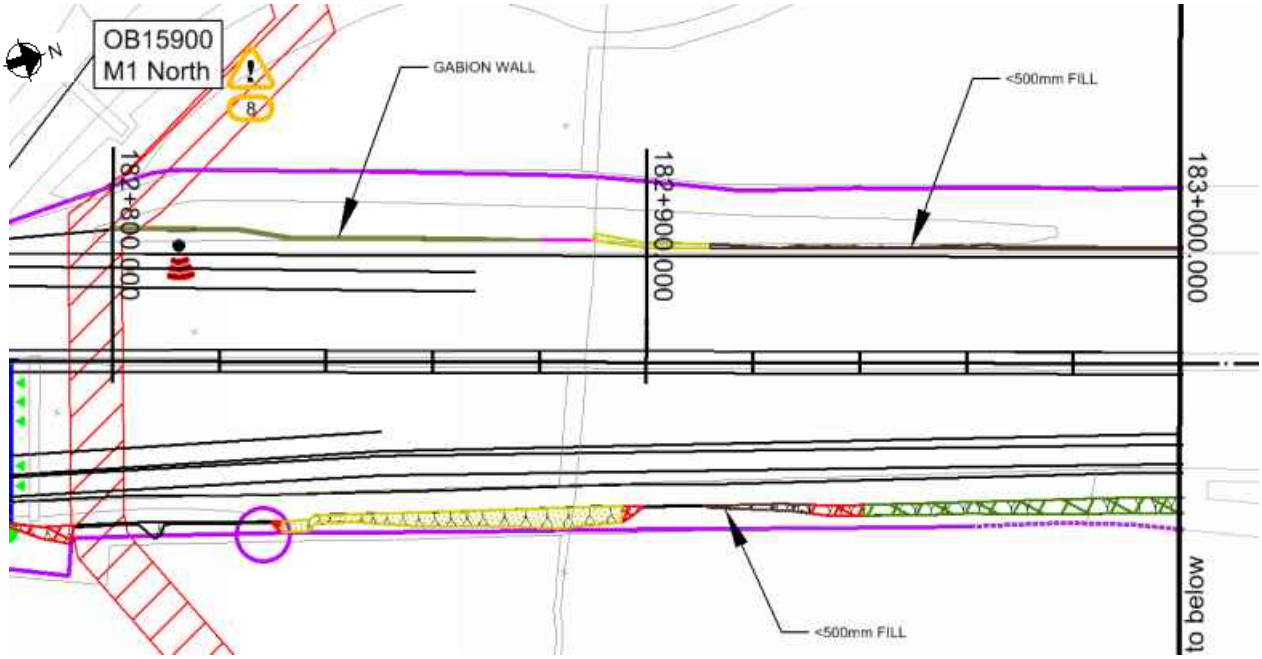


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch182800-182880 (80m), Gabion Wall;
- Ch182880-182890 (10m), Plastic Sheet Pile Wall;

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the location has an earthwork classified as a cutting ranging in height between 2.1m and 5.1m with a typical slope angle of 22°.

The critical cross sections at Ch.182810 and 182880 are based on the sections with the greatest retained height.

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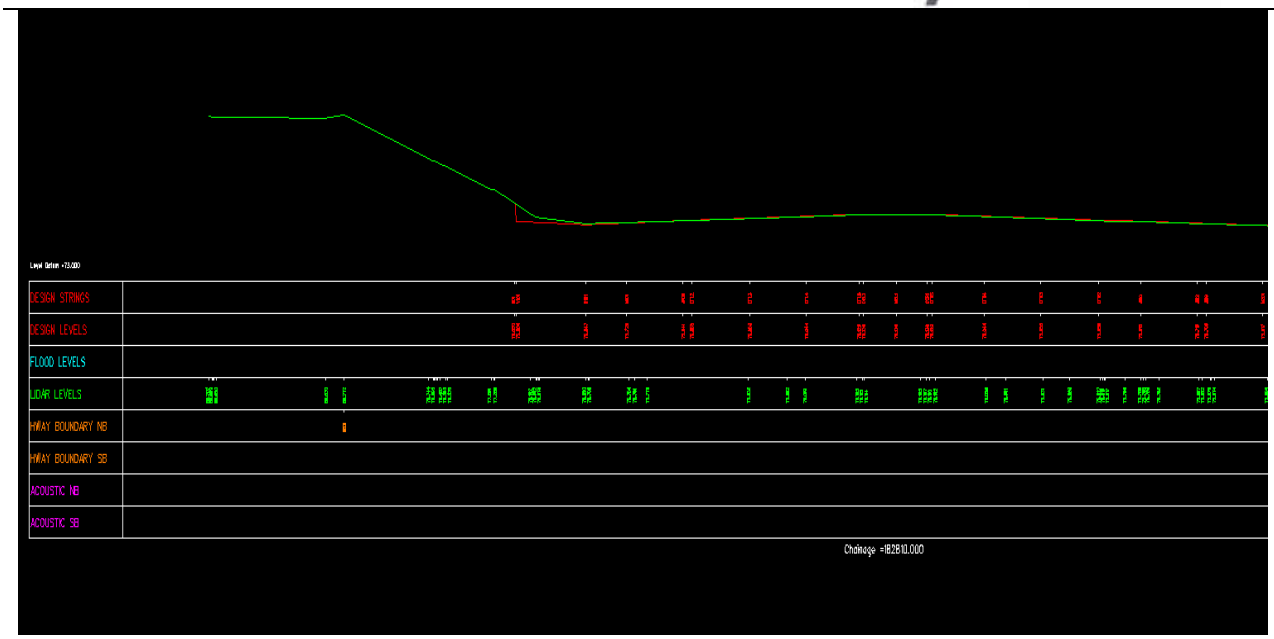


Figure 2.1: Topographic Critical Cross Section Ch182810

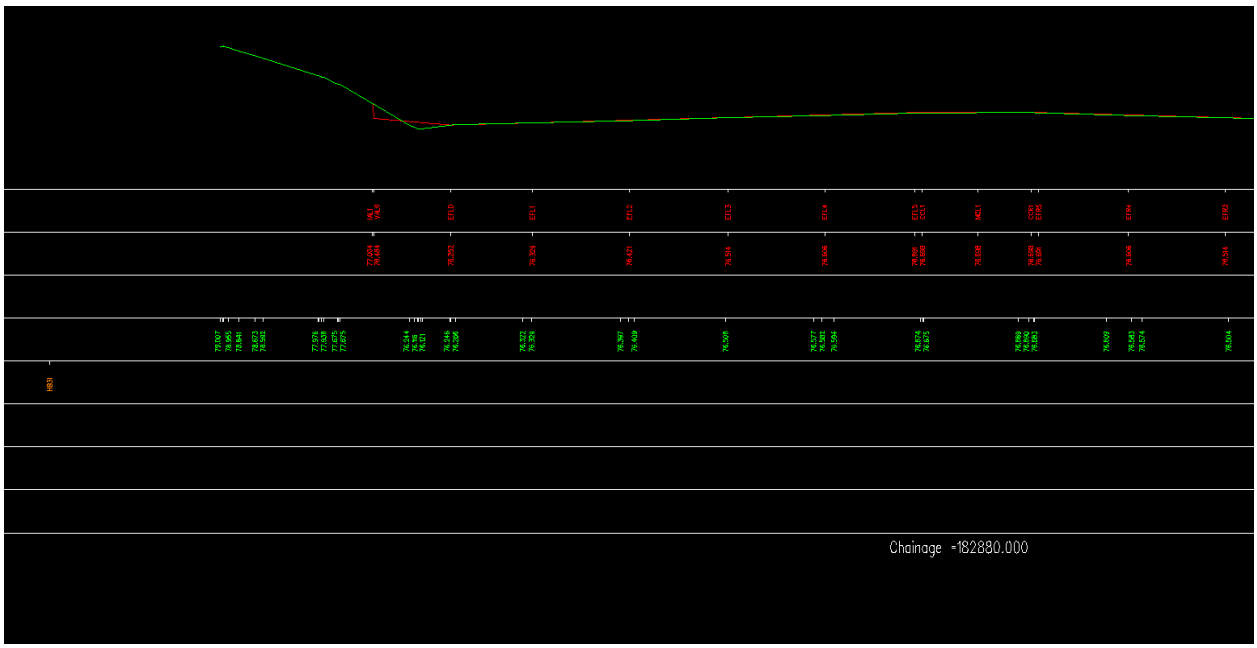


Figure 2.2: Topographic Critical Cross Section Ch182880

Utilities:

High Voltage Western Power Cable perpendicular to the carriageway at approximately Ch182790.

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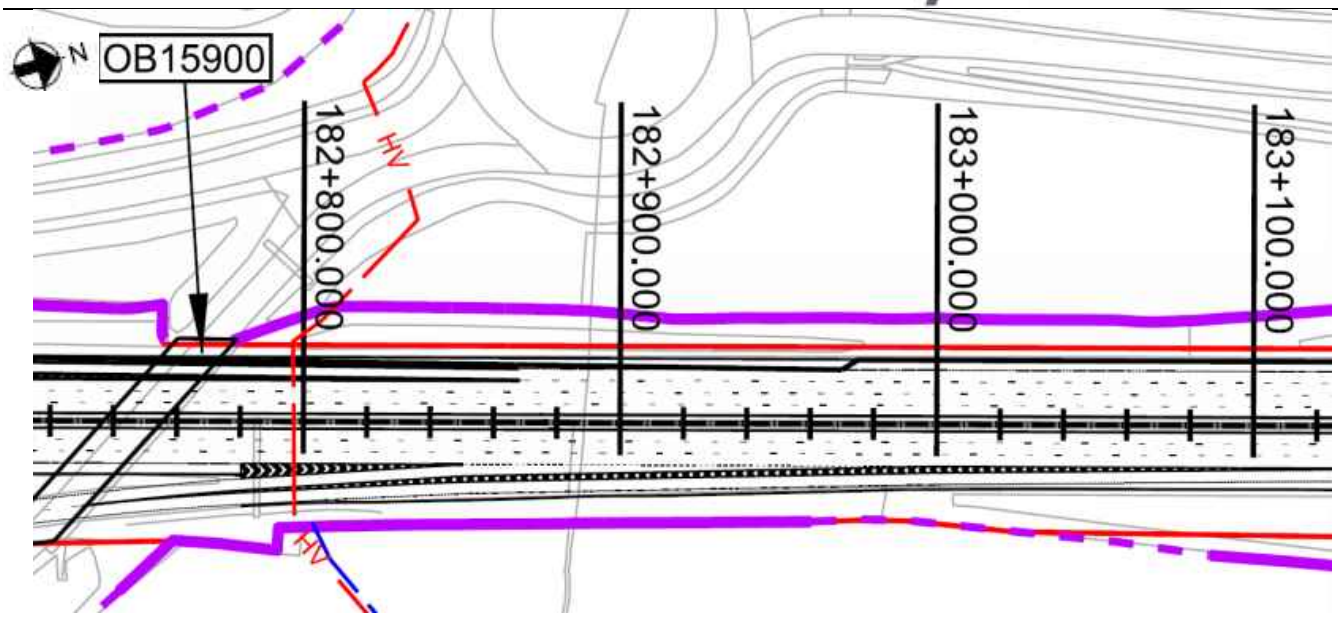


Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough, indicates that the site is underlain by:

Superficial Deposits: None Recorded

Solid Deposits: Gunthorpe Member (Mercia Mudstone Group)

Ground Investigation:

There are 2 No. historical exploratory holes recorded within the design chainage, with additional 20 no. relevant exploratory holes considered as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000021, Rev P01.

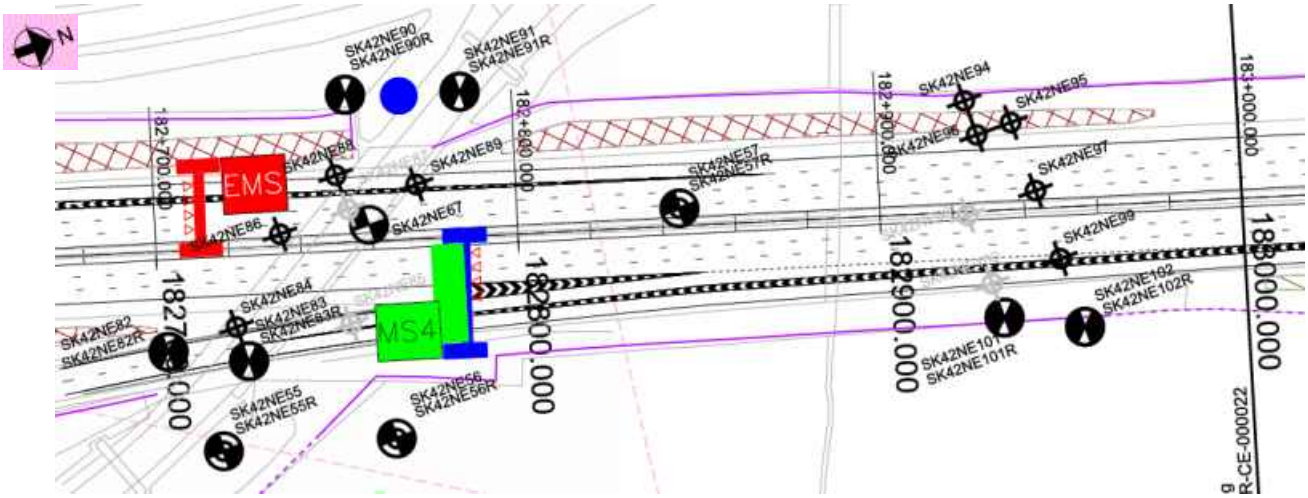


Figure 5: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole	SK42NE57/57R	SK42NE94	SK42NE95	SK42NE96
Borehole Chainage	182845	182924	182937	182926
Borehole Location	Northbound carriageway	Crest of cutting	Northbound verge	Northbound verge
National Grid Reference	E 447031, N 325296	E 447030, N 325380	E 447040, N 325390	E 447040, N 325380
Ground Level at Exploratory Hole	75.49mAOD	79.62mAOD	76.57mAOD	76.54mAOD
RAG Analysis	Green	Green	Green	Green
Date Drilled	28/01/1988 – 29/01/1988	01/10/1984 – 03/10/1984	10/09/1984 – 11/09/1984	10/09/1984 – 11/09/1984
Termination Depth	20.13mbgl (metres below ground level)	20.00mbgl	20.00mbgl	20.00mbgl
Other suitable holes	SK42NE101, SK42NE101R, SK42NE102, SK42NE102R, SK42NE56, SK42NE56R, SK42NE67, SK42NE83, SK42NE83R, SK42NE84, SK42NE86, SK42NE88, SK42NE89, SK42NE90, SK42NE90R, SK42NE91, SK42NE91R, SK42NE97, SK42NE99			

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Mercia Mudstone – III/IV	-	-	25-150 (30)

(1) Ground level is assumed to be at the crest of the cutting.
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(3) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

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In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes SK42NE56, SK42SE57, SK42NE67, SK42NE83, SK42NE84, SK42NE86, SK42NE88, SK42NE89, SK42NE90, SK42NE94, SK42NE96, SK42NE97, SK42NE99, SK42NE101 and SK42NE102.

Groundwater:

Groundwater Strikes between 5.0-11.9mbgl (63.39-70.72mAOD), within the historical exploratory holes.

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
SK42NE102R	Mercia Mudstone	10.50	65.00	-	-	-
SK42NE56	Mercia Mudstone	5.25	70.53	-	3.40	72.38
SK42NE83R	Mercia Mudstone	5.00	70.72	-	-	-
SK42NE86	Mercia Mudstone	5.45	69.88	-	-	-
SK42NE88	Mercia Mudstone	10.10	64.99	-	-	-
SK42NE89	Mercia Mudstone	11.40	63.89	-	-	-
SK42NE95	Mercia Mudstone	12.05	64.52	-	-	-

Groundwater Design Level:

A groundwater level of 1.0m below toe of embankment has been assumed for WALLAP & GAWACwin analysis for sheet piles. When checking the global stability check of the earthwork and sheet pile (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

16 No. Atterberg Limit Tests and 16 No. Moisture Content Tests were recorded within Mercia Mudstone – III/IV with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Mercia Mudstone – III/IV	5.0	17	31	17	14	CL
Mercia Mudstone – III/IV	4.5	15	28	16	12	CL
Mercia Mudstone – III/IV	7.5	16	34	20	14	CL
Mercia Mudstone – III/IV	3.0	18	32	18	14	CL
Mercia Mudstone – III/IV	2.5	21	30	18	12	CL
Mercia Mudstone – III/IV	3.0	20	29	17	12	CL
Mercia Mudstone – III/IV	2.0	14	31	19	12	CL
Mercia Mudstone – III/IV	2.7	25	38	22	16	CI
Mercia Mudstone – III/IV	5.0	13	37	20	17	CI
Mercia Mudstone – III/IV	3.0	15	31	18	13	CL
Mercia Mudstone – III/IV	0.5	13	40	20	20	CI
Mercia Mudstone – III/IV	0.5	19	49	23	26	CI
Mercia Mudstone – III/IV	3.5	14	34	20	14	CL
Mercia Mudstone – III/IV	2.95	13	33	19	14	CL
Mercia Mudstone – III/IV	2.0	14	30	17	13	CL
Mercia Mudstone – III/IV	0.5	13	45	20	25	CI

39 No. undrained triaxial tests were undertaken within Mercia Mudstone – III/IV with the following results:

Stratum	Depth to Top of Test (mbgl)	Depth to Top of Test (mAOD)	Undrained Shear Strength (kN/m^2)
Mercia Mudstone – III/IV	1.5	75.04	140
Mercia Mudstone – III/IV	1.0	74.5	45
Mercia Mudstone – III/IV	1.0	74.5	45
Mercia Mudstone – III/IV	0.5	75.1	270

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Mercia Mudstone – III/IV	0.5	75.1	270
Mercia Mudstone – III/IV	0.5	75.1	270
Mercia Mudstone – III/IV	1.0	74.6	120
Mercia Mudstone – III/IV	1.0	74.6	120
Mercia Mudstone – III/IV	0.5	78.53	75
Mercia Mudstone – III/IV	0.5	78.53	75
Mercia Mudstone – III/IV	0.5	78.53	75
Mercia Mudstone – III/IV	1.5	75.04	140
Mercia Mudstone – III/IV	3.0	74.04	370
Mercia Mudstone – III/IV	3.0	74.04	370
Mercia Mudstone – III/IV	3.0	74.04	370
Mercia Mudstone – III/IV	1.5	75.04	140
Mercia Mudstone – III/IV	2.0	77.03	210
Mercia Mudstone – III/IV	2.0	77.03	210
Mercia Mudstone – III/IV	2.0	77.03	210
Mercia Mudstone – III/IV	5.0	74.03	360
Mercia Mudstone – III/IV	5.0	74.03	360
Mercia Mudstone – III/IV	5.0	74.03	360
Mercia Mudstone – III/IV	1.0	74.5	45
Mercia Mudstone – III/IV	1.0	74.6	120
Mercia Mudstone – III/IV	5.0	70.72	210
Mercia Mudstone – III/IV	5.0	70.72	210
Mercia Mudstone – III/IV	2.0	73.6	370
Mercia Mudstone – III/IV	2.0	73.6	370
Mercia Mudstone – III/IV	4.5	70.83	120
Mercia Mudstone – III/IV	3.0	72.33	230
Mercia Mudstone – III/IV	5.0	70.72	210
Mercia Mudstone – III/IV	3.0	73.51	290

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Mercia Mudstone – III/IV	3.0	73.51	290
Mercia Mudstone – III/IV	3.0	73.51	290
Mercia Mudstone – III/IV	4.5	70.83	120
Mercia Mudstone – III/IV	4.5	70.83	120
Mercia Mudstone – III/IV	3.0	72.33	230
Mercia Mudstone – III/IV	3.0	72.33	230
Mercia Mudstone – III/IV	2.0	73.6	370

Lab Test Data - BRE Classification:

The table below presents the chemical test data undertaken:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Water Soluble Sulphate as SO4	2:1 soil/water extract	11	0.01-0.50	g/l SO4
Embankment Fill	pH	2:1 soil/water extract	11	7.70-8.20	-

Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000021 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outlines the assumed anticipated ground model:

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that road level on the base of the cutting is straight on to the Mercia Mudstone III/IV at this location. The below table outline the assumed anticipated ground model:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Mercia Mudstone – III/IV (<10mbgl)	0.0 – 6.8	80.8 – 74.0	6.8	21	26	2	180	10.80	8.60	-	0.50	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10mbgl)	>6.8	<74.0	-	21	27	2	275	16.8	13.4	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Depth to base (mbgl) is based on topographic critical cross section Ch182810.
(3) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) The ϕ' for Mercia Mudstone – III/IV (>74mAOD) was based on a typical PI value of 20% and Table 2 in BS8002:2015.
(5) The ϕ' for Mercia Mudstone – III/IV (<74mAOD) was based on a typical PI value of 14% and Table 2 in BS8002:2015.
(6) c_u for Mercia Mudstone – III/IV (>74mAOD) was based on Stroud's relationship between SPT 'N' values and PI. For a typical PI of 20%, approximately f1=6.0, and SPT 'N' value of 30, c_u = 180kN/m^2.
(7) c_u for Mercia Mudstone – III/IV (<74mAOD) was based on Stroud's relationship between SPT 'N' values and PI. For a typical PI of 14%, approximately f1=5.5, and SPT 'N' value of 50, c_u = 275kN/m^2.
(8) Eu for Mercia Mudstone – III/IV (>74mAOD) was derived using SPT 'N' values (Bowles) where Eu = 300 (N+6); using a typical SPT 'N' value of 30 gives Eu = 10.8MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 8.6MN/m^2.
(9) Eu for Mercia Mudstone – III/IV (<74mAOD) was derived using SPT 'N' values (Bowles) where Eu = 300 (N+6); using a typical SPT 'N' value of 50 gives Eu = 16.8MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 13.4MN/m^2.
(10) BRE Classification is determined using criteria set out in BRE Special Digest 1.

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Imported Granular Fill (Class 6N) was used in the design of sheet pile and Gabion Wall as backfill material and Gabion Fill (Class 6G) was used for the gabion baskets; the material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25
Gabion Fill	24	-	-	-

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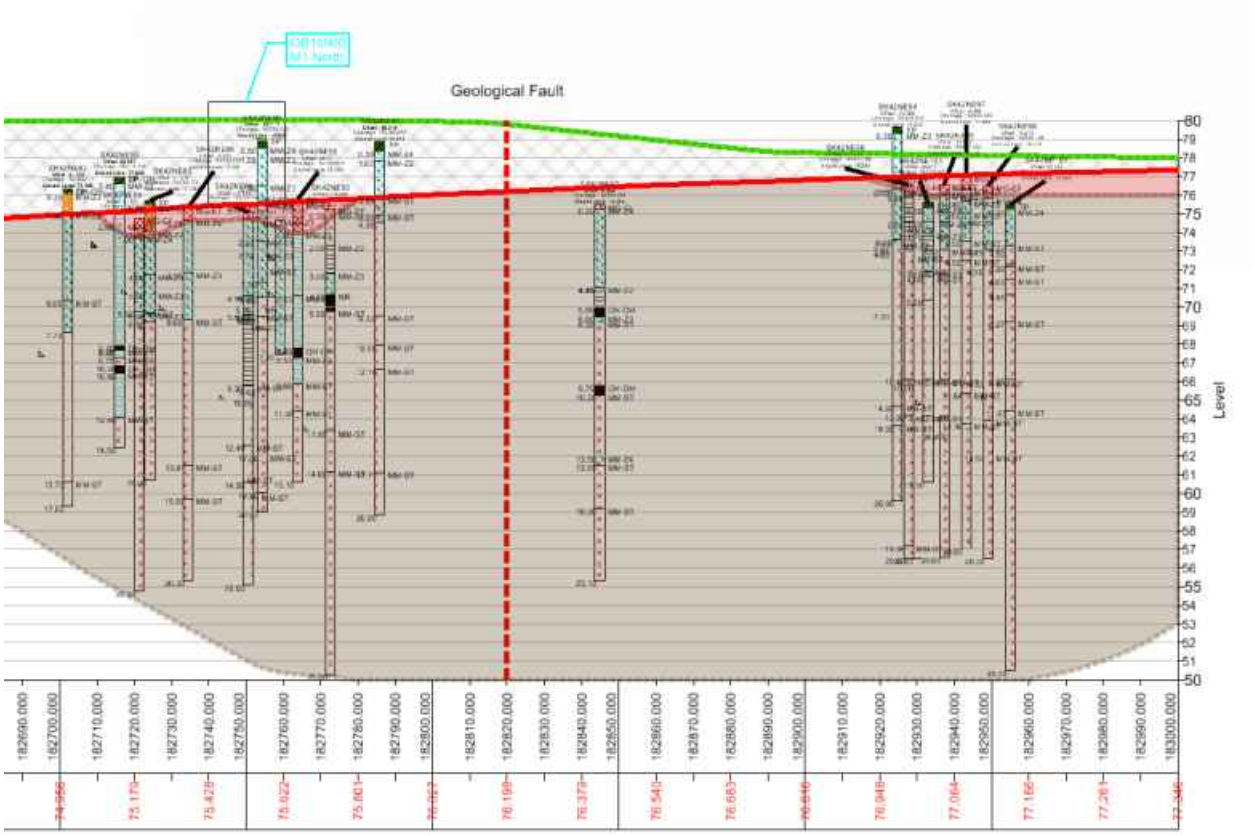


Figure 6: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to regrade encroaching on the highway boundary, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Gabion Wall:

Start Chainage	End Chainage	Carriageway	Solution	Layers	Gabion Wall Dimensions			
					Width (m)	Length (m)	Height (m)	Benching Detail
182800	182880	Northbound	Gabion Wall	Lower	1.0	1.0	1.0	45^{o}
				Upper	0.5	0.5	0.5	

Sheet Pile Wall:

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
182880	182890	Larssen 602 (Plastic)	0.4	1.1	1.5	32	70	1	0.1

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FURTHER GROUND INVESTIGATION

No further ground investigation is required at this location.

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HISTORICAL EXPLORATORY HOLES

Rotary Core Log

Borehole No. SK42NE101 Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447090.00 - 325370.00	Hole Type CP
Location:		Level: 75.60	Scale 1:50
Client: Highways England		Dates: 01/10/1984 - 01/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	J				0.30	75.30		Turf onto TOPSOIL TP
		0.50 - 0.95	U							Very stiff red brown mottled grey green fissured silty CLAY with many mudstone/siltstone lithorelicts and occasional thin bands of highly weathered very weak to weak siltstone. (KEUPER MARL : ZONE III) MM-Z4
		1.00	J				1.00	74.60		
		1.00 - 1.50	B							Stiff red brown and grey green fissured silty to very silty CLAY with some siltstone lithorelicts and occasional thin bands of highly weathered very weak siltstone. (KEUPER MARL : ZONE III) MM-Z4
		1.45	J							
		1.70	J				1.70	73.90		
		2.00 - 2.45	U							Highly weathered fissured red brown very weak MUDSTONE/SILTSTONE with residual silty clay. (KEUPER MARL : ZONE III) MM-Z3
		2.50	J				2.50	73.10		
		2.95	J							Very stiff red brown fissured silty CLAY with many siltstone lithorelicts. (KEUPER MARL : ZONE II/III) Some thin bands of highly weathered fissured grey green very weak siltstone. MM-Z2
		3.20	J							
		3.70	J				3.70	71.90		
		4.45	J							Moderately weathered fissured red brown and grey green weak calcareous SILTSTONE. (KEUPER MARL : ZONE II) Becoming just red brown below 4.90m. MM-ST
		4.50	B							
		4.60	J							
		5.20	J				5.20	70.40		End of borehole at 5.20 m

Remarks

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Rotary Core Log

Borehole No. SK42NE101R

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447090.00 - 325370.00	Hole Type RC
Location:		Level: 75.60	Scale 1:50
Client: Highways England		Dates: 04/10/1984 - 04/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Open hole adjacent to previously drilled percussion hole OH-OH
		4.00 - 4.70		100		20	4.00	71.60		Slightly occasionally moderately weathered laminated to thinly bedded red brown occasionally green grey fine grained very weak occasionally weak SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		4.70 - 7.00		98		34				
		7.00 - 8.20		100		9				
		8.20 - 9.80		98		26				
							9.50	66.10		Slightly weathered thinly bedded green grey occasionally red brown fine grained weak and moderately weak SILTSTONE. (KEUPER MARL

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE101R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447090.00 - 325370.00	Hole Type RC
Location:		Level: 75.60	Scale 1:50
Client: Highways England		Dates: 04/10/1984 - 04/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										: ZONE I) MM-ST
		9.80 - 12.50		98		50	11.45	64.15		Slightly to moderately weathered laminated to very thinly bedded red brown occasionally green grey fine grained very weak clayey SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		12.50 - 13.80		97		50				
		13.80 - 15.00		67		19				
							15.00	60.60		End of borehole at 15.00 m

11 12 13 14 15 16 17 18 19 20

Remarks

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Rotary Core Log

Borehole No. SK42NE102

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447100.00 - 325390.00	Hole Type CP
Location:		Level: 75.50	Scale 1:50
Client: Highways England		Dates: 28/09/1984 - 28/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	J				0.30	75.20		Turf onto TOPSOIL. TP
		0.50 - 0.95	U							Very stiff and stiff red brown fissured silty to very stiff CLAY with many siltstone lithorelicts. (KEUPER MARL : ZONE III) Some thin bands of highly weathered weak to moderately weak siltstone below 0.30m. Becoming mottled grey green below 1.70m. MM-Z4
		1.00	J							
		1.00 - 1.50	B							
		1.45	J							
		1.70	J							
		2.20	J				2.20	73.30		Moderately weathered fissured grey green weak to moderately weak calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
							2.50	73.00		
		2.95	J							Very stiff red brown fissured silty CLAY with many mudstone/siltstone lithorelicts and occasional thin bands of highly weathered very weak mudstone/siltstone. (KEUPER MARL : ZONE II/III) MM-ST
		3.20	J				3.20	72.30		
		3.50 - 4.00	B				3.30	72.20		
		3.95	J							Moderately weathered fissured grey green weak to moderately weak calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		4.00	B							
		4.30	J							Very stiff red brown mottled grey green silty to very silty CLAY with some thin bands of highly weathered weak calcareous siltstone. (KEUPER MARL : ZONE III) MM-ST
		4.85	J				4.85	70.65		
										End of borehole at 4.85 m
		6.27 - 6.56	C							
		6.27 - 6.56	C							
		7.71 - 7.81	C							
		7.71 - 7.81	C							
		7.81 - 7.91	C							
		7.81 - 7.91	C							
		8.50 - 8.60	C							
		8.50 - 8.60	C							
		8.60 - 8.71	C							
		8.60 - 8.71	C							

Remarks

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Rotary Core Log

Borehole No. SK42NE102R

Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447100.00 - 325390.00	Hole Type RC
Location:		Level: 75.50	Scale 1:50
Client: Highways England		Dates: 03/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Rotary Open Holed through overburden alongside Shell and Auger Hole previously drilled to 4.00 OH-OH
		4.00 - 5.50		100		44	4.00	71.50		Highly weathered very fissured red brown very weak calcareous SILTSTONE. Very to extremely closely spaced, rough discontinuities. (KEUPER MARL : ZONE III) MM-ST slightly weathered moderately weak band
		5.50 - 8.50		99		33	6.27	69.23		Slightly weathered fissured red brown very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST subvertical discontinuities slightly weathered grey green moderately weak band subvertical discontinuities 45 deg discontinuities
		8.50 - 10.50		97		39	9.36	66.14		subvertical discontinuities 45 deg discontinuities 45 deg discontinuities Slightly weathered grey green moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE102R
Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447100.00 - 325390.00	Hole Type RC
Location:		Level: 75.50	Scale 1:50
Client: Highways England		Dates: 03/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
	▼						11.05	64.45		very weak band
		10.50 - 12.50		95		50				Moderately to slightly weathered fissured red brown occasionally grey green very weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal smooth discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
										slightly weathered grey green moderately strong band
										slightly weathered grey green moderately strong band
										highly weathered zone degraded to stiff silty clay with many lithorelicts
		12.50 - 15.20		100		74				highly weathered zone degraded to stiff silty clay with many lithorelicts
										highly weathered zone degraded to stiff silty clay with many lithorelicts
		15.20 - 17.00		94		41				slightly weathered grey green moderately strong band
										slightly weathered grey green moderately strong band
		17.00 - 18.30		100		66				slightly weathered grey green moderately strong band
										highly weathered zone degraded to stiff silty clay with many lithorelicts
		18.30 - 19.80		96		23				slightly weathered grey green moderately strong band
										Continued on next sheet

Remarks

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447100.00 - 325390.00	Borehole No. SK42NE102R Sheet 3 of 3
Location:		Level: 75.50	Hole Type RC Scale 1:50
Client: Highways England		Dates: 03/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		19.80 - 22.00		98		30				highly weathered zone degraded to stiff silty clay with many lithorelicts
		22.00 - 24.50		97		30				highly weathered zone degraded to stiff silty clay with many lithorelicts
		24.50 - 25.00		88		0				
							25.00	50.50		End of borehole at 25.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE56** Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447064.00 - 325201.00	Hole Type CP
Location:		Level: 75.78	Scale 1:50
Client: Highways England		Dates: 20/01/1988 - 21/01/1988	Logged By GAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	D				0.20	75.58		Clayey topsoil TP
		0.50 - 0.95	U							Firm yellow brown, red brown and brown sandy CLAY with occasional assorted generally subrounded gravel and black organic pockets (PROBABLE FILL) MG-EF
		1.00	D							
		1.00 - 1.45	D							
		1.80	D				1.80	73.98		Stiff becoming very stiff red brown CLAY with frequent up to coarse gravel sized lithorelics (KEUPER MARL 3/4a) below 2.40m with occasional pockets of light red brown silt becoming very silty by 3.40m below 3.90m with bands of hard very silty clay MM-Z3
		1.90 - 2.35	U							
		2.40	D							
		2.40 - 2.85	D							
	▼	3.40 - 3.85	U							
		3.90	D							
		3.90 - 4.35	D							
		4.90 - 5.20	U							
	▽	5.25	D				5.20	70.58		Very stiff (hard) red brown to dark red brown extremely to closely fissured very silty CLAY with pockets and lenses of light grey to light red brown silt locally cemented and occasional lens of green grey fine sandy siltstone , black speckled staining on vertical fissures (KEUPER MARL 3/4a) MM-Z3
		5.25 - 5.70	D							
		5.30	W							
		6.25 - 6.44	D							
		7.25 - 7.51	D							
		7.80 - 7.91	D							
							8.00	67.78		End of borehole at 8.00 m

Remarks

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Rotary Core Log

Borehole No. SK42NE56R
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447064.00 - 325201.00	Hole Type CP+RC
Location:		Level: 75.78	Scale 1:50
Client: Highways England		Dates: 21/01/1988 - 22/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Cable Tool Boring to 8.00m OH-OH
							8.00	67.78		Assessed zone of core loss OH-OH
		8.00 - 9.00		50	20	10	8.50	67.28		Stiff becoming very stiff red brown silty CLAY with fine to medium gravel sized lithorelics thinly interbedded with red brown locally light grey green moderately weathered SILTSTONE moderately weak (KEUPER MARL 2/3) MM-Z3
		9.00 - 10.50		100	5	0				*disturbed* *sub-vertical joint stained black* *disturbed by SPT* *closely spaced joints stained black*
							9.88	65.90		Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE56R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447064.00 - 325201.00	Hole Type CP+RC
Location:		Level: 75.78	Scale 1:50
Client: Highways England		Dates: 21/01/1988 - 22/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							11.35	64.43		Red brown locally light grey green moderately weathered SILTSTONE weak to moderately weak. Very to extremely closely spaced fractures with speckled black staining (KEUPER MARL 2) MM-ST very stiff (hard) red brown very silty CLAY assessed zone of core loss assessed zone of core loss
		10.50 - 13.20		81	22	20				Red brown moderately weathered SILTSTONE strong becoming moderately strong with occasional bands of dense clayey silt with frequent fine to medium gravel sized lithorelics (KEUPER MARL 2) Below 11.80m with extremely closely spaced often tight generally sub-vertical joints with speckled black staining. From 13.50m to 13.90m greenish grey slightly to moderately weathered . Below 14.90m becoming light greenish grey slightly weathered moderately strong to strong MM-ST 70 joint stained black non intact very stiff (hard) red brown CLAY non intact assessed zone of core loss
		13.20 - 15.00		83	25	11				non intact non intact due to 2 intersecting sub-vertical joints stained black non intact
							15.15	60.63		End of borehole at 15.15 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE57**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447031.00 - 325296.00	Hole Type CP
Location:		Level: 75.49	Scale 1:50
Client: Highways England		Dates: 28/01/1988 - 29/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	75.29		FILL (Foreman's description) MG-CL
		1.00 - 1.45	U							Very stiff (hard) red brown very silty CLAY locally with occasional fine gravel sized lithorelics (KEUPER MARL 3/4a) Below 3.80m with occasional medium gravel sized lithorelics and occasional bands and lenses of light greenish grey locally slightly fine sandy silt and siltstone MM-Z4
		1.60	D							
		1.60 - 2.01	D							
		2.30 - 2.75	D							
		3.60 - 3.80	D							*thinly laminated clay with frequent fine gravel sized lithorelics and occasional fine to medium sub-rounded fine to medium gravel*
		3.80	D							
		3.80 - 4.02	D							
		4.30 - 4.45	D							
							4.45	71.04		End of borehole at 4.45 m

Remarks

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Rotary Core Log

Borehole No. SK42NE57R
Sheet 1 of 3

Project Name:	SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords:	447031.00 - 325296.00	Hole Type CP+RC
Location:			Level:	75.49	Scale 1:50
Client:	Highways England		Dates:	01/02/1988 - 03/02/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Cable Tool Boring to 4.45m OH-OH
		4.00 - 5.50		87	50	11	4.45	71.04		Red brown moderately locally highly weathered locally very silty MUDSTONE weak with occasional bands of light grey green fine sandy siltstone up to 80mm thick. Very closely spaced often tight sub-vertical joints with black stain (KM 2/3) MM-Z2
							5.50	69.99		Assessed zone of core loss OH-OH
		5.50 - 6.70		58	33	13	6.00	69.49		Very stiff red brown very silty CLAY with frequent fine to medium gravel sized lithorelics (weathered MUDSTONE) (KM 3/4a) MM-Z3
							6.30	69.19		Red brown moderately weathered locally very clayey SILTSTONE moderately weak: extremely closely fractured with black staining (KEUPER MARL 2) From 7.00m to 7.40m with occasional bands of light grey green slightly fine sandy siltstone strong. From 8.75m to 9.40m moderately to highly weathered weak to very weak locally altered to a hard clayey silt with up to coarse gravel sized lithorelics MM-ST
		6.70 - 9.70		93	20	13				non intact assessed zone of core loss non intact non intact non intact non intact
							9.70	65.79		Assessed zone of core loss
										Continued on next sheet

Remarks
Open hole drilling, air flush, using 6.75in rock bit from ground level to 4.00m

AGS

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Rotary Core Log

Borehole No. SK42NE57R
Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447031.00 - 325296.00	Hole Type CP+RC
Location:		Level: 75.49	Scale 1:50
Client: Highways England		Dates: 01/02/1988 - 03/02/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										OH-OH
		9.70 - 12.60		83	43	21	10.20	65.29		Red brown slightly to moderately weathered SILTSTONE moderately strong becoming strong with very closely spaced sub-horizontal fractures. From 11.05m to 11.60m thinly interbedded with hard red brown clayey silt. Below 11.60m becoming light green slightly fine to sandy with closely to moderately widely spaced sub-horizontal fractures (bedding?) (KEUPER MARL 2) MM-ST *light greenish grey fine sandy siltstone strong* *non intact due to 2 intersecting sub-vertical joints with black staining* *non intact due to 2 intersecting sub-vertical joints with black staining* *occasional bands and lenses of red brown mudstone and very stiff hard red brown clay*
		12.60 - 15.55		88	73	37	13.50 13.95	61.99 61.54		Very stiff (hard) red brown very clayey SILT (weathered SILTSTONE) (KM3/4a) MM-Z4 Light grey green and red brown mottled moderately becoming highly weathered fine sandy SILTSTONE moderately weak to moderately strong (KEUPER MARL 3/4a) Below 14.50m becoming completely weathered altered to a dense silt with fine to coarse gravel sized lithorelics MM-ST *non intact* *assessed zone of core loss*
		15.55 - 18.00		80	20	16	16.30	59.19		Red brown slightly to moderately weathered locally very clayey SILTSTONE weak becoming moderately weak with extremely closely spaced often tight sub-horizontal fractures with black staining Below 18.20m becoming weak with occasional bands of very stiff (hard) red brown silty CLAY (KM 2) MM-ST *non intact* *assessed zone of core loss*
		18.00 - 20.00		90	75	48				*light grey green slightly fine sandy siltstone moderately weak* *non intact* Continued on next sheet

Remarks
Open hole drilling, air flush, using 6.75in rock bit from ground level to 4.00m

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Rotary Core Log

Borehole No.
SK42NE57R
Sheet 3 of 3

Project Name:	SMP - M1 J23A TO J25	Project No.	COCDFL1SMP01	Co-ords:	447031.00 - 325296.00
Location:				Level:	75.49
Client:	Highways England			Dates:	01/02/1988 - 03/02/1988

Hole Type: CP+RC
Scale: 1:50
Logged By: AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							20.13	55.36		End of borehole at 20.13 m

Remarks
Open hole drilling, air flush, using 6.75in rock bit from ground level to 4.00m

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Rotary Core Log

Borehole No. **SK42NE67**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447006.00 - 325214.00	Hole Type CP
Location:		Level: 74.65	Scale 1:50
Client: Highways England		Dates: 27/01/1988 - 28/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 1.00	B							Very stiff (hard) red brown locally friable very silty CLAY with frequent fine to medium gravel sized mudstone lithorelics. Locally with closely spaced subhorizontal fissures. (KEUPER MARL) Below 1.25m with occasional pockets and lenses of light greenish grey silt. Below 6.70m with medium to coarse gravel sized mudstone lithorelics. MM-Z3
		1.00 - 1.20	U							
		1.25	D							
		1.25 - 1.55	D							
		2.25 - 2.70	D							*dense friable red brown silt with frequent fine to medium gravel sized lithorelics.*
		3.25 - 3.70	D							
		4.25 - 4.55	D							
		5.20 - 5.43	D							*light red brown locally greenish probably moderately weathered silty fine grained sandstone weak*
		5.60	W							
		6.25 - 6.70	D							
		7.00	D							
							7.20	67.45		End of borehole at 7.20 m

Remarks
Hand dug inspection pit from ground level to 1.00m

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Rotary Core Log

Borehole No. **SK42NE83**

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325170.00	Hole Type CP
Location:		Level: 75.72	Scale 1:50
Client: Highways England		Dates: 20/09/1984 - 21/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										TOPSOIL TP
		0.30	J				0.30	75.42		Very stiff yellowish brown fissured sandy CLAY with occasional subangular medium gravel (sandstone and flint). (GLACIAL TILL) GTA-CL
		0.50 - 0.95	U							
		1.00	J							
		1.45	J							
		1.70	J				1.70	74.02		Very stiff red brown fissured silty to very silty CLAY with many siltstone/mudstone lithorelicts. (KEUPER MARL : ZONE III) MM-Z2
		2.00 - 2.45	U							
		2.50	J							
		2.95	J							
		3.00	B							
		3.20	J							
		3.50 - 3.95	U							
		4.00	J				4.00	71.72		Very stiff red brown and grey green fissured silty CLAY with many siltstone lithorelicts and occasional bands of highly weathered fissured very weak calcareous siltstone with residual silty clay. (KEUPER MARL : ZONE III) MM-Z3
		4.45	J							
		4.50	B							
		4.70	J							
		5.00 - 5.40	U							
		5.40	J							
		5.50 - 5.85	J							
		6.10	J							
		6.50	J				6.50	69.22		End of borehole at 6.50 m
		9.50 - 9.60	C							

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE83** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325170.00	Hole Type CP
Location:		Level: 75.72	Scale 1:50
Client: Highways England		Dates: 20/09/1984 - 21/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.22 - 10.34	C							
		10.34 - 10.45	C							
		11.09 - 11.20	C							
		12.20 - 12.32	C							
		12.32 - 12.46	C							
		13.24 - 13.36	C							
		13.36 - 13.46	C							
		14.48 - 14.58	C							
		14.58 - 14.69	C							
		14.69 - 14.81	C							

11 12 13 14 15 16 17 18 19 20

Remarks

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Rotary Core Log

Borehole No. SK42NE83R
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325170.00	Hole Type RC
Location:		Level: 75.72	Scale 1:50
Client: Highways England		Dates: 01/10/1984 - 01/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Rotary Open Holed alongside Shell and Auger Hole previously drilled to 5.00m. OH-OH
	▼	5.00 - 6.00		81		20	5.00	70.72		Highly weathered red brown siltstone degraded to stiff silty CLAY with many siltstone lithorelicts. (KEUPER MARL : ZONE III) MM-Z3
		6.00 - 6.70		98		0	6.08	69.64		Slightly weathered fissured red brown occasionally grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		6.70 - 8.30		96		26				Slightly weathered grey green moderately weak bands. Slightly weathered grey green moderately weak bands. Highly weathered degraded to stiff silty clay with many lithorelicts
		8.30 - 9.60		100		28				Slightly weathered grey green moderately weak bands. Slightly weathered grey green moderately weak bands.
										Continued on next sheet.

Remarks

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Rotary Core Log

Borehole No. SK42NE83R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325170.00	Hole Type RC
Location:		Level: 75.72	Scale 1:50
Client: Highways England		Dates: 01/10/1984 - 01/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.60 - 11.00		94		27				
		11.00 - 12.60		100		53				Subvertical discontinuities
		12.60 - 15.00		95		62				Slightly weathered grey green moderately weak bands
							15.00	60.72		Slightly weathered grey green moderately weak bands End of borehole at 15.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE84** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447020.00 - 325170.00	Hole Type CP+RC
Location:		Level: 74.77	Scale 1:50
Client: Highways England		Dates: 18/09/1984 - 19/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPINGS, Motorway verge MG-EF
		1.00	J				1.00	73.77		Stiff to very stiff red brown mottled grey green fissured silty to very silty CLAY with some mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE III) Occasional thin bands of moderately weathered fissured weak calcareous siltstone below 2.00m and many mudstone/siltstone lithorelicts. Becoming mottled grey green below 2.70m. MM-Z4
		1.20	J							
		1.50 - 1.95	U							
		2.00	J							
		2.45	J							
		2.50	B							
		2.70	J							
		3.50	B							
		3.65	J							
		4.30	J							
		4.50	J							
		5.00	J				5.00	69.77		Slightly weathered fissured red brown occasionally grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal smooth discontinuities. (KEUPER MARL : ZONE II) MM-ST
		5.50	B							
		5.50 - 5.83	C							
		5.50 - 5.85	C							
		5.00 - 7.00		97		45				Slightly weathered grey green moderately weak bands
		6.10 - 6.20	C							
		6.20 - 6.34	C							Slightly weathered grey green moderately weak bands
										Slightly weathered grey green moderately weak bands
		7.00 - 7.15	C							Highly weathered zone degraded to stiff silty clay with many lithorelicts
		7.15 - 7.25	C							
		7.00 - 8.50		100		40				Subvertical discontinuities
										Highly weathered zone degraded to stiff silty clay with many lithorelicts
										Slightly weathered grey green moderately weak bands
		8.50 - 9.50		97		0				Slightly weathered grey green moderately weak bands
										Slightly weathered grey green moderately weak bands
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE84** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447020.00 - 325170.00	Hole Type CP+RC
Location:		Level: 74.77	Scale 1:50
Client: Highways England		Dates: 18/09/1984 - 19/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.58 - 10.86 10.86 - 11.00	C C	96		56				
		11.50 - 14.30 13.00 13.00 - 13.30 13.35 - 13.45 13.45 - 13.55 13.55 - 13.66 13.66 - 13.76	B C C C C C	95		56				Slightly weathered grey green moderately weak bands Subvertical discontinuities
		14.30 - 14.75		97		0				Slightly weathered grey green moderately weak bands 45 deg discontinuity
		14.75 - 15.80 15.66 - 15.80	C C	100		47				Slightly weathered grey green moderately weak bands Subvertical discontinuities Slightly weathered grey green moderately weak bands
		15.80 - 17.40		92		41				Highly weathered zone degraded to stiff silty clay with many lithorelicts Highly weathered zone degraded to stiff silty clay with many lithorelicts Slightly weathered grey green moderately weak bands
		17.74 - 17.86 17.86	C C							
		17.40 - 20.00		94		51				Slightly weathered grey green moderately weak bands
							20.00	54.77		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE86**

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 325190.00	Hole Type CP+RC
Location:		Level: 75.33	Scale 1:50
Client: Highways England		Dates: 26/09/1984 - 29/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPINGS (Motorway central reserve) MG-EF
		0.70	J				0.70	74.63		Firm red brown fissured silty CLAY with many siltstone lithorelicts. (KEUPER MARL : ZONE III) Becoming stiff and very stiff with depth. Occasional thin bands of highly weathered very weak siltstone at 2.00. MM-Z4
		1.00	J							
		1.50 - 1.95	U							
		2.00	J							
		2.45	J							
		2.50	B							
		2.80	J							
		3.00 - 3.45	U							
		3.50	J				3.50	71.83		Stiff red brown fissured silty CLAY with many mudstone/siltstone lithorelicts and occasional thin bands of highly weathered very weak to weak mudstone/siltstone. (KEUPER MARL : ZONE III) Mottled grey green at 5.00. MM-Z3
		3.95	J							
		4.00	B							
		4.20	J							
		4.50 - 4.95	U							
		5.00	J							
	▼	5.45	J							
		5.60	J							
		6.00	J				6.00	69.33		Slightly weathered fissured red brown very weak to weak calcareous SILTSTONE occasionally with thin interstratified mudstone. Very to extremely closely spaced rough subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		6.00 - 8.40		97		26				Slightly weathered grey green moderately weak band Slightly weathered grey green moderately weak band Subvertical discontinuity Slightly weathered grey green moderately weak band
		8.40 - 8.80		100		0				
		8.80 - 9.50		94		0				Slightly weathered grey green moderately weak band Slightly weathered grey green moderately weak band Highly weathered zone degraded to stiff silty clay with many lithorelicts Subvertical discontinuity
										Continued on next sheet

Remarks

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 325190.00	Borehole No. SK42NE86 Sheet 2 of 2
Location:		Level: 75.33	Hole Type CP+RC
Client: Highways England		Dates: 26/09/1984 - 29/09/1984	Scale 1:50
			Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.50 - 12.25		96		23				Subvertical discontinuity
										Slightly weathered grey green moderately weak band
										45 deg discontinuity
										45 deg discontinuity
										45 deg discontinuity
										Subvertical discontinuity
		12.25 - 14.50		98		54				Subvertical discontinuity
							13.81	61.52		Slightly weathered grey green occasionally red brown moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
										45 deg discontinuity
		14.50 - 16.90		92		57	15.59	59.74		Slightly weathered fissured red brown occasionally grey green very weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		16.90 - 17.70		100		26				Subvertical discontinuity
										Highly weathered zone degraded to stiff silty clay with many lithorelicts
		17.70 - 20.00		94		43				Highly weathered zone degraded to stiff silty clay with many lithorelicts
							20.00	55.33		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE88**

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446990.00 - 325210.00	Hole Type CP+RC
Location:		Level: 75.09	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 19/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.40	74.69		Limestone Ballast. (MADE GROUND, MOTORWAY VERGE) MG-EF
		0.50	J							Very stiff red brown silty CLAY with occasional mudstone lithorelicts and thin bands of highly weathered very weak calcareous mudstone, siltstone. (KEUPER MARL : ZONE III) Band of moderately weak to weak calcareous mudstone at 2.00m. MM-Z3
		1.00	J							
		1.50 - 1.95	U							
		2.00	J							
		2.30	J							
		2.80	J							
		3.00	B							
		3.10	D							
		3.10	J							
		3.60	J							
		3.80	J							
		4.45	J				4.50	70.59		
		4.80	J							Very stiff red brown mottled grey green silty/very silty CLAY with occasional bands of highly weathered very weak calcareous mudstone. (KEUPER MARL : ZONE III) MM-Z3
		5.45	J				5.50	69.59		
		5.73	B							Highly to moderately weathered fissured very weak red brown occasionally grey green calcareous MUDSTONE, blue grey staining on fissure surfaces with very and extremely closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-Z2
		5.73 - 5.98	C							
		5.50 - 7.10		98		34				
										Highly weathered zone degraded to stiff silty clay with many lithorelicts
										Highly weathered zone degraded to stiff silty clay with many lithorelicts
		7.10 - 8.20		99		0				*Subvertical discontinuity*
										Highly weathered zone degraded to stiff silty clay with many lithorelicts
		8.20 - 10.10		95		41				
							9.30	65.79		Moderately weathered slightly fissured very weak red brown mottled grey green calcareous SILTSTONE. Very to extremely closely spaced subhorizontal discontinuities. Becoming highly
		9.70 - 9.80	C							
		9.80 - 9.90	C							

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE88**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446990.00 - 325210.00	Hole Type CP+RC
Location:		Level: 75.09	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 19/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										weathered and fissured below 11.76. (KEUPER MARL : ZONE II/III) MM-ST
										Subvertical discontinuity
										Moderately weak band
										Moderately weak band
		10.10 - 13.10		100		59				
		12.65 - 12.77	C				12.49	62.60		
		12.77 - 12.90	C							Moderately weathered weak to moderately weak grey green calcareous SILTSTONE. Very to extremely closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		13.73 - 13.84	C							
		13.91 - 14.04	C							Highly weathered zone degraded to very silty clay
		13.10 - 15.10		97		28				Highly weathered zone degraded to very silty clay
										Highly weathered zone degraded to very silty clay
							14.50	60.59		Highly weathered zone degraded to very silty clay
										Highly weathered very weak fissured red brown and grey green SILTSTONE. (KEUPER MARL : ZONE II/III) MM-ST
		15.10 - 16.10		100		83				Highly weathered zone degraded to stiff very silty clay with many lithorelicts
		16.10 - 18.10		100		55				
		17.30 - 17.42	C							
		18.10 - 18.20	C							Moderately weak siltstone moderately weathered bands
		18.20 - 18.32	C							Highly weathered zone degraded to stiff very silty clay with many lithorelicts
		18.10 - 20.00		94		35				Highly weathered zone degraded to stiff very silty clay with many lithorelicts
										Highly weathered zone degraded to stiff very silty clay with many lithorelicts
							20.00	55.09		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE89**

Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 325230.00	Hole Type CP+RC
Location:		Level: 75.29	Scale 1:50
Client: Highways England		Dates: 11/09/1984 - 14/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	74.99		LIMESTONE BALLAST. (Motorway verge) MG-EF
		0.50 - 1.00	B							Slightly weathered moderately weak red brown grey green calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		1.30	J							
		1.50 - 1.95	U							
		2.00	J				2.00	73.29		Highly weathered very weak red brown micaceous MUDSTONE. (KEUPER MARL : ZONE III) MM-Z2
		2.00 - 2.50	C							
		2.45	J							
		2.80	J							
		3.00	B							
		3.00 - 3.45	U							
		3.50	J				3.50	71.79		Very stiff red brown and grey green very silty CLAY with bands of highly weathered weak mudstone/siltstone. (KEUPER MARL : ZONE III) MM-Z3
		3.95	J							
		4.30	J							
		4.60	J				4.60	70.69		LIMESTONE FRAGMENTS (fallen limestone fragments after Shell and Auger drilling). NR
							5.50	69.79		Slightly weathered fissured red brown very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST
		5.50 - 7.00		97		18				45 deg discontinuity Subvertical discontinuities Highly weathered zone
		7.00 - 8.00		100		11				Slightly weathered grey green moderately strong band
		8.00 - 9.60		95		61				Highly weathered zone
		10.00 - 10.10	C							Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE89** Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 325230.00	Hole Type CP+RC
Location:		Level: 75.29	Scale 1:50
Client: Highways England		Dates: 11/09/1984 - 14/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.10 - 10.20	C							Highly weathered zone Highly weathered zone
		9.60 - 11.40		97		33				Subvertical discontinuities
	▼	11.40 - 11.90		100		0				Highly weathered zone
		12.05 - 12.15	C				11.95	63.34		Slightly weathered fissured grey green occasionally red brown moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II/III) MM-ST
		12.30 - 12.40	C							45 deg discontinuity
		11.90 - 13.30		100		50				Highly weathered zone degraded to stiff silty clay with many lithorelicts
										Highly weathered zone degraded to stiff silty clay with many lithorelicts
										45 deg discontinuity
		13.30 - 15.10		100		42	14.09	61.20		45 deg discontinuity Moderately to slightly weathered fissured red brown occasionally grey green very weak calcareous SILTSTONE. Becoming slightly weathered below 19.10m. Very to extremely closely spaced rough subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
										45 deg discontinuity
		15.10 - 16.10		93		32				Slightly weathered grey green moderately weak band Slightly weathered grey green moderately weak band
										Completely weathered zone degraded to stiff silty clay with many lithorelicts
										Slightly weathered grey green moderately weak band
		16.30 - 16.42	C							
		16.42 - 16.54	C							
		16.10 - 19.10		95		53				Completely weathered zone degraded to stiff silty clay with many lithorelicts Completely weathered zone degraded to stiff silty clay with many lithorelicts Slightly weathered grey green moderately weak band
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE89**

Sheet 3 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 325230.00	Hole Type CP+RC
Location:		Level: 75.29	Scale 1:50
Client: Highways England		Dates: 11/09/1984 - 14/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		19.10 - 22.00		99		59				Slightly weathered grey green moderately weak band
		22.00 - 23.40		97		27				Slightly weathered grey green moderately weak band Completely weathered zone degraded to stiff silty clay with many lithorelicts Slightly weathered grey green moderately weak band Subvertical discontinuity Slightly weathered grey green moderately weak band
		23.40 - 25.00		96		67				Slightly weathered grey green moderately weak band Completely weathered zone degraded to stiff silty clay with many lithorelicts
							25.00	50.29		End of borehole at 25.00 m

21 22 23 24 25 26 27 28 29 30

Remarks

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Rotary Core Log

Borehole No. **SK42NE90** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446970.00 - 325220.00	Hole Type CP
Location:		Level: 79.03	Scale 1:50
Client: Highways England		Dates: 14/08/1984 - 15/08/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										TOPSOIL. TP
		0.50	J				0.50	78.53		
		0.50 - 0.95	U							Firm to stiff red brown fissured silty CLAY with many subangular grey green fine to medium sized fragments of very weak siltstone. (KEUPER MARL : ZONE IV) MM-Z4
		1.00	J				1.00	78.03		
		1.45	J							Firm red brown mottled grey green silty CLAY and very silty CLAY with lithorelicts of siltstone becoming very stiff tending to very weak siltstone 1.00-1.30m. Friable with no lithorelicts below 1.80m. (KEUPER MARL : ZONE III/IVa) MM-Z3
		1.50	B							
		1.80	J							
		2.00 - 2.45	U							
		2.50	J				2.50	76.53		
		2.95	J							Stiff and very stiff red brown occasionally mottled grey green silty CLAY with lithorelicts of mudstone. (KEUPER MARL : ZONE III) Occasional thin bands of very weak mudstone and firm friable silty clay. Band of very weak mudstone at 4.20m. Band of very weak grey green siltstone noted at 4.80m. MM-Z3
		3.00	B							
		3.30	J							
		3.50 - 3.95	U							
		4.00	J							
		4.20	J							
		4.95	J							
		5.00	B							
		5.00	J							
		5.00 - 5.45	U							
		5.50	J				5.50	73.53		
		5.95	J							Very stiff red brown fissured silty CLAY and bands of grey green fissured clayey silt with many siltstone lithorelicts. Band of stiff friable silty clay at 6.30m. (KEUPER MARL : ZONE III) MM-Z3
		6.00	B							
		6.30	J							
		6.50 - 6.95	U							
		7.00	J							
		7.45	J							
		7.50	B							
		7.70	J				7.70	71.33		Firm red brown slightly mottled grey green friable silty CLAY with mudstone lithorelicts becoming stiff to very stiff below 8.30m. Band of very weak fissured mudstone at 8.20m and weak to moderately weak siltstone at 8.40m. (KEUPER MARL : ZONE III) MM-Z3
		8.20	J							
							8.50	70.53		End of borehole at 8.50 m
		10.00 - 10.10	C							Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE90**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446970.00 - 325220.00	Hole Type CP
Location:		Level: 79.03	Scale 1:50
Client: Highways England		Dates: 14/08/1984 - 15/08/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.10 - 10.20	C							
		12.05 - 12.15	C							
		12.30 - 12.40	C							
		16.30 - 16.42	C							
		16.42 - 16.54	C							

11 12 13 14 15 16 17 18 19 20

Remarks

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Rotary Core Log

Borehole No. SK42NE90R
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446970.00 - 325220.00	Hole Type RC
Location:		Level: 79.03	Scale 1:50
Client: Highways England		Dates: 09/10/1984 - 11/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		7.00 - 8.00		80		0				Moderately to highly weathered friable weak to very weak red brown mottled grey green calcareous SILTSTONE. Extremely closely spaced subhorizontal discontinuities containing some clay. (KEUPER MARL : ZONE II/III) MM-ST
										highly weathered zone degraded to stiff silty clay with many lithorelicts
		8.00 - 9.50		93		7				
		9.50 - 9.90		88		0	9.55	69.48		Moderately to slightly weathered weak to moderately weak red brown mottled grey green
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE90R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446970.00 - 325220.00	Hole Type RC
Location:		Level: 79.03	Scale 1:50
Client: Highways England		Dates: 09/10/1984 - 11/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.90 - 11.15		96		16				calcareous SILTSTONE. Very to extremely closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
										highly weathered zone degraded to stiff silty clay with many lithorelicts
		11.15 - 12.15		90		15				highly weathered zone degraded to stiff silty clay with many lithorelicts
		12.15 - 13.80		56		7				
		13.80 - 14.80		85		33				
										subvertical discontinuities
		14.80 - 17.00		81		22				very weak highly weathered zone
										subvertical discontinuities
										very weak highly weathered zone
		17.00 - 18.75		100		42	17.00	62.03		Slightly weathered moderately weak to moderately strong grey green SILTSTONE. Very closely and closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST
							19.00	60.03		Moderately to highly weathered very weak friable red brown SILTSTONE. Very closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
							20.00	59.03		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE91**

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446980.00 - 325250.00	Hole Type CP
Location:		Level: 78.85	Scale 1:50
Client: Highways England		Dates: 16/08/1984 - 16/08/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										TOPSOIL TP
		0.50	J				0.50	78.35		
		0.50 - 0.95	U							Very stiff red brown mottled light brown fissured silty CLAY with mudstone lithorelicts and rootlets. (KEUPER MARL : ZONE III) MM-Z4
		1.00	J				1.00	77.85		
		1.45	J							Very stiff red brown slightly mottled grey green fissured silty CLAY with mudstone lithorelicts becoming firm to stiff sand friable in zones. Bands of weak to very weak grey green siltstone at 1.00m and 2.40m. Tending to very weak and weak mudstone in zone below 3.50m. (KEUPER MARL : II/III) MM-Z2
		1.70	J							
		2.00 - 2.45	U							
		2.50	J							
		2.95	J							
		4.00	J							
		4.00	B							
		4.30	J				4.30	74.55		End of borehole at 4.30 m
		5.23	B							
		5.23 - 5.66	C							
		8.20 - 8.30	C							
		8.30 - 8.44	C							
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No.
SK42NE91
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446980.00 - 325250.00	Hole Type CP
Location:		Level: 78.85	Scale 1:50
Client: Highways England		Dates: 16/08/1984 - 16/08/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		12.64 - 12.78	C							
		12.96 - 13.09	C							
		14.86 - 14.97	C							
		14.97 - 15.10	C							
		15.42 - 15.52	C							
		15.52 - 15.62	C							
		17.74 - 17.85	C							
		17.85 - 17.96	C							

11 12 13 14 15 16 17 18 19 20

Remarks

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Rotary Core Log

Borehole No. SK42NE91R
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446980.00 - 325250.00	Hole Type RC
Location:		Level: 78.85	Scale 1:50
Client: Highways England		Dates: 04/10/1984 - 04/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Rotary Open Holed through previously drilled Shell and Auger hole to 3.00 OH-OH
		3.00 - 3.70		71		22	3.00	75.85		Highly weathered fissured red brown very weak SILTSTONE. (KEUPER MARL : ZONE III) MM-ST
		3.70 - 4.70		94		20	3.90	74.95		Slightly weathered fissured red brown occasionally grey green very weak SILTSTONE. Very to extremely closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST highly weathered zone slightly weathered grey green moderately weak band
		4.70 - 6.20		99		53				highly weathered zone slightly weathered grey green moderately weak band
		6.20 - 7.90		100		49				slightly weathered grey green moderately weak band slightly weathered grey green moderately weak band
		7.90 - 9.40		97		48				slightly weathered grey green moderately weak band
		9.40 - 10.50		98		0	9.32	69.53		Slightly weathered very fissured red brown and grey green weak to moderately weak calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE91R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446980.00 - 325250.00	Hole Type RC
Location:		Level: 78.85	Scale 1:50
Client: Highways England		Dates: 04/10/1984 - 04/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										subvertical discontinuity
		10.50 - 11.75		100		43	10.90	67.95		Highly weathered fissured red brown mottled grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE III) MM-ST
		11.75 - 13.45		94		33	12.18	66.67		slightly weathered grey green moderately weak band Slightly weathered fissured to very fissured red brown very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST
		13.45 - 15.00		85		21				subvertical discontinuity 45 deg discontinuity
		15.00 - 16.85		92		29				slightly weathered grey green moderately weak band
		16.85 - 17.85		65		48				45 deg discontinuity
		17.85 - 18.85		100		32	17.71	61.14		Slightly weathered fissured grey green moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		18.85 - 20.00		81		59				subvertical discontinuity subvertical discontinuity
							20.00	58.85		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE94**

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325380.00	Hole Type CP+RC
Location:		Level: 79.62	Scale 1:50
Client: Highways England		Dates: 01/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	J				0.30	79.32		TOPSOIL TP
		0.50 - 0.95	U							Very stiff red brown silty CLAY with some mudstone/siltstone lithorelicts, becoming mottled grey/green below 1.00m. (KEUPER MARL : ZONE III) Thin band of highly weathered fissured weak calcareous siltstone with residual silty clay at 1.80m. Clay becoming stiff at 2.50m with occasional thin bands of highly weathered fissured red brown very weak calcareous siltstone with residual silty clay. MM-Z3
		1.00	J							
		1.45	J							
		1.80	J							
		2.00 - 2.45	U							
		2.50	J							
		2.95	J							
		3.30	J				3.30	76.32		Very stiff red brown fissured silty CLAY with some siltstone lithorelicts. Some thin bands of highly weathered fissured red brown and grey green weak calcareous siltstone with residual silty clay between 4.00 and 5.50m. (KEUPER MARL : ZONE III/IVa) MM-Z3
		4.00	J							
		4.45	J							
		4.80	J							
		5.50	J							
		5.75	J							
		6.00	J				6.00	73.62		Slightly weathered laminated and thinly bedded red brown fine grained very weak to weak SILTSTONE. With bands (up to 150mm) of highly weathered very weak clayey siltstone between 6.00 - 9.50m. (KEUPER MARL : ZONE II) MM-ST
		6.00 - 7.00		83		10				siltstone very fractured. Generally intact below 11.20m
		7.00 - 8.00		84		0				
		8.00 - 9.00		85		15				
		9.00 - 10.50		100		0				

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE94 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325380.00	Hole Type CP+RC
Location:		Level: 79.62	Scale 1:50
Client: Highways England		Dates: 01/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 - 12.00		93		19				
		12.00 - 13.50		100		37				
		13.50 - 15.00		100		41				
							14.90	64.72		Slightly weathered to fresh very thinly and thinly bedded green grey occasionally red brown fine grained weak to moderately weak SILTSTONE. (KEUPER MARL : ZONE I) MM-ST
		15.00 - 16.65		100		69				
							16.00	63.62		Slightly weathered very thinly and thinly bedded red brown occasionally green grey fine grained very weak to weak SILTSTONE. (KEUPER MARL : ZONE I/II) MM-ST
		16.65 - 17.00		94		43				highly weathered zone of very weak clayey siltstone
		17.00 - 18.50		85		62				highly weathered zone of very weak clayey siltstone
		18.50 - 20.00		99		90				
							20.00	59.62		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE95** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447040.00 - 325390.00	Hole Type CP+RC
Location:		Level: 76.57	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 11/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE BALLAST. (MADE GROUND - MOTORWAY VERGE) MG-EF
		0.50	J				0.50	76.07		Firm red brown friable very silty CLAY with thin bands of highly weathered very weak calcareous mudstone. (KEUPER MARL : ZONE III) MM-Z2
		1.00	J							
		1.50	B							
		1.50 - 1.95	U							
		2.00	J				2.00	74.57		Stiff red brown slightly mottled grey green fissured silty CLAY with many mudstone lithorelicts. Occasional pockets of sand and bands of highly weathered weak and moderately weak calcareous mudstone/siltstone. (KEUPER MARL : ZONE II/III) MM-Z2
		2.45	J							
		2.70	B							
		2.80	J							
		2.90	J							
		3.30	J							
		3.50 - 5.00		98		12	3.50	73.07		Slightly weathered fissured red brown occasionally mottled grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced, rough subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST subvertical discontinuities highly weathered zone degraded to stiff silty clay with many lithorelicts slightly weathered grey green moderately weak band
		5.00 - 6.80		84		5				slightly weathered grey green moderately weak band subvertical discontinuities
		7.60 - 7.72	C							
		7.72 - 7.82	C							
		6.80 - 9.50		100		51				subvertical discontinuities slightly weathered grey green moderately weak band subvertical discontinuities slightly weathered grey green moderately weak band
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE95** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447040.00 - 325390.00	Hole Type CP+RC
Location:		Level: 76.57	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 11/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.08 - 10.19	C							
		10.19 - 10.30	C							
		10.50 - 10.52	C				10.48	66.09		
		10.52 - 10.64	C							Slightly weathered fissured grey green moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		9.50 - 11.80		94		41				45 deg discontinuity very weak siltstone
		12.05 - 12.17	C							
		12.17 - 12.29	C				12.43	64.14		
		11.80 - 13.80		100		47				Slightly weathered fissured red brown occasionally grey green very weak calcareous SILTSTONE. Very to extremely closely spaced, subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST
										grey green moderately weak siltstone
		13.80 - 15.00		94		32				
										grey green moderately weak siltstone
		15.38 - 15.50	C							
		16.14 - 16.25	C							
		16.25 - 16.37	C							
		15.00 - 17.90		96		68				subvertical discontinuities
		17.27 - 17.37	C							
		17.37 - 17.47	C							
										grey green moderately weak siltstone
		17.90 - 20.00		97		68				highly weathered zones
		19.50 - 19.62	C							
		19.62 - 19.72	C							grey green moderately weak siltstone
							20.00	56.57		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE96**

Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447040.00 - 325380.00	Hole Type CP+RC
Location:		Level: 76.54	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 11/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPINGS (MADE GROUND - MOTORWAY VERGE) MG-EF
		0.60	J				0.60	75.94		Highly weathered very weak fissured calcareous MUDSTONE tending to stiff and very stiff silty clay. (KEUPER MARL : ZONE III) MM-Z3
		1.00	J							
		1.00	B							
		1.00 - 1.50	B							
		1.50 - 1.95	U							
		2.00	J				2.00	74.54		Very stiff red brown silty CLAY with bands of highly weathered very weak calcareous MUDSTONE. (KEUPER MARL : ZONE III) Becoming very silty clay with zones of clayey silt. Band of moderately weak to weak red brown calcareous mudstone at 3.20m. MM-Z4
		2.45	J							
		2.70	B							
		2.80	J							
		3.00 - 3.20	U							
		3.20	J							
		3.50	J				3.50	73.04		Slightly weathered fissured red brown very weak to weak SILTSTONE. Very to extremely closely spaced, subhorizontal rough and smooth discontinuities. (KEUPER MARL : ZONE II) MM-ST
		3.97 - 4.07	C							
		4.07 - 4.18	C							
		3.50 - 5.00		100		36				
										highly weathered zone degraded to stiff silty clay with many lithorelicts
										slightly weathered red brown and grey green moderately weak band
										slightly weathered red brown and grey green moderately weak band
										slightly weathered red brown and grey green moderately weak band
		5.00 - 6.90		91		41				
		6.50 - 6.62	C							
		6.90 - 8.50		97		41				subvertical discontinuities
										slightly weathered red brown and grey green moderately weak band
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE96**

Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447040.00 - 325380.00	Hole Type CP+RC
Location:		Level: 76.54	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 11/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 10.50 - 10.91 8.50 - 11.50	B C	96		62	10.40	66.14		Slightly weathered grey green occasionally red brown moderately weak to moderately strong SILTSTONE. Very to extremely closely spaced, subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST *occasional voids approx. 20mm diameter containing completely weathered siltstone* *moderately weathered zone* *45 deg discontinuity* *moderately weathered zone* *45 deg discontinuity*
		11.50 - 14.10		98		51	12.32	64.22		Slightly weathered fissured red brown occasionally grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II/III) MM-ST *grey green moderately weak band* *grey green moderately weak band* *highly weathered zone degraded to stiff silty clay with many lithorelicts* *highly weathered zone degraded to stiff silty clay with many lithorelicts*
		14.10 - 17.10		98		75				*highly weathered zone degraded to stiff silty clay with many lithorelicts*
		17.10 - 20.00		97		65				*grey green moderately weak band* *grey green moderately weak band*
							19.36	57.18		Highly weathered fissured red brown and grey green very weak calcareous SILTSTONE. (KEUPER MARL : ZONE III) MM-ST
							20.00	56.54		Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE96**

Sheet 3 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447040.00 - 325380.00	Hole Type CP+RC
Location:		Level: 76.54	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 11/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										slightly weathered grey green moderately strong siltstone 45 deg discontinuity End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE97**
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447060.00 - 325390.00	Hole Type CP+RC
Location:		Level: 77.04	Scale 1:50
Client: Highways England		Dates: 27/09/1984 - 28/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPINGS. (MADE GROUND - Motorway central reserve) MG-EF
		0.70	J				0.70	76.34		Firm red brown mottled grey green fissured silty CLAY with many mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE III) MM-Z3
		1.00	J							
		1.40	J				1.40	75.64		Firm red brown fissured silty CLAY with occasional mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE IVa) MM-Z3
		1.50 - 1.95	U							
		2.00	J				2.00	75.04		Stiff red brown mottled grey green fissured silty to very silty CLAY with many mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE II/III) Occasional thin bands of highly weathered very weak calcareous siltstone at 2.00m. Very stiff towards base. MM-Z3
		2.45	J							
		2.50	B							
		2.80	J							
		3.00 - 3.45	U							
		3.50	J				3.50	73.54		Highly weathered fissured red brown very weak calcareous SILTSTONE with residual silty clay. (KEUPER MARL : ZONE III) MM-ST
		3.80	J							
		4.50	J				4.50	72.54		Moderately to slightly weathered fissured red brown very weak calcareous SILTSTONE with occasional thin mudstone bands. Very to extremely closely spaced rough subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		4.59 - 4.50								
		5.54	B	98		53				45 deg discontinuity
		5.54 - 5.90	C							
										highly weathered zone degraded to stiff silty clay with many lithorelicts
										slightly weathered grey green moderately weak band
										highly weathered zone degraded to stiff silty clay with many lithorelicts
		6.50 - 7.90		100		18				
		8.59 - 8.70	C							
		8.70	C							
		7.90 - 9.95		97		46				
										subvertical discontinuity
										slightly weathered grey green moderately weak band

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE97**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447060.00 - 325390.00	Hole Type CP+RC
Location:		Level: 77.04	Scale 1:50
Client: Highways England		Dates: 27/09/1984 - 28/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.30 - 10.40	C							slightly weathered grey green moderately weak band
		10.40 - 10.50	C							
		9.95 - 12.60		95		58				
		11.40 - 11.50	C							
		11.50 - 11.64	C							
		11.64 - 11.76	C				11.64	65.40		Slightly weathered grey green moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		11.76 - 11.88	C							moderately weathered zone
										subvertical discontinuity
										moderately weathered zone
		12.60 - 13.30		95		54				
		13.08 - 13.19	C							
		13.19 - 13.30	C							
		13.75	B				13.30	63.74		Moderately to slightly weathered fissured red brown occasionally grey green very weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		13.75 - 14.12	C							slightly weathered grey green moderately weak band
		13.30 - 15.00		97		38				completely weathered zone degraded to stiff silty clay with many lithorelicts
										completely weathered zone degraded to stiff silty clay with many lithorelicts
		15.00 - 15.70		100		25				slightly weathered grey green moderately weak band
		16.27 - 16.38	C							
		16.38 - 16.50	C							
		15.70 - 18.10		97		58				
		18.10 - 18.20	C							slightly weathered grey green moderately weak band
		18.20 - 18.30	C							
										completely weathered zone degraded to stiff silty clay with many lithorelicts
		18.10 - 20.00		96		81				
		19.10 - 19.21	C							
		19.21 - 19.33	C							
							20.00	57.04		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE99**
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447080.00 - 325390.00	Hole Type CP+RC
Location:		Level: 76.51	Scale 1:50
Client: Highways England		Dates: 17/09/1984 - 18/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPING. (MADE GROUND - MOTORWAY VERGE) MG-EF
		0.70	J				0.70	75.81		Firm red brown mottled grey green fissured very silty CLAY with many mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE II/III) Becoming stiff and very stiff with depth. Occasional thin bands of highly weathered fissured grey green weak to very weak siltstone at 1.00m and 2.00m. MM-Z4
		1.00	J							
		1.50 - 1.95	U							
		2.00	J							
		2.45	J							
		2.70	J							
		3.00 - 3.45	U							
		3.45	J				3.45	73.06		Highly weathered fissured red brown mottled grey green very weak SILTSTONE with residual silty clay. (KEUPER MARL : ZONE III) Moderately weak at 4.00m. MM-ST
		3.75	J							
		4.00	J							
		4.50	J				4.50	72.01		Slightly weathered fissured red brown very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST
		4.50 - 5.50		98		60				highly weathered zone slightly weathered grey green moderately weak band
		5.50 - 7.00		98		34				slightly weathered grey green moderately weak band
		7.00 - 8.50		94		60				subvertical discontinuity slightly weathered grey green moderately weak band
		8.50 - 11.35		99		27				slightly weathered grey green moderately weak band subvertical discontinuity
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE99** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447080.00 - 325390.00	Hole Type CP+RC
Location:		Level: 76.51	Scale 1:50
Client: Highways England		Dates: 17/09/1984 - 18/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 10.50 - 10.74	B C				10.50	66.01		Slightly weathered grey green moderately strong calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST highly weathered very weak zone highly weathered very weak zone highly weathered very weak zone
		11.35 - 13.10		100		69				
							12.60	63.91		Moderately weathered fissured red brown occasionally mottled grey green very weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST
		13.10 - 14.50		97		49				
							14.50	62.01		Slightly weathered fissured red brown occasionally mottled grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced smooth subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST 45 deg discontinuity
		14.50 - 17.50		100		62				
										slightly weathered grey green moderately strong band
		17.50 - 20.00		99		66				
										slightly weathered grey green moderately strong band
							20.00	56.51		End of borehole at 20.00 m

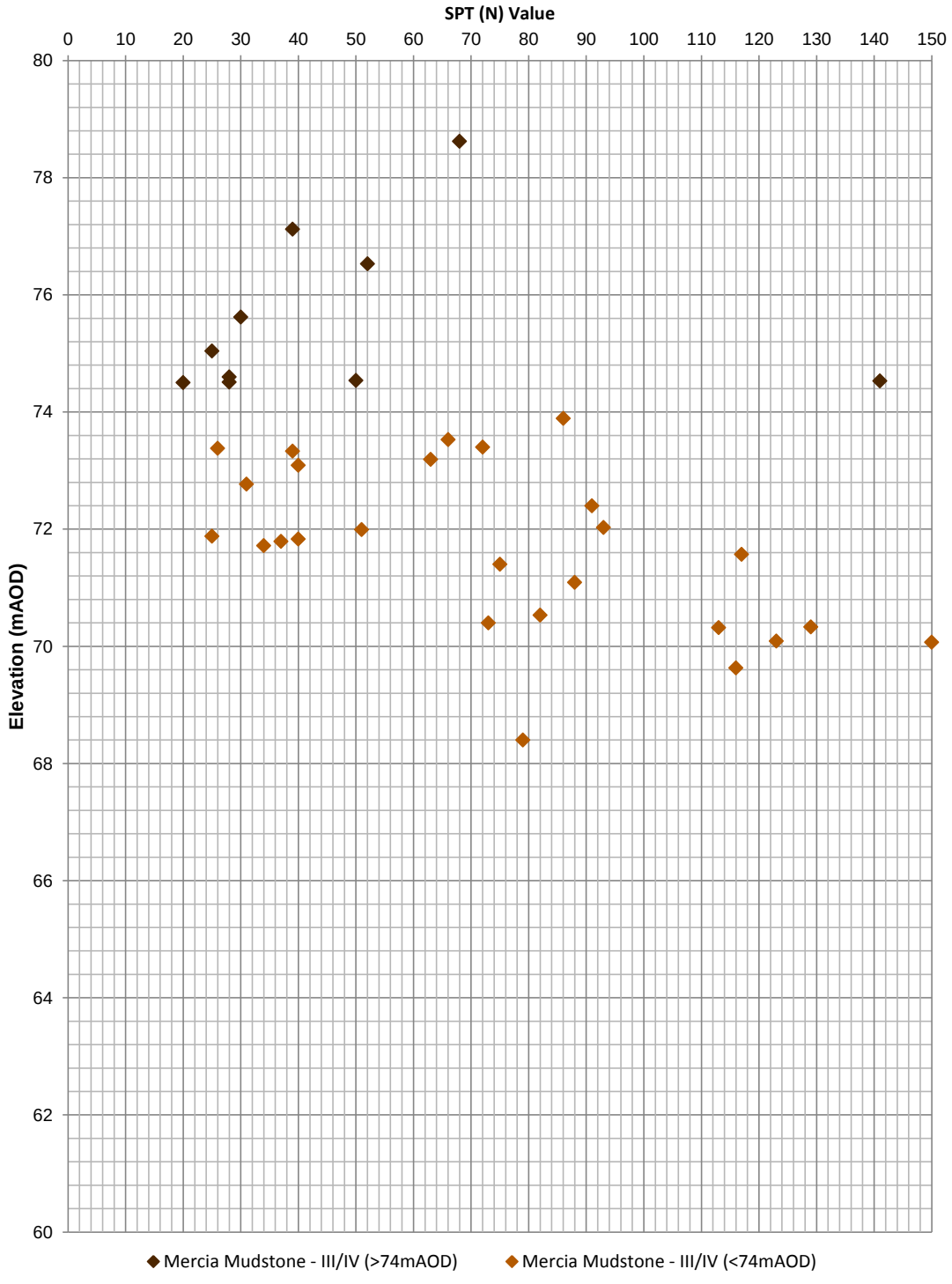
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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182800-183000NB**
Client: **Highways England**	Borehole ID: **SK42NE101, 102, 56, 57, 67, 83, 84, 86, 88, 89, 90, 94, 96, 97, 99**	



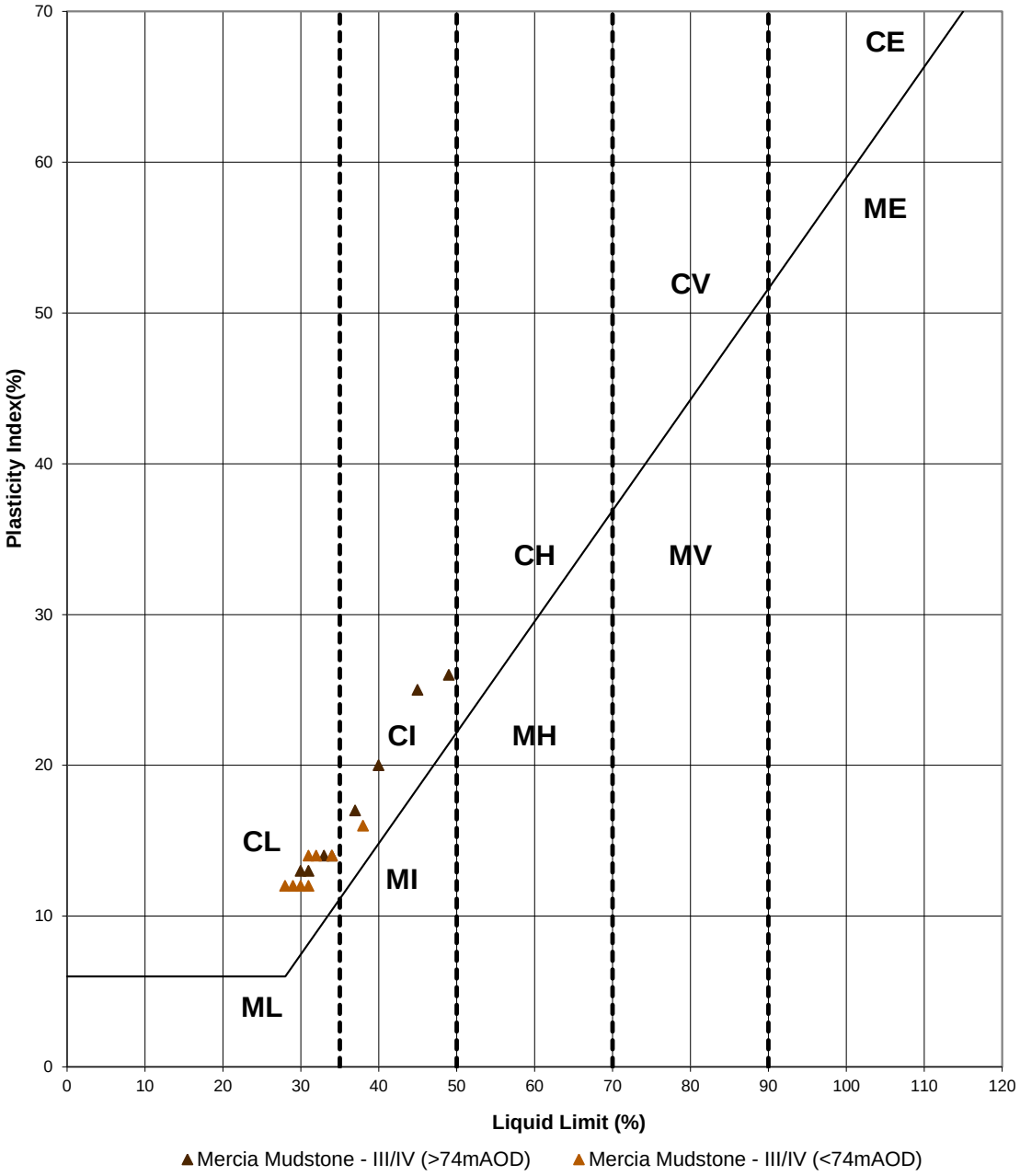
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 25/01/2017 Ref: HA549342-AMAR-HGT-182800-183000NB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182800-183000NB**
Client: **Highways England**	Borehole ID: **SK42NE83, 84, 86, 88, 90, 91, 94, 96, 97, 101, 102**	



Key

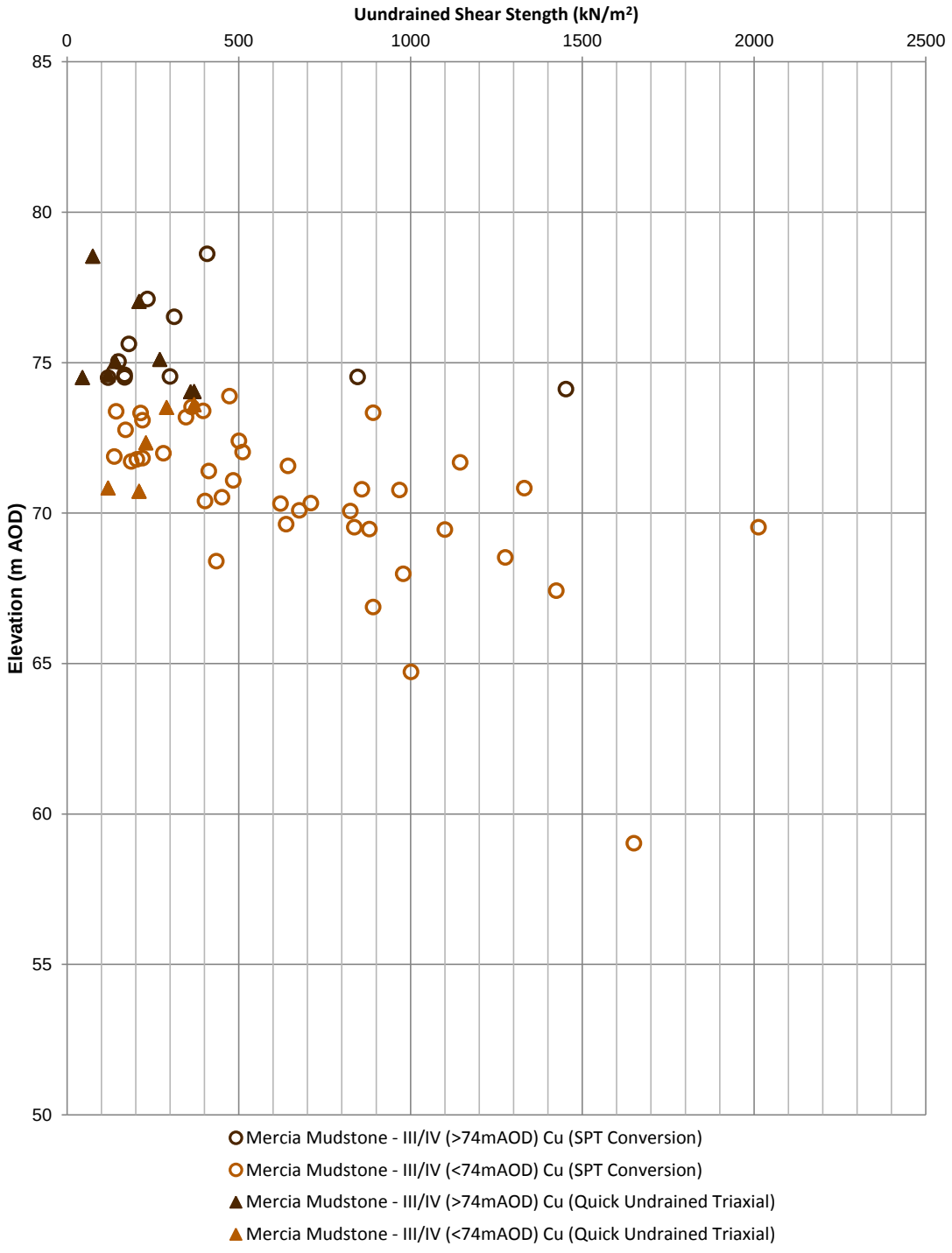
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 26/01/2017 Ref: HA549342-AMAR-HGT-182800-183000NB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182800-18300NB**
Client: **Highways England**	Borehole ID: **SK42NE101, 102, 56, 57, 67, 83, 84, 86, 88, 89, 90, 94, 96, 97, 99**	



Rev: P01 Date: 26/01/2017 Ref: HA549342-AMAR-HGT-182800-18300NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-183080-183400-GSS-000001		
Earthworks Widening Solution	Full Height Embankment Widening (1:2.0), Granular Wedge at Embankment Crest (1:2.0).		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	183080-183400		
Carriageway	Northbound		
Marker Post	183/1A+00-183/4A+00		
National Grid Reference	E 447115 , N 325642		
Existing Ground Level at Location	Carriageway	77.45mAOD	
	Toe of Embankment	71.05mOAD	
Earthwork Type	NB: Embankment	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_42051	SB: N/A	HAGDMS designation
Earthwork Height	NB: 6.4m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 23°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	05/12/2016	[redacted]
Checked	Alice Bazen	25/04/2017	
Reviewed	Gary Summerfield	25/04/2017	
Approved	Thomas Bulteel	02/05/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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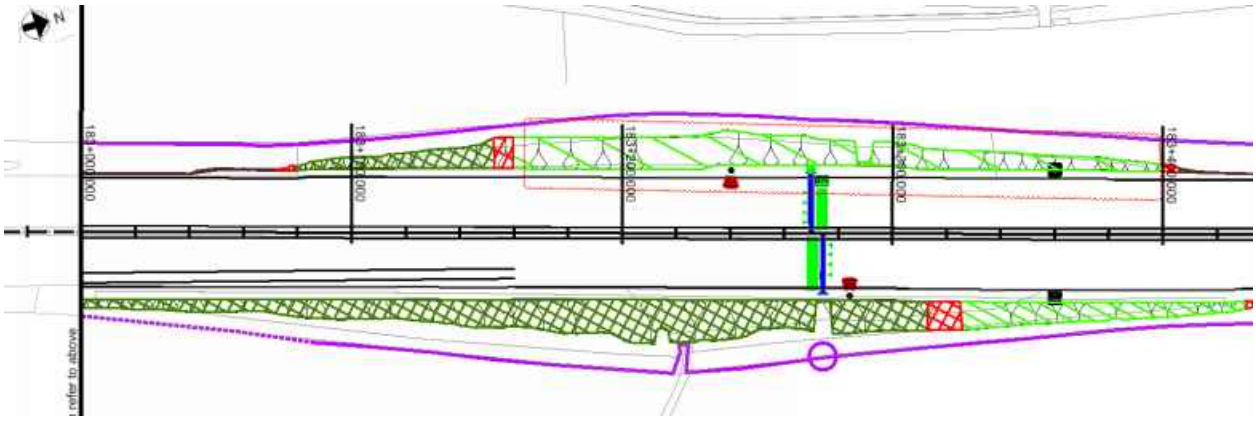


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Granular Wedge at Embankment Crest 1:2.0 – Ch.183080-Ch.183150
- Full Height Embankment Widening 1:2.0 – Ch.183160-Ch.183400

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an Embankment with a maximum height of approximately 6.4m.

The critical cross sections at ch.183140 and ch.183240 are based on sections with the greatest earthwork height for the proposed solutions.

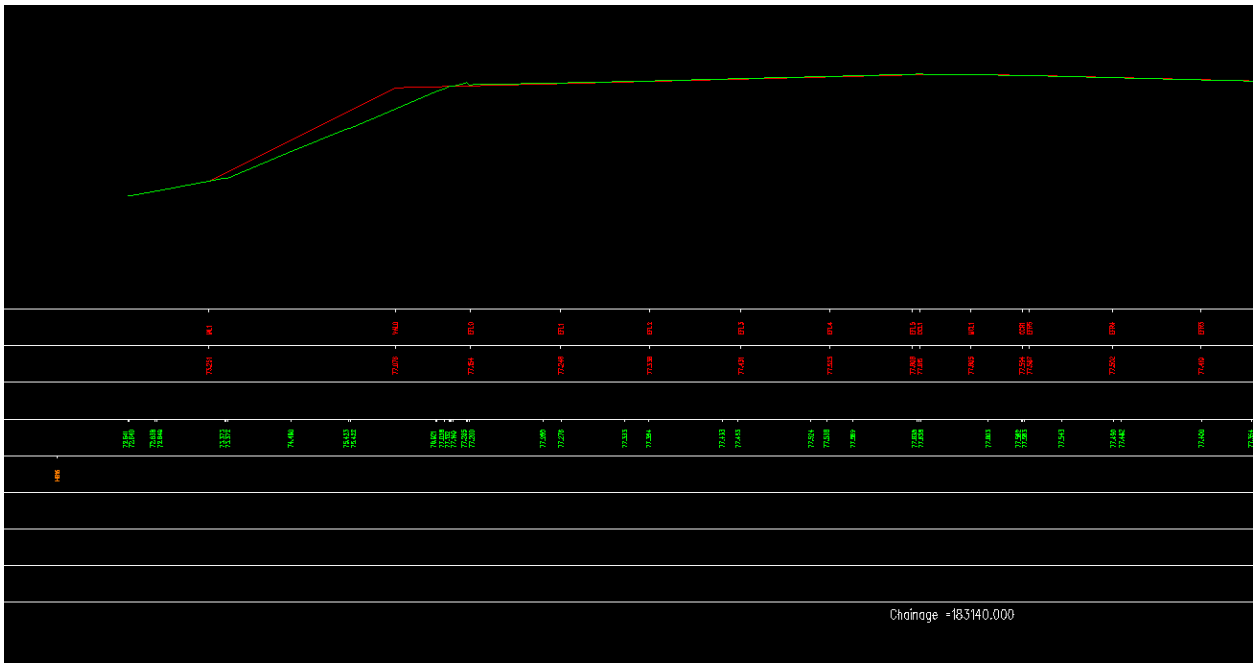


Figure 2.1: Topographic Cross Section Chainage 183140

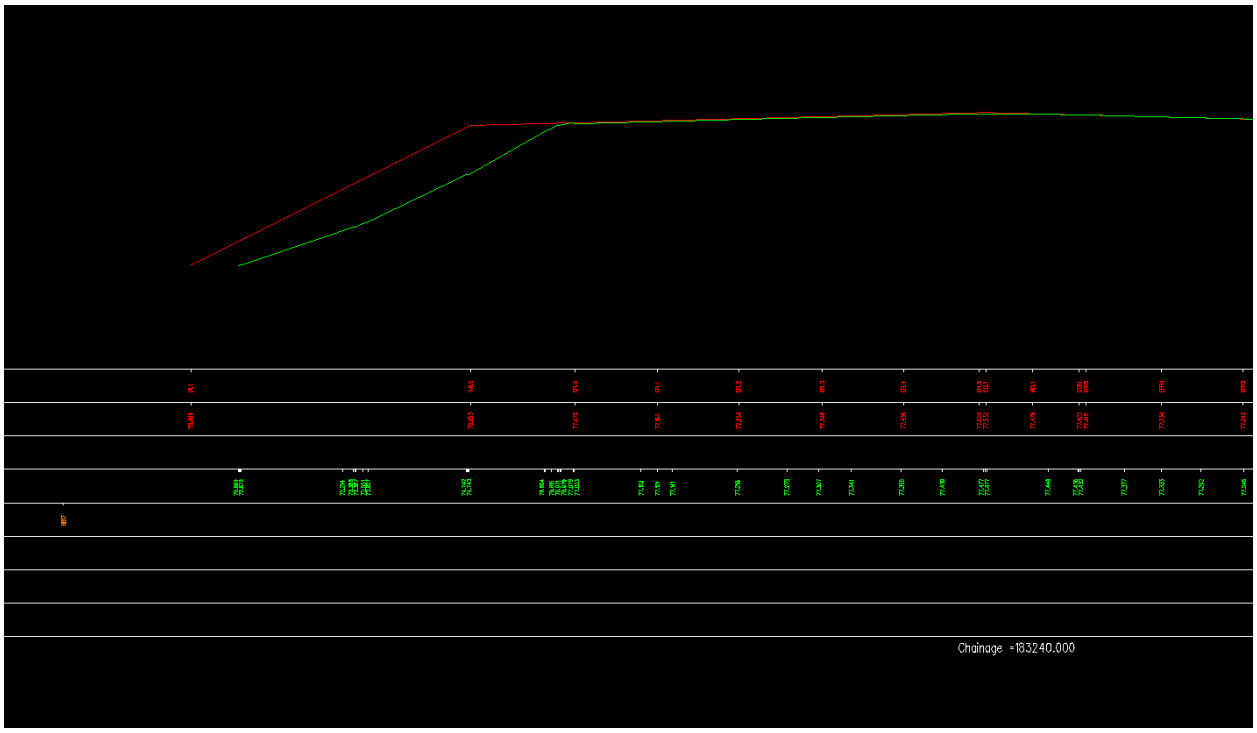


Figure 2.2: Topographic Cross Section Chainage 183240

Utilities:

A culvert is present between chainage 183220 and 183230.

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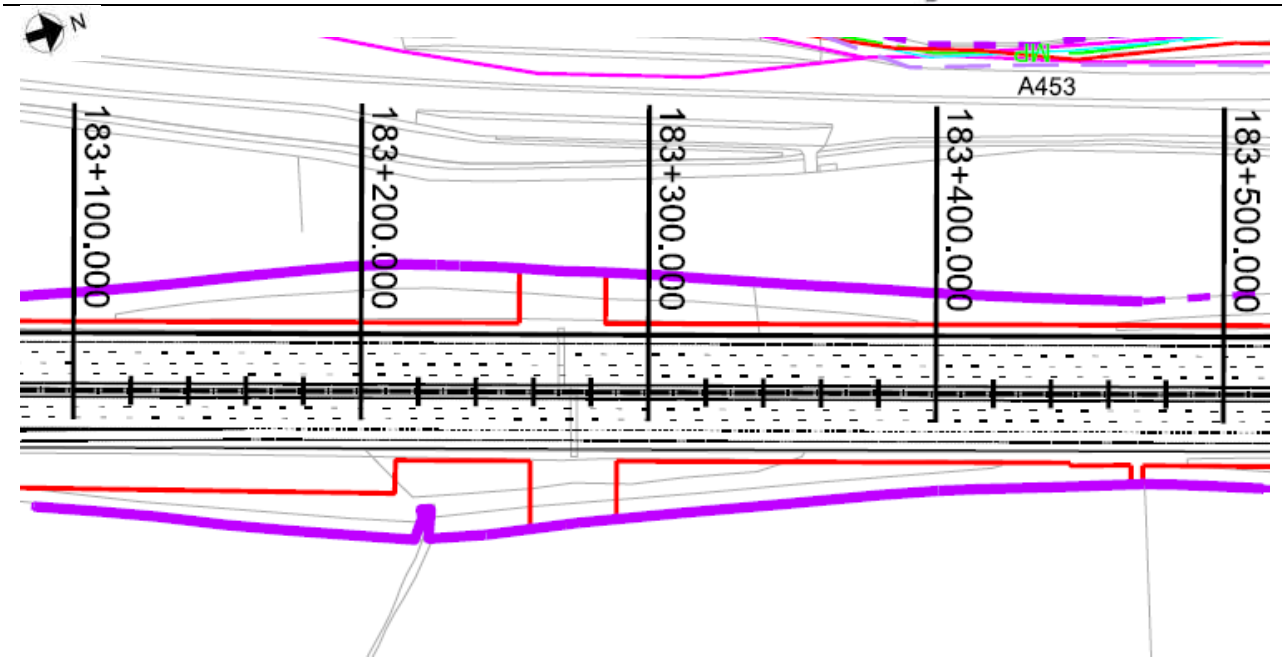


Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: N/A

Solid Deposits: Mudstone, Siltstone and Sandstone

Ground Investigation:

There are 2 No. historical exploratory holes recorded within the design chainage, with an additional no. relevant exploratory holes considered outside the design chaiange as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000020, Rev P01.



Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42NE69	SK42NE4
Borehole Chainage	183146	183206
Borehole Location	Southbound	Northbound
National Grid Reference	E 447155, N 325573	E 447140, N 325640
Ground Level at Exploratory Hole	77.21mAOD	69.30mAOD
RAG Analysis	Green	Amber
Date Drilled	25/01/1988	24/08/1961-28/08/1961
Termination Depth	7.45 metres below ground level (mbgl)	9.14 metres below ground level (mbgl)
Other suitable holes	CP1078	

Existing Ground Conditions

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Made Ground – Embankment Fill	6.40	71.05	17-29 (17)
Mercia Mudstone – III/IV	17.29	60.16	41-56 (50)

(1) Ground level is assumed to be at the carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory hole SK42NE69.

Groundwater:

Groundwater was encountered in borehole SK42NE4 at 4.42mbgl (64.88mAOD) and rose to 2.29mbgl (67.01mAOD).

Groundwater Design Level:

Due to limited local groundwater data available and a design groundwater level 1.0m below toe of embankment has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

5 No. Atterberg Limit Tests were undertaken within the Mercia Mudstone – III/IV in borehole SK42NE4 and CP1078 with the following results

Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
1.52	37	18	19	CI
3.05	34	23	11	CL
4.57	33	18	15	CL
6.10	30	16	14	CL
2.00	29	13	16	CL

3 No, Quick Undrained Triaxial Tests were undertaken in the Mercia Mudstone – III/IV, with the following results:

Depth (mbgl)	Undrained Shear Strength (kN/m^2)
1.52	34
4.57	176
6.1	283

Lab Test Data - BRE Classification:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Mercia Mudstone – III/IV	Water Soluble Sulphate as SO4	Water	1	0.04	g/l SO4
Mercia Mudstone – III/IV	pH	Solid	1	8.5	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outline the assumed anticipated ground model:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0.00 – 6.40	77.45 -71.05	6.4	21	27	0	100	7.8	6.2	-	0.5	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV (<10mbgl)	6.40 – 10.00	71.05 -67.45	3.6	21	30	2	150	10.8	8.6	-	0.5	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10mbgl)	>10.00	<67.45	-	21	30	2	325	16.8	13.4	-	0.5	0.50	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical borehole SK42NE4, SK42NE69 and Drawing No. HA549342-AMAR-HCT-SWI-DR-CE-000020.
(3) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) Geotechnical Parameters for Embankment Fill is based on values from the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.
(5) The ϕ' for Mercia Mudstone – III/IV 1-10m bgl is based on values from the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002 °.
(6) A conservative SPT N value of 50 has been used for the Mercia Mudstone III/IV, combined with an f1 value of 6.5 (PI of 15%). This gives a Cu of 267kN/m2. However, due to a limited number of SPT's, a conservative value of 150 kN/m2 has been adopted for design from the AMAR GIR.
(7) Eu for Mercia Mudstone – III/IV has been adopted from the derived values in the AMAR GIR due to limited test data in this stratum.
(8) Geotechnical Parameters for Mudstone>10mbgl is based on values from the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.
(9) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Embankment Fill and lack of reliable data for Mercia Mudstone – III/IV, the classification used for the strata in the AMAR GIR was adopted.

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Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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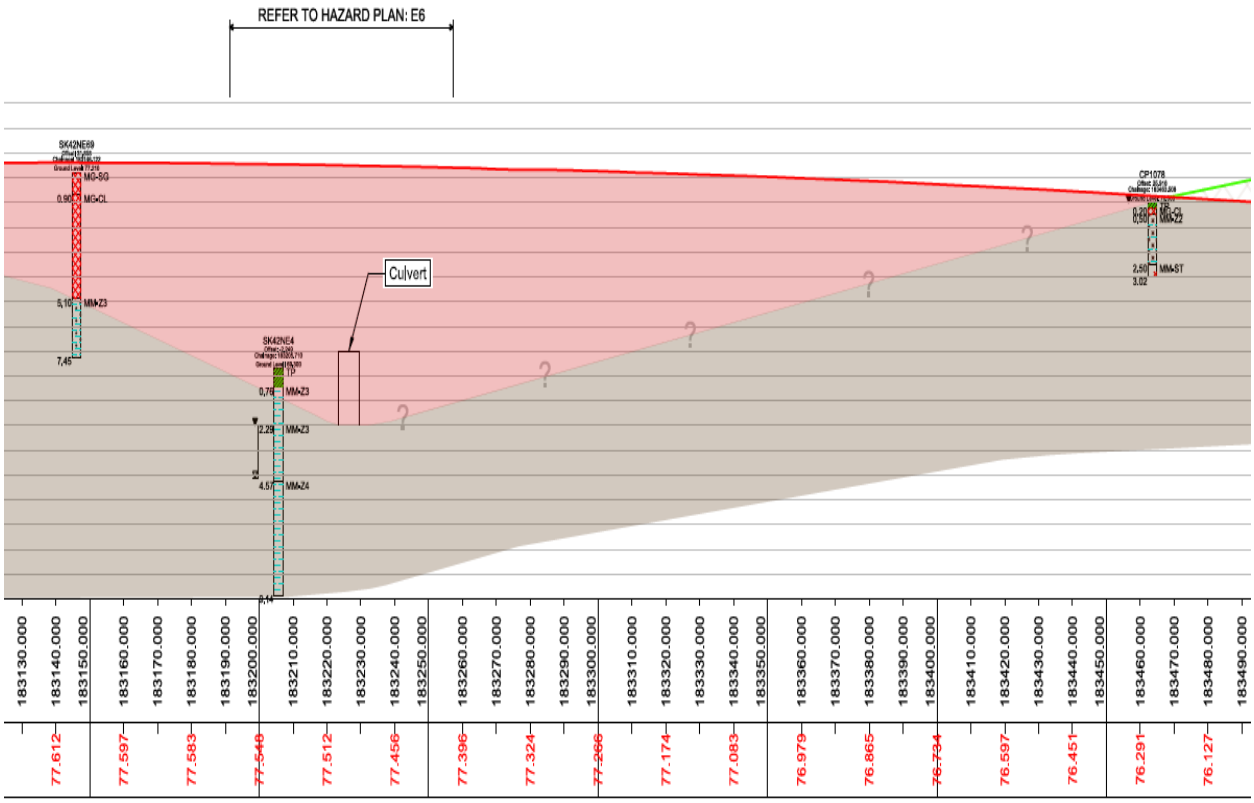


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
183080	183150	Granular Wedge at Embankment Crest (1:2.0)	4.0	26.6 (1V:2H)
183160	183400	Full Height Embankment Widening (1:2.0)	5.0	26.6 (1V:2H)

Proposed Structure Solution:

N/A

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Further Ground Investigation

No further GI is proposed at this location.

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HISTORICAL EXPLORATORY HOLES

amey

Borehole Log

Borehole No.
SK42NE69
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447155.00 - 325573.00	Hole Type CP
Location:		Level: 77.21mbgl	Scale 1:50
Client: Highways England		Dates: 25/01/1988 - 25/01/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 0.60	1B						Angular medium to coarse sandstone GRAVEL with some cobbles and a little to some clayey sand. (FILL) MG-SG
		0.85 - 1.30	2U	29blows		0.90	76.31		
		1.50	SPT (S)	N=17 (2,3/3,4,5,5)	Water=-				Very stiff locally stiff red brown silty CLAY with occasional mudstone and siltstone lithorelics and occasional pockets and lenses of light green grey silt and siltstone. Below 3.10m with occasional decayed rootlets and rare wood fragments. Below about 4.20m becoming very stiff (hard) dark brown to brown locally very silty locally with rounded fine to medium gravel and frequent decayed rootlets. (FILL) MG-CL
		1.50 - 1.95	3D						
		2.50 - 2.95	4U	44blows					
		3.10	5D						
		3.10	SPT (S)	N=18 (2,4/4,3,5,6)	Water=-				
		3.10 - 3.55	6D						
		4.00 - 4.45	7U	48blows					
		4.60	8D						
		4.60	SPT (S)	N=29 (2,3/5,6,7,11)	Water=-				
		4.60 - 5.05	9D			5.10	72.11		
		5.50 - 5.95	10U	59blows					Very stiff (hard) red brown slightly silty CLAY with frequent fine to medium gravel sized mudstone lithorelics and occasional pockets and lenses of light greenish grey silt (KEUPER MARL 3/4a) Below about 6.10m with very closely spaced subhorizontal fissures occasionally stained black. MM-Z3
		6.10	11D						
		6.10	SPT (S)	N=41 (4,11/14,8,8,11)	Water=-				
		6.10 - 6.55	12D						
		7.00	SPT (S)	N=56 (5,9/12,12,15,17)	Water=-				
		7.00 - 7.45	13D			7.45	69.76		End of borehole at 7.45m

Remarks
Hand dug inspection pit from ground level to 0.85m

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Borehole Log

Borehole No. **SK42NE4**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447140.00 - 325640.00	Hole Type CP
Location:		Level: 69.30mbgl	Scale 1:50
Client: Highways England		Dates: 24/08/1961 - 28/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									Topsoil TP
		0.76	353D			0.76	68.54		Firm brown clay & stones MM-Z3
		1.52 - 1.98	354U						
		1.98	355D						
	▼	2.29	356D			2.29	67.01		Stiff red & grey silty clay MM-Z3
		3.05	357D						
		3.05 - 3.51	358U						
		3.81	359D						
	▽	4.42	372 W						
		4.57	360D			4.57	64.73		Stiff red & grey silty clay & siltstone MM-Z4
		4.57 - 5.03	361U	37blows					
		5.03	362D						
		5.33	363D						
		6.10 - 6.55	364U	79blows					
		6.55	365D						
		6.86	366D						
		7.62 - 8.00	367U	100blows					
		8.08	368D						
		8.38	369D						
		8.69 - 9.14	370U	70blows					
		9.14	371D			9.14	60.16		End of borehole at 9.14 m

Remarks

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Borehole Log

Borehole No. **CP1078** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447243.00 - 325878.00	Hole Type CP
Location:		Level: 76.00mbgl	Scale 1:50
Client: Highways England		Dates: 25/10/2006 - 25/10/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.20	1B			0.20	75.80		TOPSOIL. TP
		0.50	2B			0.50	75.50		MADE GROUND: Stiff brown friable slightly sandy silt locally silt/clay with occasional gravel of fine to coarse subangular sandstone and siltstone. With rare subangular cobbles of flint. With rootlets. MG-CL
		1.50 - 1.95	3U	100blows					Stiff friable red brown occasionally grey green SILT, locally silt/clay. MM-Z2
		2.00	4D						
		2.50	5D			2.50	73.50		Weak grey green SILTSTONE recovered as medium to coarse subangular to angular gravel size fragments. MM-ST
		2.50	SPT (S)	50 (10 for 75mm/50 for 35mm)	Casing=2.50m Water=1.20m				
		2.50 - 3.00	6B			3.02	72.98		End of borehole at 3.02 m
		3.00	7D						
		3.00	SPT (S)	25 (25 for 10mm/25 for 10mm)	Casing=2.50m Water=1.60m				

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 2.00m.;The borehole was advanced by chiselling methods from 2.50m to 3.00m (1 hour).;No visual or olfactory indication of contamination was observed.;The borehole was backfilled on completion with grout.;

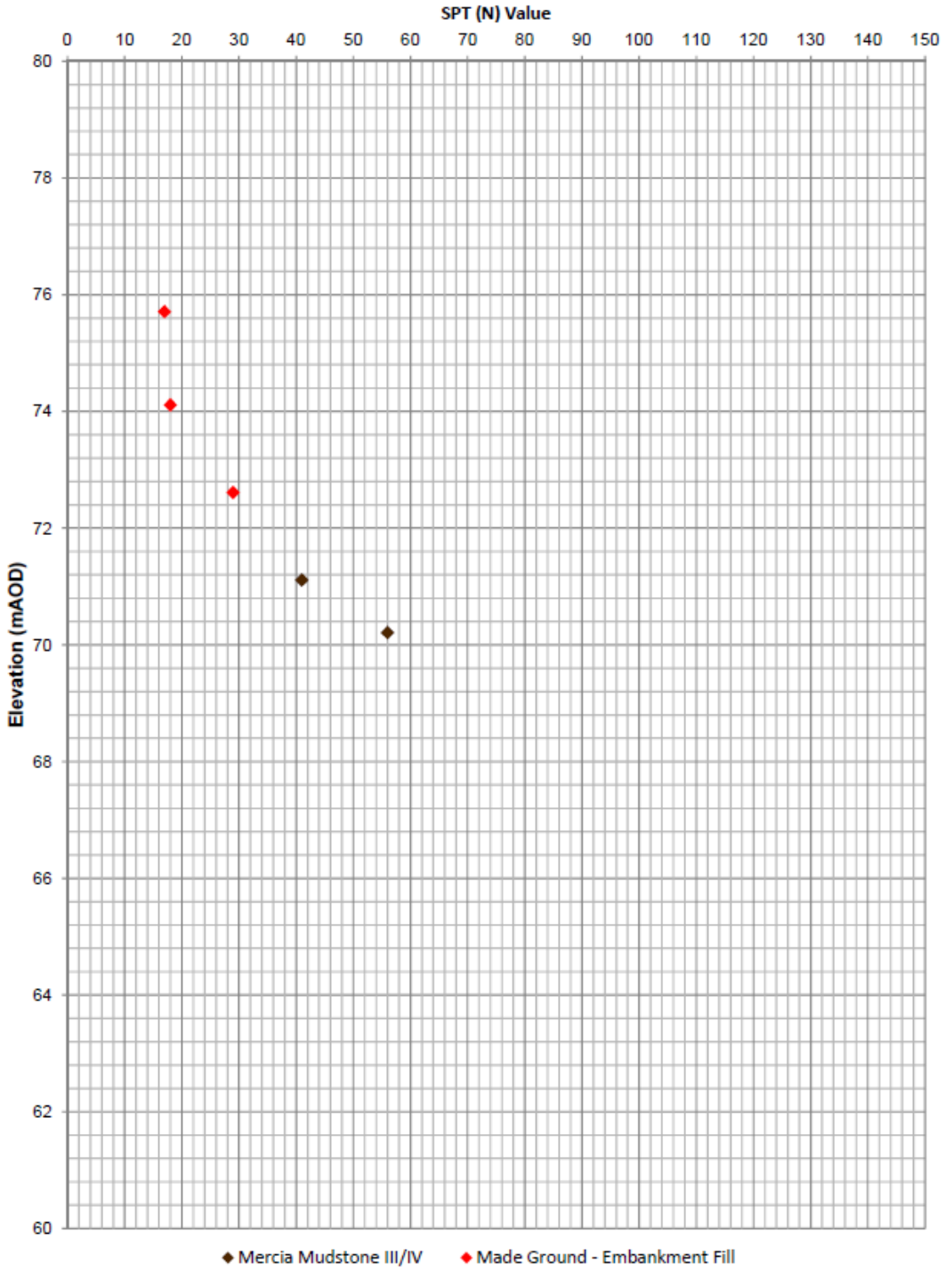
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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183080-183400**
Client: **Highways England**	Borehole ID: **SK42NE4, SK42NE69, CP1078**	

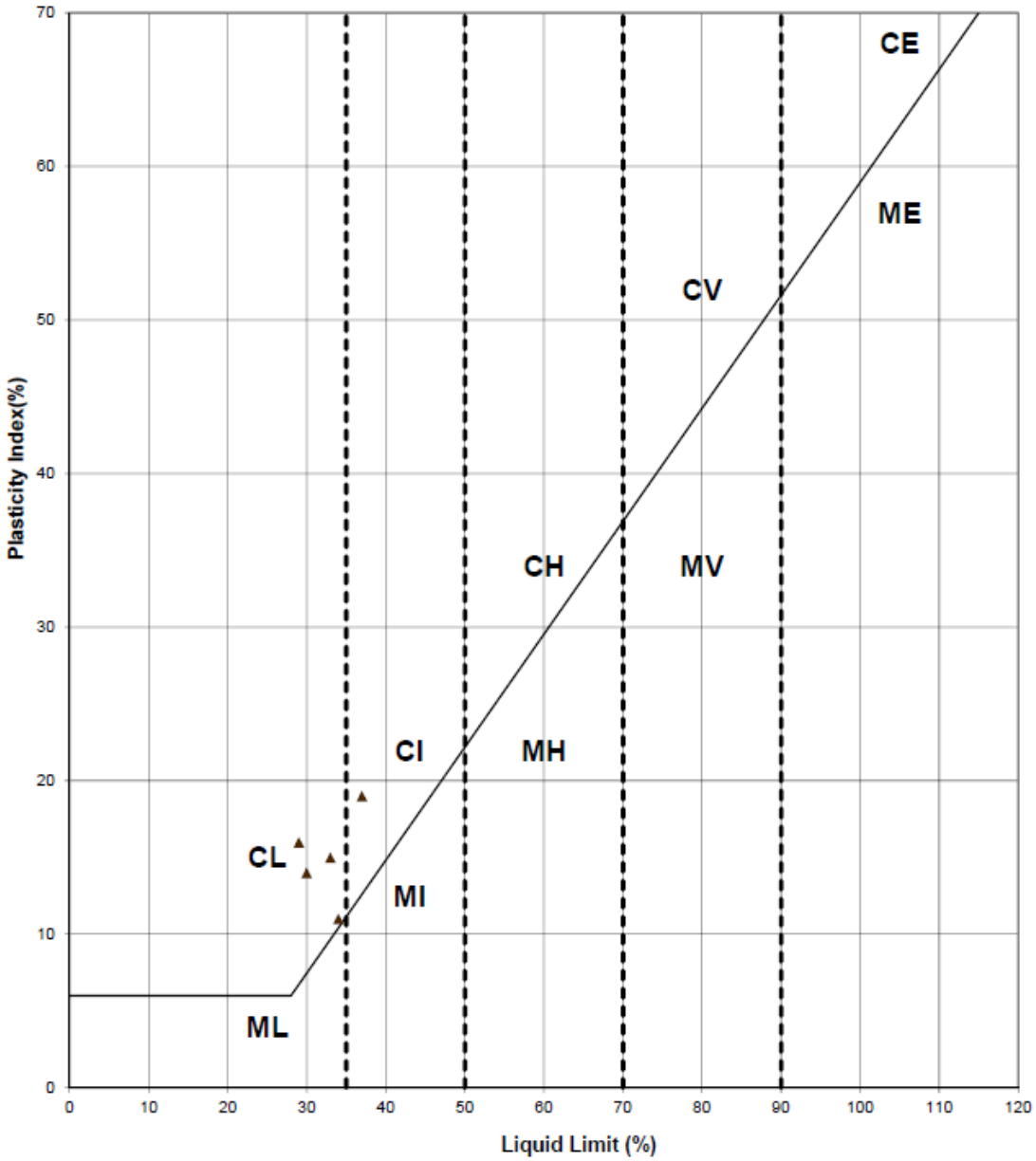


Extrapolated SPT (N) Values >150 have not been shown

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183080-183400**
Client: **Highways England**	Borehole ID: **SK42NE4, SK42NE69 and CP1086**	



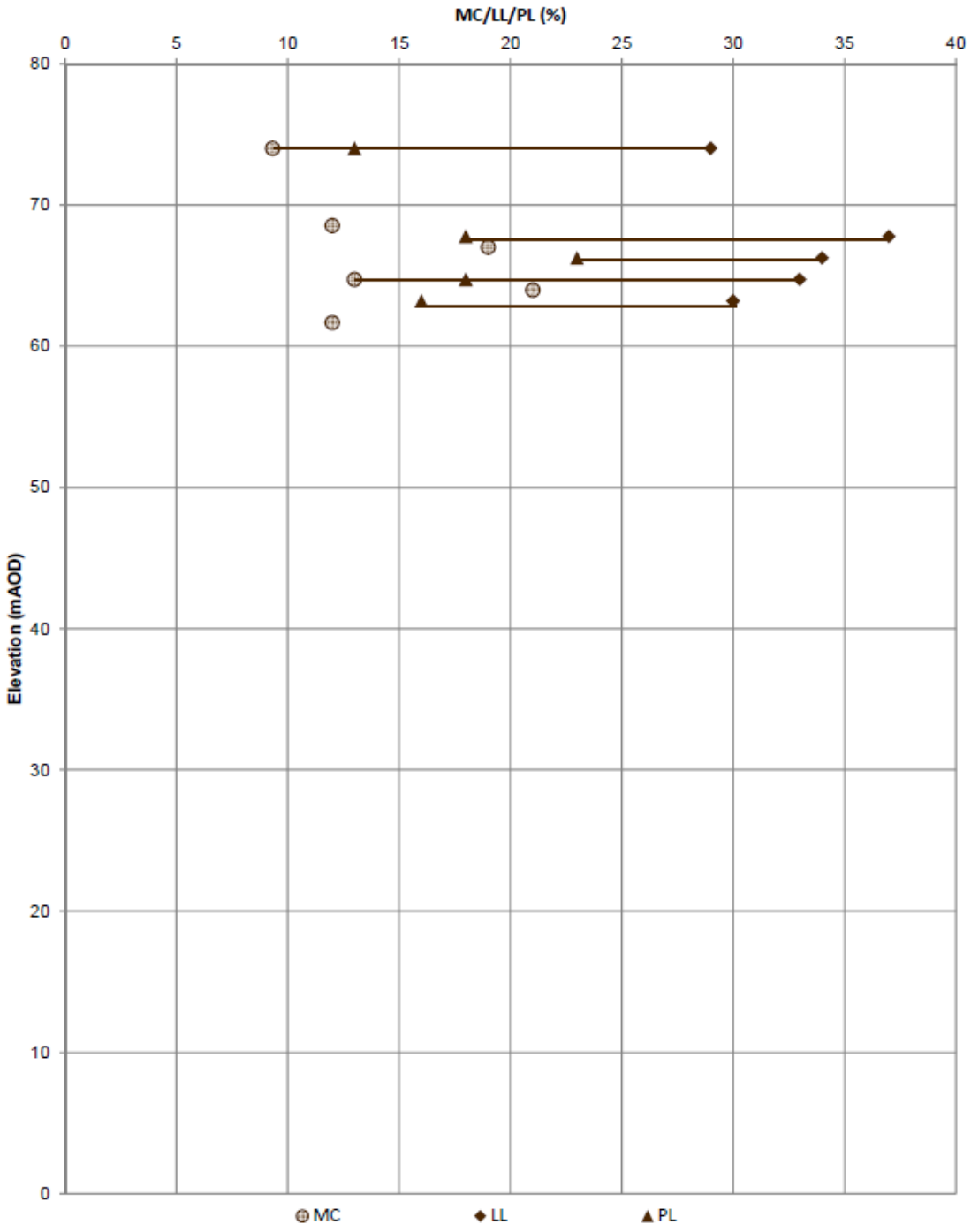
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

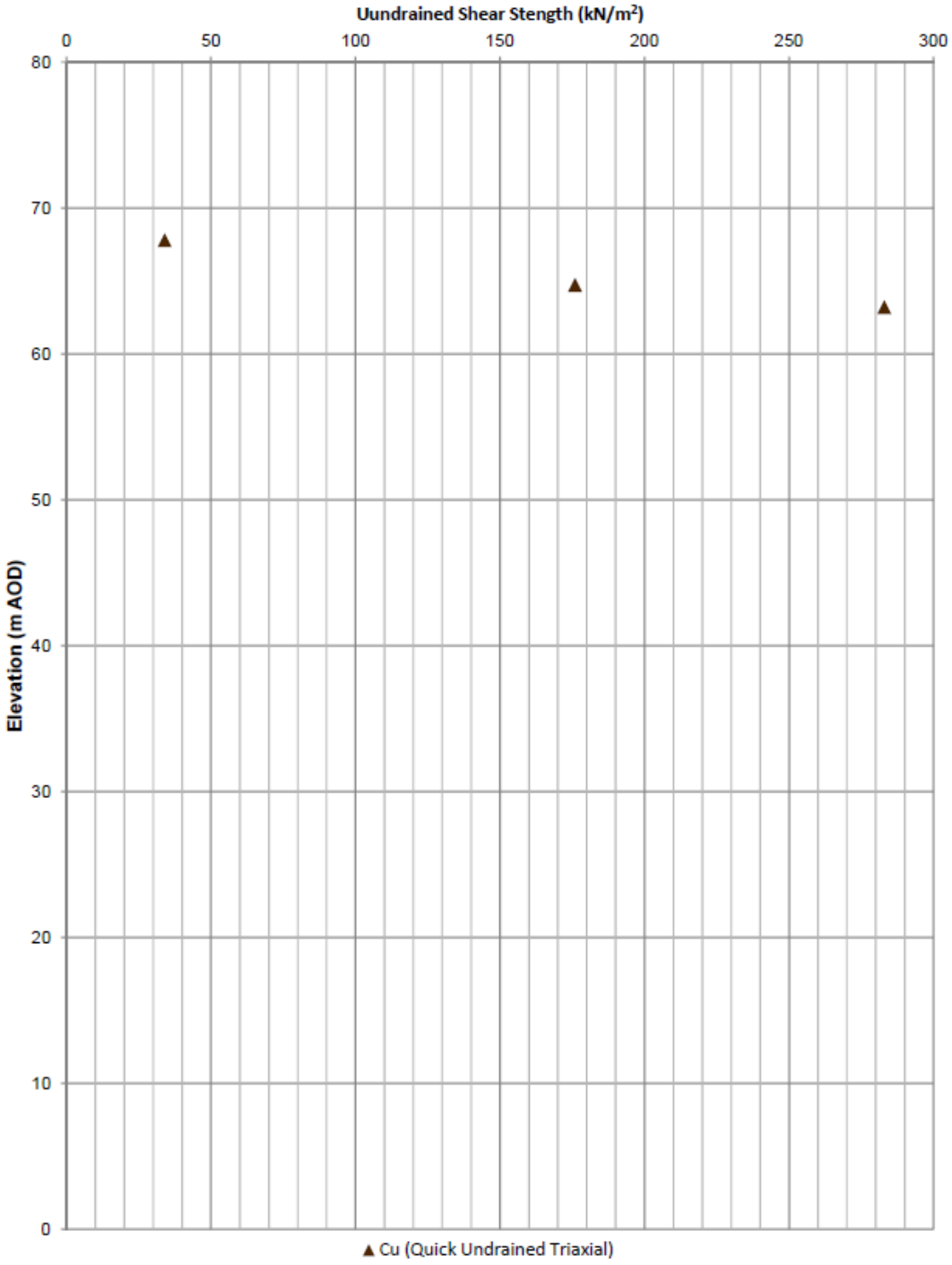
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183080-183400**
Client: **Highways England**	Borehole ID: **SK42NE4, SK42NE69, CP1078**	



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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183080-183400**
Client: **Highways England**	Borehole ID: **SK42NE4, SK42NE69, CP1078**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-183620-183780NB-GSS-000001		
Earthworks Widening Solution	1:3 Full Height Regrade, Gabion Wall		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	183620-183780		
Carriageway	Northbound		
Marker Post	MP183/6A +20 – MP183/7A +80		
National Grid Reference	E 447241 , N 326033 - E 447296 , N 326194		
Existing Ground Level at Location	Crest	81.54mAOD	
	Carriageway	71.64mAOD	
Earthwork Type	NB: Cutting	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_42052	SB: N/A	HAGDMS designation
Earthwork Height	NB: 11.1m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 23°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	25/04/2017	[redacted]
Checked	Alice Bazen	26/04/2017	
Reviewed	Gary Summerfield	27/04/2017	
Approved	Thomas Bulteel	09/05/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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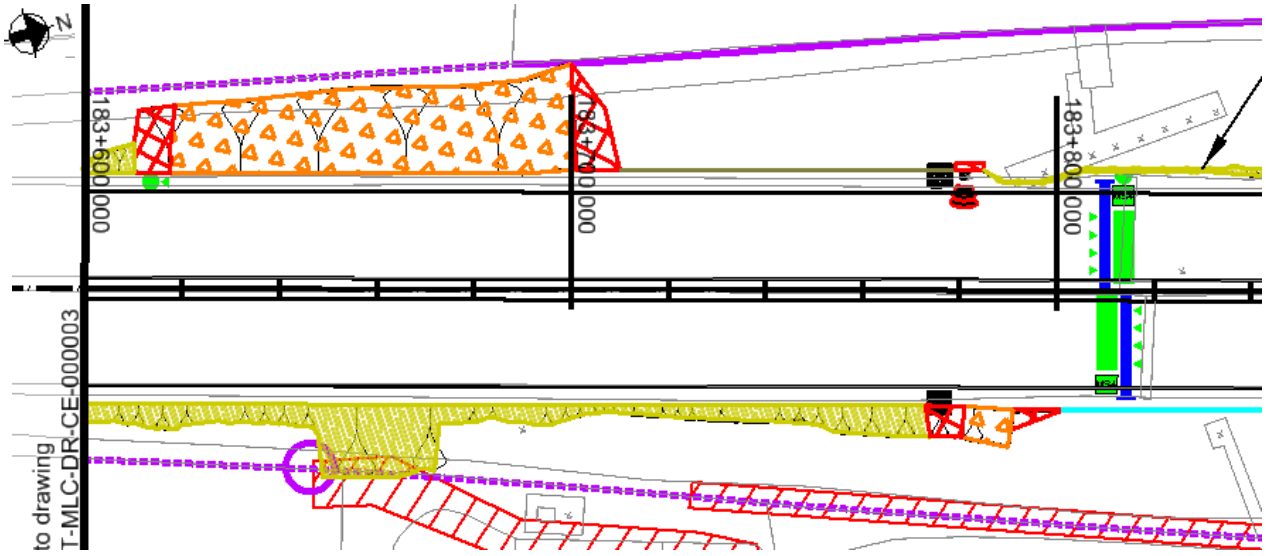


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch183620-182700 Full Height Regrade at 1:3
- Ch183210-108780 Gabion retaining wall

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a Cutting with heights ranging between 5m and 10m, with a typical slope angle of 23 degrees.

The critical cross section for the regrade solution was taken at ch.183700 and is based on the section with the greatest earthwork height.

The critical cross section for the gabion wall solution was taken at ch.183780 and is based on the section with the greatest retained height.

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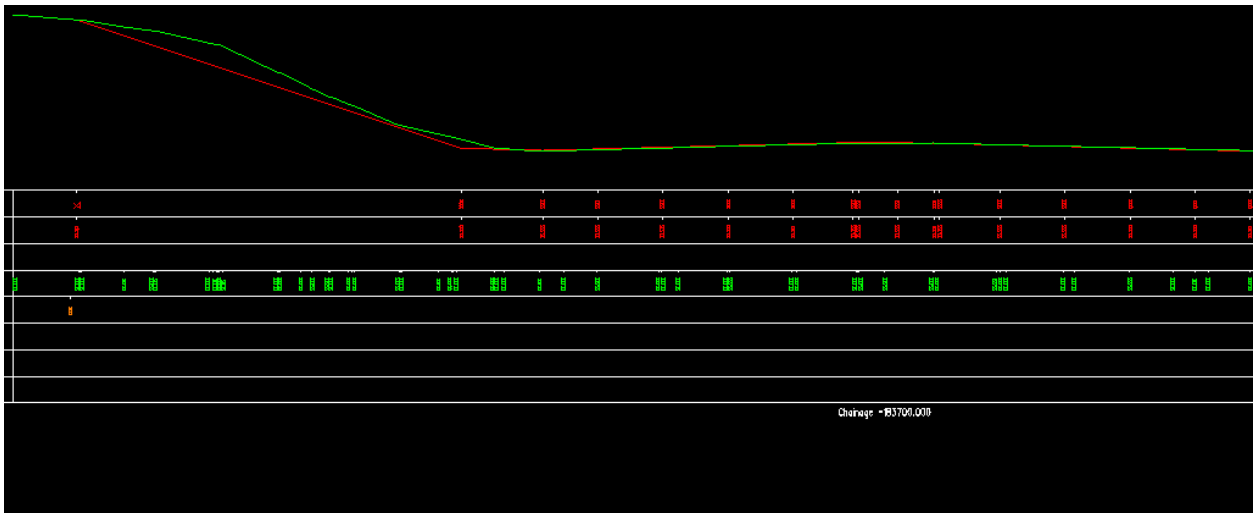


Figure 2.1: Topographic Cross Section Chainage 183700

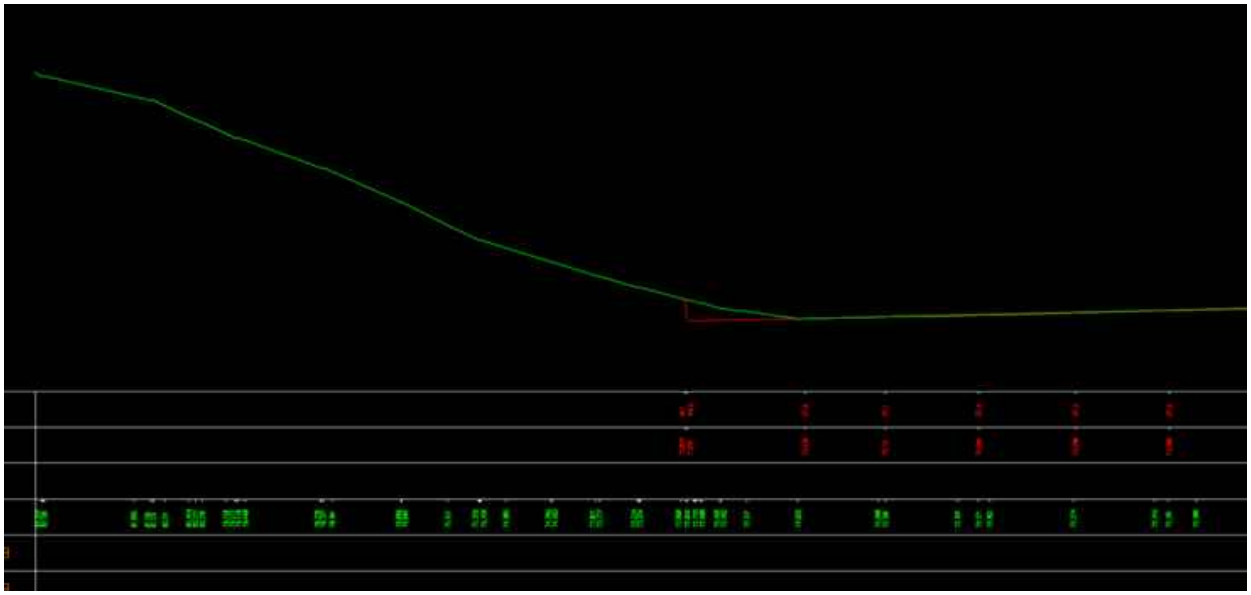


Figure 2.2: Topographic Cross Section Chainage 183780

Utilities:

No known utilities are located in within widening areas.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: None recorded.

Solid Deposits: Gunthorpe Member – Mudstone & Tarporley Siltstone Formation - Siltstone, Mudstone and Sandstone

Ground Investigation:

There are 10 No. historical exploratory holes recorded within the design chainage, with additional 3 no. relevant exploratory holes considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000023, Rev P01.



Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42NE6	SK42NE70	SK42NE5	RC1079
Borehole Chainage	183854	183722	183664	183679
Borehole Location	Northbound	Northbound	Northbound	Northbound
National Grid Reference	E 447330, N 326260	E 447292, N 326133	E 447270, N 326080	E 447240, N 326105
Ground Level at Exploratory Hole	82.30metres above Ordnance Datum (mAOD)	73.45mAOD	79.90mAOD	80.00mAOD
RAG Analysis	Amber	Green	Amber	Green
Date Drilled	18/08/1961-22/08/1961	01/02/1988-02/02/1988	22/08/1961-24/08/1961	25/10/2006
Termination Depth	15.24 metres below ground level (mbgl)	5.00 mbgl	9.14 mbgl	15.50 mbgl
Other suitable holes	RC1079,SK42NE5, SK42NE70, SK42NE58,SK42NE59/R, SK42NE60, SK42NE61/R, SK42NE62, SK42NE63/R, SK42NE64, SK42NE65/R. SK42NE66			

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Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR Survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Mercia Mudstone III/IV	15.24	67.06	12-150 (24)

(1) Ground level is assumed to be at the crest of the cutting.
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory hole SK42NE5, RC1079, SK42NE59/59R, SK42NE60, SK42NE61/61R, SK42NE62, SK42NE63/63R, SK42NE64, SK42NE65/65R, SK42NE66 and SK42NE70.

Groundwater:

Groundwater was encountered in a number of boreholes and is presented in the table below:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
SK42NE6	Mercia Mudstone – III/IV	4.57	77.73	-	-	-
SK42NE5	Mercia Mudstone – III/IV	3.05	76.85	-	2.29	77.61
SK42NE60	Mercia Mudstone – III/IV	6.30	67.70	-	-	-
SK42NE61	Mercia Mudstone – III/IV	2.50	77.10	-	2.00	77.60
RC1079	Mercia Mudstone – III/IV	0	80.00	-	-	-

Groundwater Design Level:

A design groundwater level of 1.0m below ground level throughout cutting has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

11 No. Atterberg Limit Tests and 11 No. Natural Moisture Content Tests were undertaken within the Mercia Mudstone III/IV in boreholes SK42NE5 and SK42NE6 with the following results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Classification
Mercia Mudstone – III/IV	0.76	14	-	-	-	-
Mercia Mudstone – III/IV	1.52	24	33	19	14	CL
Mercia Mudstone – III/IV	1.52	-	35	18	17	CI
Mercia Mudstone – III/IV	2.29	21	-	-	-	-
Mercia Mudstone – III/IV	3.81	14	-	-	-	-
Mercia Mudstone – III/IV	4.57	12	29	21	8	CL
Mercia Mudstone – III/IV	4.57	15	33	19	14	CL
Mercia Mudstone – III/IV	5.33	15	-	-	-	-
Mercia Mudstone – III/IV	6.10	15	32	18	14	CL
Mercia Mudstone – III/IV	6.10	-	31	18	13	CL
Mercia Mudstone – III/IV	6.86	20	-	-	-	-
Mercia Mudstone – III/IV	7.62		33	16	17	CL
Mercia Mudstone – III/IV	8.38	19	-	-	-	-
Mercia Mudstone – III/IV	8.84	-	32	17	15	CL
Mercia Mudstone – III/IV	9.14		33	19	14	CL
Mercia Mudstone – III/IV	9.91	19	-	-	-	-
Mercia Mudstone – III/IV	10.67	-	28	19	9	CL
Mercia Mudstone – III/IV	12.19	22	-	-	-	-

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Mercia Mudstone – III/IV	12.80	-	30	20	10	CL
Mercia Mudstone – III/IV	13.72	21	-	-	-	-
Mercia Mudstone – III/IV	14.48	20	-	-	-	-

9 No, Quick Undrained Triaxial Tests were undertaken in Borehole SK42NE5 and SK42NE6, with the following results:

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Mercia Mudstone – III/IV	6.10	269
Mercia Mudstone – III/IV	6.10	131
Mercia Mudstone – III/IV	4.57	214
Mercia Mudstone – III/IV	7.32	212
Mercia Mudstone – III/IV	10.67	376
Mercia Mudstone – III/IV	12.8	400
Mercia Mudstone – III/IV	1.52	45
Mercia Mudstone – III/IV	3.05	155
Mercia Mudstone – III/IV	6.10	317

Lab Test Data – BRE Classification:

1 No. pH test and 1 No. Sulphate test was completed in borehole SK42NE6 with the results presented in the table below:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Mercia Mudstone – III/IV	Water Soluble Sulphate as SO4	Water	1	0.00	g/l SO4
Mercia Mudstone – III/IV	pH	Water	1	7.20	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γ_b (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Mercia Mudstone – III/IV	0->10.00	71.67-<61.67	>10.00	21	30	2	156	9.0	7.2	-	0.5	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) The ϕ' for Mercia Mudstone –III/IV is based on values from the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002 °.
(4) A conservative SPT N value of 24 has been used for the Mercia Mudstone III/IV, combined with an f1 value of 6.5 (PI of 15%). This gives a Cu of 156kN/m^2.
(5) Eu for Mercia Mudstone – III/IV can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 24 gives Eu = 9.0MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 7.2MN/m^2.
(6) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of reliable BRE test data for Mercia Mudstone, the classification used for the strata in the AMAR GIR was adopted.

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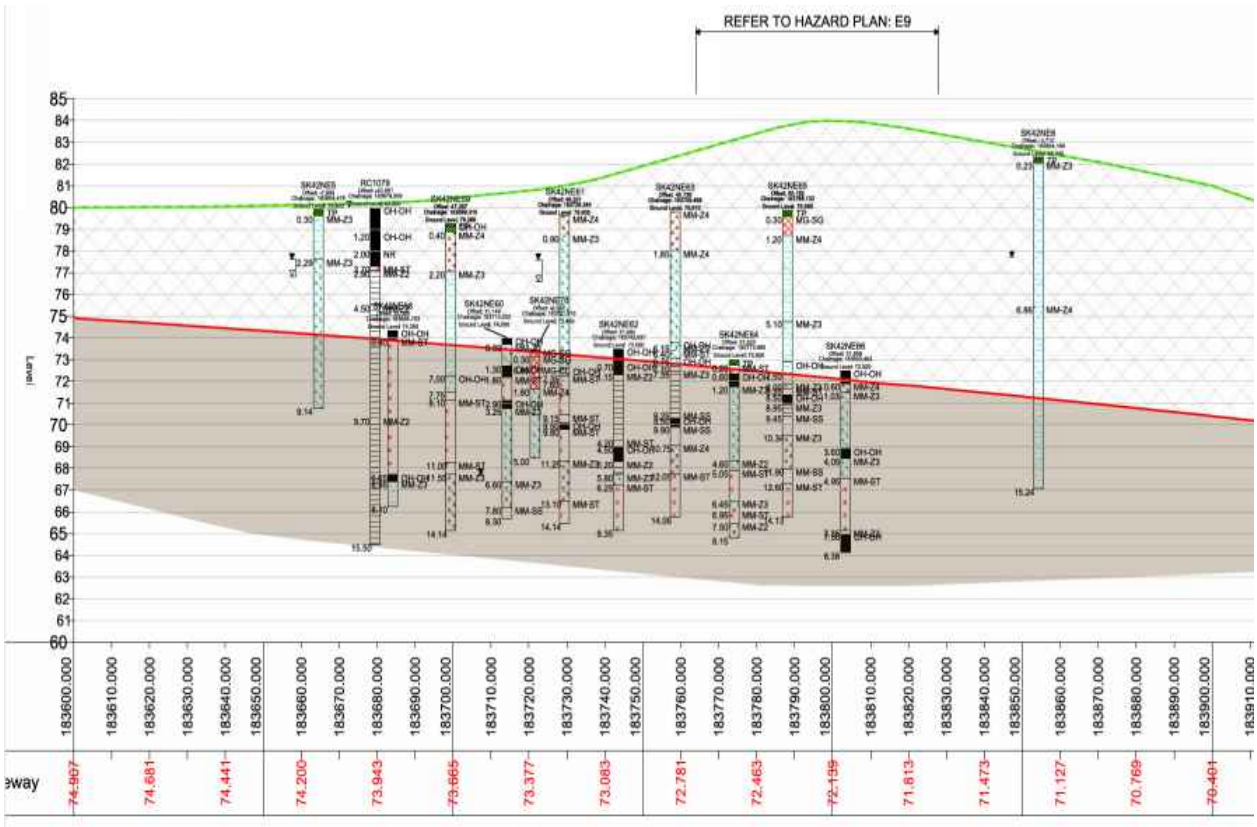


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
183620	183700	Full Height Regrade 1:3.0

Earthwork regrade was considered between 183710 and 183780, however due to this encroaching on to the highway boundary, this solution was not viable. A retaining wall is recommended as the earthwork widening solution between these chainages:

Start Chainage	End Chainage	Carriageway	Solution	Layers	Gabion Wall Dimensions			
					Width (m)	Length (m)	Height (m)	Benching Detail
183710	183780	Northbound	Gabion Wall	Lower	1.0	1.0	1.0	45^0
				Upper	0.5	0.5	0.5	

Proposed Structural Solution:

N/A

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FURTHER GROUND INVESTIGATION

No further GI is required at this location to confirm the ground conditions:

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HISTORICAL EXPLORATORY HOLES

Rotary Core Log

Borehole No. **RC1079** HISTORIC Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447240.00 - 326105.00	Hole Type RC
Location:		Level: 80.00mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 25/10/2006 - 25/10/2006	Logged By TL

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 1.20									Inspection Pit. OH-OH
								1.20	78.80		
		1.20 - 2.00									Open Hole. OH-OH
								2.00	78.00		
		2.00 - 3.50		53	0	0					No recovery. NR
								2.70	77.30		
								2.90	77.10		Recovered non-intact as moderately strong light grey brown subangular cobbles of SILTSTONE. MM-ST
		3.50	SPT(S)				N=54 (4,8/8,9,16,21)				Generally very weak variably very stiff clay to weak red brown locally mottled grey green calcareous MUDSTONE with occasional very thin beds of moderately weak to moderately strong grey green siltstone. Fractures: horizontal (where evident), extremely closely to closely spaced, planar to irregular; subvertical, locally very closely spaced, planar to irregular, occasional; others irregular, apparently random strike. MM-Z2
		3.50 - 5.00		100	0	0					
		4.40	1PL					4.50	75.50		
		5.00	SPT(S)				N=77 (6,10/10,21,19,27)				
		5.60	2PL								Very weak to weak red brown locally mottled grey to green calcareous MUDSTONE with occasional thin to medium beds of weak to moderately strong grey to green siltstone. Weathering: occasional black speckling and surface discolouration. Fractures: where evident horizontal, extremely closely to closely spaced, planar to irregular; subvertical, locally very closely spaced, planar and undulating to irregular. MM-Z2
		5.00 - 6.50		63	13	0					
		6.50	SPT(S)				N=67 (6,7/9,14,18,26)				
		6.50 - 8.00		95	61	9					*Between 5.00m to 5.50m; no recovery, possibly due to SPT.*
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
25/10/2006 08:00	0.00			
25/10/2006 18:00	15.50	13.97	1.95	

Backfill

Top	Base	Description
0.00	1.00	906
1.00	12.00	903
12.00	13.00	903
13.00	14.00	903
14.00	15.50	903

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks
0.00						

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447240.00 - 326105.00	Borehole No. **RC1079** HISTORIC Sheet 2 of 3
Location:		Level: 80.00mbgl Orientation: ° Inclination: 90°	Hole Type RC
Client: Highways England		Dates: 25/10/2006 - 25/10/2006	Scale 1:50
			Logged By TL

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		7.60	3PL								*Between 6.80m and 6.95m; moderately strong siltstone.*
		~~8.00~~	SPT(S)				N=78 (5,6/9,12,26,31)				
		8.00 - 9.50		87	43	15					*Between 8.40m and 9.00m; weak to moderately strong siltstone.*
		8.90	4PL								
		~~9.50~~	SPT(S)				N=57 (8,9/12,13,17,15)	9.70	70.30		*Between 9.30m and 9.70m; moderately weak to strong siltstone with very frequent small rounded vugs (up to 5mm).*
		9.50 - 11.00	5PL	83	74	31					Generally weak variably very weak to moderately weak red brown locally mottled grey green calcareous MUDSTONE with occasional thin beds of very weak to weak grey green siltstone. Fractures: horizontal, very closely to medium spaced, planar and undulating, very tight to open, subvertical, planar, tight to open, occasionally becoming irregular. MM-Z2
		~~11.00~~	SPT(S)				N=55 (9,11/11,15,13,16)				*MUDSTONE (as next sheet)*
		11.00 - 12.50		87	23	20					*Between 11.00m and 11.20m; no recovery, possibly due to SPT.*
		12.00	6PL								
		~~12.50~~	SPT(S)				50 (12,13/50 for 46mm)				
		12.50 - 14.00		91	85	51					
		13.80	7PL								
		~~14.00~~	SPT(S)				50 (9,16/50 for 37mm)				
		14.00 - 15.50		67	31	15					*Between 14.20m and 15.00m; fractures are generally subhorizontal to subvertical, very closely spaced, undulating to irregular.*
		14.60	8PL								
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
25/10/2006 08:00	0.00			
25/10/2006 18:00	15.50	13.97	1.95	

Backfill

Top	Base	Description
0.00	1.00	906
1.00	12.00	903
12.00	13.00	903
13.00	14.00	903
14.00	15.50	903

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks
0.00						

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447240.00 - 326105.00	Borehole No. **RC1079** HISTORIC Sheet 3 of 3
Location:		Level: 80.00mbgl Orientation: ° Inclination: 90°	Hole Type RC
Client: Highways England		Dates: 25/10/2006 - 25/10/2006	Scale 1:50
			Logged By TL

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
								15.50	64.50		End of borehole at 15.50 m

16 17 18 19 20 21 22

Shift Information

Date & Time	Depth	Water	Casing	Remarks
25/10/2006 08:00	0.00			
25/10/2006 18:00	15.50	13.97	1.95	

Backfill

Top	Base	Description
0.00	1.00	906
1.00	12.00	903
12.00	13.00	903
13.00	14.00	903
14.00	15.50	903

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks
0.00						

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **SK42NE5**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447270.00 - 326080.00	Hole Type CP
Location:		Level: 79.90mbgl	Scale 1:50
Client: Highways England		Dates: 22/08/1961 - 24/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.30	79.60		Topsoil TP Hard red clay and siltstone MM-Z3
		0.76	2249 D						
		1.52 - 1.98	2250 U						
	▼	2.29	2251 D			2.29	77.61		Stiff red & grey silty clay and siltstone MM-Z3
		2.29	2260 AW						
	▽	3.05	2252 D						
		3.81	2253 D						
		4.57 - 5.03	2254 U	86blows					
		5.33	2255 D						
		6.10 - 6.55	2256 U	103blows					
		7.32 - 7.62	2257 U	216blows					
		7.62	2258 D						
		8.38	2259 D						
		8.84 - 9.14	2260 U	210blows					
						9.14	70.76		End of borehole at 9.14 m

Remarks

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Borehole Log

Borehole No. **SK42NE6** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447330.00 - 326260.00	Hole Type CP
Location:		Level: 82.30mbgl	Scale 1:50
Client: Highways England		Dates: 18/08/1961 - 22/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.23	82.07		Topsoil TP
		0.76	533D						Firm to stiff red & grey silty clay MM-Z3
		1.52 - 1.98	534U						
		2.29	535D						
		3.05 - 3.51	536U						
		3.35	537D						
		3.81	538D						
	▼	4.57	539D						
		4.57	555A W						
		4.57 - 4.88	540B						
		5.33	541D						
		6.10 - 6.48	542U	125blows					
		6.86	543D			6.86	75.44		Stiff red silty clay and siltstone MM-Z4
		7.62 - 7.92	544U	229blows					
		7.92	545D						
		8.38	546D						
		9.14 - 9.32	547U	140blows					
		9.91	548D						
									Continued on next sheet

Remarks

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Borehole Log

Borehole No. **SK42NE70** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447292.00 - 326133.00	Hole Type CP
Location:		Level: 73.45mbgl	Scale 1:50
Client: Highways England		Dates: 01/02/1988 - 02/02/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.30	73.15		FILL (Foreman's description) MG-SG
		0.50 - 0.70	1B						Angular to subangular medium to coarse and cobbles sized fragments of light grey green locally red brown slightly fine sandy SILTSTONE moderately strong to strong. (FILL) MG-SG
		1.00	SPT (S)	N=34 (5,9/7,5,8,14)	Water=-	0.80	72.65		
		1.00 - 1.45	2D						Very stiff red brown and dark brown mottled CLAY with occasional decayed plant matter and rare angular medium gravel. (FILL) MG-CL
		2.00	SPT (S)	N=71 (6,8/8,12,22,29)	Water=-	1.80	71.65		Stiff becoming very still (hard) red brown locally very silty CLAY with occasional fine gravel sized lithorelics and locally with occasional pockets and lenses of light grey green silt and siltstone. (KEUPER MARL) From 4.00mm to 4.60m dense light grey green SILT with occasional fine gravel sized lithorelics. Below about 4.80m becoming light grey green probably moderately weathered SILTSTONE weak to very weak. MM-Z4
		2.00 - 2.45	3D						
		3.00	SPT (S)	N=47 (3,9/12,11,6,18)	Water=-				
		3.00 - 3.45	4D						
		4.00	SPT (S)	94 (7,14/94 for 225mm)	Water=-				
		4.00 - 4.38	5D						
		4.70	SPT (S)	54 (13,24/54 for 75mm)	Water=-				
		4.70 - 5.00	6D			5.00	68.45		End of borehole at 5.00 m

Remarks
Hand dug inspection pit from ground level to 1.00m

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447314.00 - 326087.00	Borehole No. **SK42NE58** HISTORIC Sheet 1 of 2
Location:		Level: 74.35mbgl Orientation: ° Inclination: 90°	Hole Type RC
Client: Highways England		Dates: 28/01/1988 - 29/01/1988	Scale 1:50
			Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											Inspection pit dug to 0.40m OH-OH
								0.40	73.95		
		0.40 - 1.50		95	82	64					Red brown slightly to moderately weathered locally very clayey SILTSTONE weak to very weak with frequent pockets and lenses of light grey green silt and siltstone. Closely spaced sub- horizontal often tight fractures with occasional black speckled staining (KEUPER MARL 2) From 0.55m to 0.65m, 2.00m to 2.20m and From 3.20m to 3.40m completely weathered altered to a dense clayey silt with occasional lithorelics From 2.70m to 3.00m very thinly interbedded with light grey green slightly fine sandy SILTSTONE strong MM-ST
		1.50	SPT(3)				N=30 (11,10/8,7,7,8)				
		1.50 - 3.00		77	60	56					*very stiff red brown CLAY*
											assessed zone of core loss
											assessed zone of core loss
		3.00 - 4.20		83	67	58					
											assessed zone of core loss
											stiff becoming very stiff very silty clay
											light green grey siltstone band very weak
		4.20 - 6.65		95	93	80					*light green grey locally mottled red brown and grey green siltstone weak to very weak*
											light grey green siltstone strong with lenses of red brown mudstone
								6.65	67.70		Assessed zone of core loss OH-OH
		6.65 - 8.00		78	59	54		6.95	67.40		Very stiff (hard) in parts firm to stiff red brown CLAY locally very silty with occasional bands of highly weathered
											Continued on next sheet

Shift Information					Backfill			Chiselling				Depth Related Remarks		
Date & Time	Depth	Water	Casing	Remarks	Top	Base	Description	Top	Base	Duration	Tool	Top	Base	Remarks
28/01/1988 18:00 29/01/1988 08:30	3.00 3.00							7.10	7.60					

Water Strike							Discontinuities				
Struck	Rose to	Date	Time	Sealed	Casing	Remarks	Top	Base	Strength	Seepage	Water Flow

Remarks

Hand dug inspection pit from ground level to 0.40m

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Rotary Core Log

Borehole No. **SK42NE58** HISTORIC
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447314.00 - 326087.00	Hole Type RC
Location:		Level: 74.35mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 28/01/1988 - 29/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.00	SPT(S)				0 (18,50/0 for 0mm)	8.10	66.25		siltstone weak: occasional pockets of light grey green silt (weathered MUDSTONE) (KEUPER MARL 3) MM-Z3 non intact End of borehole at 8.10 m

8 9 10 11 12 13 14 15

Shift Information

Date & Time	Depth	Water	Casing	Remarks
28/01/1988 18:00	3.00			
29/01/1988 08:30	3.00			

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool
7.10	7.60		

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks
Hand dug inspection pit from ground level to 0.40m

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Borehole Log

Borehole No. **SK42NE59** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447333.00 - 326097.00	Hole Type CP
Location:		Level: 79.26mbgl	Scale 1:50
Client: Highways England		Dates: 02/02/1988 - 02/02/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	1D			0.40	78.86		Light brown and dark brown mottled locally very clayey slightly fine sandy SILT with rare sub-rounded fine to medium gravel and occasional plant roots (TOPSOIL) TP
		0.50 - 0.95	2U	52blows					
		1.00	3D						Dense light grey green in parts mottled red brown fine sandy SILT locally with occasional fine to medium gravel sized lithorelics (KM 4a) MM-Z4
		1.00 - 1.45	4D						*band of light green grey sandy siltstone moderately weak*
		2.00 - 2.45	5U	100blows		2.20	77.06		Very stiff (hard) red brown very silty CLAY with frequent becoming occasional fine to medium gravel sized mudstone lithorelics and occasional pockets and lenses of light greenish grey silt (KEUPER MARL 3/4a) MM-Z3
		2.50	6D						*band of light greenish grey fine sandy siltstone strong*
		2.50 - 2.95	7D						
		3.50 - 3.95	8U	140blows					
		4.00	9D						*light greenish grey and reddish brown mottled fine sandy silt with rare fine gravel sized lithorelics*
		4.00 - 4.45	10D						
		5.00 - 5.45	11D						
		6.00	SPT (S)	85 (15,21/85 for 125mm)	Water=-				
		6.00 - 6.28	12D						
		7.00	SPT (S)	90 (21,33/90 for 120mm)	Water=-				
		7.00 - 7.27	13D						
		7.60	SPT (S)	0 (72 for 105mm/0 for 0mm)	Water=-	7.75	71.51		End of borehole at 7.75 m
		7.60 - 7.71	14D						

Remarks

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447333.00 - 326097.00	Borehole No. SK42NE59R HISTORIC Sheet 1 of 2
Location:		Level: 79.26mbgl Orientation: ° Inclination: 90°	Hole Type CP+RC
Client: Highways England		Dates: 04/02/1988 - 05/02/1988	Scale 1:50
			Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											Cable Tool Boring to 7.75m OH-OH
		~~7.00~~	SPT(S)				122 (6,14/122 for 225mm)	7.00	72.26		Assessed zone of core loss OH-OH
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
04/02/1988 18:00	7.00		7.00	
05/02/1988 08:00	7.00		7.00	
05/02/1988 17:30	14.00	11.70	9.40	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush, using 6.75in rock bit from ground level to 7.00m

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Rotary Core Log

Borehole No. **SK42NE59R** HISTORIC Sheet 2 of 2			
Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447333.00 - 326097.00	Hole Type CP+RC
Location:		Level: 79.26mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 04/02/1988 - 05/02/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		7.00 - 8.40		21	6	0		8.10	71.16		Red brown moderately weathered SILTSTONE weak to moderately weak with closely spaced sub-horizontal fractures with black speckled staining thinly interbedded with very stiff red brown silty CLAY with frequent fine to medium gravel sized lithorelics (weathered MUDSTONE). Occasional bands of light grey green fine sandy siltstone and silt (KEUPER MARL 2/3)
		8.40 - 9.40		70	60	60					MM-ST
		9.40	SPT(S)				N=114 (15,17/28,32,28,26)				*non intact*
		9.40 - 11.40		85	63	15					*assessed zone of core loss*
											sub-vertical joint with speckled black stain disturbed by SPT
											non intact due to 2 intersecting sub-vertical joints with speckled black stain
											non intact due to 2 intersecting sub-vertical joints with speckled black stain
								11.00	68.26		Red brown slightly weathered SILTSTONE moderately weak with closely spaced sub-horizontal fractures (KM 2)
		11.40	SPT(S)				0 (50 for 60mm/0 for 0mm)	11.55	67.71		MM-ST
		11.40 - 14.00		98	69	54					*assessed zone of core loss*
											Dense red brown clayey SILT with occasional fine becoming medium to coarse gravel sized lithorelics and occasional pockets and lenses of light grey green silt and siltstone thinly interbedded with red brown locally reddish green moderately weathered SILTSTONE very weak with extremely closely spaced fractures with black speckled staining (KEUPER MARL 2/3)
											MM-Z3
											non intact
											non intact
		14.00	SPT(S)				0 (82 for 135mm/0 for 0mm)	14.14	65.12		*light grey green slightly fine sandy siltstone moderately weak*
											End of borehole at 14.14 m

Shift Information

Date & Time	Depth	Water	Casing	Remarks
04/02/1988 18:00	7.00		7.00	
05/02/1988 08:00	7.00		7.00	
05/02/1988 17:30	14.00	11.70	9.40	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush, using 6.75in rock bit from ground level to 7.00m

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Rotary Core Log

Borehole No. **SK42NE60** HISTORIC
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447322.00 - 326116.00	Hole Type RC
Location:		Level: 74.00mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 26/01/1988 - 26/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											Hand dug inspection pit to 0.30m OH-OH
								0.30	73.70		Stiff red brown friable very silty CLAY with fine to medium occasionally coarse gravel sized lithorelics (weathered MUDSTONE). Occasional pockets and bands of light grey green silt and siltstone (KEUPER MARL 3) MM-Z3
		1.30	SPT(S)				52 (9,30/52 for 75mm)	1.30	72.70		*assessed zone of core loss*
											Assessed zone of core loss OH-OH
								1.80	72.20		Red brown slightly moderately weathered SILTSTONE moderately weak to moderately strong. Closely locally very closely spaced sub-horizontal fractures with speckled black stain (KM 2) MM-ST
		2.90	SPT(S)				77 (9,11/77 for 150mm)	2.90	71.10		*highly to completely weathered; medium to coarse lithorelics in a silt matrix*
								3.25	70.75		*highly to completely weathered; medium to coarse lithorelics in a silt matrix*
											Assessed zone of core loss OH-OH
		4.45	SPT(S)				75 (10,10/75 for 150mm)				Very stiff (hard) red brown very silty CLAY with occasional fine gravel sized lithorelics and locally with occasional pockets of light grey green silt (weathered MUDSTONE) (KEUPER MARL 2/3) MM-Z3
											occasional bands of moderately weathered SILTSTONE weak to very weak
											light grey green fine sandy SILT with frequent medium to coarse gravel sized lithorelics
											with bands of light grey green and red brown siltstone moderately weak
	▼	6.30	SPT(S)				83 (11,17/83 for 150mm)				*assessed zone of core loss*
								6.60	67.40		Dense becoming (hard) red brown clayey SILT with occasional fine to medium gravel sized lithorelics (completely weathered SILTSTONE) (KM 4a)
											70 fissure with speckled black stain
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks
6.30		26-01-1988	12:00		4.45	

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks
Hand dug inspection pit from ground level to 0.30m

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447322.00 - 326116.00	Borehole No. **SK42NE60** HISTORIC Sheet 2 of 2
Location:		Level: 74.00mbgl Orientation: ° Inclination: 90°	Hole Type RC
Client: Highways England		Dates: 26/01/1988 - 26/01/1988	Scale 1:50
			Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											MM-Z3
		8.00	SPT(S)				94 (10,16/94 for 150mm)	7.80	66.20		Light grey brown moderately weathered very silty fine grained SANDSTONE weak to very weak (KEUPER SANDSTONE 2) MM-SS
								8.30	65.70		End of borehole at 8.30 m

8 9 10 11 12 13 14 15

Shift Information

Date & Time	Depth	Water	Casing	Remarks

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks
6.30		26-01-1988	12:00		4.45	

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Hand dug inspection pit from ground level to 0.30m

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Borehole Log

Borehole No. **SK42NE61** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447341.00 - 326126.00	Hole Type CP
Location:		Level: 79.60mbgl	Scale 1:50
Client: Highways England		Dates: 01/02/1988 - 01/02/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	1D						Light grey brown becoming brown slightly fine sandy locally very clayey SILT with occasional medium gravel sized lithorelics. (KEUPER MARL 4a) MM-Z4
		0.50 - 0.95	2U	54blows					
						0.90	78.70		
		1.00	3D						Stiff to very stiff red brown very silty CLAY with occasional fine to medium gravel sized lithorelics. Locally with pockets and lenses of light greenish grey silt and sandstone. (KEUPER MARL 3/4a) Below 3.70m, becoming stiff (hard) with occasional fine gravel sized lithorelics. Locally with very closely spaced fissures with speckled black staining. MM-Z3
		1.00	SPT (S)	N=24 (2,3/3,5,7,9)	Water=-				
		1.00 - 1.45	4D						
	▼	2.00 - 2.45	5U	72blows					
		2.50	6D						*dense light greenish grey slightly fine sandy SILT with occasional medium gravel sized lithorelics.*
		2.50	SPT (S)	N=58 (7,8/12,14,17,15)	Water=-				
	▽	2.50 - 2.95	7D						*dense becoming very dense (hard) light green grey locally mottled red brown slightly fine sandy SILT with occasional lithorelics.*
		3.10	8W						
		3.50 - 3.95	9U	131blows					
		4.00	10D						
		4.00	SPT (S)	N=92 (9,14/16,19,27,30)	Water=-				
		4.00 - 4.45	11D						
		5.00	SPT (S)	N=129 (10,22/28,30,31,40)	Water=-				
		5.00 - 5.45	12D						
		6.00	SPT (S)	N=109 (9,18/21,24,29,35)	Water=-				
		6.00 - 6.45	13D						
		7.00	SPT (S)	50 (15,27/50 for 50mm)	Water=-				
		7.00 - 7.21	14D						
		7.40	SPT (S)	50 (21,36/50 for 33mm)	Water=-				
		7.40 - 7.58	15D			7.60	72.00		End of borehole at 7.60 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE61R** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447341.00 - 326126.00	Hole Type CP+RC
Location:		Level: 79.60mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 08/02/1988 - 09/02/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		7.00	SPT(S)				N=124 (5,10/18,36,30,40)	7.35	72.25		Assessed zone of core loss OH-OH
											Continued on next sheet

1 2 3 4 5 6 7

Shift Information

Date & Time	Depth	Water	Casing	Remarks
08/02/1988 18:00	7.00		7.00	
09/02/1988 08:00	7.00		7.00	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush, using 6.75in rock bit from ground level to 7.00m

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Rotary Core Log

Borehole No. **SK42NE61R** HISTORIC Sheet 2 of 2		
Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447341.00 - 326126.00
Hole Type CP+RC		
Location:	Level: 79.60mbgl	Orientation: ° Inclination: 90°
Scale 1:50		
Client: Highways England	Dates: 08/02/1988 - 09/02/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		7.00 - 8.50		63	37	27					Red brown moderately weathered SILTSTONE moderately weak with occasional bands of very dense red brown silt with up to coarse gravel sized lithorelics. Closely locally very closely spaced fractures with black speckled staining. (KEUPER MARL 2/3) MM-ST
		~~8.50~~	SPT(S)				81 (10,22/81 for 150mm)				*non intact*
		8.50 - 9.50		70	50	29					*assessed zone of core loss*
								9.15	70.45		Light grey green moderately weathered slightly fine sandy SILTSTONE very weak. (KEUPER MARL 2) MM-ST
		~~9.50~~	SPT(S)				N=94 (10,18/18,18,28,30)	9.50	70.10		*altered to a friable silt with frequent lithorelics*
								9.80	69.80		Assessed zone of core loss OH-OH
		9.50 - 11.50		85	45	34					Red brown moderately locally highly weathered SILTSTONE weak to very weak locally altered to a dense silt with medium to coarse gravel sized lithorelics. (KEUPER MARL 2/3) MM-ST
											non intact
								11.25	68.35		*non intact*
		~~11.50~~	SPT(S)				N=105 (14,13/22,26,27,30)				*greenish grey and red brown mottled slightly weathered weak to moderately weak*
											Very dense red brown clayey SILT (Weathered SILTSTONE) (KEUPER MARL 4a/b) Below 12.40m, locally with fine to coarse gravel sized lithorelics. MM-Z3
		11.50 - 14.00		88	80	28					*assessed zone of core loss*
								13.10	66.50		*band of light grey green silt with frequent lithorelics.*
											Red brown slightly to moderately weathered SILTSTONE weak to very weak with occasional bands of very stiff (hard) clay. Closely spaced subhorizontal fractures. (KEUPER MARL 3/4a) MM-ST
		~~14.00~~	SPT(S)				0 (83 for 135mm/0 for 0mm)	14.14	65.46		*subvertical joint tight with black stain*
											End of borehole at 14.14 m

Shift Information					Backfill			Chiselling				Depth Related Remarks		
Date & Time	Depth	Water	Casing	Remarks	Top	Base	Description	Top	Base	Duration	Tool	Top	Base	Remarks
08/02/1988 18:00	7.00		7.00											
09/02/1988 08:00	7.00		7.00											

Water Strike							Discontinuities				
Struck	Rose to	Date	Time	Sealed	Casing	Remarks	Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush, using 6.75in rock bit from ground level to 7.00m

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Rotary Core Log

Borehole No. **SK42NE62** HISTORIC Sheet 1 of 2			
Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447331.00 - 326144.00	Hole Type RC
Location:		Level: 73.50mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 28/01/1988 - 28/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											Inspection pit dug to 0.70m. OH-OH
								0.70	72.80		Assessed zone of core loss OH-OH
		0.70 - 1.50		44	31	0		1.15	72.35		Red brown slightly locally slightly to moderately weathered MUDSTONE weak with occasional lenses of siltstone interbedded with light greenish grey slightly fine sandy SILTSTONE moderately weak to moderately strong beds up to 120mm thick. Closely spaced subhorizontal fractures. (KEUPER MARL 2) MM-Z2
		~~1.50~~	~~SPT(S)~~				50 (13,28/50 for 75mm)				*assessed zone of core loss* *very stiff (hard) friable clay with mudstone lithorelics.*
		1.50 - 3.00		33	20	15					*non intact*
		~~3.00~~	~~SPT(S)~~				89 (3,5/89 for 225mm)				*70 deg joint*
		3.00 - 4.50		97	90	60		4.20	69.30		Red brown slightly weathered SILTSTONE strong with occasional light grey green siltstone pockets or lenses, (KEUPER MARL 2) MM-ST
								4.50	69.00		Assessed zone of core loss OH-OH
								5.20	68.30		Red brown slightly to moderately weathered locally silty MUDSTONE weak to moderately weak with occasional pockets of light grey silt. (KEUPER MARL) MM-Z2
		4.50 - 7.00		72	34	25		5.80	67.70		*non intact*
								6.25	67.25		Firm to stiff becoming very stiff red brown very silty CLAY with frequent lithorelics. (Weathered MUDSTONE) (KEUPER MARL 3) MM-Z3
											Red brown moderately weathered SILTSTONE moderately strong with occasional pockets and lenses of
											Continued on next sheet

Shift Information					Backfill			Chiselling				Depth Related Remarks		
Date & Time	Depth	Water	Casing	Remarks	Top	Base	Description	Top	Base	Duration	Tool	Top	Base	Remarks

Water Strike							Discontinuities				
Struck	Rose to	Date	Time	Sealed	Casing	Remarks	Top	Base	Strength	Seepage	Water Flow

Remarks
Inspection pit pit dug to 0.70m

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447331.00 - 326144.00	Borehole No. **SK42NE62** HISTORIC Sheet 2 of 2
Location:		Level: 73.50mbgl Orientation: ° Inclination: 90°	Hole Type RC
Client: Highways England		Dates: 28/01/1988 - 28/01/1988	Scale 1:50
			Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		7.00 - 8.00		90	75	63					mudstone: closely to very closely spaced subhorizontal fractures. (KEUPER MARL 2) MM-ST
		8.00 - 8.20 8.20	SPT(S)	100	0	0	0 (28,50/0 for 0mm)	8.35	65.15		*subvertical joint* *light greenish grey slightly fine sandy siltstone very weak (non intact)* *subvertical joint* *very dense silt with frequent lithorelics* *subvertical joint.* End of borehole at 8.35 m

Shift Information					Backfill			Chiselling				Depth Related Remarks		
Date & Time	Depth	Water	Casing	Remarks	Top	Base	Description	Top	Base	Duration	Tool	Top	Base	Remarks

Water Strike							Discontinuities				
Struck	Rose to	Date	Time	Sealed	Casing	Remarks	Top	Base	Strength	Seepage	Water Flow

Remarks
Inspection pit pit dug to 0.70m

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Borehole Log

Borehole No. **SK42NE63**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447349.00 - 326154.00	Hole Type CP
Location:		Level: 79.81mbgl	Scale 1:50
Client: Highways England		Dates: 29/01/1988 - 29/01/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.20	1D						Dense mottled red brown and light greenish brown locally red brown slightly fine sandy locally very clayey SILT with occasional fine to medium gravel sized siltstone lithorelics. (KEUPER MARL 4a) MM-Z4
		0.50 - 0.95	2U	60blows					
		1.00	3D						
		1.00	SPT (S)	N=19 (2,2/3,4,6,6)	Water=-				
		1.00 - 1.45	4D						
		1.80	5D			1.80	78.01		
		1.90 - 2.35	6U	55blows					Stiff becoming very stiff (hard) red brown very silty CLAY with occasional pockets and lenses of light greenish grey silt. (KEUPER MARL) Below 2.40m, with fine to medium gravel sized silty mudstone lithorelics. Locally with very closely spaced fissures occasionally with speckled black staining. MM-Z4
		2.40	7D						
		2.40	SPT (S)	N=15 (3,5/4,4,3,4)	Water=-				
		2.40 - 2.95	8D						
		3.40 - 3.85	9U	75blows					*dense mottled red brown and grey green locally very clayey SILT with rare lithorelics.*
		3.90	10D						
		3.90	SPT (S)	N=45 (5,7/7,10,12,16)	Water=-				
		3.90 - 4.35	11D						
		4.90 - 5.25	12U	150blows					
		5.30	13D						
		5.30	SPT (S)	N=85 (9,12/17,19,23,26)	Water=-				*red brown locally green grey probably moderately weathered SILTSTONE band weak to very weak.*
		5.30 - 5.75	14D						
		6.30	SPT (S)	86 (12,24/86 for 125mm)	Water=-				
		6.30 - 6.58	15D						
		6.90	SPT (S)	0 (71 for 116mm/0 for 0mm)	Water=-				
		6.90 - 7.02	16D			7.10	72.71		End of borehole at 7.10 m

Remarks

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447349.00 - 326154.00	Borehole No. SK42NE63R HISTORIC Sheet 1 of 2
Location:		Level: 79.81mbgl Orientation: ° Inclination: 90°	Hole Type CP+RC
Client: Highways England		Dates: 10/02/1988 - 11/02/1988	Scale 1:50
			Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		~~6.00~~	SPT(S)				78 (10,19/78 for 150mm)	6.15	73.66		Assessed zone of core loss OH-OH
								6.40	73.41		Very stiff (hard) red brown very silty CLAY with occasional fine gravel sized lithorelics. (KEUPER MARL 3/4b) MM-Z3
		6.00 - 7.50		60	23	0		6.75	73.06		Red brown and light greenish grey slightly to moderately weathered SILTSTONE moderately weak.
								7.35	72.46		Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
10/02/1988 17:30	12.30	10.80	6.70	
11/02/1988 08:30	12.30	9.80	6.70	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush, using 6.75in rock bit from ground level to 6.00m

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Rotary Core Log

Borehole No. **SK42NE64** HISTORIC Sheet 1 of 2			
Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447340.00 - 326173.00	Hole Type RC
Location:		Level: 72.95mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 25/01/1988 - 26/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
								0.20	72.75		TOPSOIL TP
								0.60	72.35		Red brown moderately weathered SILTSTONE moderately weak to moderately strong with frequent black staining. (KEUPER MARL) MM-ST
		0.60 - 1.50		33	9	0					
								1.20	71.75		Assessed zone of core loss OH-OH
		1.50	SPT(3)				N=58 (7,8/14,12,13,19)				Very stiff (hard) red brown very silty CLAY with medium gravel sized mudstone lithorelics. (Weathered MUDSTONE. Frequent pockets and lenses of light greenish grey silt and siltstone. (KEUPER MARL 3) Below 2.50m, with medium to coarse gravel sized lithorelics. Locally with subvertical fissures with speckled black staining. MM-Z3
		1.50 - 2.80		77	46	11					
		2.80	SPT(3)				87 (4,7/87 for 150mm)				*assessed zone of core loss* *disturbed by SPT* *light greenish grey slightly fine sandy siltstone strong* *reddish brown moderately weathered siltstone band*
		2.80 - 4.60		83	65	47					
		4.60	SPT(3)				N=59 (8,12/12,13,15,19)	4.60	68.35		Stiff to very stiff red brown very silty CLAY. (Weathered MUDSTONE) (KEUPER MARL 4b) MM-Z2
								5.05	67.90		*disturbed by SPT*
		4.60 - 6.45		100	100	75					Greenish brown slightly to moderately weathered sandy SILTSTONE weak becoming moderately weak with very closely spaced fractures with black speckled staining. (KEUPER MARL 2) At 5.75m, becoming red brown with occasional reduction spots. MM-ST
								6.45	66.50		
		6.45 - 8.00		87	87	23		6.95	66.00		Very stiff red brown very clayey SILT locally with up to coarse gravel sized lithorelics. (Weathered SILTSTONE) (KEUPER MARL 3/4a) MM-Z3
								7.50	65.45		*assessed zone of core loss*
											Continued on next sheet

Shift Information					Backfill			Chiselling				Depth Related Remarks		
Date & Time	Depth	Water	Casing	Remarks	Top	Base	Description	Top	Base	Duration	Tool	Top	Base	Remarks
26/01/1988 08:00	1.50													

Water Strike							Discontinuities				
Struck	Rose to	Date	Time	Sealed	Casing	Remarks	Top	Base	Strength	Seepage	Water Flow

Remarks
Hand dug inspection pit from ground level to 0.60m

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447340.00 - 326173.00	Borehole No. **SK42NE64** HISTORIC Sheet 2 of 2
Location:		Level: 72.95mbgl Orientation: ° Inclination: 90°	Hole Type RC
Client: Highways England		Dates: 25/01/1988 - 26/01/1988	Scale 1:50
			Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.00	SPT(S)				0 (21,50/0 for 0mm)	8.15	64.80		Red brown slightly to moderately weathered sandy SILTSTONE moderately weak. (KEUPER MARL 2) MM-ST
											Very stiff (hard) red brown clayey SILT locally with closely spaced subhorizontal fissures. (Weathered SILTSTONE) (KEUPER MARL 3) MM-Z2
											End of borehole at 8.15 m

8 9 10 11 12 13 14 15

Shift Information

Date & Time	Depth	Water	Casing	Remarks
25/01/1988 08:00	1.50			

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Hand dug inspection pit from ground level to 0.60m

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Borehole Log

Borehole No. **SK42NE65**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447362.00 - 326181.00	Hole Type CP
Location:		Level: 79.88mbgl	Scale 1:50
Client: Highways England		Dates: 22/01/1988 - 23/01/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.00	79.88		TOPSOIL TP
		0.30	1D			0.30	79.58		Angular medium to coarse gravel sized fragments of greenish grey slightly weathered silty fine grained SANDSTONE moderately strong to strong with red brown clay smearing. (Possibly MADE GROUND) MG-SG
		0.50	SPT (S)	N=24 (3,4/4,6,7,7)	Water=-				
		0.50 - 0.95	2D						
		1.20	3D			1.20	78.68		Stiff becoming very stiff (hard) red brown silty CLAY with occasional pockets and lenses of light greenish grey silt and siltstone. Locally with very closely spaced fissures with speckled black staining. (KEUPER MARL 3/4a) Below 1.80m with fine to coarse gravel sized lithorelics. From 2.80m to 3.30m; Light grey green fine sandy SILT with medium to coarse gravel sized lithorelics and occasional bands and lenses of very stiff red brown silty clay. At 4.60m; Grey green SILTSTONE band moderately weak to moderately strong. MM-Z4
		1.30 - 1.75	4U	61blows					
		1.80	5D						
		1.80	SPT (S)	N=12 (2,3/2,2,4,4)	Water=-				
		1.80 - 2.25	6D						
		2.80 - 3.25	7U	94blows					
		3.30	8D						
		3.30	SPT (S)	N=56 (5,6/9,10,14,23)	Water=-				
		3.30 - 3.75	9D						
		4.30 - 4.60	10U	150blows					
		4.65	11D						
		4.65	SPT (S)	N=58 (5,5/7,11,19,21)	Water=-				
		4.65 - 5.10	12D			5.10	74.78		Very stiff (hard) red brown silty CLAY with frequent medium to coarse gravel sized silty mudstone lithorelics and occasional pockets and lenses of light greenish grey silt and siltstone. (KEUPER MARL 3) By 6.60m becoming moderately weathered MUDSTONE very weak MM-Z3
		5.10	13W						
		5.60	SPT (S)	N=77 (5,7/14,15,21,27)	Water=-				
		5.60 - 6.05	14D						
		6.60	SPT (S)	50 (14,23/50 for 50mm)	Water=-				
		6.60 - 6.80	15D						
		7.20	SPT (S)	0 (67 for 109mm/0 for 0mm)	Water=-				
		7.20 - 7.31	16D			7.50	72.38		End of borehole at 7.50 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE65R** HISTORIC Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447362.00 - 326181.00	Hole Type CP+RC
Location:		Level: 79.88mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 11/02/1988 - 12/02/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		7.00	SPT(S)				N=88 (7,14/18,16,24,30)				Assessed zone of core loss OH-OH
											Continued on next sheet

1 2 3 4 5 6 7

Shift Information

Date & Time	Depth	Water	Casing	Remarks
11/02/1988 17:30	8.50		7.00	End of shift
12/02/1988 08:30	8.50		7.00	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush, using 6.75in rock bit from ground level to 7.00m

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Rotary Core Log

Borehole No. **SK42NE65R** HISTORIC Sheet 2 of 3			
Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447362.00 - 326181.00	Hole Type CP+RC
Location:		Level: 79.88mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 11/02/1988 - 12/02/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		7.00 - 8.50		33	30	13		8.00	71.88		
								8.20	71.68		Very stiff (hard) red brown very silty CLAY with occasional fine gravel sized lithorelics. (Weathered MUDSTONE) (KEUPER MARL 3/4a) MM-Z3
								8.50	71.38		
		8.50 - 9.80		65	28	8		8.95	70.93		Red brown slightly to moderately weathered SILTSTONE weak to moderately weak. (KEUPER MARL 2) MM-ST
								9.45	70.43		Assessed zone of core loss OH-OH
		~~9.80~~	SPT(S)				81 (6,21/81 for 150mm)				Red brown moderately to highly weathered silty MUDSTONE locally altered to a very stiff silty clay with coarse gravel sized lithorelics. (KEUPER MARL 2/3) MM-Z3
		9.80 - 11.50		82	68	8		10.34	69.54		Light greenish brown locally red brown slightly to moderately weathered very silty fine SANDSTONE. (KEUPER MARL) From 9.80m to 10.10m stiff red brown silty CLAY with frequent fine to medium gravel sized lithorelics. MM-SS *assessed core loss*
		~~11.50~~	SPT(S)				50 (15,18/50 for 75mm)				
								11.90	67.98		Very dense (hard) red brown clayey SILT with occasional fine gravel sized lithorelics. (Weathered SILTSTONE) (KEUPER MARL 3) From 10.60m to 11.60m with coarse gravel sized lithorelics. Below 11.60m becoming slightly fine sandy. MM-Z3 *assessed zone of core loss*
		11.50 - 14.00		96	86	52		12.60	67.28		Light reddish green slightly to moderately weathered very silty fine SANDSTONE weak closely spaced subhorizontal fractures. (KEUPER MARL 2/3) MM-SS *irregular 70 deg joint* *subvertical joint*
		~~14.00~~	SPT(S)				0 (88 for 125mm/0 for 0mm)	14.13	65.75		Red brown slightly to moderately weathered SILTSTONE weak to moderately weak with moderately widely becoming widely spaced subhorizontal fractures. (KEUPER
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
11/02/1988 17:30	8.50		7.00	End of shift
12/02/1988 08:30	8.50		7.00	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush, using 6.75in rock bit from ground level to 7.00m

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Rotary Core Log

Borehole No. **SK42NE65R** HISTORIC
Sheet 3 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447362.00 - 326181.00	Hole Type CP+RC
Location:		Level: 79.88mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 11/02/1988 - 12/02/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											MARL 2) MM-ST stiff red brown very silty CLAY End of borehole at 14.13 m

16 17 18 19 20 21 22

Shift Information

Date & Time	Depth	Water	Casing	Remarks
11/02/1988 17:30	8.50		7.00	End of shift
12/02/1988 08:30	8.50		7.00	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks
Open hole drilling, air flush, using 6.75in rock bit from ground level to 7.00m

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Rotary Core Log

Borehole No. **SK42NE66** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447349.00 - 326201.00	Hole Type RC
Location:		Level: 72.50mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 27/01/1988 - 27/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											Inspection pit OH-OH
								0.60	71.90		Dense light greenish grey locally friable SILT with occasional lithorelics. (KEUPER MARL 4a) MM-Z4
		0.60 - 2.10		100	93	72		1.03	71.47		Very stiff (hard) red brown locally very silty CLAY with occasional bands and lenses of light greenish grey and red brown siltstone very weak. (KEUPER MARL 3/4a) MM-Z3
		~~2.10~~	SPT(S)				50 (9,18/50 for 75mm)				*assessed zone of core loss*
		2.10 - 3.60		87	77	59					*disturbed by SPT*
		~~3.60~~	~~SPT(S)~~				50 (8,21/50 for 75mm)	3.60	68.90		Assessed zone of core loss OH-OH
		3.60 - 4.70		59	59	0		4.05	68.45		Very stiff locally stiff red brown very silty CLAY locally with occasional lithorelics. (Weathered MUDSTONE) (KEUPER MARL 3) From 4.84m to 4.93m band of light greenish grey silt. MM-Z3
		~~4.70~~	SPT(S)				108 (10,19/108 for 225mm)	4.95	67.55		*red brown siltstone* *disturbed by SPT*
		4.70 - 6.90		100	89	64					Red brown slightly to moderately weathered SILTSTONE very weak to weak with occasional mudstone bands up to 80mm thick; closely locally very closely spaced often tight fractures occasionally with speckled black staining. (KEUPER MARL 2) MM-ST
		6.90 - 8.00		36	0	0		7.35	65.15		
								7.50	65.00		Continued on next sheet

Shift Information					Backfill			Chiselling				Depth Related Remarks		
Date & Time	Depth	Water	Casing	Remarks	Top	Base	Description	Top	Base	Duration	Tool	Top	Base	Remarks

Water Strike							Discontinuities				
Struck	Rose to	Date	Time	Sealed	Casing	Remarks	Top	Base	Strength	Seepage	Water Flow

Remarks
Hand dug inspection pit from ground level to 0.60m

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Rotary Core Log

Borehole No. **SK42NE66** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447349.00 - 326201.00	Hole Type RC
Location:		Level: 72.50mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 27/01/1988 - 27/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.00	SPT(S)				115 (11,8/115 for 225mm)				Stiff red brown very silty CLAY with occasional lithorelics. (Weathered MUDSTONE) (KEUPER MARL 4a) MM-Z3
											Assessed zone of core loss OH-OH
								8.38	64.12		End of borehole at 8.38m

8 9 10 11 12 13 14 15

Shift Information

Date & Time	Depth	Water	Casing	Remarks

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks
Hand dug inspection pit from ground level to 0.60m

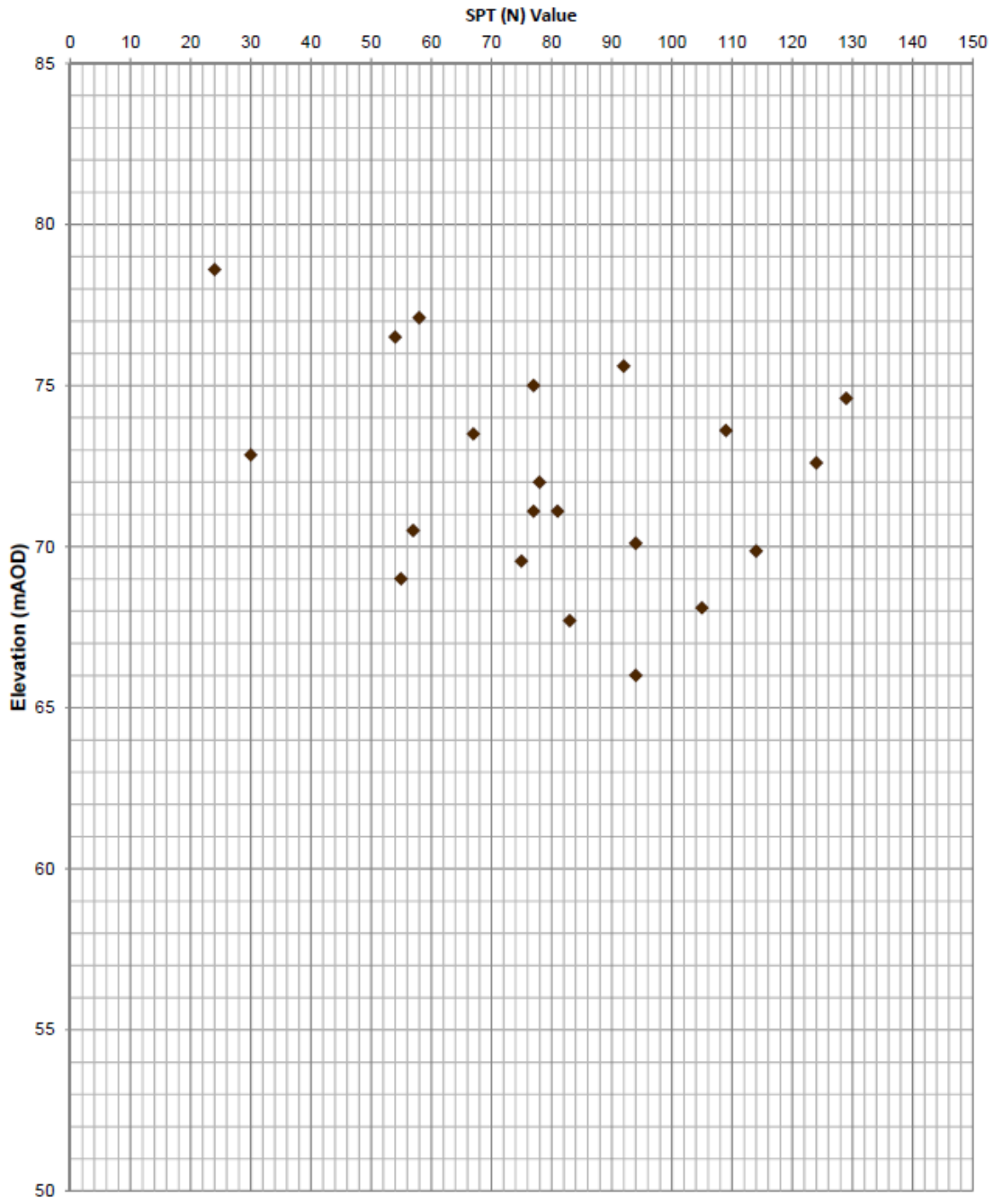
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PLOTS

SPT N Value vs Depth

Project ID: HA549342	Project Title: SMP - M1 J23A TO J25	Data Sheet: 183620-183780 NB
Client: Highways England	Borehole ID: RC1079,SK42NE5,SK42NE6 SK42NE70, SK42NE58,SK42NE59/R, SK42NE60, SK42NE61/R, SK42NE62, SK42NE63/R, SK42NE64, SK42NE65/R. SK42NE66	

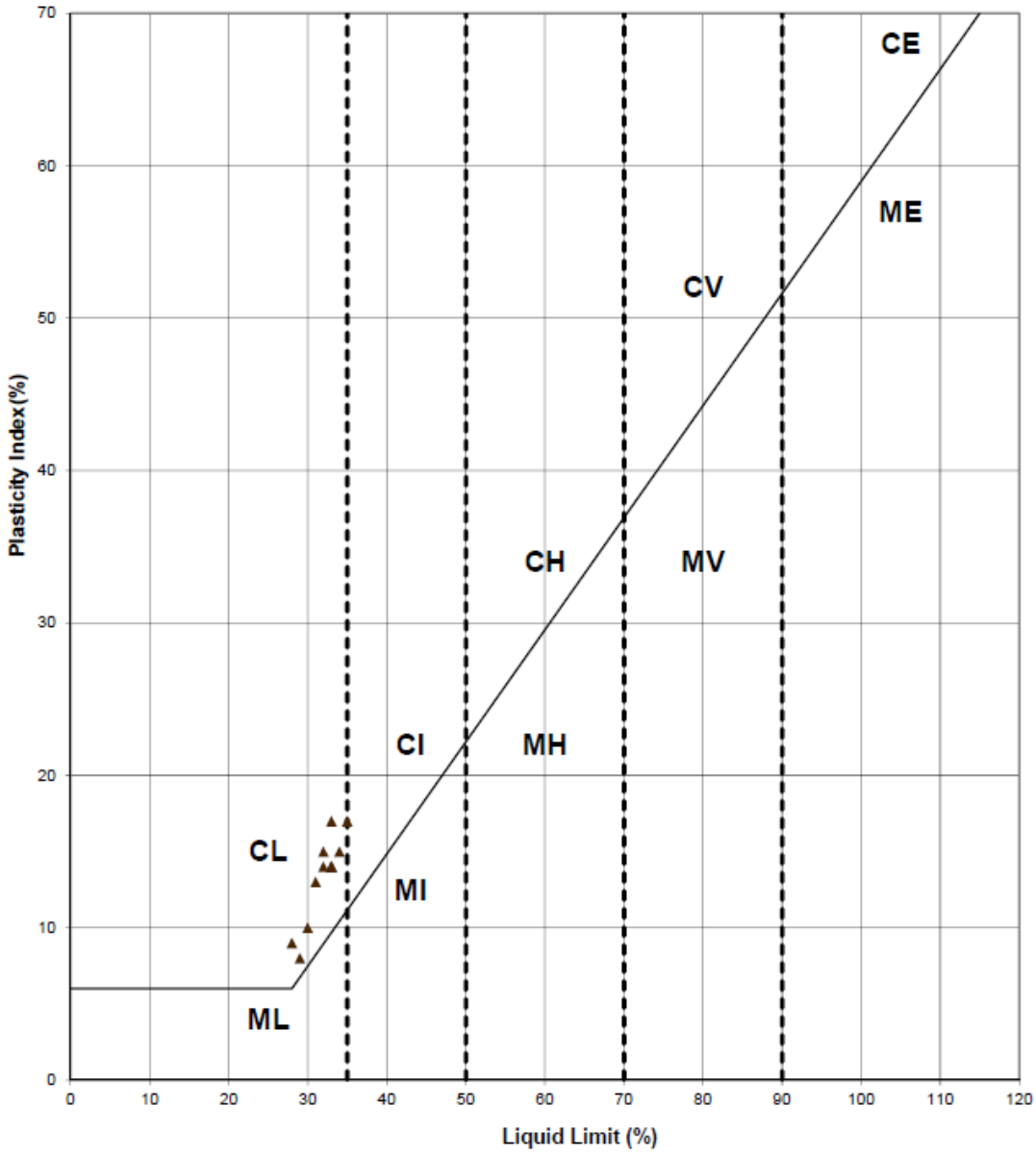


Extrapolated SPT (N) Values >150 have not been shown

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183620-183780NB**
Client: **Highways England**	Borehole ID: **RC1079,SK42NE5,SK42NE6 SK42NE70, SK42NE58,SK42NE59/R, SK42NE60, SK42NE61/R, SK42NE62, SK42NE63/R, SK42NE64, SK42NE65/R. SK42NE66**	



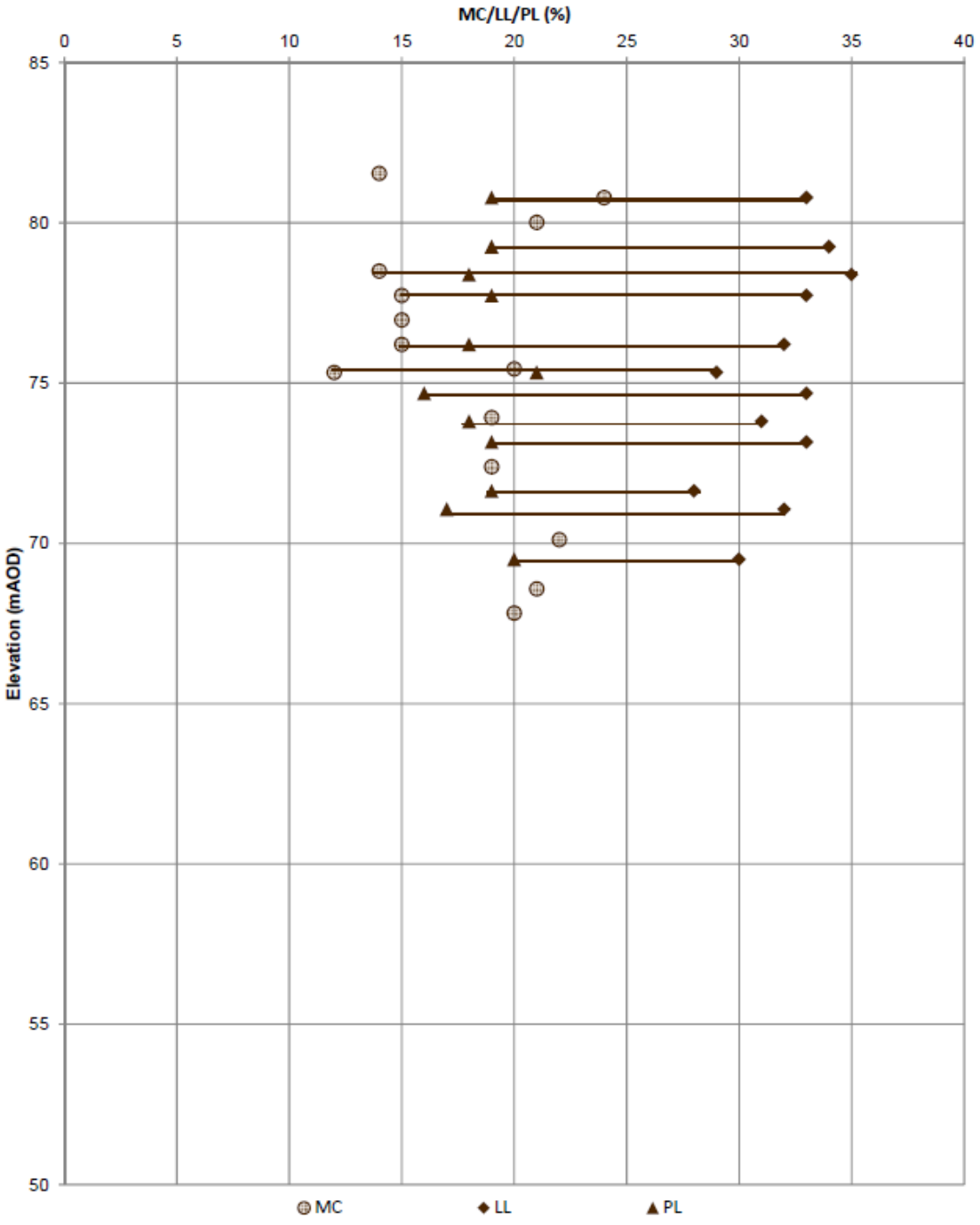
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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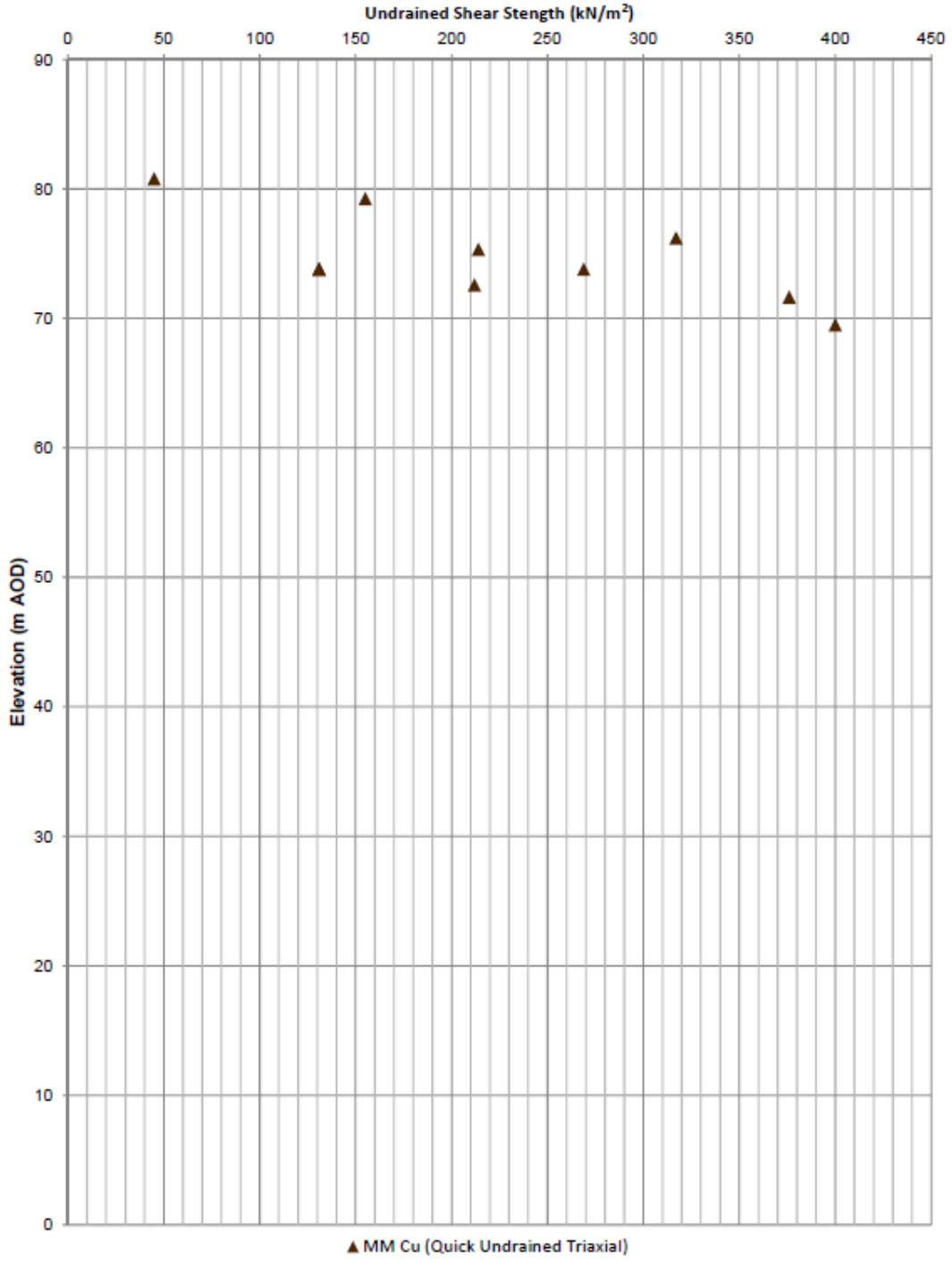
Moisture Content/Atterberg Limits

Project ID: HA549342	Project Title: SMP - M1 J23A TO J25	Data Sheet: 183620-183780NB
Client: Highways England	Borehole ID: RC1079,SK42NE5,SK42NE6 SK42NE70, SK42NE58,SK42NE59/R, SK42NE60, SK42NE61/R, SK42NE62, SK42NE63/R, SK42NE64, SK42NE65/R. SK42NE66	



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amey ARUP	Undrained Shear Strength vs Elevation	
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183620-183990**
Client: **Highways England**	Borehole ID: **RC1079,SK42NE5,SK42NE6 SK42NE70, SK42NE58,SK42NE59/R, SK42NE60, SK42NE61/R, SK42NE62, SK42NE63/R, SK42NE64, SK42NE65/R. SK42NE66**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-184000-184450NB-GSS-000001		
Earthworks Widening Solution	Gabion Wall , King Sheet Pile Wall		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	184000-184450		
Carriageway	Northbound		
Marker Post	MP184/0A +00 – MP184 /4A +50		
National Grid Reference	E 447359, N 326407 - E 447461, N 326841		
Existing Ground Level at Location	Crest	77.0mAOD	
	Carriageway	69.2mAOD	
Earthwork Type	NB: Cutting	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_42053	SB: N/A	HAGDMS designation
Earthwork Height	NB: 7.8m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 25^{o}	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	25/04/2017	[redacted]
Checked	Alice Bazen	25/04/2017	
Reviewed	Gary Summerfield	25/04/2017	
Approved	Thomas Bulteel	02/05/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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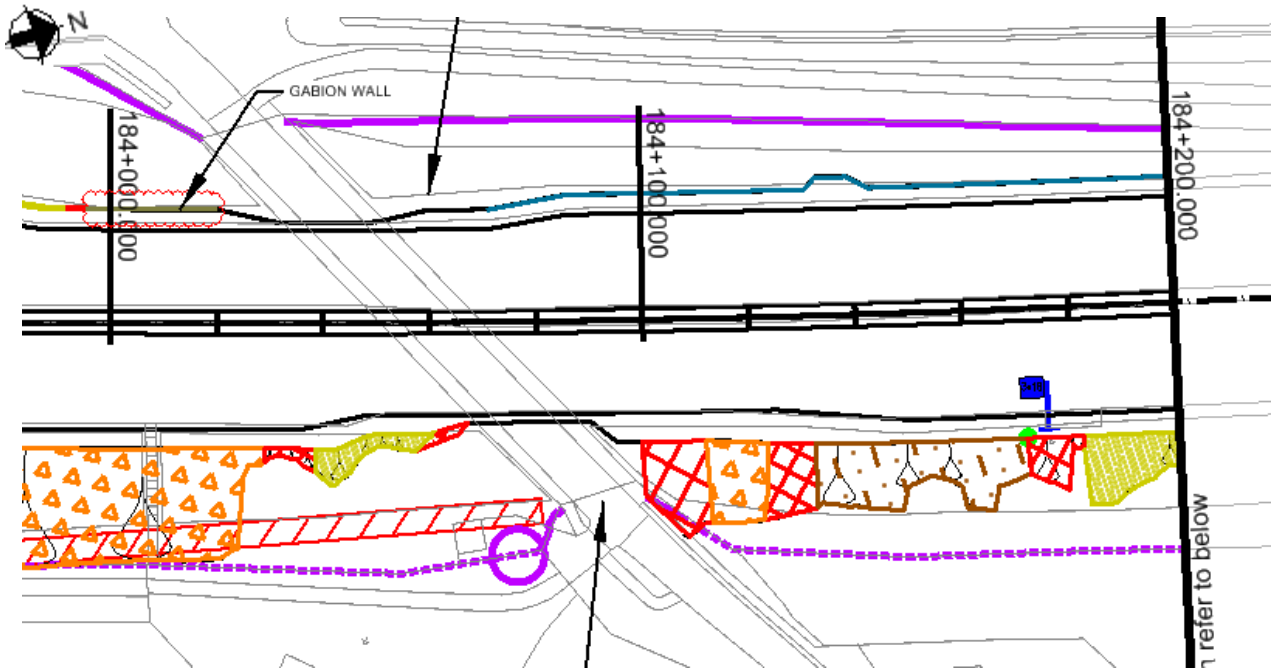


Figure 1.1: Location Plan – 184000-184200

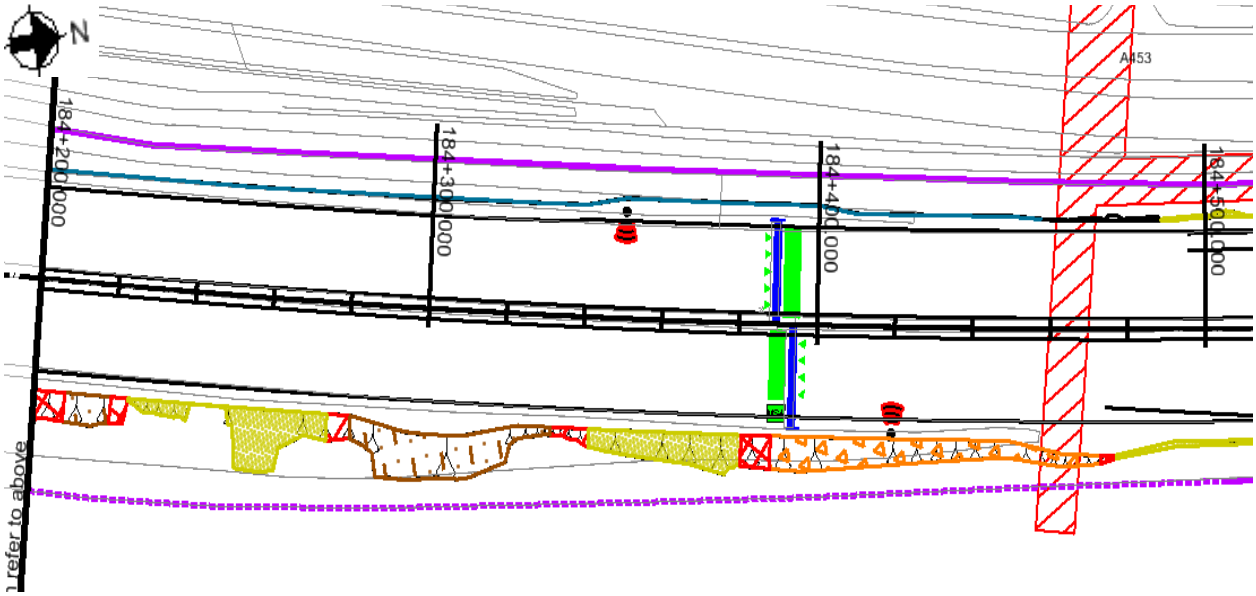


Figure 1.2: Location Plan – 184200-184450

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Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Retaining Wall has been proposed to prevent any additional land take beyond the highway boundary. The retaining wall has been split as per the chainages below:
  - 184070 – 184020: 0.70m Retained Height
  - 184070 – 184140: 1.00m Retained Height
  - 184140 – 184430: 1.80m Retained Height
  - 184430 – 184450: 1.00m Retained Height

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a Cutting with a maximum height of approximately 7.8m.

Critical Sections were based on sections with the greatest earthwork heights as shown below.

Figure 2.1 below presents the cross section used for design of the Gabion Wall:



Figure 2.1: Topographic Cross Section Chainage 184020

Figure 2.2 below presents the cross section used for design of the King Sheet Pile wall for a retained height of up to 1m.

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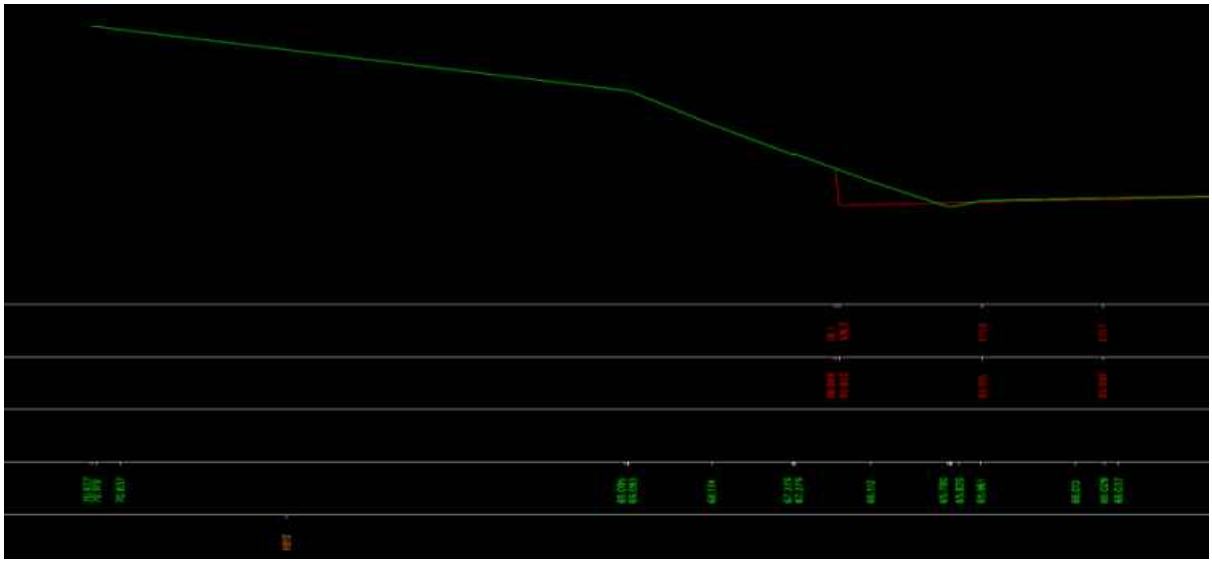


Figure 2.2: Topographic Cross Section Chainage 184090

Figure 2.3 below presents the cross section used for design of the King Sheet Pile wall for a retained height of up to 1.8m.

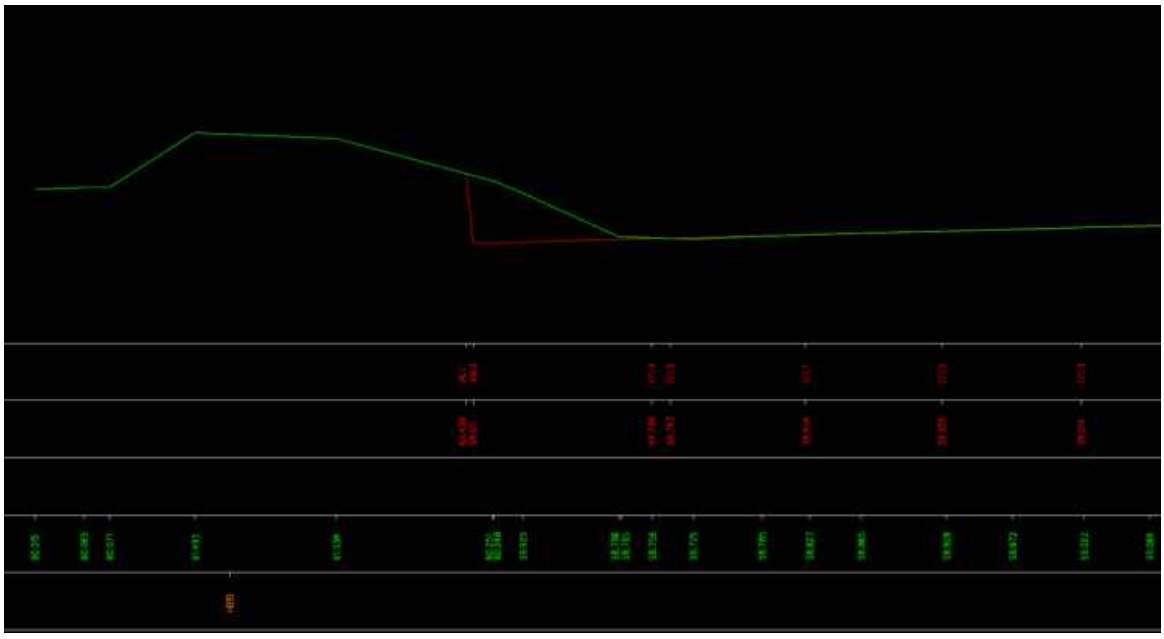


Figure 2.3: Topographic Cross Section Chainage 184360.

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Utilities:

National Grid Gas – Mid pressure pipe running across OB423.

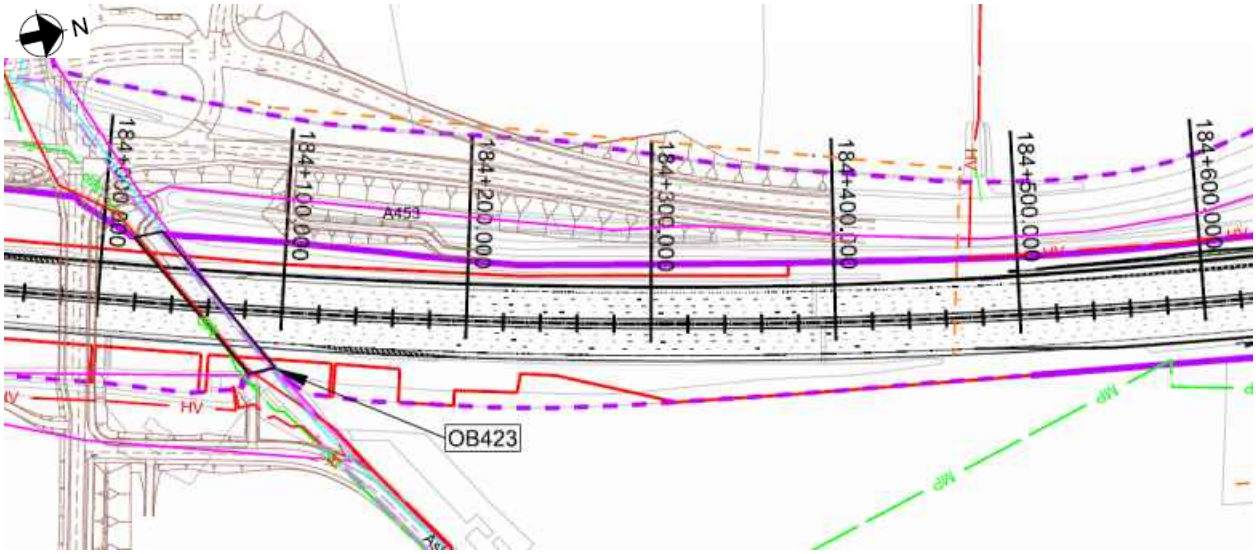


Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: None Recorded.

Solid Deposits: Tarporley Siltstone Formation – Mudstone, Siltstone and Sandstone & Bromsgrove Sandstone Formation – Sandstone.

Ground Investigation:

There are 2 No. historical exploratory holes recorded within the design chainage, with additional 2 no. relevant exploratory holes considered outside the design chainage; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000023-24, Rev P01.

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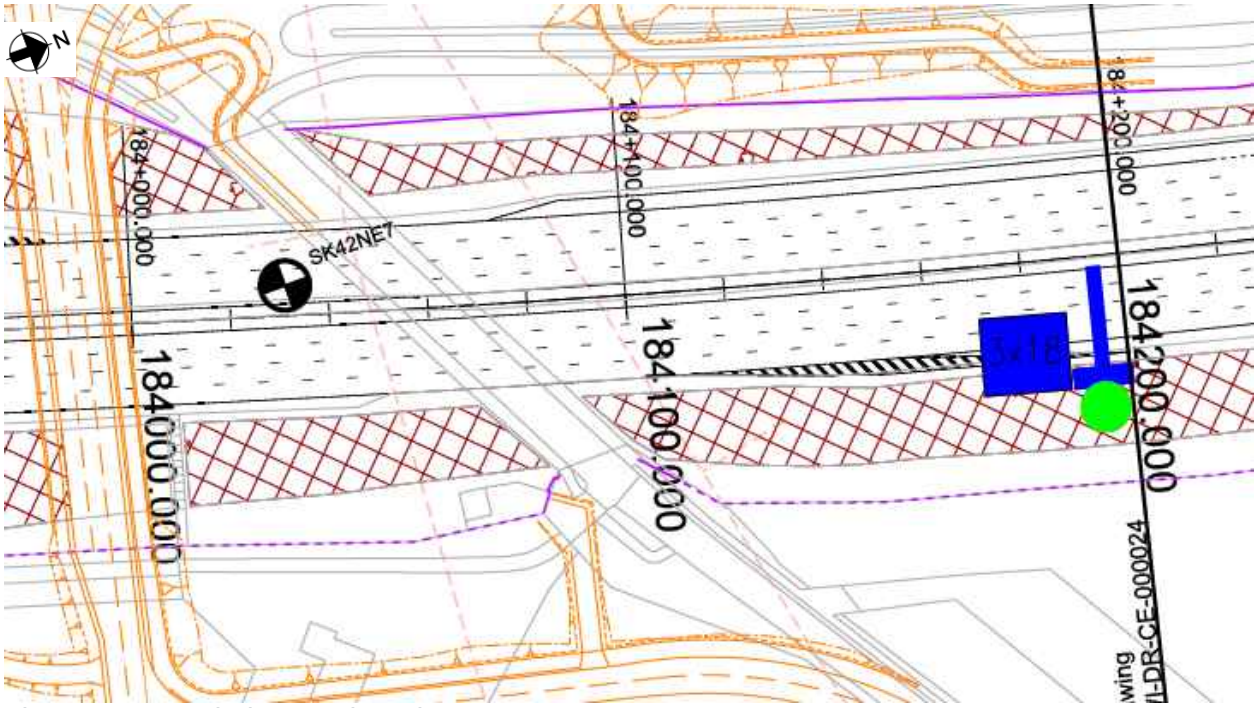


Figure 4.1: Borehole Location Plan – 184000-184200

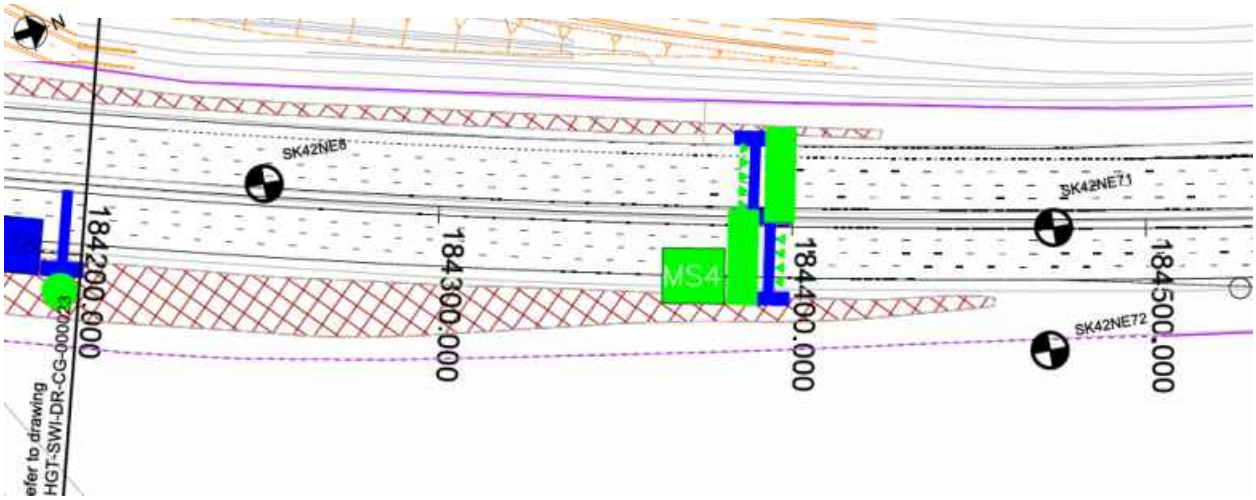


Figure 4.2: Borehole Location Plan – 184200-184450

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Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42NE8	SK42NE7	SK42NE71	SK42NE72
Borehole Chainage	184250	184031	184473	184474
Borehole Location	Northbound	Northbound	Southbound	Southbound
National Grid Reference	E 447440, N 326640	E 447380, N 326430	E 447491, N 326858	E 447525, N 326851
Ground Level at Exploratory Hole	66.10mAOD	75.00mAOD	56.75mOAD	57.35mbgl
RAG Analysis	Amber	Amber	Amber	Green
Date Drilled	17/08/1961-18/08/1961	15/08/1961 – 17/08/1961	02/02/1988	25/01/1988-26/01/1988
Termination Depth	7.62mbgl	12.19mbgl	3.61mbgl	7.20mbgl
Other suitable holes	None			

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Mercia Mudstone III/IV	>17.00	<60.00	53-150

(1) Ground level is assumed to be at the crest of the cutting.
(2) SPT capped at 150.
(3) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes SK42NE71 and SK42NE72, but are not considered to be representative between 184000-184450.

Groundwater:

No ground water encountered within the exploratory boreholes

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Groundwater Design Level:

No local groundwater data is available and therefore a groundwater level of 1.0m below carriageway level has been assumed for WALLAP analysis for king sheet piles and GAWACwin for Gabion Wall analysis. When checking the global stability check of the earthwork and king sheet pile (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

9 No. Atterberg Limit Tests and 15 no Mositure Content Tests were undertaken within the Mudstone III/IV in boreholes SK42NE7 and SK42NE8 with the following results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Mudstone - III/IV	1.22	15	-	-	-	-
Mudstone - III/IV	1.52	19	37	20	17	CI
Mudstone - III/IV	2.29	15	-	-	-	-
Mudstone - III/IV	3.05	-	31	16	15	CL
Mudstone - III/IV	3.81	16	-	-	-	-
Mudstone - III/IV	4.57	-	39	17	22	CI
Mudstone - III/IV	5.33	15	-	-	-	-
Mudstone - III/IV	6.10	-	30	19	11	CL
Mudstone - III/IV	6.86	17	-	-	-	-
Mudstone - III/IV	9.91	20	-	-	-	-
Mudstone - III/IV	10.67	22	-	-	-	-
Mudstone - III/IV	11.43	21	-	-	-	-
Mudstone - III/IV	0.61	8	36	17	19	CI
Mudstone - III/IV	1.52	15	31	19	12	CL
Mudstone - III/IV	3.05	14	-	-	-	-
Mudstone - III/IV	3.35	-	28	20	8	CL
Mudstone - III/IV	4.57	7	-	-	-	-
Mudstone - III/IV	5.18	-	34	19	15	CL
Mudstone - III/IV	6.1	21	-	-	-	-
Mudstone - III/IV	6.71	-	26	17	9	CL
Mudstone - III/IV	7.62	15	-	-	-	-

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5 No, Quick Undrained Triaxial Tests were undertaken in Borehole SK42NE7 and SK42NE8, with the following results:

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Mudstone - III/IV	1.52	141
Mudstone - III/IV	4.57	141
Mudstone - III/IV	1.52	97
Mudstone - III/IV	5.18	210
Mudstone - III/IV	6.71	90

Lab Test Data - BRE Classification:

1 No. Test for pH Value and 1 No. Sulphate test was completed in borehole SK42NE7 with the results presented in the table below:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Water Soluble Sulphate as SO4	Water	1	0.00	g/l SO4
Embankment Fill	pH	Water	1	7.30	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that road level on the base of the cutting is straight on to the Mercia Mudstone III/IV at this location. The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Validation Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Mercia Mudstone – III/IV (<10mbgl)	0.00 – 17.00	77.00 – 60.00	17.00	21	30	2	100	10.8	8.6	-	0.5	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10mbgl)	>17.00	<60.00	-	21	30	2	150	16.8	13.4	-	0.5	0.2	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Due to limited geotechnical data available for the Mercia Mudstone III/IV <10mbgl, the geotechnical parameters derived in AMAR GIR have been adopted for design.
(4) Due to the lack of local ground investigation data available and, geotechnical parameters for Mercia Mudstone >10mbgl has been based on values derived in AMAR GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.
(5) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Mercia Mudstone III/IV, the classification used for the strata in the AMAR GIR was adopted

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Imported Granular Fill (Class 6N) was used in the design of king sheet pile and gabion wall as backfill material, and Gabion Fill (Class 6G) was used to represent the fill in the gabion baskets; the materials were assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25
Gabion Fill	24	-	-	-

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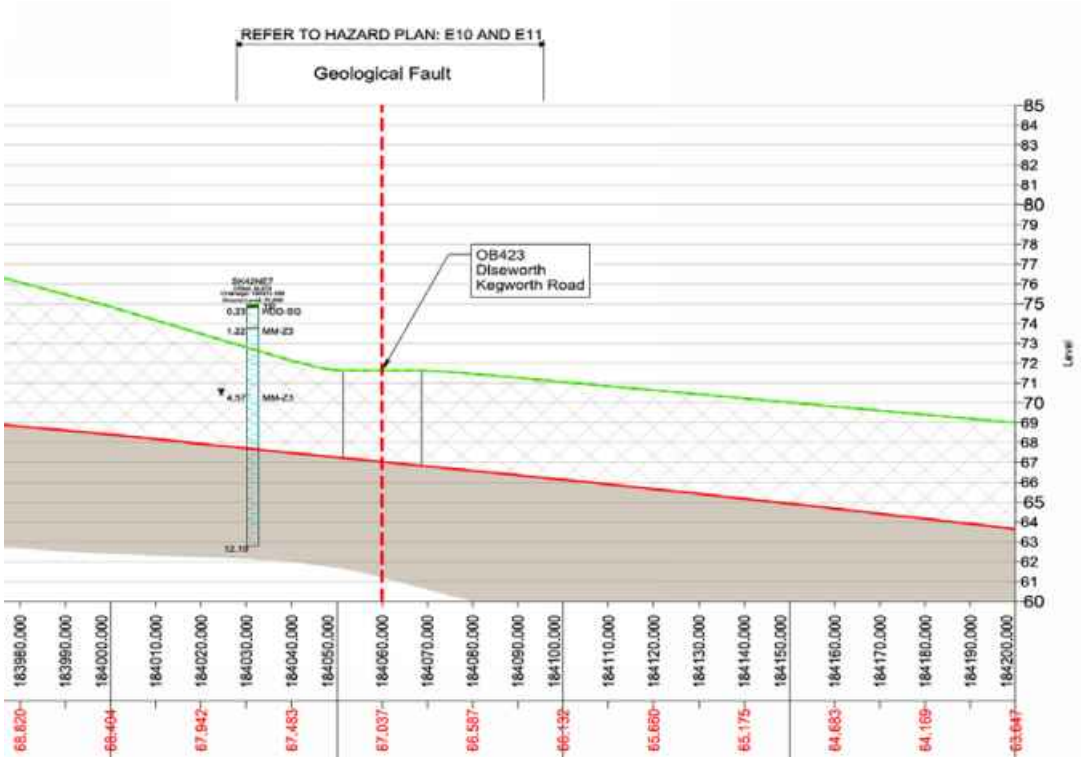


Figure 5.1: Geological Long Section – 184000-184200

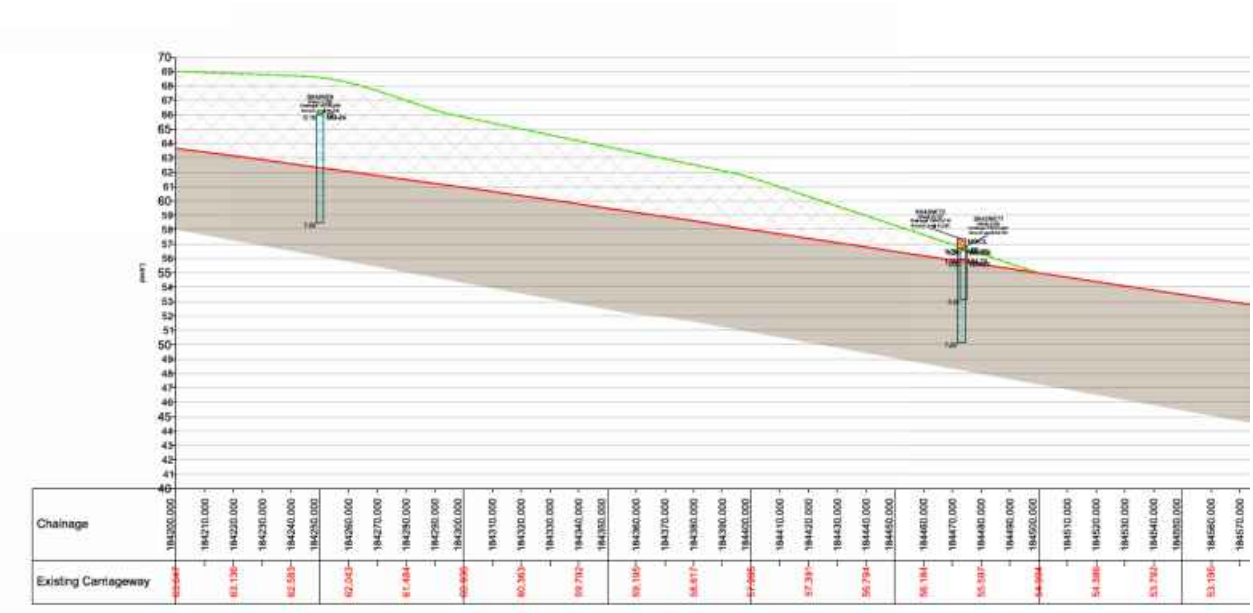


Figure 5.2: Geological Long Section – 184200-184450

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to the requirement of additional land take because of the highway boundary, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Gabion Wall:

Start Chainage	End Chainage	Carriageway	Solution	Layers	Gabion Wall Dimensions			
					Width (m)	Length (m)	Height (m)	Benching Detail
184000	184020	Northbound	Gabion Wall	Lower	1.0	1.0	1.0	45°
				Upper	0.5	0.5	0.5	

King Sheet Pile Retaining Wall:

Start Chainage	End Chainage	King Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
184070	184140	AZ-12 700 S390 GP	1.0	3.50	4.50	81	47	9.0	16
184140	184430	AZ-12 700 S390 GP	1.8	3.50	6.0	89	41	26.0	50
184430	184450	AZ-12 700 S390 GP	1.0	3.50	4.50	81	47	9.0	16

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.

Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

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Further Ground Investigation

No further ground investigation has been proposed.

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HISTORICAL EXPLORATORY HOLES

Borehole Log

Borehole No. **SK42NE7** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447380.00 - 326430.00	Hole Type CP
Location:		Level: 75.00mbgl	Scale 1:50
Client: Highways England		Dates: 15/08/1961 - 17/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.23	74.77		Topsoil TP
		0.76	556D						Silty soil HDD-SG
		1.22	557D			1.22	73.78		Stiff red silty clay MM-Z3
		1.52	558D						
		1.52 - 1.98	559U						
		2.29	560D						
		3.05	561D						
		3.05 - 3.35	562B						
		3.81	563D						
	▼	4.42	577 W						
		4.57 - 4.88	564U			4.57	70.43		Stiff red and grey silty clay and siltstone MM-Z3
		4.72	565D						
		5.33	566D						
		6.10 - 6.40	567U						
		6.86	568D						
		7.62	569D						
		8.23 - 8.38	570U	100blows					
		9.14	571D						
		9.14 - 9.45	572U	130blows					
		9.91	573D						

Continued on next sheet

Remarks

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Borehole Log

Borehole No. **SK42NE7** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447380.00 - 326430.00	Hole Type CP
Location:		Level: 75.00mbgl	Scale 1:50
Client: Highways England		Dates: 15/08/1961 - 17/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		10.67	574D						
		11.43	575D						
		12.19	576D			12.19	62.81		End of borehole at 12.19 m

Remarks

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Borehole Log

Borehole No. **SK42NE8**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447440.00 - 326640.00	Hole Type CP
Location:		Level: 66.10mbgl	Scale 1:50
Client: Highways England		Dates: 17/08/1961 - 18/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
						0.15	65.95		Topsoil TP
		0.61	577D						Stiff red & grey silty clay & siltstone MM-Z4
		1.52	578D						
		1.52 - 1.98	579U	93blows					
		3.05	580D						
		3.35 - 3.51	581U	250blows					
		4.57	582D						
		5.18 - 5.46	583U	380blows					
		6.10	584D						
		6.71 - 6.93	585U	180blows					
		7.62	586D			7.62	58.48		End of borehole at 7.62 m

Remarks
No groundwater

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Borehole Log

Borehole No. **SK42NE71**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447491.00 - 326858.00	Hole Type CP
Location:		Level: 56.75mbgl	Scale 1:50
Client: Highways England		Dates: 02/02/1988 - 02/02/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.20 - 0.80	1B			0.20	56.55		TOPSOIL TP Light grey green moderately weathered silty fine grained porous SANDSTONE weak to very weak with occasional red brown siltstone lenses and occasional black speckled staining. (KEUPER SERIES SANDSTONE 3) MM-SS
		1.00	SPT (S)	N=98 (8,9/12,15,24,47)	Water=-	1.00	55.75		
		1.00 - 1.45	2D						Very stiff (hard) red brown CLAY with occasional fine gravel sized lithorelics thinly to thickly interlaminated very dense light grey green SILT. Below 2.30m stiff becoming very stiff red brown locally thinly laminated locally very silty CLAY with occasional fine to medium occasionally coarse gravel sized lithorelics and occasional bands and lenses of light greenish grey slightly fine sandy siltstone. (KEUPER SERIES MARL 3/4a) MM-Z3
		1.70	SPT (S)	N=53 (7,15/19,9,8,17)	Water=-				
		1.70 - 2.15	3D						
		2.50	SPT (S)	N=98 (8,14/17,21,26,34)	Water=-				
		2.50 - 2.95	4D						
		3.00	SPT (S)	50 (12,37/50 for 40mm)	Water=-				
		3.00 - 3.19	5D						
		3.40	SPT (S)	50 (9,28/50 for 55mm)	Water=-	3.61	53.14		End of borehole at 3.61m
		3.40 - 3.61	6D						

Remarks
Hand dug inspection pit from ground level to 1.00m

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Borehole Log

Borehole No. **SK42NE72** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447525.00 - 326851.00	Hole Type CP
Location:		Level: 57.35mbgl	Scale 1:50
Client: Highways England		Dates: 25/01/1988 - 26/01/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.20	1D						Very stiff red brown very silty locally slightly fine sandy CLAY with occasional fine gravel sized lithorelics and a little to some angular medium to coarse mudstone and sandstone gravel. (Possible FILL) MG-CL
		0.50 - 0.95	2U	150blows		0.70	56.65		
		1.00	3D						Light grey green moderately weathered silty fine grained SANDSTONE weak to very weak with black speckled staining. Below 1.00m becoming fine silty SAND with frequent medium to coarse gravel sized lithorelics. (KEUPER SERIES SANDSTONE 3) MM-SS
		1.00	SPT (S)	N=64 (3,10/15,12,17,20)	Water=-	1.40	55.95		
		1.00 - 1.45	4D						
		2.00	SPT (S)	N=92 (7,12/17,23,25,27)	Water=-				Very stiff red brown locally thinly laminated CLAY with occasional fine to medium gravel sized lithorelics and occasional pockets and lenses of light grey green silt and siltstone. Frequent bands of light reddish green silty fine SAND with occasional fine to medium gravel sized lithorelics. (KEUPER SERIES MARL 3/4a) Below 7.00m becoming probably sandstone MM-Z3
		2.00 - 2.45	5D						
		3.00	SPT (S)	50 (15,36/50 for 50mm)	Water=-				*red brown probably moderately weathered SILTSTONE very weak*
		3.00 - 3.20	6D						
		4.00	SPT (S)	50 (17,31/50 for 42mm)	Water=-				
		4.00 - 4.19	7D						
		5.00	SPT (S)	0 (70 for 115mm/0 for 0mm)	Water=-				
		5.00 - 5.12	8D						
		6.00	SPT (S)	50 (17,36/50 for 75mm)	Water=-				
		6.00 - 6.23	9D						
		7.00	SPT (S)	0 (72 for 125mm/0 for 0mm)	Water=-				
		7.00 - 7.12	10D			7.20	50.15		End of borehole at 7.20 m

Remarks

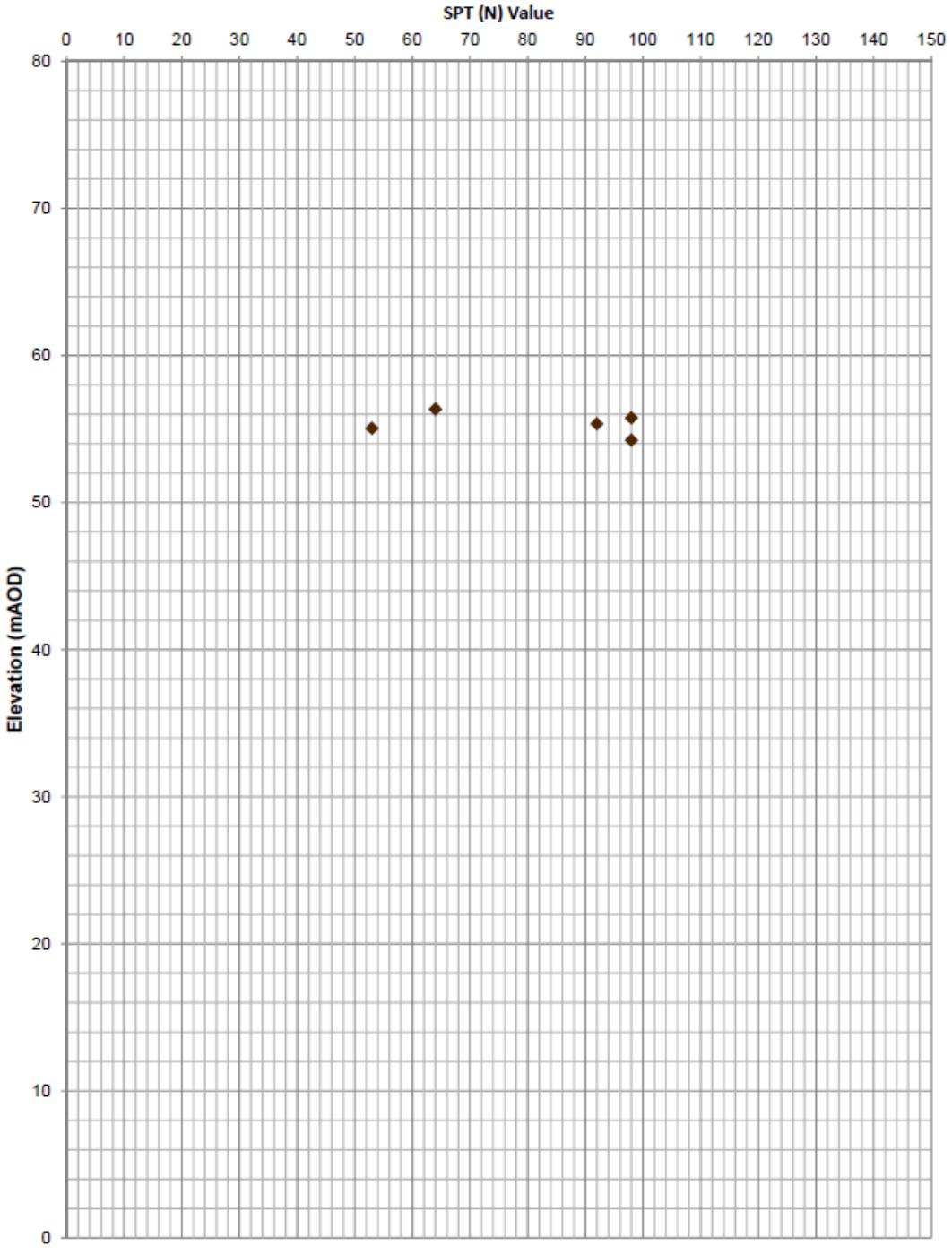
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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184000-184450NB**
Client: **Highways England**	Borehole ID: **SK42NE7, SK42NE8, SK42NE71 and SK42NE72**	

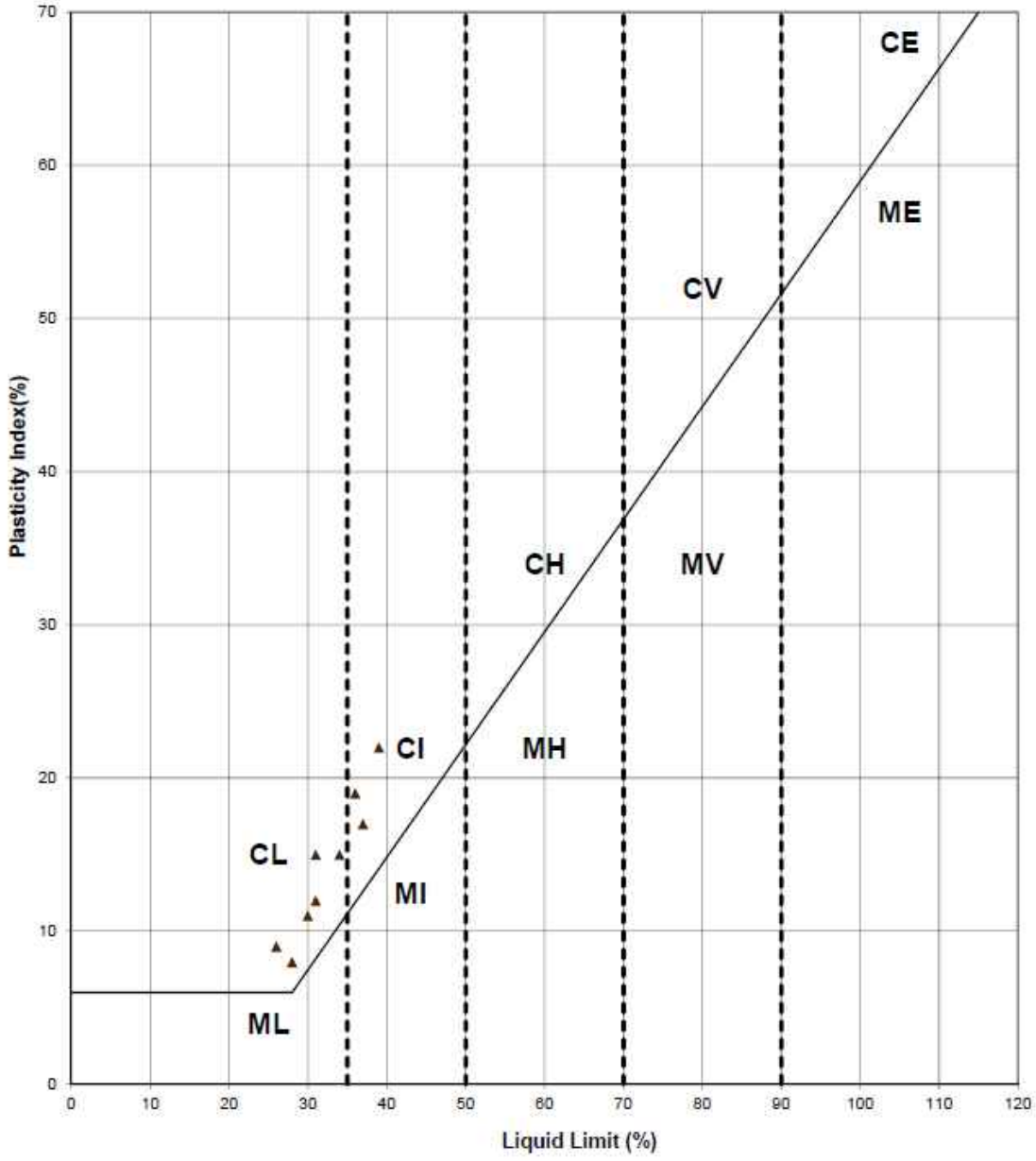


Extrapolated SPT (N) Values >150 have not been shown

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184000-184450NB**
Client: **Highways England**	Borehole ID: **SK42NE7, SK42NE8, SK42NE71 and SK42NE72**	



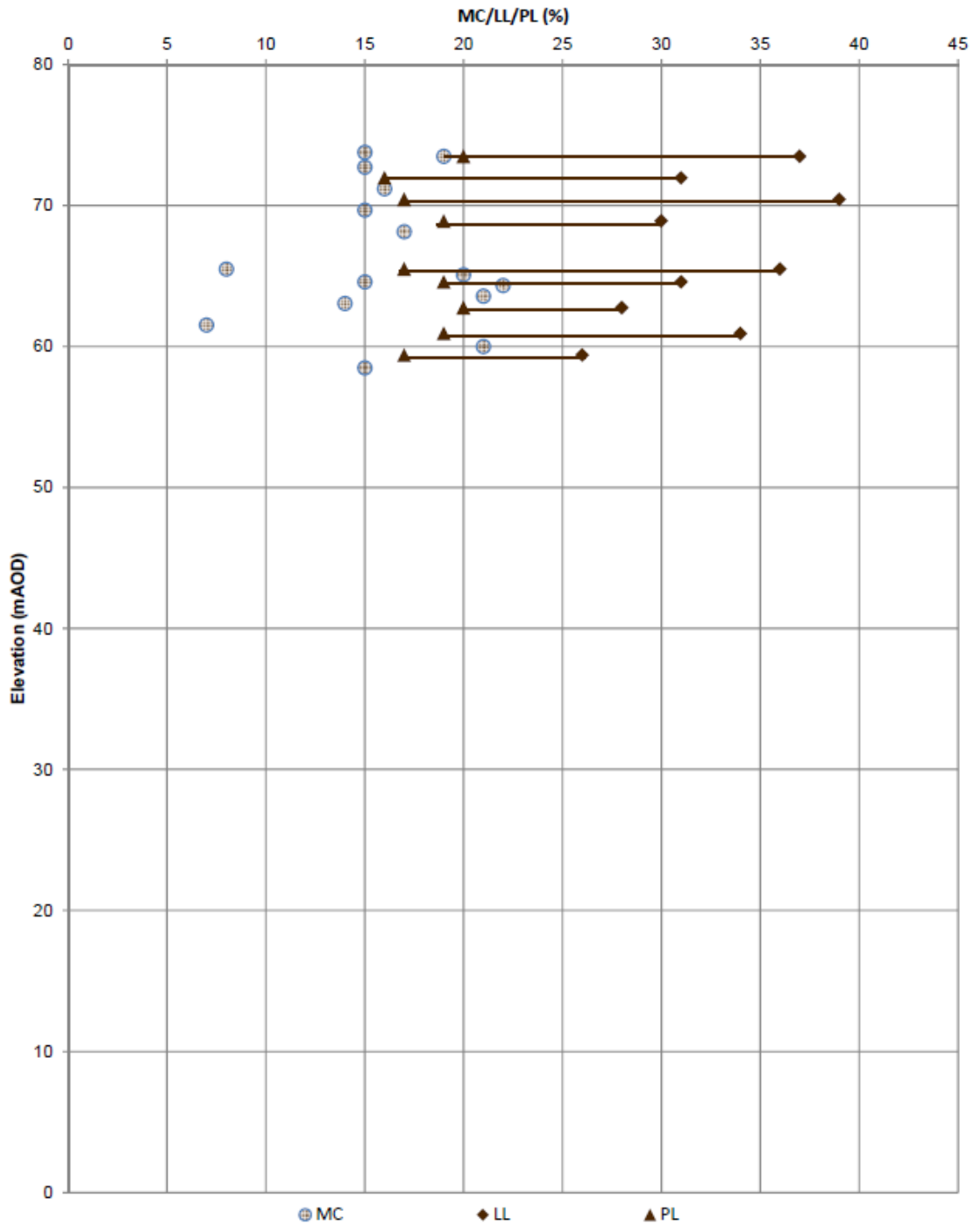
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

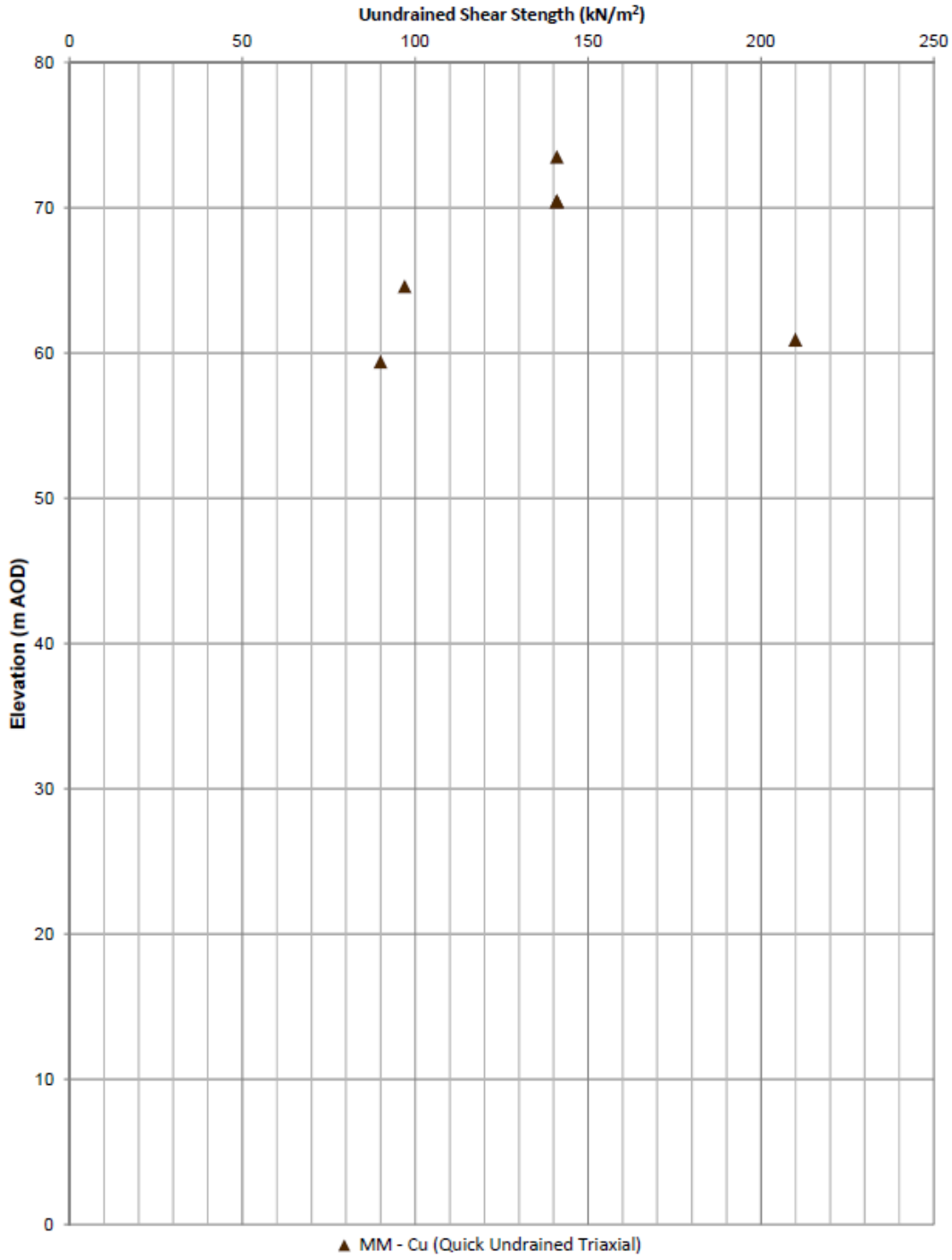
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184000-184450NB**
Client: **Highways England**	Borehole ID: **SK42NE7, SK42NE8, SK42NE71 and SK42NE72**	



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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184000-184450NB**
Client: **Highways England**	Borehole ID: **SK42NE7, SK42NE8, SK42NE71 and SK42NE72**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-184560-184700NB-GSS-000001		
Earthwork Widening Solution	1:2.5 Full Height Regrade		
Design Chainage	184560-184700		
Structure Number	N/A		
Structure Type	N/A		
Carriageway	Northbound		
Marker Post	MP184/5 +60 – MP184/7 +40		
National Grid Reference	E 447479, N 326948 - E 447496, N 327085		
Existing Ground Level at Location	Crest	52.78mAOD	
	Carriageway	51.82mAOD	
Earthwork Type	NB: Grade	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_42054	SB: N/A	HAGDMS designation
Earthwork Height	NB: 0.96m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 26.44^{o}	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	09/12/2016	[redacted]
Checked	Alice Bazen	12/12/2016	
Reviewed	Gary Summerfield	26/04/2017	
Approved	Tom Bulteel	06/06/2017	

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Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this eathwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

DESK STUDY

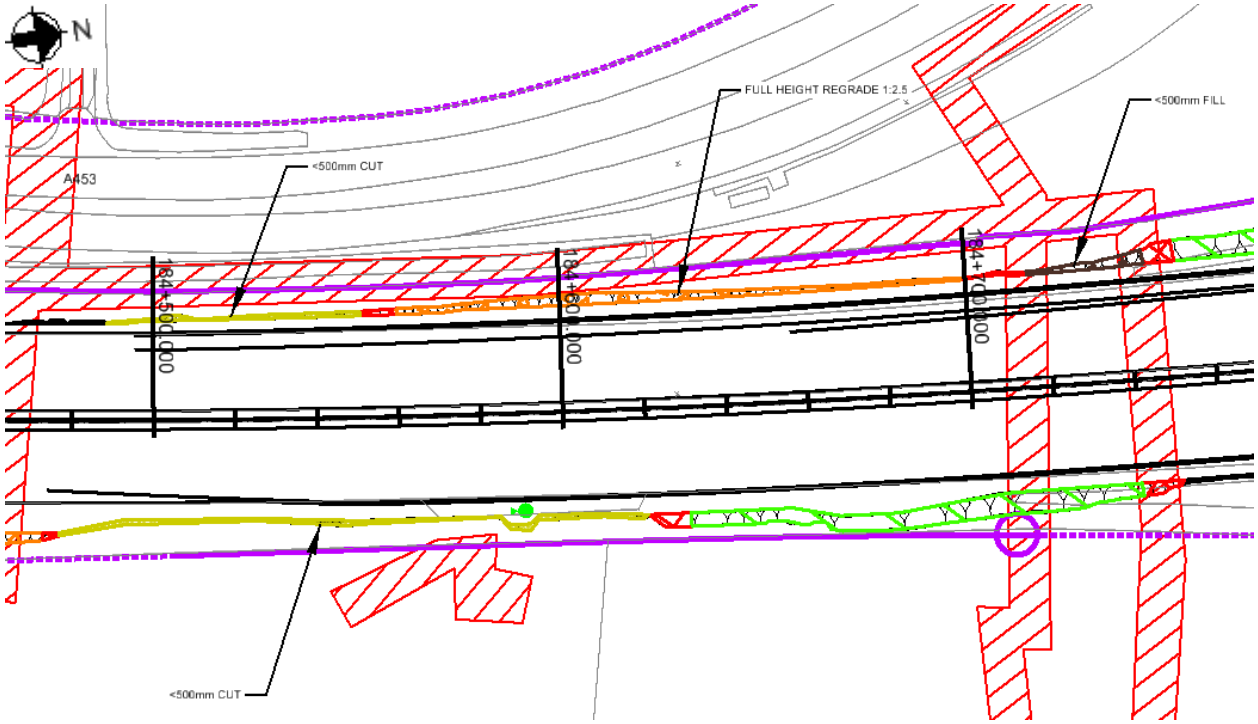


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Full Height Regrade at 1 in 2.5 gradient.

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as Grade with a maximum height of approximately 0.96m.

The critical cross sections (i.e. the cross section with the greatest earthwork height) used is Ch184590.

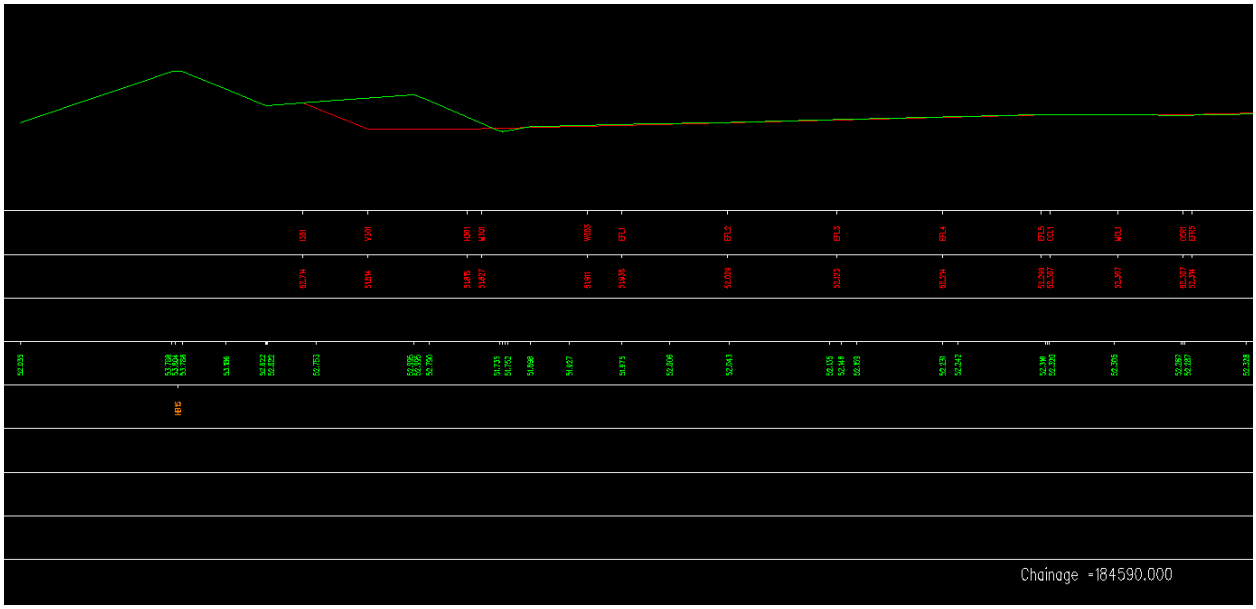


Figure 2: Topographic Cross Section Chainage 184590

Utilities:

Western Power Low Voltage Supply running northbound to southbound at approximately ch.184465. Western Power High Voltage running along Northbound verge through design chainage.

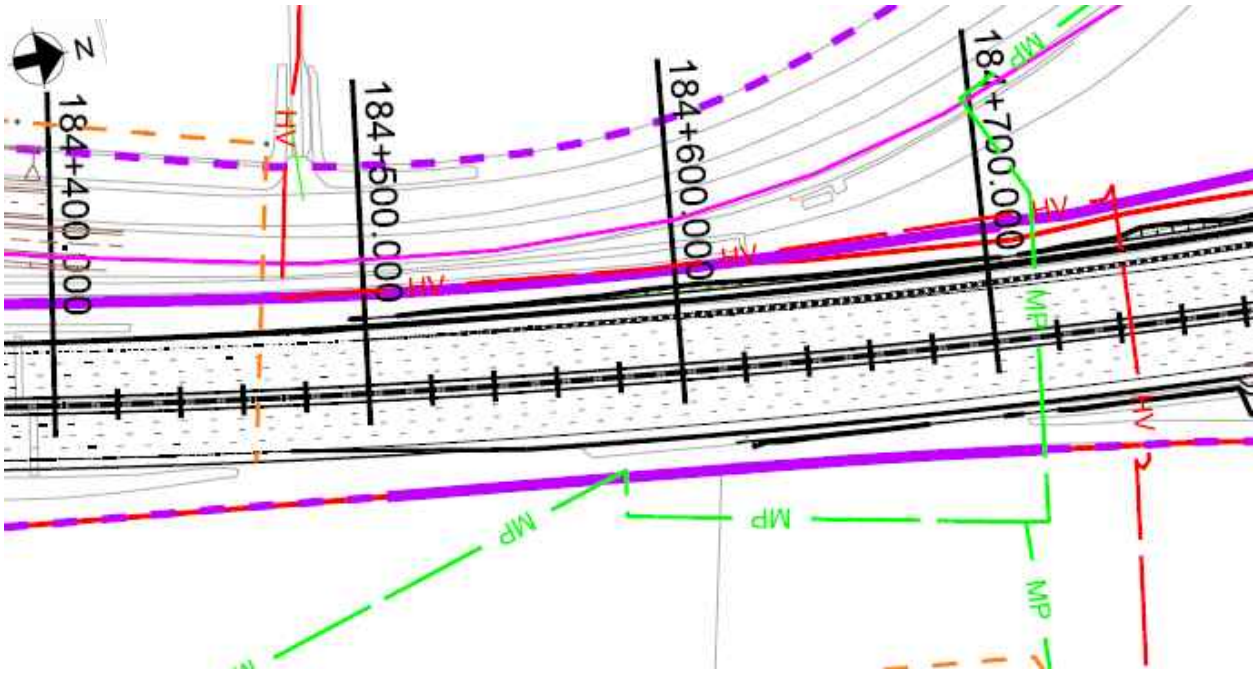


Figure 3: Utilities Location Plan

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Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: N/A

Solid Deposits: Triassic Rocks – Mudstone, Siltstone and Sandstone

Ground Investigation:

There are no. historical exploratory holes recorded within the design chainage, however 2 no. relevant exploratory holes considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000024, Rev P01.

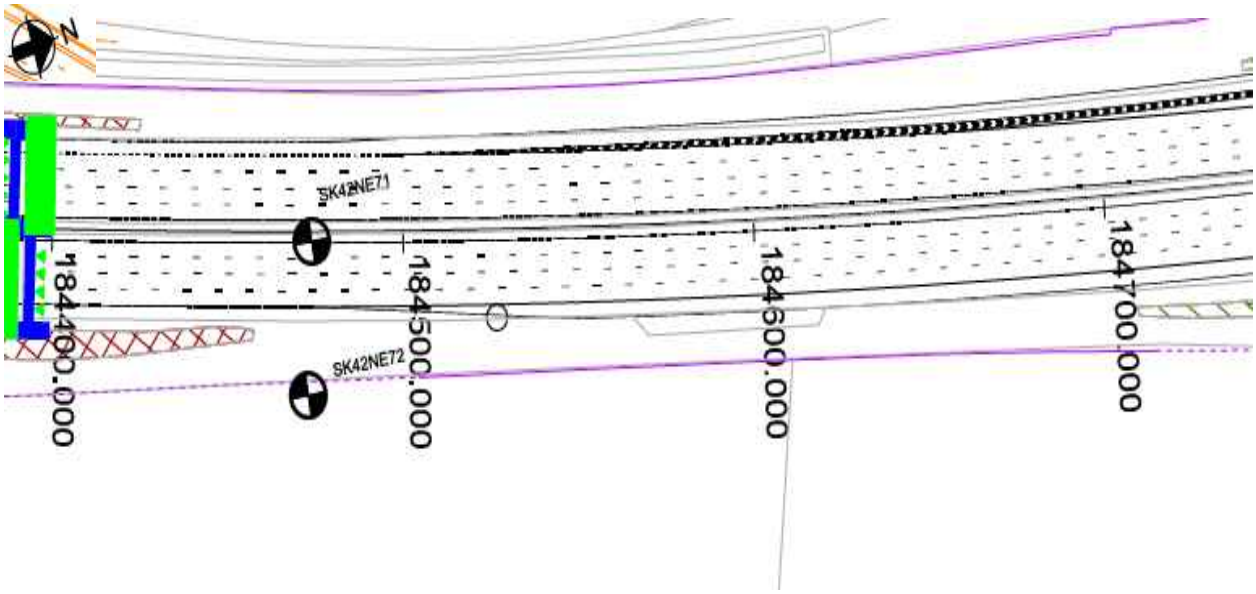


Figure 4: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42NE72
Borehole Chainage	184473
Borehole Location	Southbound Earthwork
National Grid	E 447525, N 326851

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Reference	
Ground Level at Exploratory Hole	57.35mAOD
RAG Analysis	Green
Date Drilled	25/01/1988-26/01/1988
Termination Depth	7.2 metres below ground level (mbgl) (50.15mAOD)
Other suitable holes	SK42NE71

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Mercia Mudstone III/IV	10.00	42.78	53-150 (53)

(1) Ground level is assumed to be at the crest of the cutting.
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(3) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.
(4) Nearest borehole is approximately 117m away from the critical cross section. Therefore for the purpose of design, the geotechnical parameters given in the AMAR GIR have been adopted.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes SK42NE71 and SK42NE72.

Groundwater:

No groundwater encountered in the boreholes.

Groundwater Design Level:

No local groundwater level is available and therefore a design groundwater level of 1.0m below ground level throughout cutting has been assumed.

GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

5 No, Quick Undrained Triaxial Tests were undertaken in Borehole SK42NE71 and SK42NE72, with the following results:

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Mercia Mudstone – III/IV	1.52	97
Mercia Mudstone – III/IV	1.52	141
Mercia Mudstone – III/IV	4.57	141
Mercia Mudstone – III/IV	5.18	210
Mercia Mudstone – III/IV	6.71	90

Lab Test Data - BRE Classification:

No chemical laboratory testing data is available for this location.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that road level on the base of the cutting is straight on to the Mercia Mudstone III/IV at this location. The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Validation Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Mercia Mudstone – III/IV	0.00 – >10.00	52.78 – <42.78	>10.00	21	30	2	150	10.8	8.6	-	0.5	0.20	-	3.58

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Due to limited geotechnical data available for the Mercia MudstoneIII/IV, the geotechnical parameters derived in AMAR GIR have been adopted for design.
(4) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Mercia Mudstone – III/IV, the classification used for the strata in the AMAR GIR was adopted.

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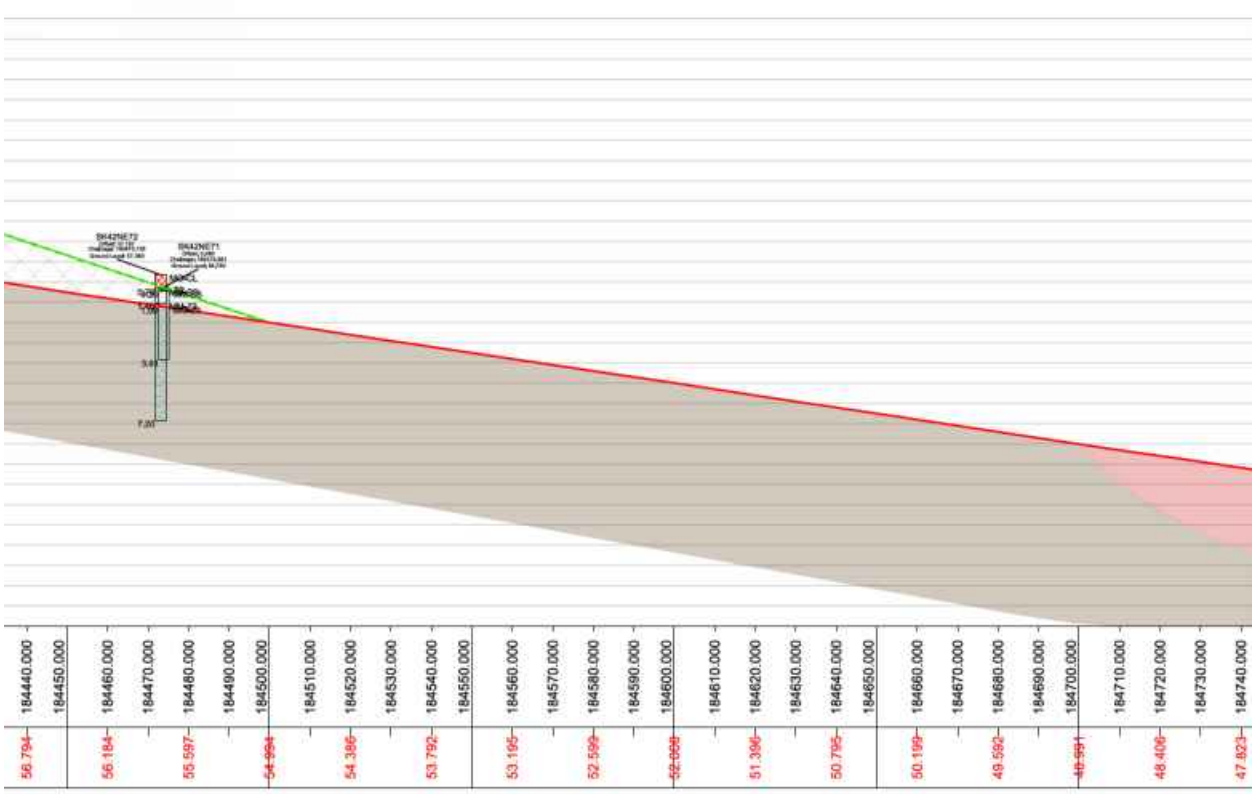


Figure 5: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
184560	184700	Full Height Regrade 1:2.5

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-R-FTPSB5_800y at chainage 184672, southbound, dynamic sample with rotary follow to 10m bgl.

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HISTORICAL EXPLORATORY HOLES

amey

Borehole Log

Borehole No.
SK42NE71
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447491.00 - 326858.00	Hole Type CP
Location:		Level: 56.75mbgl	Scale 1:50
Client: Highways England		Dates: 02/02/1988 - 02/02/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.20 - 0.80	1B			0.20	56.55		TOPSOIL TP Light grey green moderately weathered silty fine grained porous SANDSTONE weak to very weak with occasional red brown siltstone lenses and occasional black speckled staining. (KEUPER SERIES SANDSTONE 3) MM-SS
		1.00	SPT (S)	N=98 (8,9/12,15,24,47)	Water=-	1.00	55.75		
		1.00 - 1.45	2D						Very stiff (hard) red brown CLAY with occasional fine gravel sized lithorelics thinly to thickly interlaminated very dense light grey green SILT. Below 2.30m stiff becoming very stiff red brown locally thinly laminated locally very silty CLAY with occasional fine to medium occasionally coarse gravel sized lithorelics and occasional bands and lenses of light greenish grey slightly fine sandy siltstone. (KEUPER SERIES MARL 3/4a) MM-Z3
		1.70	SPT (S)	N=53 (7,15/19,9,8,17)	Water=-				
		1.70 - 2.15	3D						
		2.50	SPT (S)	N=98 (8,14/17,21,26,34)	Water=-				
		2.50 - 2.95	4D						
		3.00	SPT (S)	50 (12,37/50 for 40mm)	Water=-				
		3.00 - 3.19	5D						
		3.40	SPT (S)	50 (9,28/50 for 55mm)	Water=-	3.61	53.14		End of borehole at 3.61 m
		3.40 - 3.61	6D						

Remarks
Hand dug inspection pit from ground level to 1.00m

AGS

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Borehole Log

Borehole No. **SK42NE72** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447525.00 - 326851.00	Hole Type CP
Location:		Level: 57.35mbgl	Scale 1:50
Client: Highways England		Dates: 25/01/1988 - 26/01/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	1D						Very stiff red brown very silty locally slightly fine sandy CLAY with occasional fine gravel sized lithorelics and a little to some angular medium to coarse mudstone and sandstone gravel. (Possible FILL) MG-CL
		0.50 - 0.95	2U	150blows		0.70	56.65		
		1.00	3D						Light grey green moderately weathered silty fine grained SANDSTONE weak to very weak with black speckled staining. Below 1.00m becoming fine silty SAND with frequent medium to coarse gravel sized lithorelics. (KEUPER SERIES SANDSTONE 3) MM-SS
		1.00	SPT (S)	N=64 (3,10/15,12,17,20)	Water=-	1.40	55.95		
		1.00 - 1.45	4D						
		2.00	SPT (S)	N=92 (7,12/17,23,25,27)	Water=-				Very stiff red brown locally thinly laminated CLAY with occasional fine to medium gravel sized lithorelics and occasional pockets and lenses of light grey green silt and siltstone. Frequent bands of light reddish green silty fine SAND with occasional fine to medium gravel sized lithorelics. (KEUPER SERIES MARL 3/4a) Below 7.00m becoming probably sandstone MM-Z3
		2.00 - 2.45	5D						
		3.00	SPT (S)	50 (15,36/50 for 50mm)	Water=-				
		3.00 - 3.20	6D						*red brown probably moderately weathered SILTSTONE very weak*
		4.00	SPT (S)	50 (17,31/50 for 42mm)	Water=-				
		4.00 - 4.19	7D						
		5.00	SPT (S)	0 (70 for 115mm/0 for 0mm)	Water=-				
		5.00 - 5.12	8D						
		6.00	SPT (S)	50 (17,36/50 for 75mm)	Water=-				
		6.00 - 6.23	9D						
		7.00	SPT (S)	0 (72 for 125mm/0 for 0mm)	Water=-	7.20	50.15		End of borehole at 7.20m
		7.00 - 7.12	10D						

Remarks

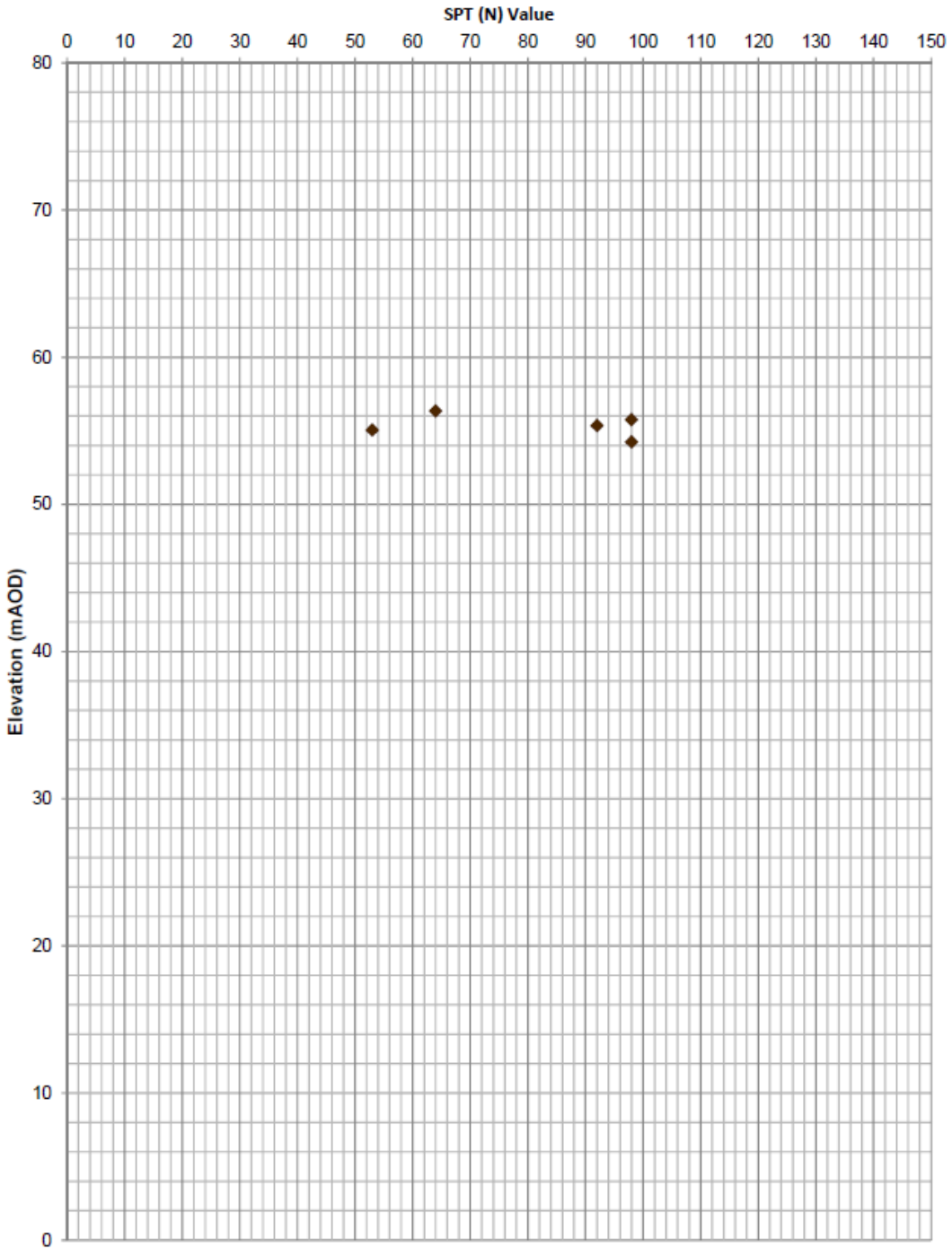
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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184550-184700NB**
Client: **Highways England**	Borehole ID: **SK42NE71 and SK42NE72**	

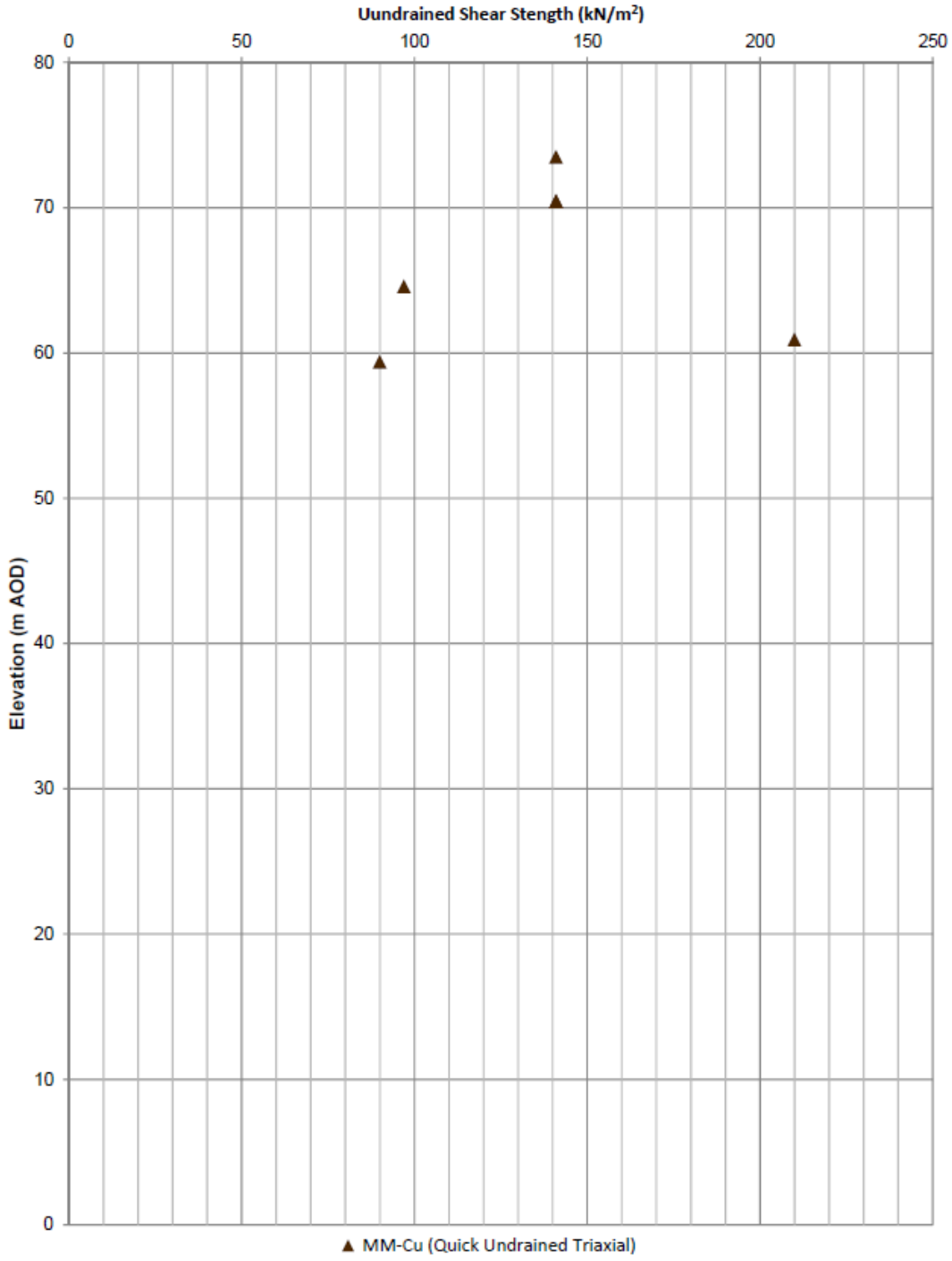


Extrapolated SPT (N) Values >150 have not been shown

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184550-184700**
Client: **Highways England**	Borehole ID: **SK42NE71 and SK42NE72**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-184750-184900NB-GSS-000001		
Earthworks Widening Solution	Full Height Embankment Widening (1:2.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	184750-184900		
Carriageway	Northbound		
Marker Post	M1 Junction 24 NB off slip (LHS)		
National Grid Reference	E 447501, N 327203		
Existing Ground Level at Location	Carriageway	45.13mAOD	
	Toe of Embankment	41.55mAOD	
Earthwork Type	NB: Embankment	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_42055	SB: N/A	HAGDMS designation
Earthwork Height	NB: 3.60m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 21.00^{o}	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	13/04/2017	[redacted]
Checked	Alice Bazen	20/04/2017	
Reviewed	Gary Summerfield	20/04/2017	
Approved	Tom Bulteel	06/06/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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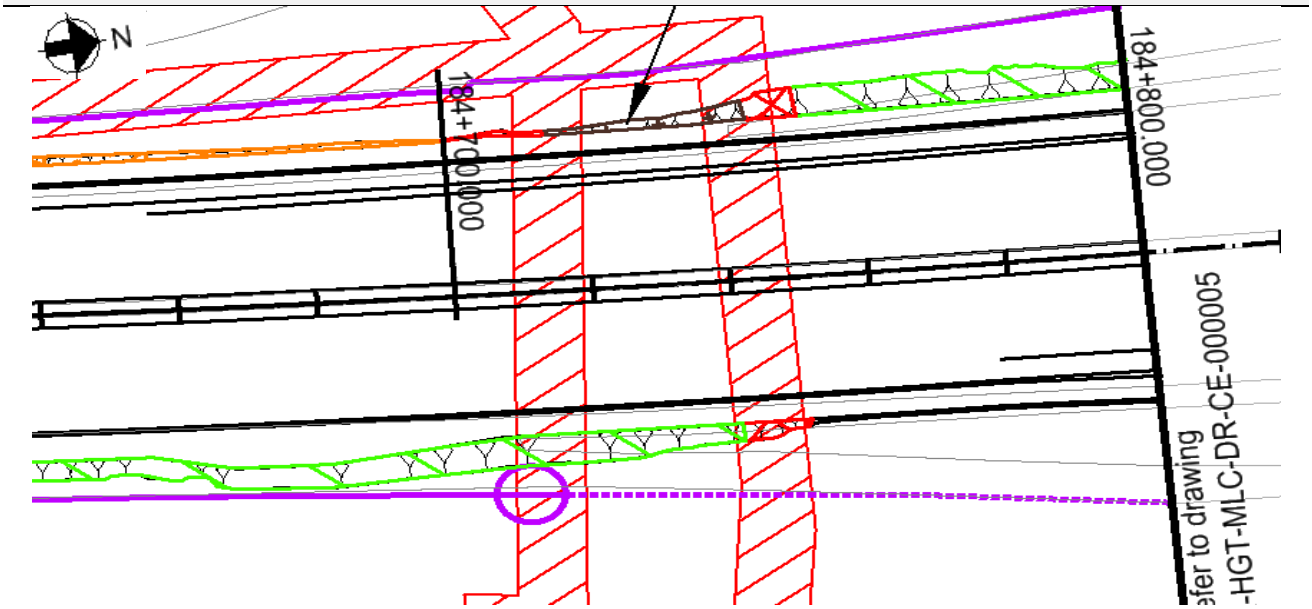


Figure 1.1: Location Plan – 184750-184800

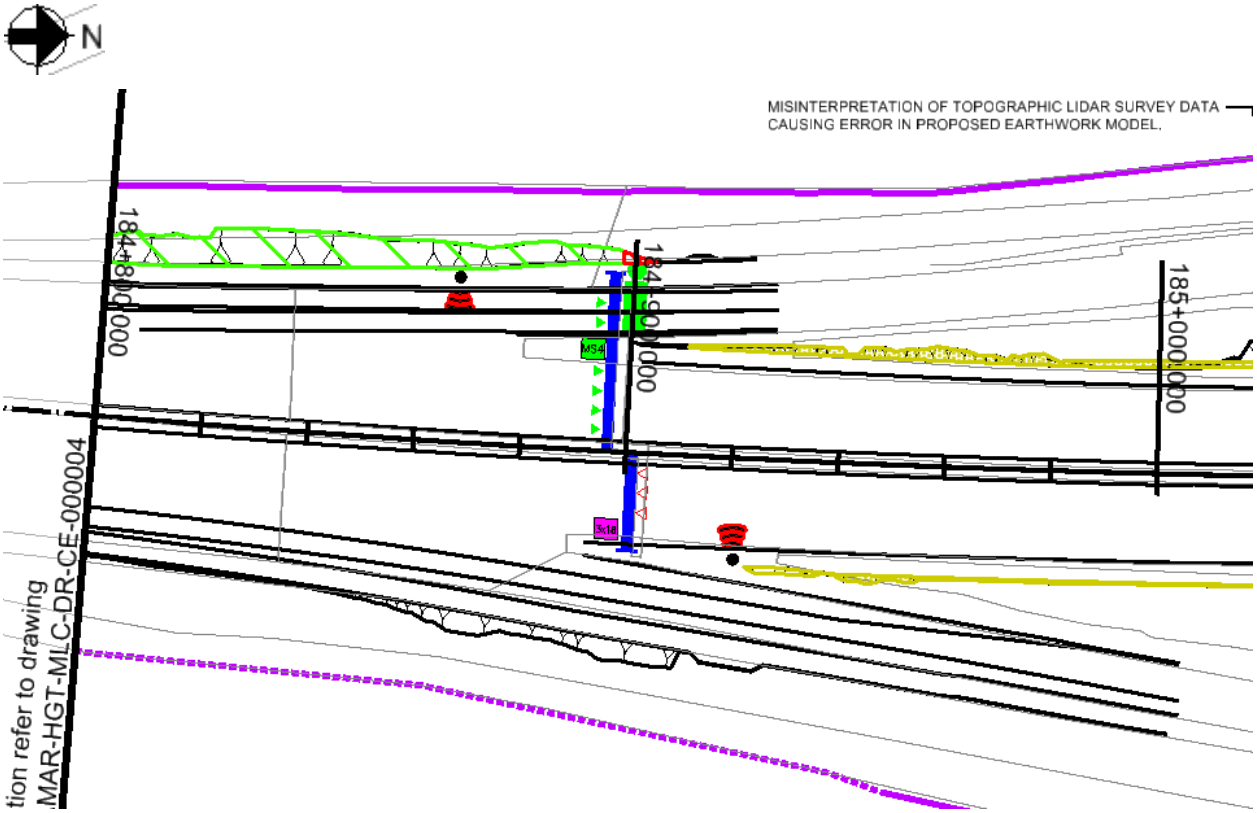


Figure 1.2: Location Plan – 184750-184800

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Full Height Embankment Widening 1:2.0

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as Embankment with a maximum height of approximately 3.60m with an approximate slope angle of 21 degrees.

The critical cross section at chainage 184810 was based on the section with the greatest earthwork height.

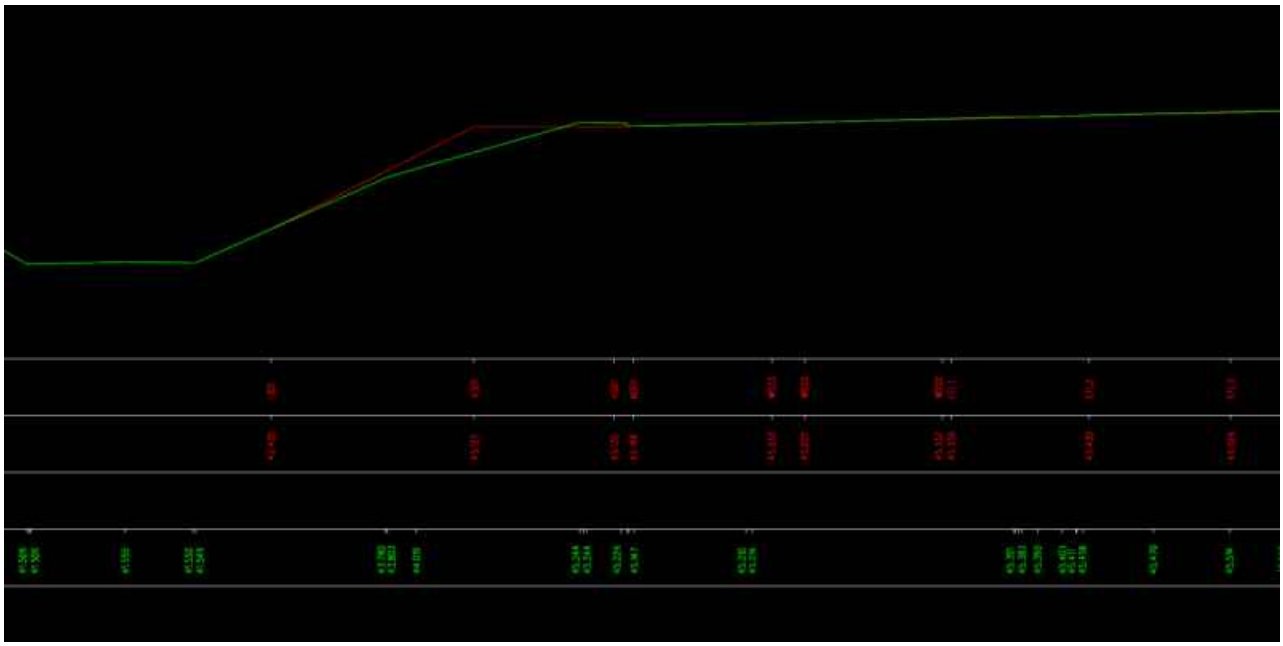


Figure 2: Topographic Cross Section Chainage 184810

Utilities:

Western Power High Voltage Supply running northbound to southbound at approximately ch.184745

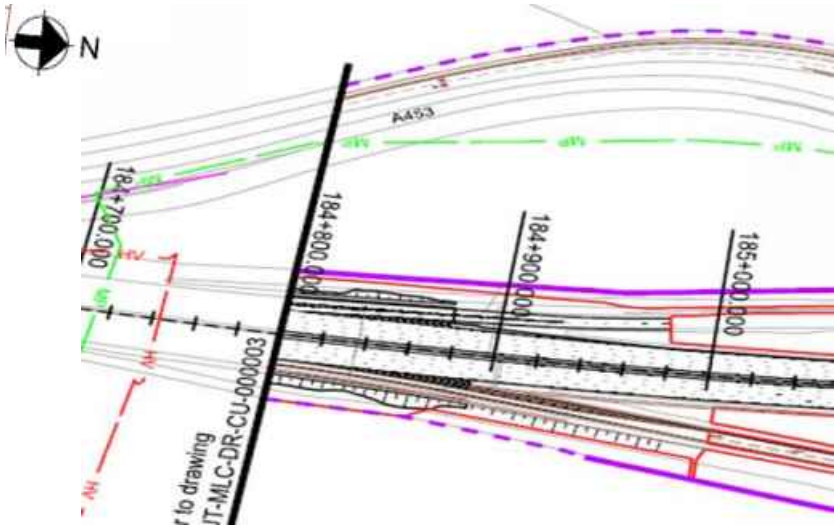


Figure 3: Utilities Location Plan.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: N/A

Solid Deposits: Triassic Rocks – Mudstone, Siltstone and Sandstone

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however 1 no. relevant exploratory hole was considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HCT-SWI-DR-CE-000027, Rev P01.

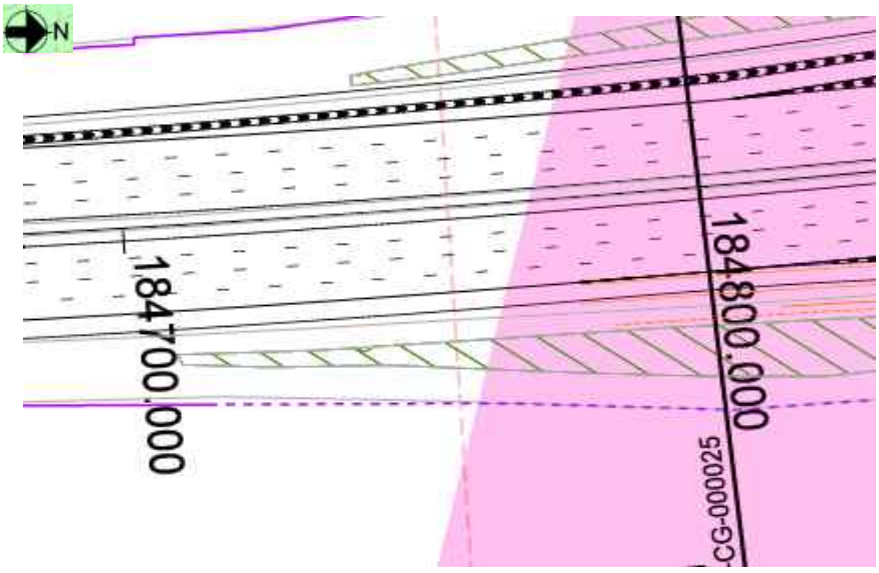


Figure 3.1: Topographic Cross Section Chainage 184750-184800

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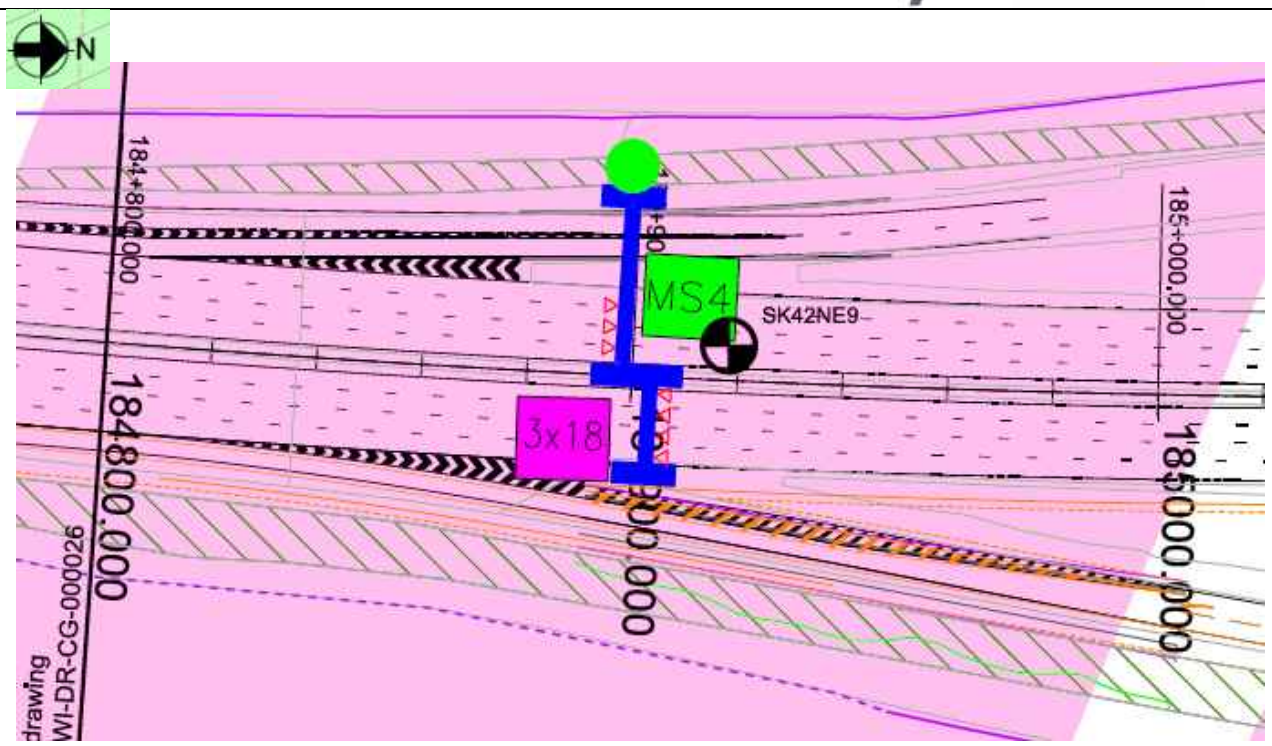


Figure 3.2: Borehole Location Plan – 184800-184900

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42NE9
Borehole Chainage	184918
Borehole Location	Northbound Carriageway
National Grid Reference	E 447530, N 327300
Ground Level at Exploratory Hole	40.10mAOD
RAG Analysis	Amber
Date Drilled	16/08/1961 – 17/08/1961
Termination Depth	6.10 metres below ground level (mbgl) (34.00mAOD)
Other suitable holes	None

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR Survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Embankment Fill	3.74	41.97	-
Mercia Mudstone III/IV	10.00	35.71	57 (57)

(1) Ground level is assumed to be at carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) Local ground information does not show any made ground between 184750-184900, as borehole were likely advanced before the construction of the earthwork. As a result, the embankment fill has been assumed to be present with a maximum height of 3.74
(4) Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard penetration test data is not available in the borehole SK42NE9

Groundwater:

Groundwater was encountered in borehole Sk42NE9 at 1.07mbgl (39.03mAOD).

Groundwater Design Level:

No local groundwater data is available and therefore a design groundwater level of 1.0m below toe of embankment has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

2 No. Atterberg Limit tests were undertaken within the Mercia Mudstone with the results presented in the table below:

Stratum	Depth (mbgl)	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Classification
Mercia Mudstone – III/IV	3.35	-	36	21	15	CI
Mercia Mudstone – III/IV	4.27	-	39	24	15	CI

2 No quick undrained triaxial tests were completed in Borehole SK42NE9 within the Mercia Mudstone layer, with results presented in the table below:

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Mercia Mudstone – III/IV	3.35	110
Mercia Mudstone – III/IV	4.27	93

Lab Test Data – BRE Classification:

No chemical testing was undertaken between these locations.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Validation Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill (Made Ground)	0.00 – 3.74	45.71 – 41.97	3.74	21	27	0	100	7.8	6.2	-	0.5	0.2	-	DS-2 AC-2
Mercia Mudstone – III/IV	3.74 – 10.00	41.97 – 35.71	6.26	21	30	2	150	10.8	8.6	-	0.5	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Due to limited localised GI data for Embankment Fill, the geotechnical parameters derived in the AMAR GIR have been adopted for design.
(4) Due to limited geotechnical data available for the Mercia Mudstone III/IV, the geotechnical parameters derived in AMAR GIR have been adopted for design.
(5) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Embankment Fill and Mercia Mudstone – III/IV, the classification used for the strata in the AMAR GIR was adopted

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Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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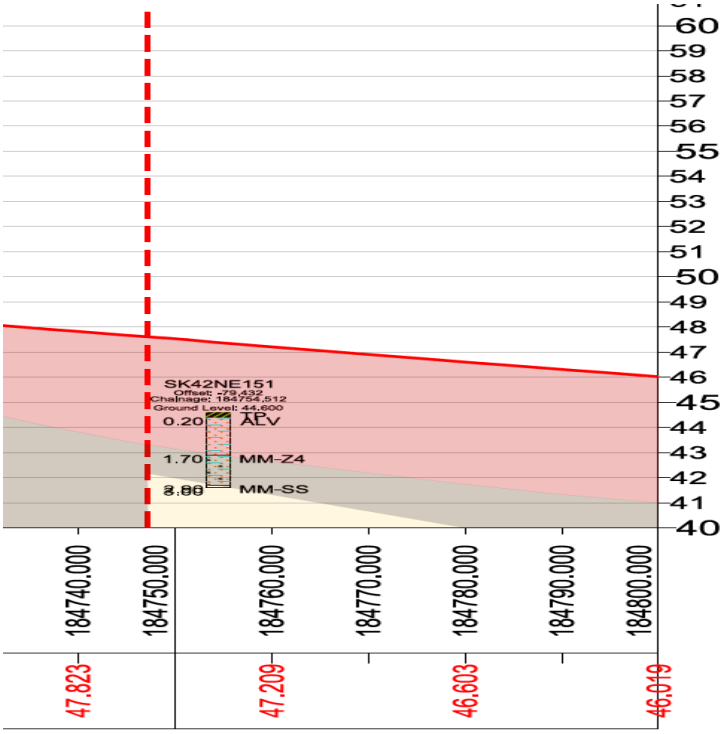


Figure 4.1: Geological Long Section – 184750-184800

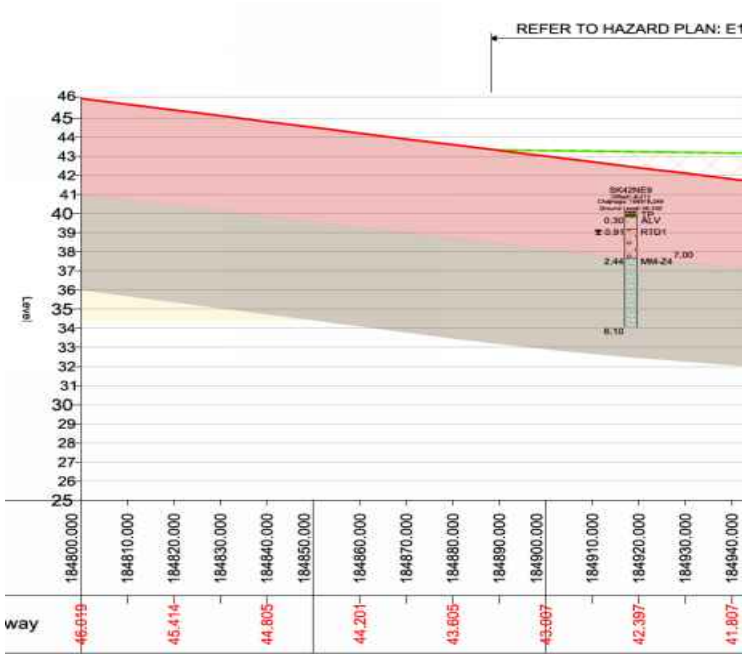


Figure 4.2: Geological Long Section – 184800-184900

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Benching Detail	
			Base Width (m)	Batter Angle (o)
184750	184900	Full Height Embankment Widening (1:2.0)	4.0	26.6 (1V:2H)

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- CPT-02 at chainage 184931, Southbound – CPT test to a depth pf 5.0mbgl.

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HISTORICAL EXPLORATORY HOLES

amey

Borehole Log

Borehole No.
SK42NE9
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447530.00 - 327300.00	Hole Type CP
Location:		Level: 40.10mbgl	Scale 1:50
Client: Highways England		Dates: 16/08/1961 - 17/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.30	587D			0.30	39.80		Topsoil TP
		0.61	588D						Silty soil & stones ALV
	▼	1.07	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-	0.91	39.19		Brown clayey sand and stones RTD1
		1.52	589D						
						2.44	37.66		Stiff red & grey silty clay & siltstone MM-Z4
		3.05	591D						
		3.35 - 3.45	592U	200blows					
		4.27 - 4.57	593U	220blows					
		4.57	594D						
		5.18 - 5.41	595U	200blows					
		6.10	596D			6.10	34.00		End of borehole at 6.10m

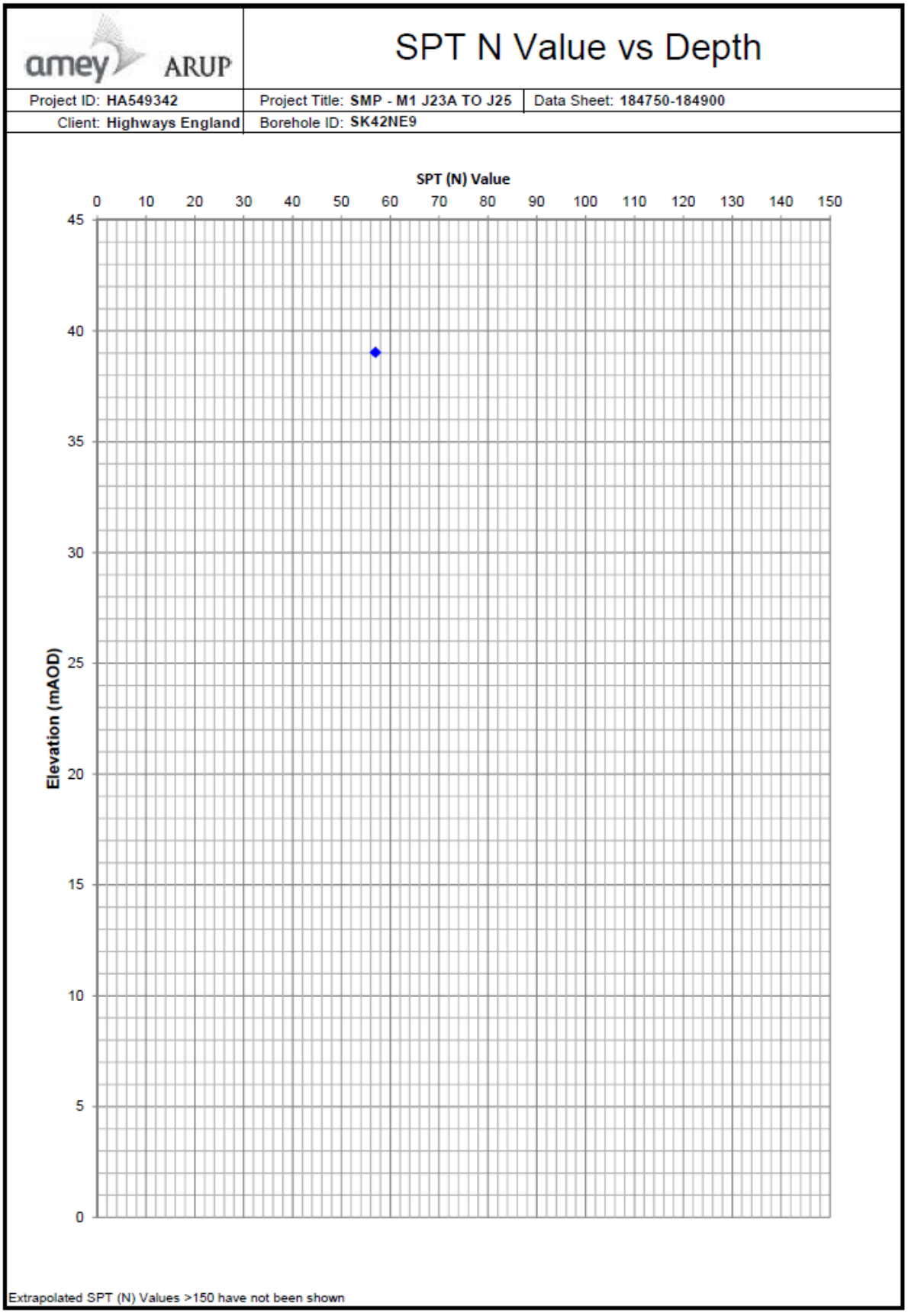
1 2 3 4 5 6 7 8 9 10

Remarks

AGS

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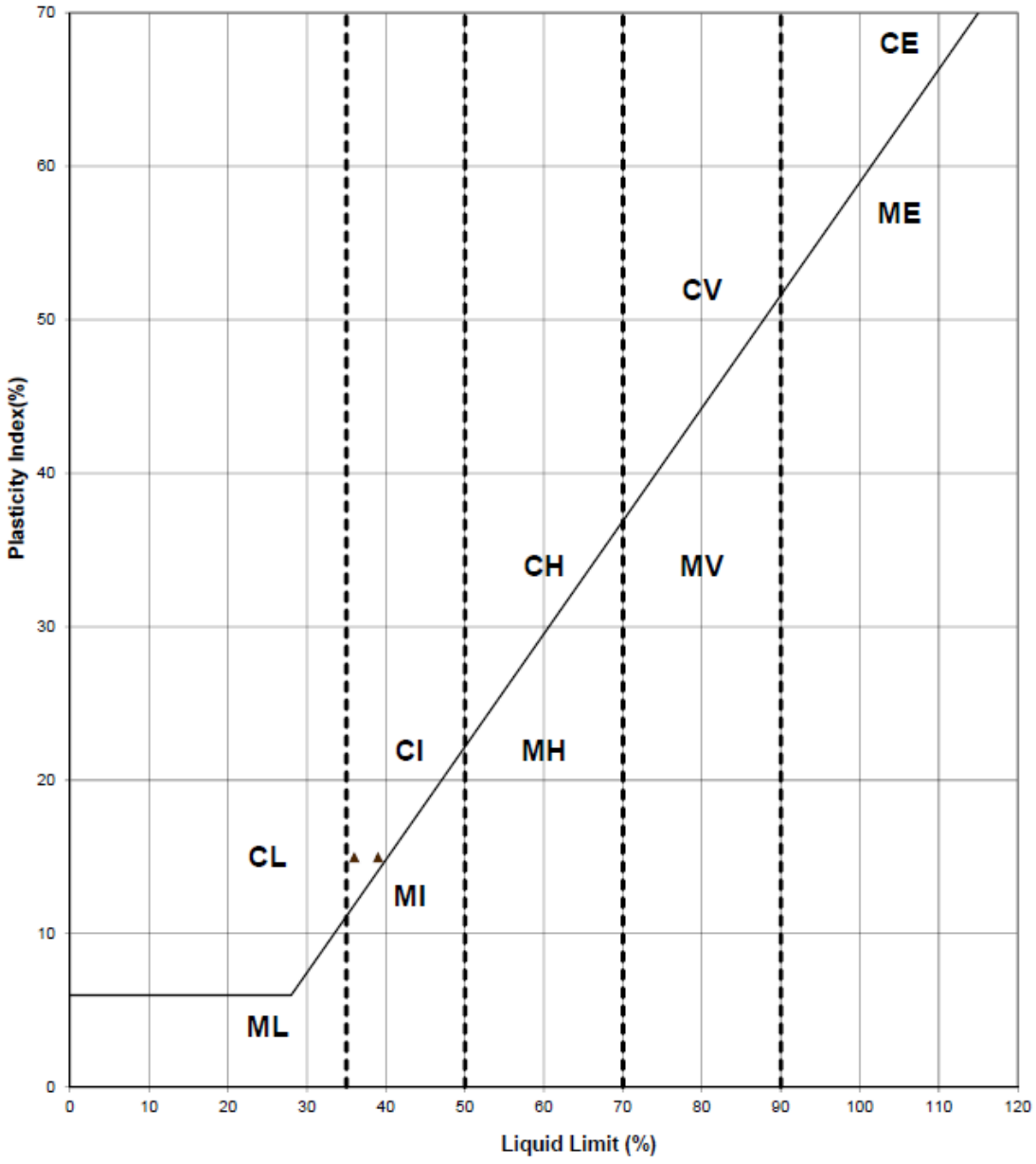
PLOTS



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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184750-184900**
Client: **Highways England**	Borehole ID: **SK42NE9**	



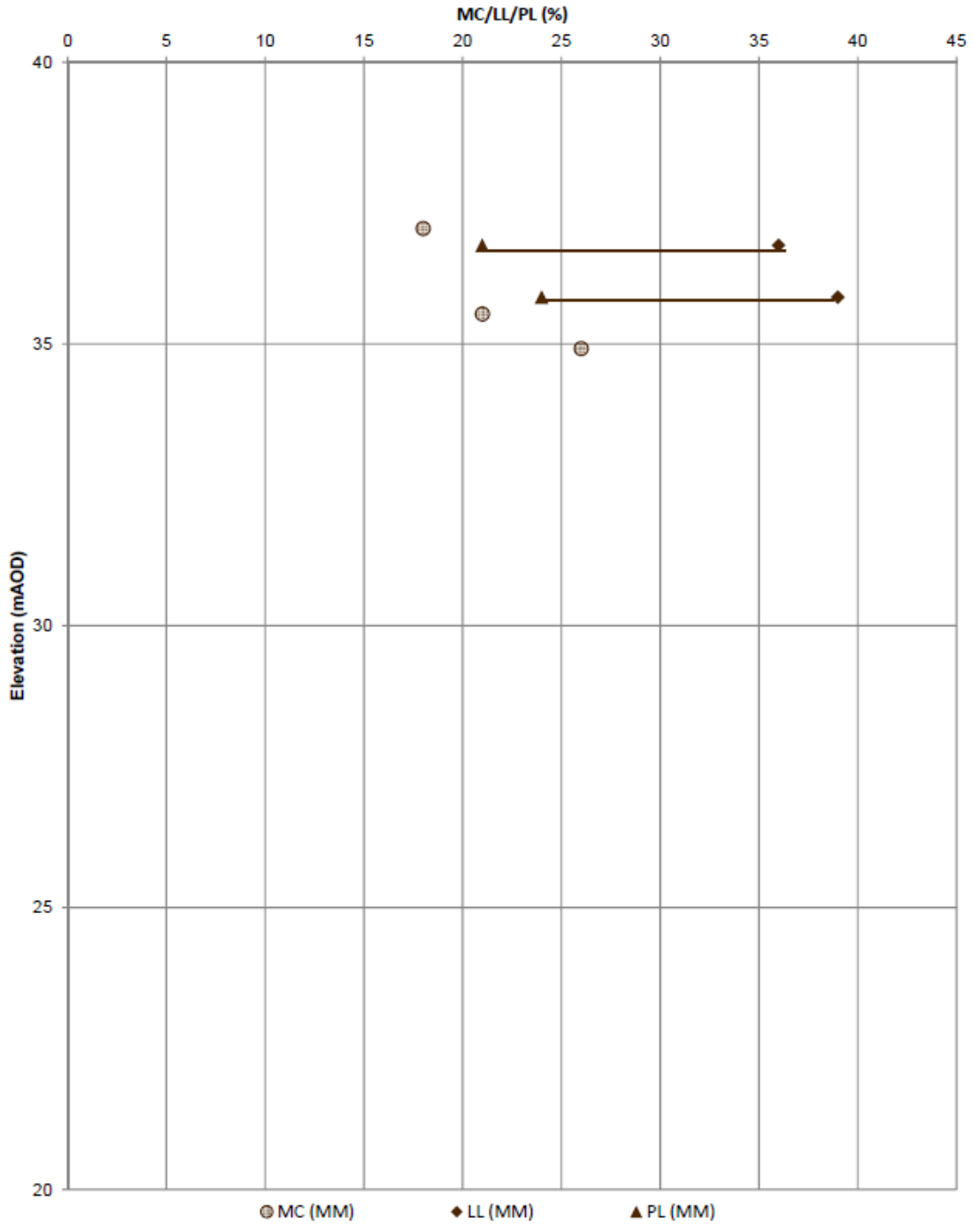
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

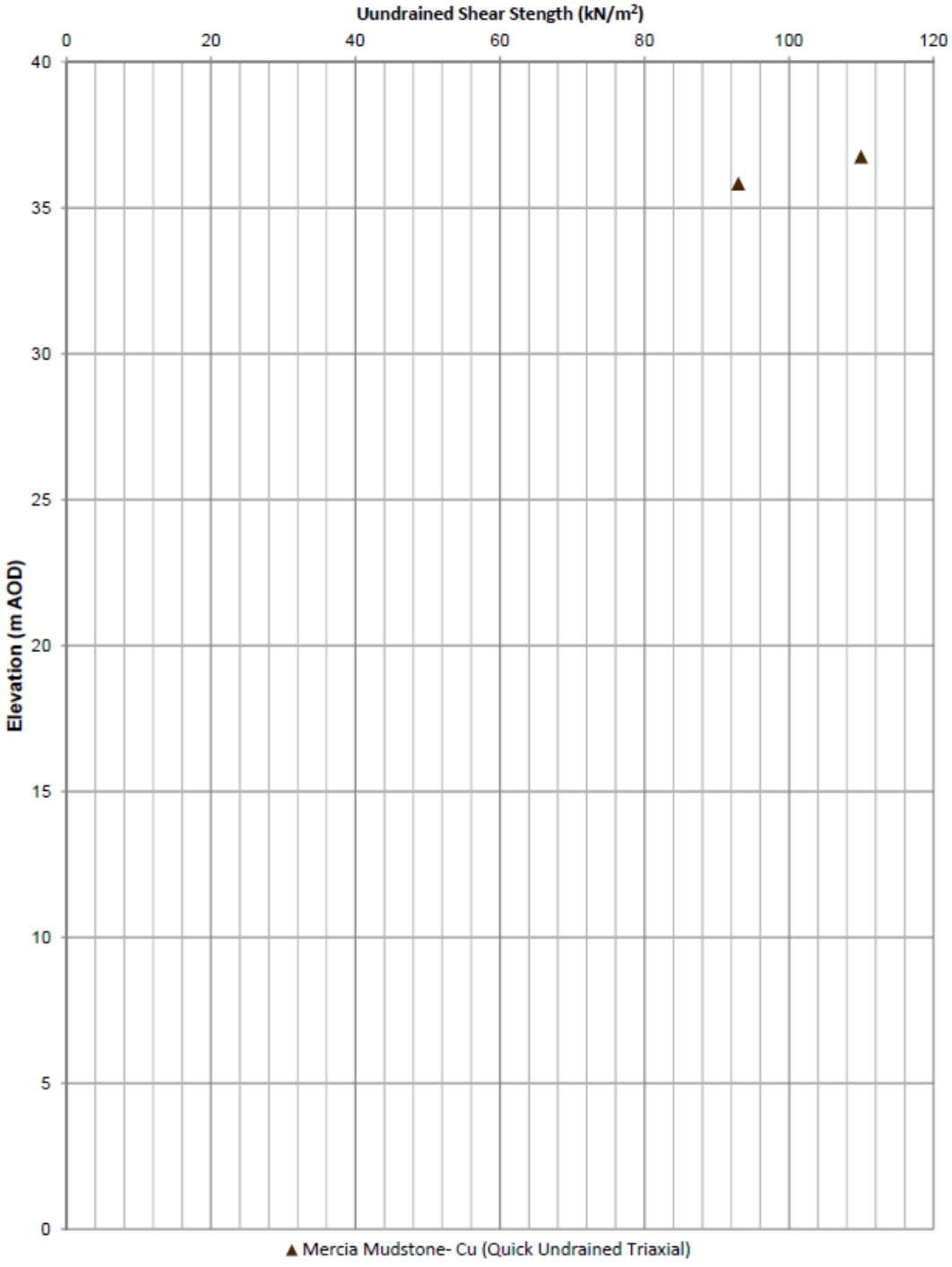
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184750-184900**
Client: **Highways England**	Borehole ID: **SK42NE9**	



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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184750-184900**
Client: **Highways England**	Borehole ID: **SK42NE9**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-185130-185320NB-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number[1]	E1-A1		
Structure Type	Emergency Refuge Area (ERA)		
Design Chainage	185130-185320		
Carriageway	Northbound		
Marker Post	185/1+30 – 185/3+20		
National Grid Reference	E 447522, N 327532 – E 447514, N 327700		
Existing Ground Level at Location	Crest of cutting	41.4mAOD	
	Carriageway	35.1mAOD	
Earthwork Type	NB: Cutting	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_42057	SB: N/A	HAGDMS designation
Earthwork Height	NB: 5.7m – 6.3m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 24^{o}	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Roheel Masrat / Scott Bishton	25/04/2017	[redacted]
Checked	Alice Bazen	26/04/2017	
Reviewed	Gary Summerfield	27/04/2017	
Approved	Tom Bulteel	06/06/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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Figure 1: Location Plan

Proposed Widening:

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- King sheet pile retaining wall to prevent interference with HE boundary. The king sheet pile walls have been subdivided as follows:
  - Ch185130-185220, maximum retained height 2.0m;
  - Ch185220-185270, maximum retained height 2.3m;
  - Ch185270-185320, maximum retained height 2.0m.

Proposed Major Structures:

Emergency Refuge Area ERA E1-A1 is proposed between Ch185195-185305 on the northbound carriageway.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at this location is classified as 5.7m-6.7m high cutting with an approximate slope angle of 24°.

The critical cross sections (Ch1825220 and Ch185230) were both found to comprise a cutting of approximately 6.3m height and a typical slope angle of 24° and are based on sections with the greatest retained heights.

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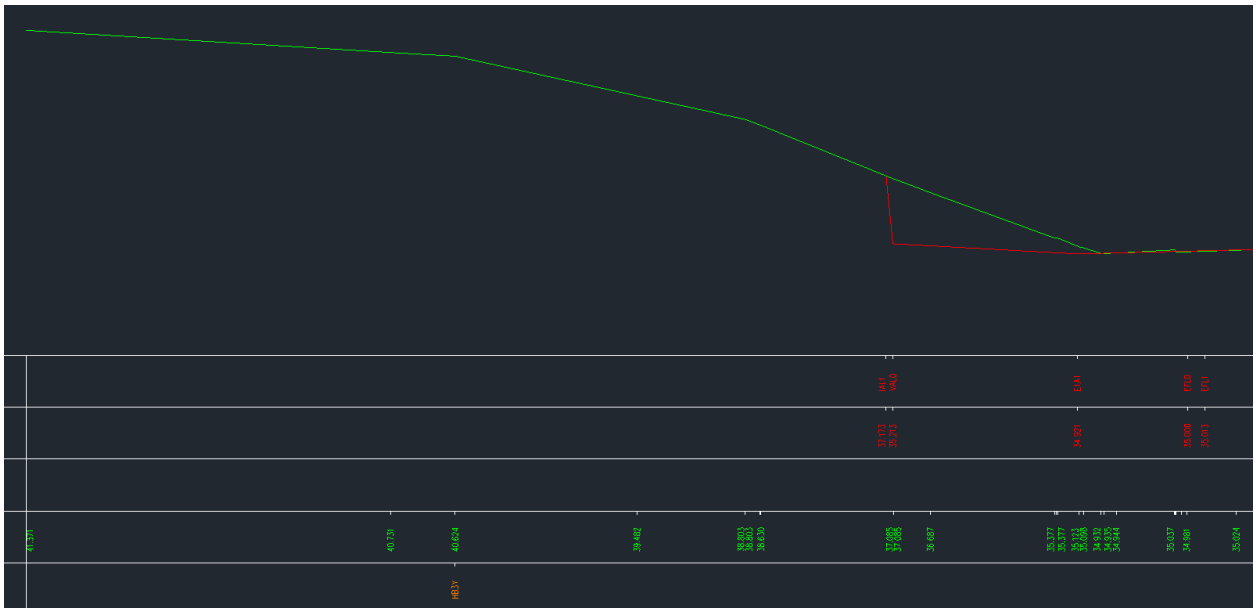


Figure 2.1: Topographic Critical Cross Section Ch185220 (for 2.0m retained height)



Figure 2.2: Topographic Critical Cross Section Ch185230 (for 2.3m retained height)

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Wanlip Member (Glaciofluvial Deposits)

Solid Deposits: Edwalton Member (Mercia Mudstone Group)

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however 3 no. relevant exploratory holes were considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000025, Rev P01.

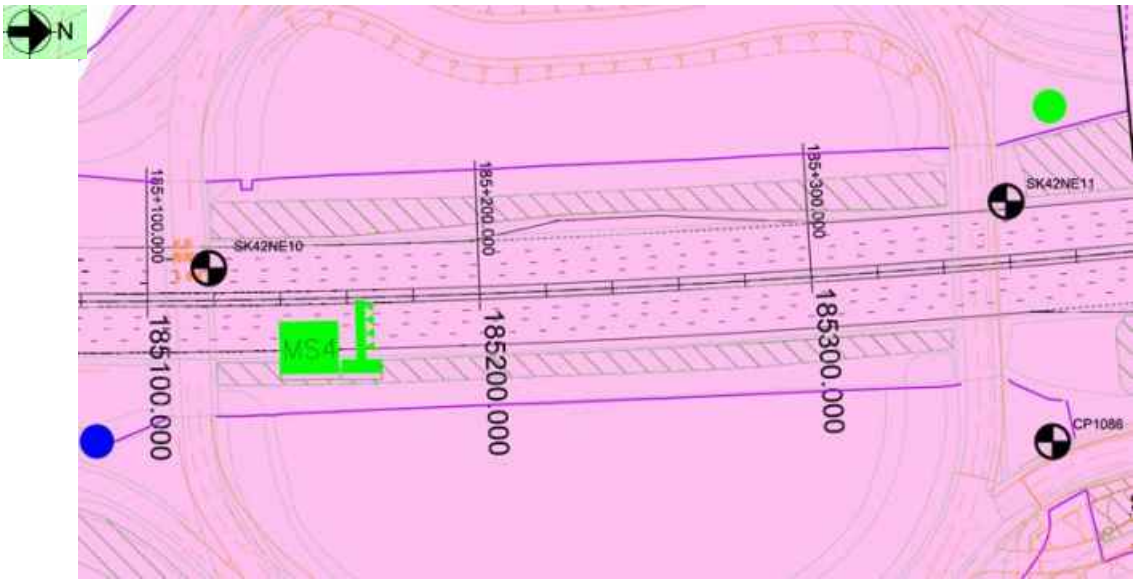


Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42NE10	SK42NE11
Borehole Chainage	185118	185359
Borehole Location	Northbound carriageway (prior to motorway construction)	Northbound verge (prior to motorway construction)
National Grid Reference	E 447530, N 327500	E 447510, N 327740
Ground Level at Exploratory Hole	39.20mAOD	37.20mAOD
RAG Analysis	Amber	Amber
Date Drilled	12/08/1961 – 15/08/1961	09/08/1961 – 11/08/1961

Termination Depth	9.14 metres below ground level (mbgl) (30.06mAOD)	12.19mbgl (25.01mAOD)
Other suitable holes	CP1086	

Existing Ground itions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Embankment Fill	6.3	35.1	15-18 (17)
Glaciofluvial Deposits (fine grained)	9.7	31.7	59 (59)
Mercia Mudstone – III/IV	Not proven	Not proven	85-130 (85)

(1) Ground level is assumed to be at the carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Embankment Fill is not recorded in historical exploratory holes SK42NE10 and SK42NE11 because they were undertaken before earthwork construction. Therefore, Embankment Fill depth was based on topographic data..
(5) Glaciofluvial Deposits were recorded as fine grained in SK42NE10 and as coarse grained in SK42NE11; for a conservative design, the Glaciofluvial Deposits were assumed to be fine grained.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in historical exploratory holes SK42NE10, SK42NE11 and CP1086.

Groundwater:

Groundwater was recorded as follows:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
SK42NE10	Mercia Mudstone – III/IV	3.96	35.24	20 mins	3.96	35.24
SK42NE11	Glaciofluvial Deposits (Fine Grained)	3.05	34.15	20 mins	3.05	34.15

Groundwater Design Level:

Due to limited local groundwater data, a groundwater level of 1.0m below toe of embankment has been assumed for WALLAP analysis for king sheet piles. When checking the global stability check of the earthwork and king sheet pile (analysed using SLOPE W) a Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

10 No. Atterberg Limit tests and 5 No. Moisture Content tests were completed within historical exploratory holes with the results presented in the table below:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	3.70	15	30	14	16	CL
Embankment Fill	5.70	17	32	13	19	ML
Glaciofluvial Deposits (fine grained)	1.37	-	22	13	9	CL
Mercia Mudstone – III/IV	12.70	19	32	16	16	CL
Mercia Mudstone – III/IV	5.64	-	29	15	14	CL
Mercia Mudstone – III/IV	7.16	-	30	18	12	CL
Mercia Mudstone – III/IV	8.69	-	47	30	17	MI
Mercia Mudstone – III/IV	6.10	-	34	24	10	ML
Mercia Mudstone – III/IV	7.77	20	32	25	7	ML
Mercia Mudstone – III/IV	10.67	14	28	17	11	CL

8 No. quick undrained triaxial tests were completed within historical exploratory holes with the results presented in the table below:

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	5.20	80
Embankment Fill	3.20	63
Glaciofluvial Deposits (fine grained)	1.37	41
Mercia Mudstone – III/IV	6.10	145
Mercia Mudstone – III/IV	6.10	66
Mercia Mudstone – III/IV	5.64	483
Mercia Mudstone – III/IV	7.16	62
Mercia Mudstone – III/IV	8.69	62

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Lab Test Data - BRE Classification:

Chemical laboratory test data in presented in the table below:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Water Soluble Sulphate as SO4	Water	2	0-0.02	g/l SO4
Embankment Fill	pH	Solid	1	8.3	-
Embankment Fill	pH	Water	1	7.1	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000025 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0.00 – 6.3	41.4 – 35.1	6.3	21	26	0	90	6.9	5.5	-	0.50	0.20	-	DS-2 AC-2
Glaciofluvial Deposits (fine grained)	6.3 – 9.7	35.1 – 30.7	3.4	21	26	0	100	7.8	6.2	-	0.50	0.20	-	DS-3 AC-3
Mercia Mudstone – III/IV	>9.7	<30.7	-	21	27	2	100	16.8	13.4	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.

(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.

(3) ϕ' of Embankment Fill was determined using Table 2 in BS8002:2015 using the recorded PI of 19% gives 26°. Although there were only 2 No. PI tests, the results were similar to the AMAR GIR characteristic value of 27° and therefore considered suitable.

(4) c_u of Embankment Fill was derived using the Stroud correlation. The recorded PI of 19% gives an f1 value of 5.5, using a typical SPT 'N' value of 17, Cu= 94kN/m^2. Based on this derived result and the recorded triaxial test results, it is considered that a c_u value of 90kN/m^2 is adopted.

(5) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the characteristic SPT 'N' value of 17, Eu = 6.9MN/m^2. Therefore E' = 5.5MN/m^2.

(6) Due to the lack of local data for Glaciofluvial Deposits (fine grained), the characteristic values given in the AMAR GIR were adopted.

(7) ϕ' of Mercia Mudstone – III/IV was determined using Table 2 in BS8002:2015 using the maximum recorded PI of 17% gives 27°.

(8) c_u of Mercia Mudstone – III/IV was derived using the Stroud correlation. The recorded PI of 17% gives an f1 value of 6, using a typical SPT 'N' value of 85, Cu= 510kN/m^2. This exceeded the range in the AMAR GIR. The undrained triaxial tests either recorded c_u values in excess of the range given in the AMAR GIR (maximum 200kN/m^2) or were uncharacteristically low (e.g. 66kN/m^2); therefore the typical value from the AMAR GIR was instead adopted.

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(9) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the characteristic SPT 'N' value of 85, Eu = 27.3MN/m^2. Therefore E' = 21.8MN/m^2. These values exceed the range given in the AMAR GIR, and considering the variation in GI lab test data for the Mercia Mudstone – III/IV (>10mbgl), the characteristic value from the AMAR GIR was adopted instead.

(10) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Embankment Fill, Glaciofluvial Deposits and Merica Mudstone, the classification used for the strata in the AMAR GIR was adopted.

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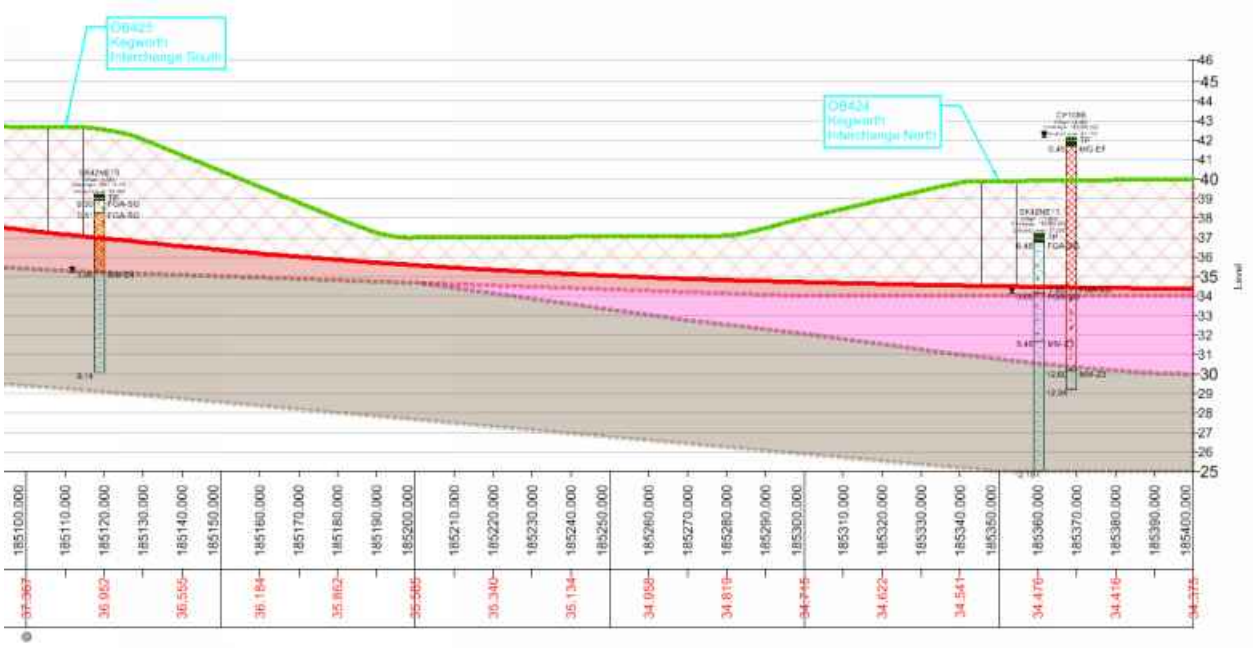


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to the requirement of additional land take beyond the highway boundary, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	King Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
185130	185220	AZ-24 700 S 390 GP	2.0	6.0	8.0	80	66	29.0	118
185220	185270	AZ-24 700 S 390 GP	2.3	7.7	10.0	87	67	37.0	217
185270	185320	AZ-24 700 S 390 GP	2.0	6.0	8.0	80	67	29.0	118

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.

Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-E1-A1.1, Ch185195, Northbound - 10m deep dynamic sample / rotary core follow on exploratory hole, located on northbound grass verge.
- BH-E1-A1.2, Ch185305, Northbound - 10m deep dynamic sample / rotary core follow on exploratory hole, located on northbound grass verge.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **CP1086** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447582.00 - 327754.00	Hole Type CP
Location:		Level: 42.15	Scale 1:50
Client: Highways England		Dates: 26/01/2007 - 29/01/2007	Logged By RMS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20 - 0.45	B							Dark brown sandy TOPSOIL. Driller notes hardcore over brown clayey sand. TP
		0.45 - 1.20	B				0.45	41.70		MADE GROUND. Firm to stiff brown gravelly clay. Gravel is subangular to subrounded fine to coarse of mudstone and siltstone. MG-EF
		1.20 - 1.65	U							
		1.70	D							Below 1.70m, with coarse rounded gravel of quartz
		2.20 - 2.65	D							Below 2.20m, mottled grey
		2.20 - 2.70	B							
		3.20 - 3.65	U							
		3.70	D							
		4.20 - 4.56	D							At 4.20m, slightly sandy, slightly gravelly
		4.20 - 4.70	B							
		5.20 - 5.65	U							
		5.70	D							
		6.20 - 6.65	D							Below 6.20m, sandy, slightly gravelly
		6.20 - 6.70	B							
		7.20 - 7.65	U							
		7.65	D				7.65	34.50		Medium dense to dense yellow brown gravelly SAND and sandy GRAVEL. Sand is fine to medium, gravel is rounded, fine to coarse of mudstone, sandstone and quartz. FGA-SG
		7.70 - 8.15	D							Below 7.70m, slightly clayey
		7.70 - 8.20	B							
		9.10	W							
		9.20 - 9.70	B							Below 9.20m, sand is fine to coarse, gravel of quartz
										Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 12.40m to 12.70m (1 hour). ;No visual or olfactory indication of contamination was observed. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 7.70m.;

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Rotary Core Log

Borehole No. CP1086 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447582.00 - 327754.00	Hole Type CP
Location:		Level: 42.15	Scale 1:50
Client: Highways England		Dates: 26/01/2007 - 29/01/2007	Logged By RMS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.70 - 11.20	B							SAND (as previous sheet)
		12.00 - 12.38	D				12.00	30.15		Stiff red brown locally mottled grey CLAY with subangular to subrounded, fine to coarse gravel sized lithorelics of mudstone. MM-Z3
		12.00 - 12.70	B							
		12.70 - 12.94	D							
							12.94	29.21		End of borehole at 12.94 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 12.40m to 12.70m (1 hour).;No visual or olfactory indication of contamination was observed.;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 7.70m.;

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Rotary Core Log

Borehole No. **SK42NE10**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447530.00 - 327500.00	Hole Type CP
Location:		Level: 39.20	Scale 1:50
Client: Highways England		Dates: 12/08/1961 - 15/08/1961	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	D				0.30	38.90		Topsoil TP
		0.61	D							Sandy soil & stones FGA-SG
							0.91	38.29		Gravel with soft sandy clay becoming clayey sand & gravel FGA-SG
		1.52	D							
		3.05	B							
		3.05	D							
		3.05 - 3.20	U							
	▼	3.96	W				3.96	35.24		Firm and stiff red and grey silty clay MM-Z4
		3.96 - 4.06	U							
		4.27	D							
		5.64 - 6.02	U							
		6.10	D							
		7.16 - 7.54	U							
		7.62	D							
		8.69 - 9.14	U							
		9.14	D				9.14	30.06		End of borehole at 9.14 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE11**

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447510.00 - 327740.00	Hole Type CP
Location:		Level: 37.20	Scale 1:50
Client: Highways England		Dates: 09/08/1961 - 11/08/1961	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	D				0.46	36.74		Topsoil TP
		0.61	D							Stiff brown clay & stones FGA-SG
		1.37 - 1.83	U							
		1.52	D							
	▼	3.05	D				3.05	34.15		Soft clay, sand and gravel FGA-SG
		4.57	D							
		5.18	D							
							5.49	31.71		Firm to stiff red & grey silty clay MM-Z3
		6.10	D							
		6.10 - 6.55	U							
		7.62	D							
		7.77 - 7.98	U							
		9.14	D							

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No.
SK42NE11
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447510.00 - 327740.00	Hole Type CP
Location:		Level: 37.20	Scale 1:50
Client: Highways England		Dates: 09/08/1961 - 11/08/1961	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.67 - 10.92	U							
		12.19	D				12.19	25.01		End of borehole at 12.19 m
		12.19 - 12.20	U							

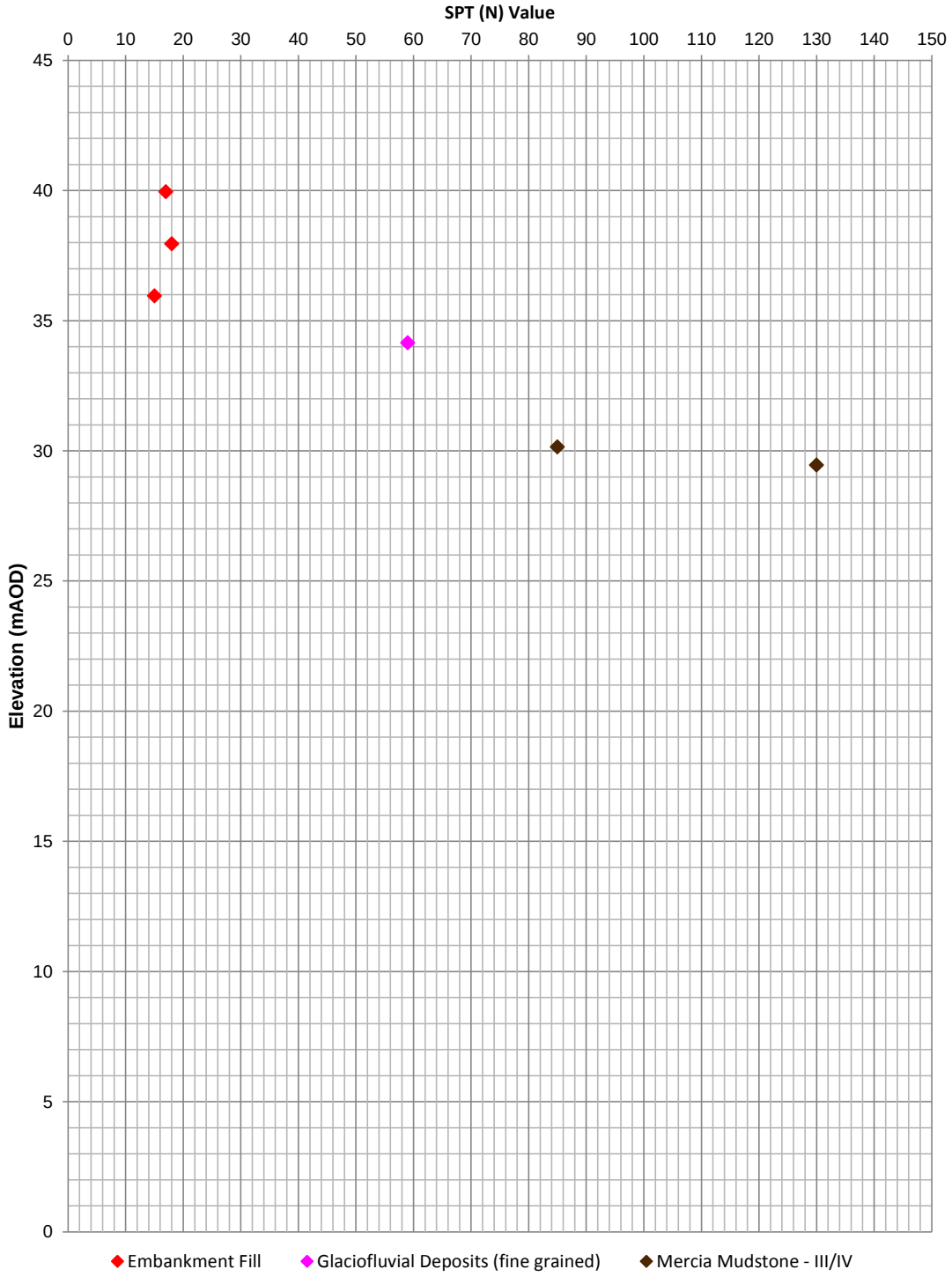
Remarks

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PLOTS

amey ARUP	SPT N Value vs Depth
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25** | Data Sheet: **185150-185320NB**
Client: **Highways England**	Borehole ID: **SK42NE10, SK42NE11, CP1086**



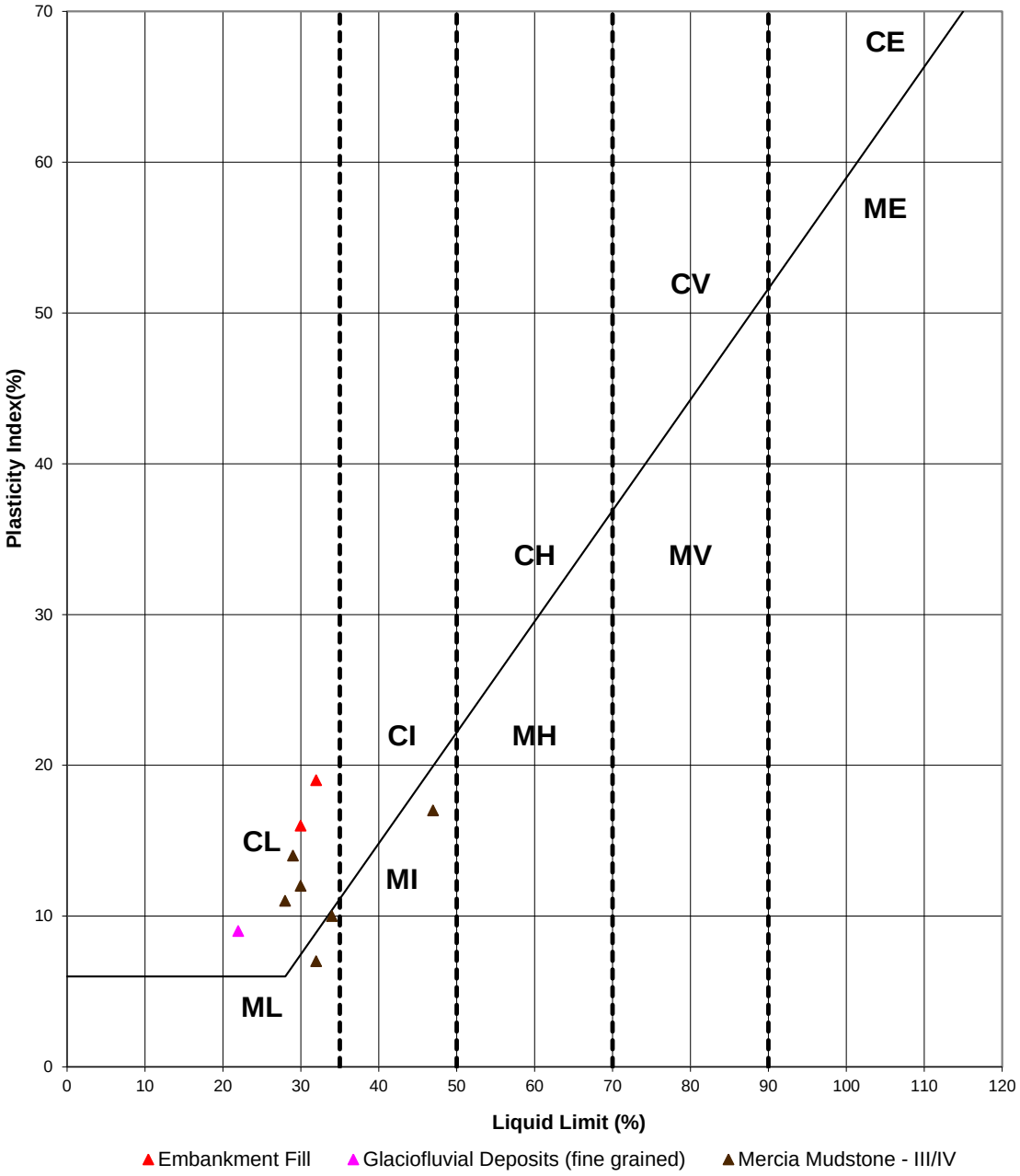
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 16/01/2017 Ref: HA549342-AMAR-HGT-185150-185320NB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185150-185320NB**
Client: **Highways England**	Borehole ID: **SK42NE10, SK42NE11, CP1086**	



Key

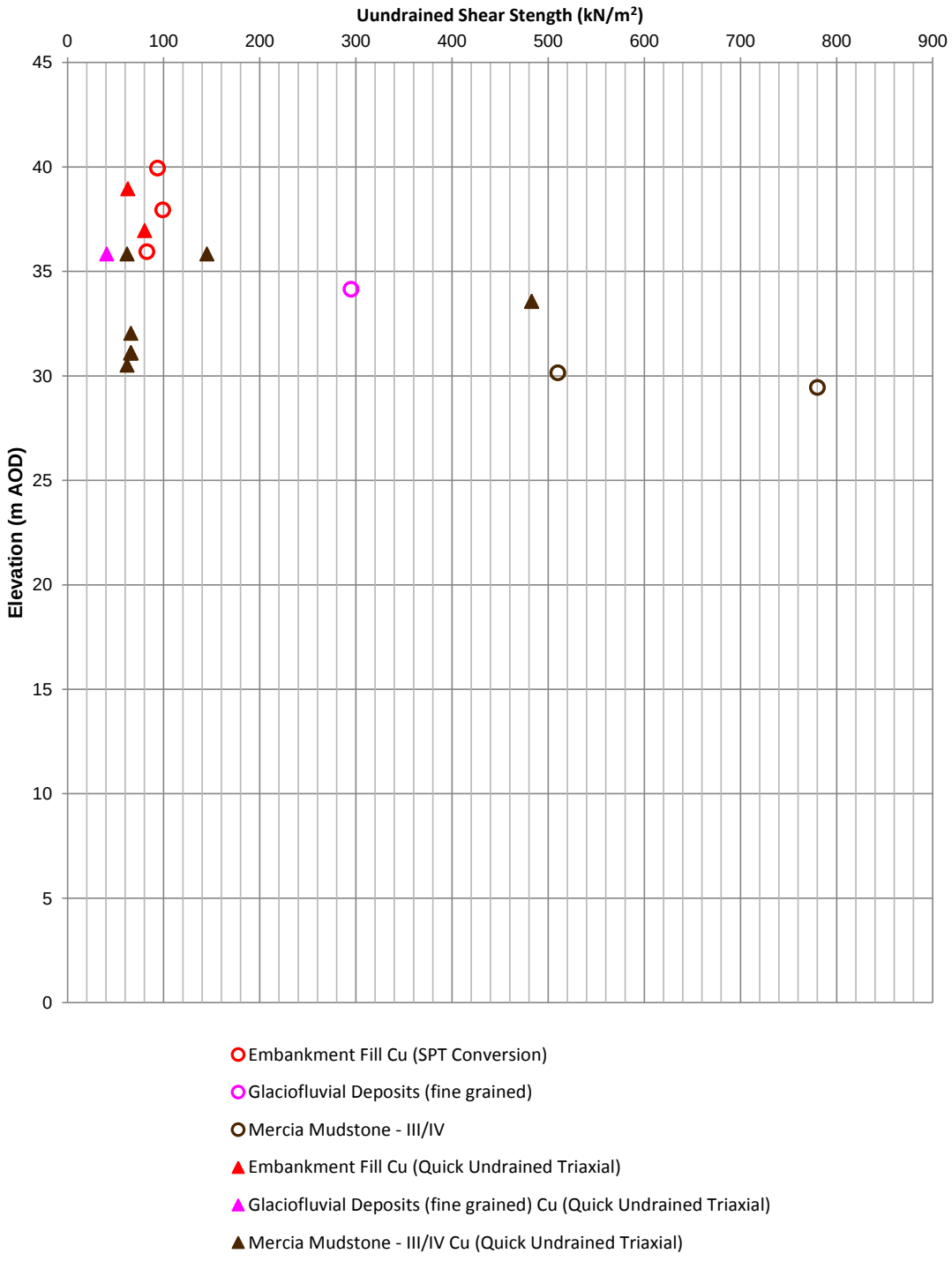
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 16/01/2017 Ref: HA549342-AMAR-HGT-185150-185320NB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185150-185320NB**
Client: **Highways England**	Borehole ID: **SK42NE10, SK42NE11, CP1086**	



Rev: P01 Date: 23/02/2016 Ref: HA549342-AMAR-HGT-185150-185320NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-185860-185880NB-GSS-000001		
Earthworks Widening Solution	Granular Wedge at Embankment Crest (1:2.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	185860-185880		
Carriageway	Northbound		
Marker Post	185MP/8A +60 – 185MP/8A +80		
National Grid Reference	E 447424, N 328237 – E 447419, N328260		
Existing Ground Level at Location	Carriageway	33.20mAOD	
	Toe of Embankment	31.60mAOD	
Earthwork Type	NB: Embankment	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_20910	SB: N/A	HAGDMS designation
Earthwork Height	NB: 1.60m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 19.00^{o}	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	28/12/2016	[redacted]
Checked	Alice Bazen	19/04/2017	
Reviewed	Gary Summerfield	19/04/2017	
Approved	Tom Bulteel	06/06/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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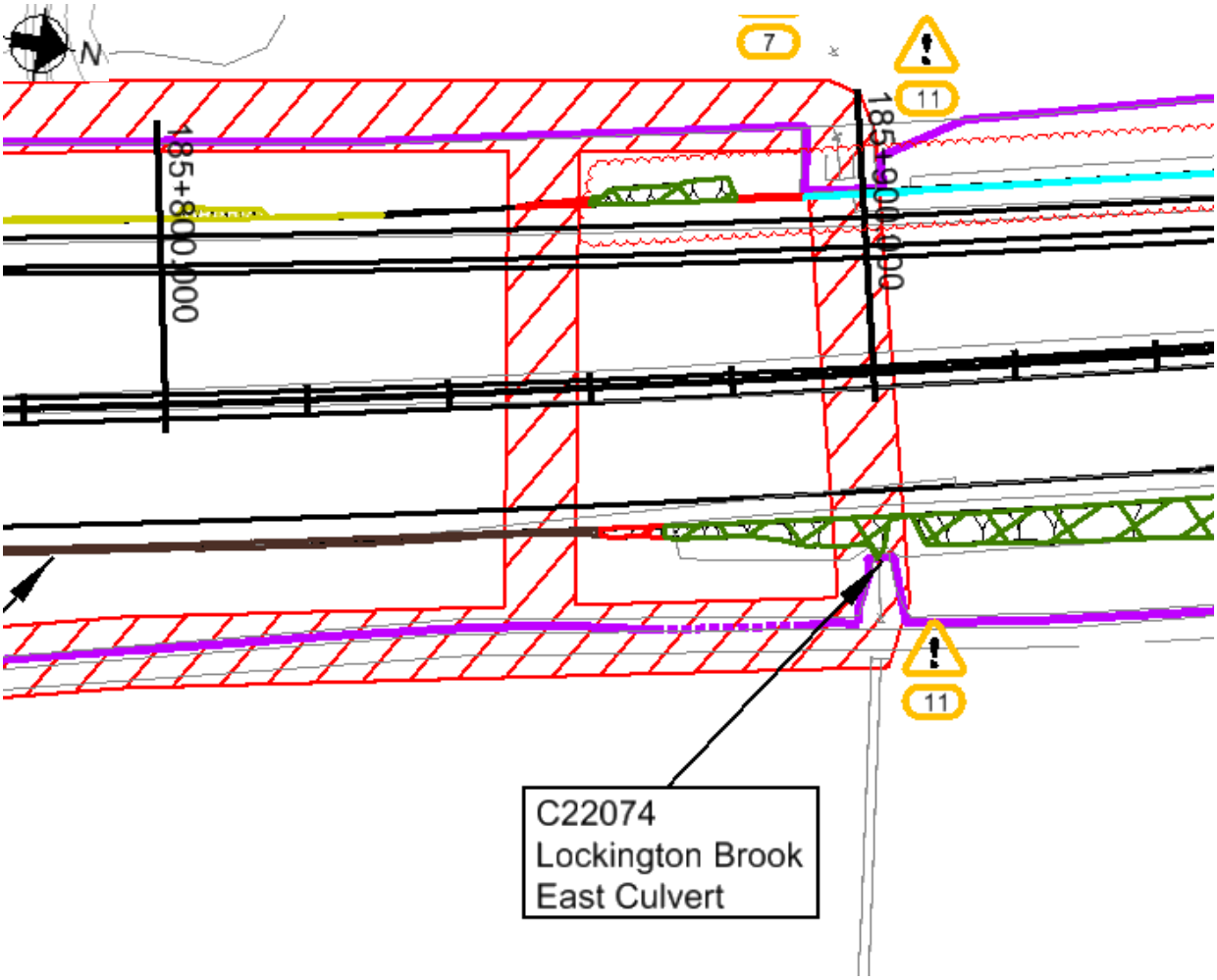


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Granular Wedge at Embankment Crest 1:2.0

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as embankment with heights ranging between 1.2 and 1.6m with an approximate slope angle of 19 degrees.

The critical cross sections (i.e. the cross section with the greatest earthwork height) used is Ch185880.

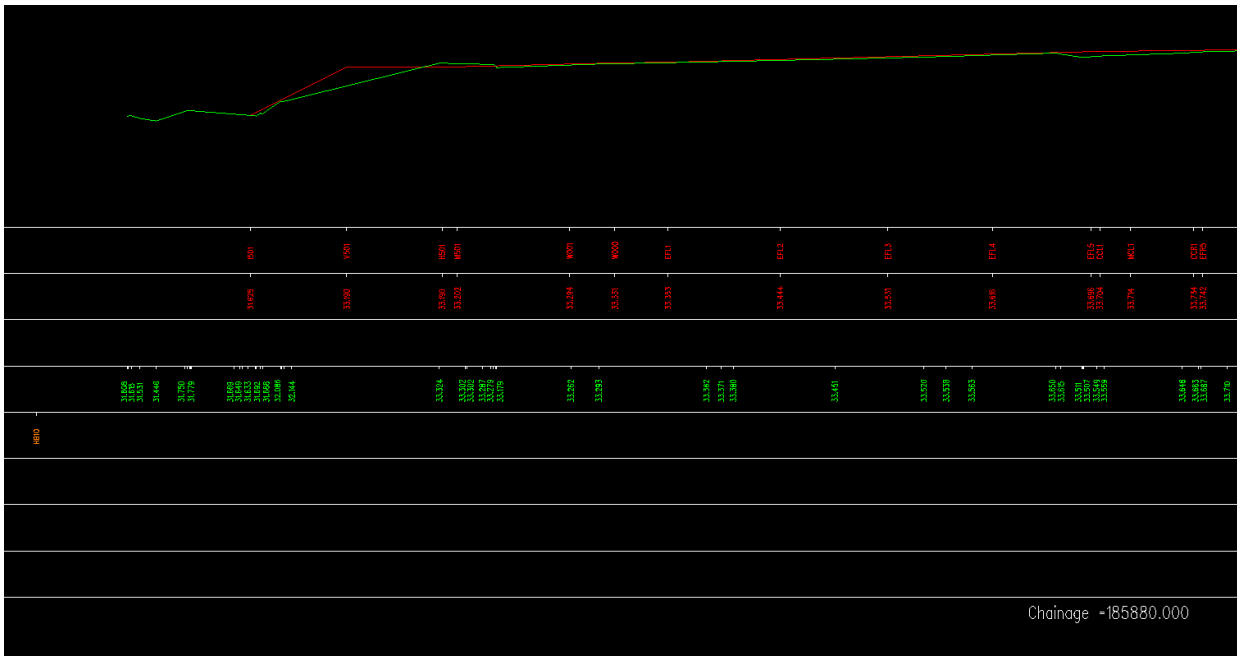


Figure 2: Topographic Cross Section Chainage 185880

Utilities:

BT Communication service present at approximate chainage 185860 and Culvert at approximately 185900.

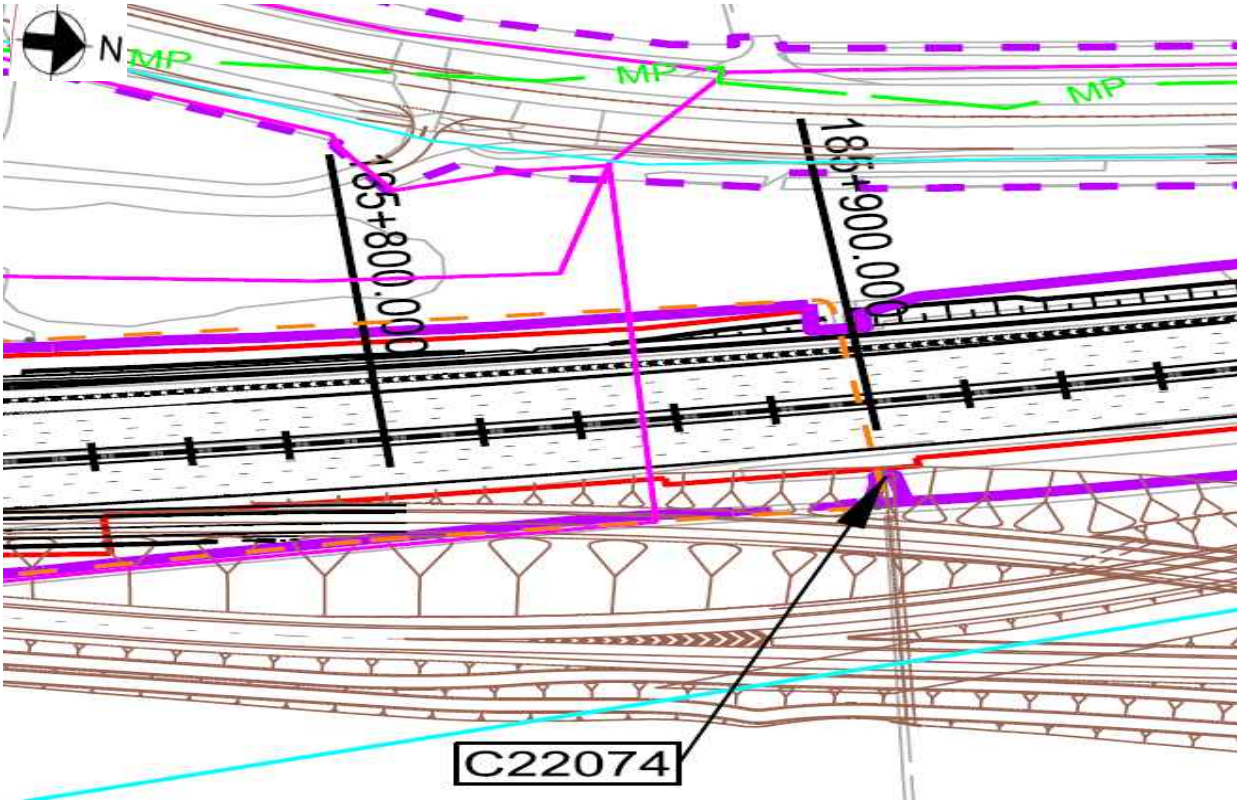


Figure 3: Utilities Location Plan

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Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Hemington Member – silt and gravel.

Solid Deposits: Branscombe Mudstone Formation - Mudstone

Ground Investigation:

1 No Historical boreholes were undertaken between chainage 185870 and 185890.

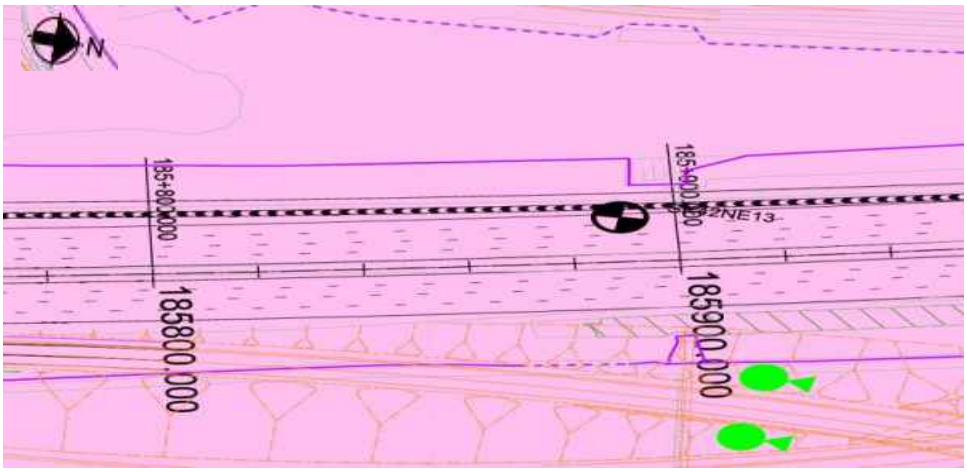


Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Closest Borehole Number	SK42NE13
Borehole Chainage	185889
Borehole Location	Northbound Carriageway
National Grid Reference	E 447430, N 328260
Ground Level at Exploratory Hole	30.40mAOD
RAG Analysis	Amber
Date Drilled	11/08/1961 – 12/08/1961
Termination Depth	9.14 metres below ground level (mbgl)

	(21.26mAOD)
Other suitable holes	None

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)
Embankment Fill	2.95	29.25
Glaciofluvial Deposits (Fine Grained)	3.17	29.03
Glaciofluvial Deposits (Coarse Grained)	5.31	26.89
Mercia Mudstone III/IV	7.74	24.46
Mercia Mudstone - Sandstone	>10.94	<21.26

(1) Ground level is assumed to be at carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) Local ground information does not show any made ground between 185870-185890, as borehole were likely advanced before the construction of the earthwork. As a result, the Made Ground has been assumed to be present as show in in the geological long sections (HA549342-AMAR-HGT-SWI-DR-CE-000025), as this was likely used to raise the roundabout level.
(4) Mercia Mudstone – Sandstone encountered in borehole logs from approximately 11mbgl, however due to uncertainties in the ground conditions and limited GI data, design will be completed using Mercia Mudstone III/IV as a conservative measure.

In Situ Testing:

Standard Penetration Tests (SPT's) was not available at this location.

Groundwater:

Groundwater was encountered within exploratory hole SK42NE13 at 1.37mbgl (29.03mAOD) and rose to 0.76mbgl (29.64mOAD) within the Glaciofluvial Deposits (Fine Grained).

Groundwater Design Level:

Limited local groundwater data is available and therefore a design groundwater level of 1.0m below toe of embankment has been assumed.

GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

3 No. Atterberg Limit tests and 1 No. Moisture Content Test were completed in the Glaciofluvial Deposits and Mercia Mudstone layers with the results presented in the table below:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Glaciofluvial Deposits	0.76	28	54	27	27	CH
Mercia Mudstone	4.11	-	28	20	8	CL
Mercia Mudstone	5.33	-	23	21	2	ML

1 No quick undrained triaxial tests were completed in SK42NE13 within the Mercia Mudstone layer:

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m2)
Mercia Mudstone III/IV	5.33	117

Lab Test Data – BRE Classification:

The table below present the chemical testing undertaken within the historical exploratory boreholes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Glaciofluvial Deposits (Fine Grained)	Water Soluble Sulphate as SO4	Water	1	1.00	g/l SO4
Glaciofluvial Deposits (Fine Grained)	pH	Water	1	7.00	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outline the assumed anticipated ground model:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill (Made Ground)	0.00 – 2.95	32.20 – 29.25	2.95	21	27	0	100	7.8	6.2	-	0.5	0.2	-	DS-2 AC-2
Glaciofluvial Deposits (fine grained)	2.95 – 3.17	30.40 – 29.03	1.37	21	26	0	100	7.8	6.2	-	0.5	0.2	-	DS-3 AC-3
Glaciofluvial Deposits (coarse grained)	4.32 – 5.31	29.03 - 26.89	2.14	21	38	-	-	-	19.20	-	-	0.25	-	DS-3 AC-3
Mercia Mudstone - III/IV	6.46 – >7.74	26.89 – 24.46	2.43	21	30	2	120	10.8	8.60	-	0.5	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Due to limited localised GI data for Embankment Fill, Glaciofluvial Deposits (fine grained), Glaciofluvial Deposits (coarse grained) and Mercia Mudstone - III/IV, the geotechnical parameters derived in the AMAR GIR have been adopted for design.

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(4) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of reliable BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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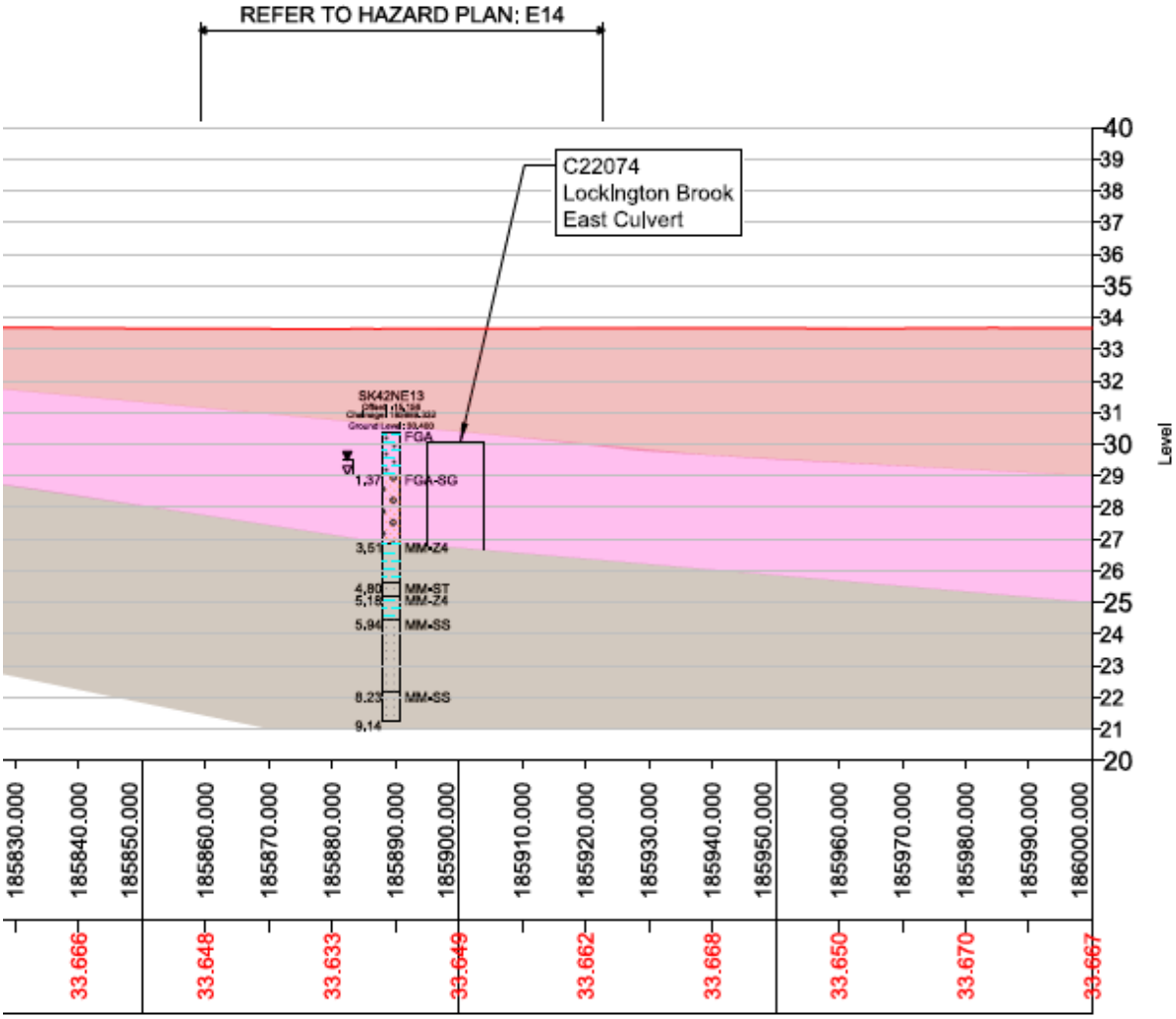


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Benching Detail	
			Base Width (m)	Batter Angle (o)
185860	185880	Granular Wedge at Embankment Crest (1:2.0)	2.0	26.6 (1V:2H)

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FURTHER GROUND INVESTIGATION

No further ground investigation has been proposed for this location.

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HISTORICAL EXPLORATORY HOLES

Borehole Log

Borehole No. **SK42NE13**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447430.00 - 328260.00	Hole Type CP
Location:		Level: 30.40mbgl	Scale 1:50
Client: Highways England		Dates: 11/08/1961 - 12/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									Firm brown silty clay FGA
		0.76	624D						
		1.37	625 W			1.37	29.03		Gravel FGA-SG
		1.52	626D						
		2.29	627D						
						3.51	26.89		Firm red & grey silty clay MM-Z4
		3.96	628D						
		4.11 - 4.57	629U	32blows					
						4.80	25.60		Sand & siltstone MM-ST
		5.18	630D			5.18	25.22		Stiff red clay MM-Z4
		5.33 - 5.79	631U	52blows					
		5.79	632D						
						5.94	24.46		Grey sand (weakly cemented) MM-SS
		6.71 - 7.16	633U	85blows					
		7.16	634D						
						8.23	22.17		Grey sandstone MM-SS
		8.38	635D						
		9.14	636D			9.14	21.26		End of borehole at 9.14m

Remarks

AGS

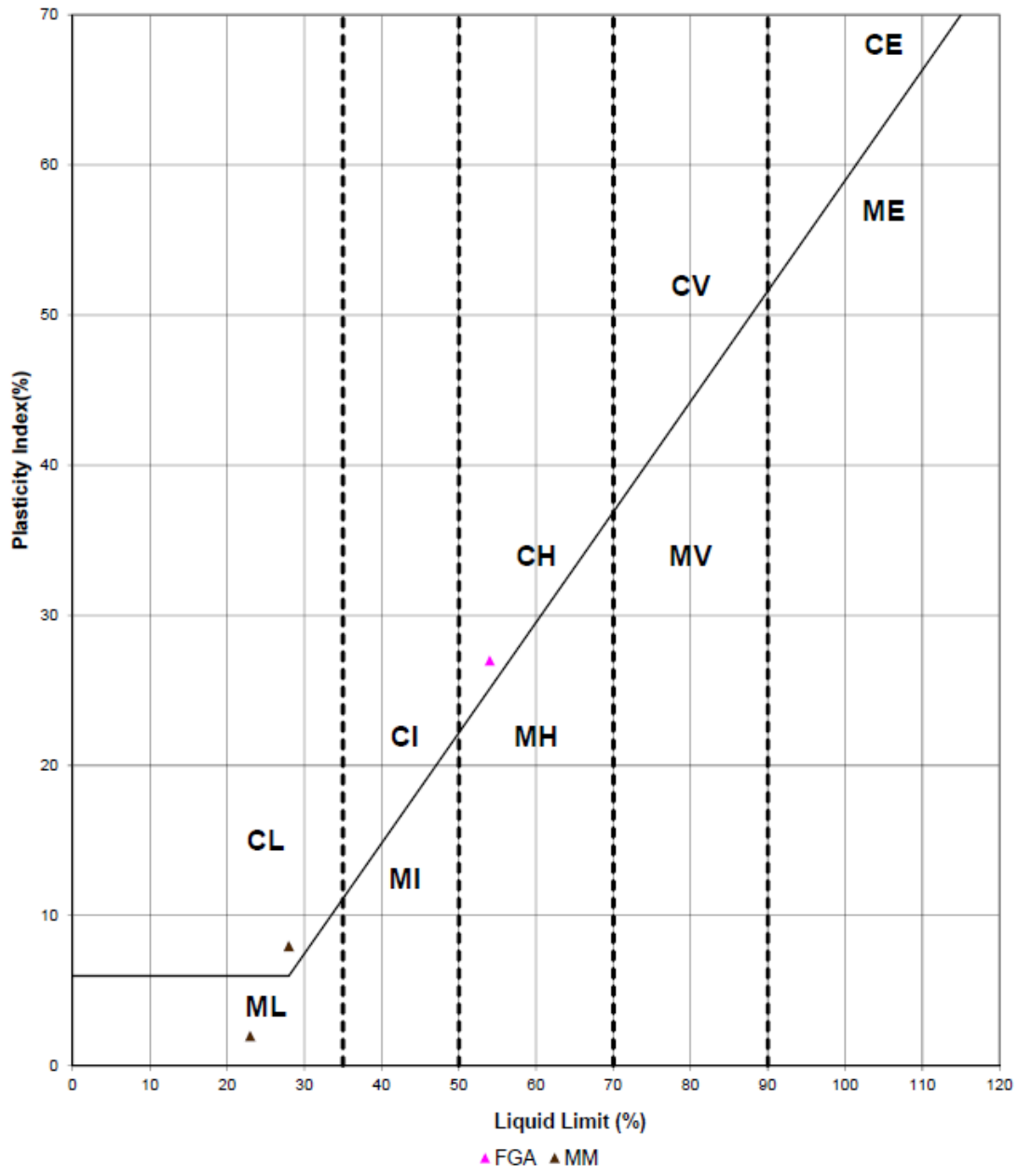
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PLOTS

amey ARUP

A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185860-185880NB**
Client: **Highways England**	Borehole ID: **SK42NE13**	



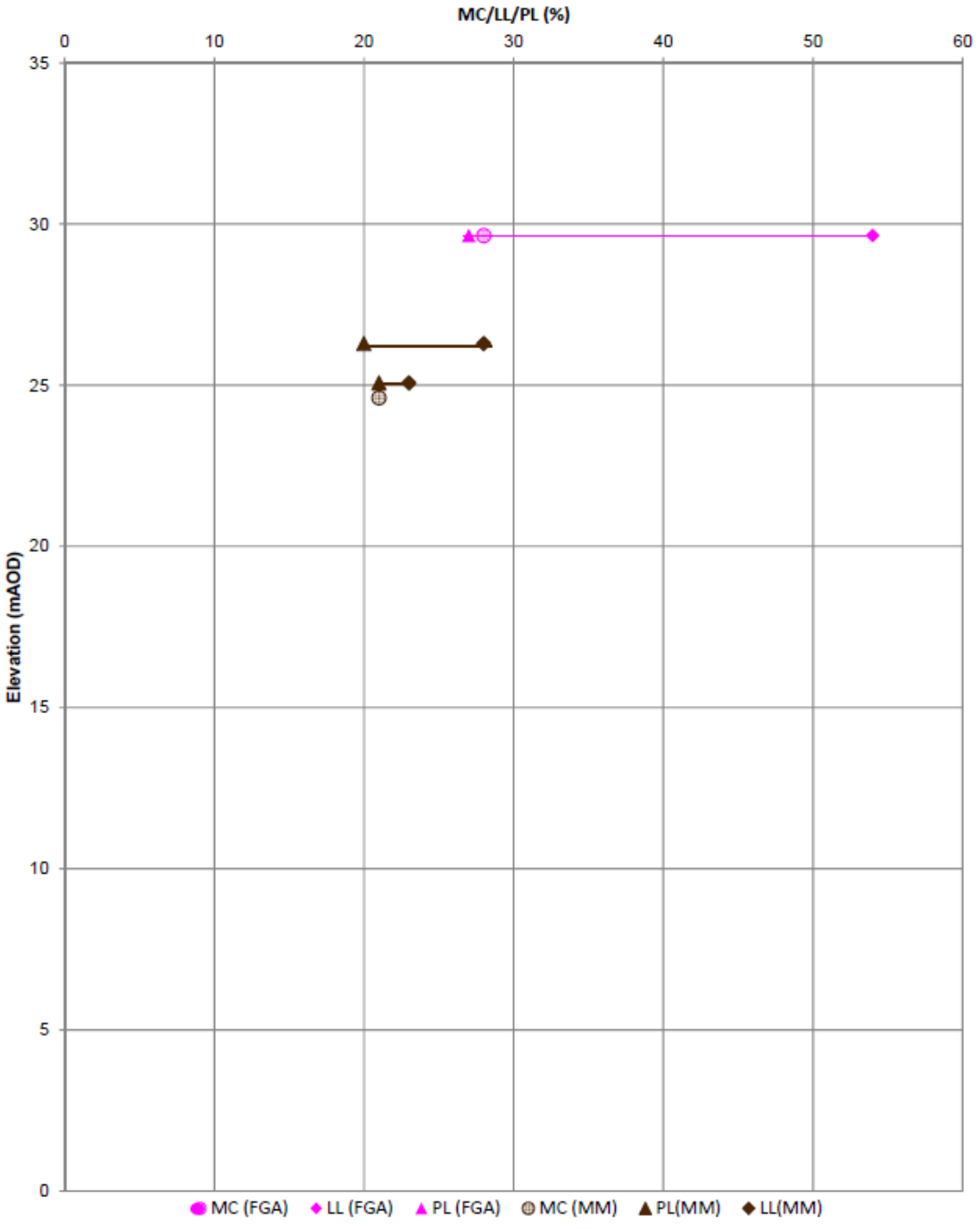
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

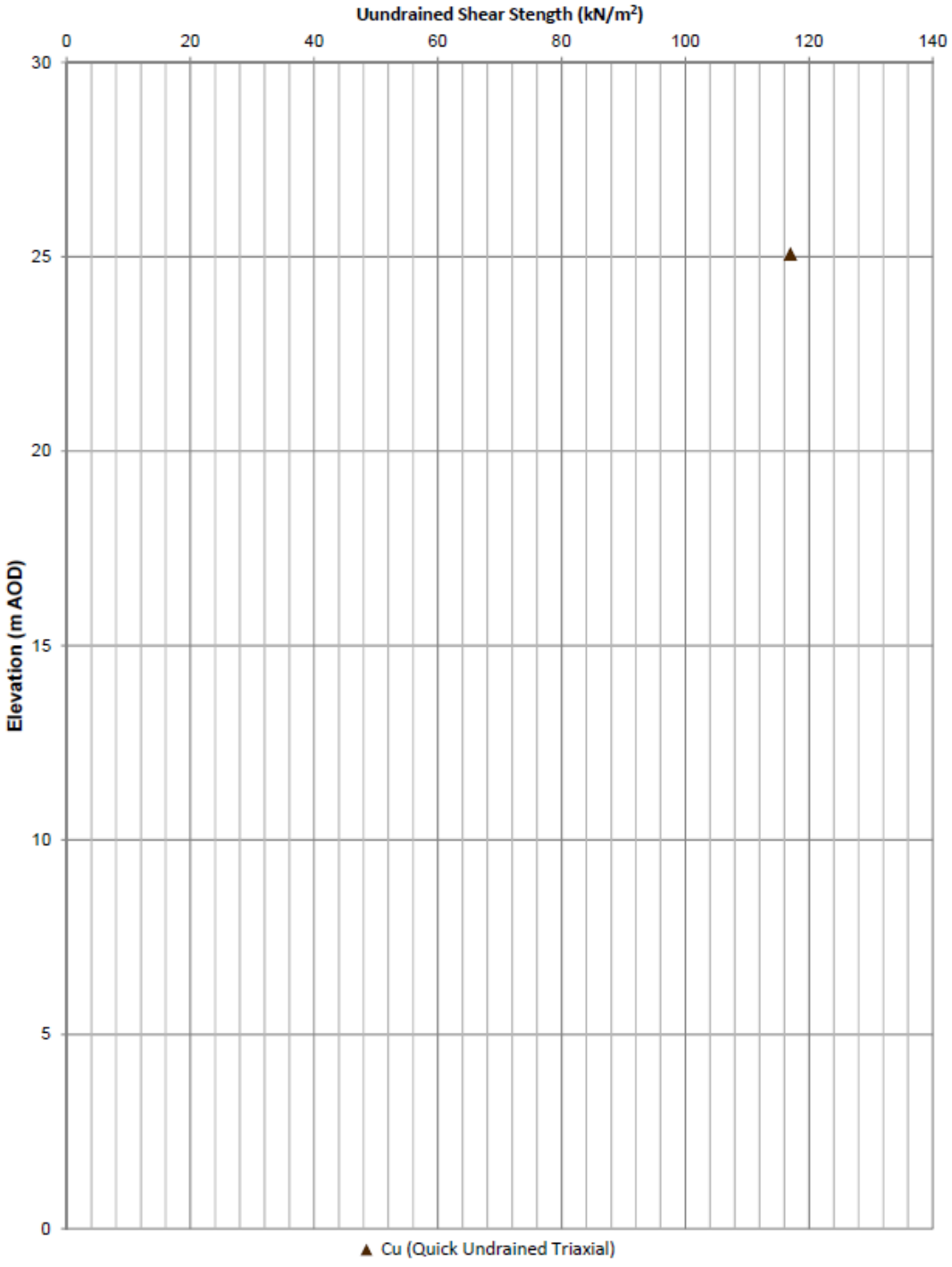
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185870-185890**
Client: **Highways England**	Borehole ID: **SK42NE13**	



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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185860-185880NB**
Client: **Highways England**	Borehole ID: **SK42NE13**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-185890-186360-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Earthwork Widening Design Chainage	185890-186360		
Structure Number	Gantry 202		
Structure Type	Superspan Portal		
Carriageway	Northbound		
Marker Post	185/8A +90 – 186/3A +60		
National Grid Reference	E 447419, N 328269 – E 447308, N 328650		
Existing Ground Level at Structure Location / Critical Section	Carriageway	33.31mAOD	
	Toe of embankment	31.11mAOD	
Earthwork Type	NB: Embankment	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: 7_M1_24418	SB: N/A	HAGDMS designation
Earthwork Height	NB: 2.1m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 21°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Roheel Masrat	13/12/2016	[redacted]
Checked	Alice Bazen	15/12/2016	
Reviewed	Gary Summerfield	16/12/2016	
Approved	Thomas Bulteel	06/06/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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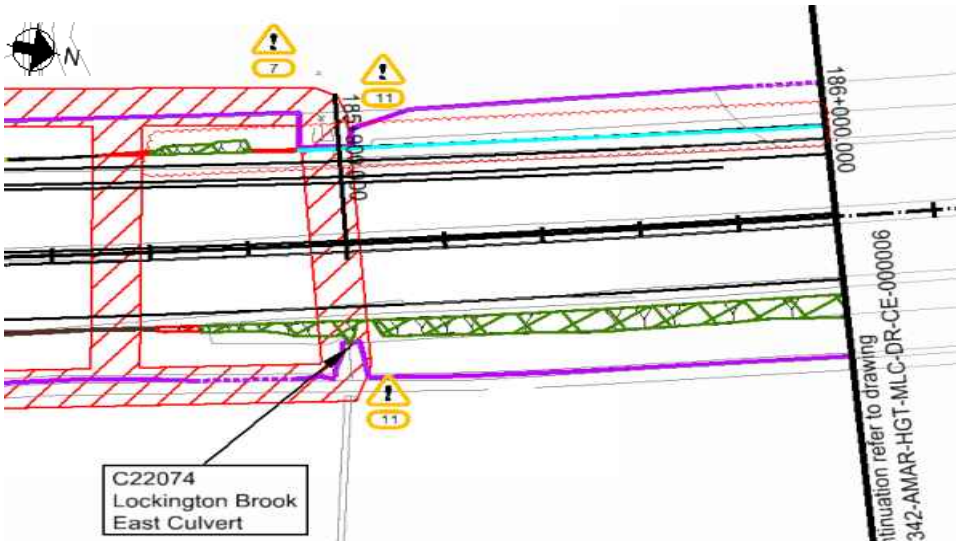


Figure 1.1: Location Plan – 185890 - 186000

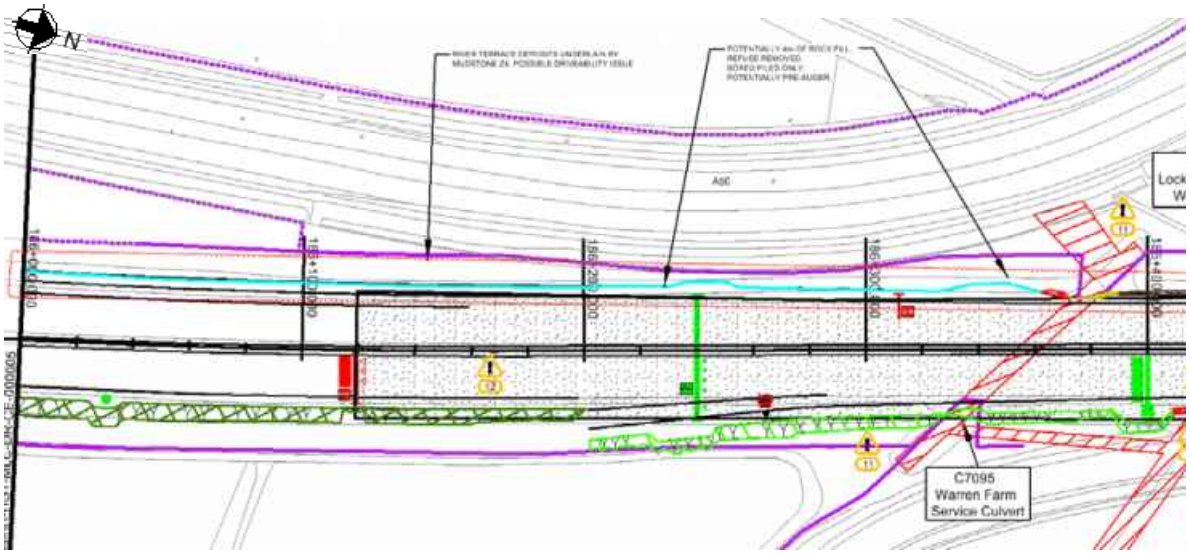


Figure 1.2: Location Plan – 18600 - 186360

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- King Sheet Pile Retaining Wall:
  - 185890-185950 – Retaining Wall – Maximum Retained Height 2.0m
  - 185950-185990 – Retaining Wall – Maximum Retained Height 2.1m
  - 185990-186040 – Retaining Wall – Maximum Retained Height 2.0m
  - 186040-186090 – Retaining Wall – Maximum Retained Height 2.3m
  - 186090-186230 – Retaining Wall – Maximum Retained Height 2.0m

- o 186230-186270 – Retaining Wall – Maximum Retained Height 2.5m
- o 186270-186360 – Retaining Wall – Maximum Retained Height 2.0m

Proposed Major Structures:

A new Superspan Portal Gantry structure (Gantry 202), which is proposed at Ch.186240.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the NB side of the structure is to be located on an embankment of approximately 2.1m.

The critical cross sections (i.e. the cross sections with the greatest retained height) used is Ch186100 and Ch.186240.

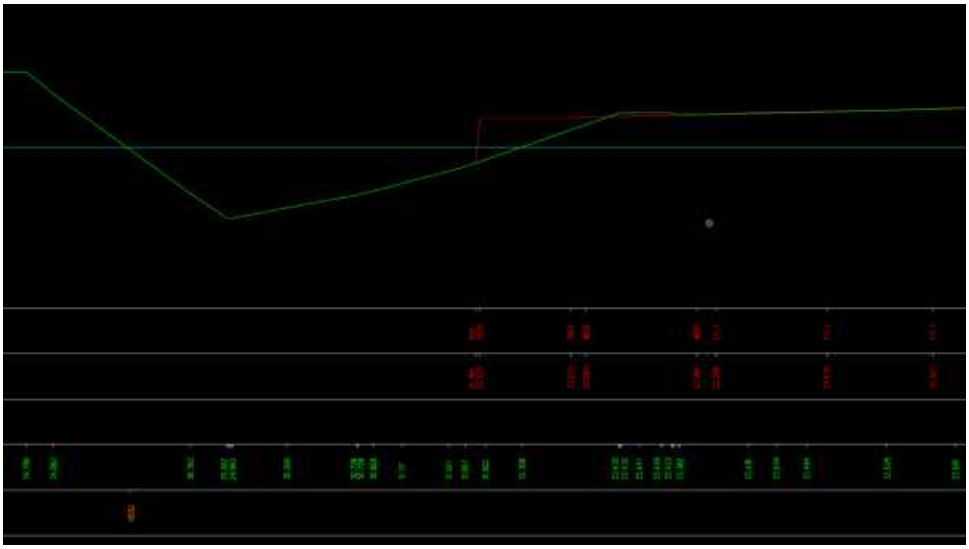


Figure 2.1: Topographic Cross Section Chainage 186100



Figure 2: Topographic Cross Section Chainage 186240

Utilities:

There is a water supply pipe 1m back from the NB side of the gantry; however it is out of the proposed site boundary

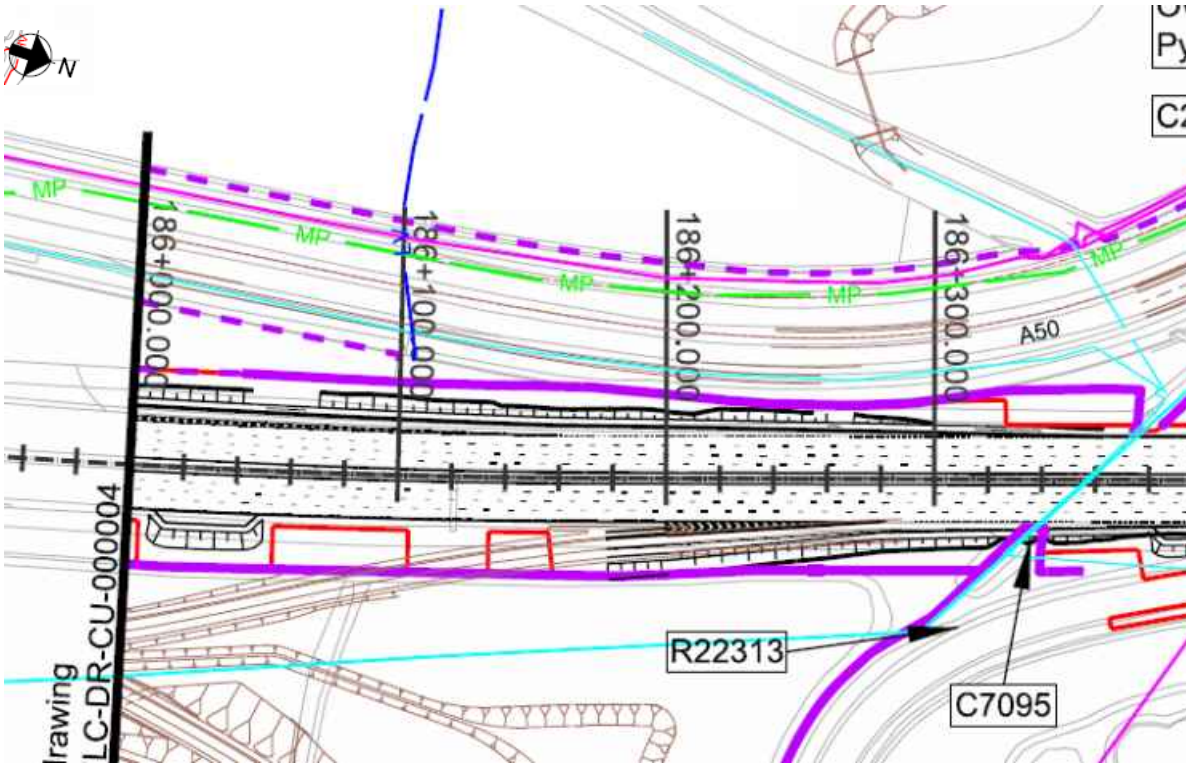


Figure 3: Utilities Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Holme Pierrepont Sand and Gravel Member – Sand and Gravel (Glaciofluvial Deposits)

Solid Deposits: Branscombe Mudstone Formation (Mercia Mudstone Group)

Ground Investigation:

There are 3 No. historical exploratory holes recorded within the design chainage, with additional 2 no. relevant exploratory holes considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000026-27, Rev P01.

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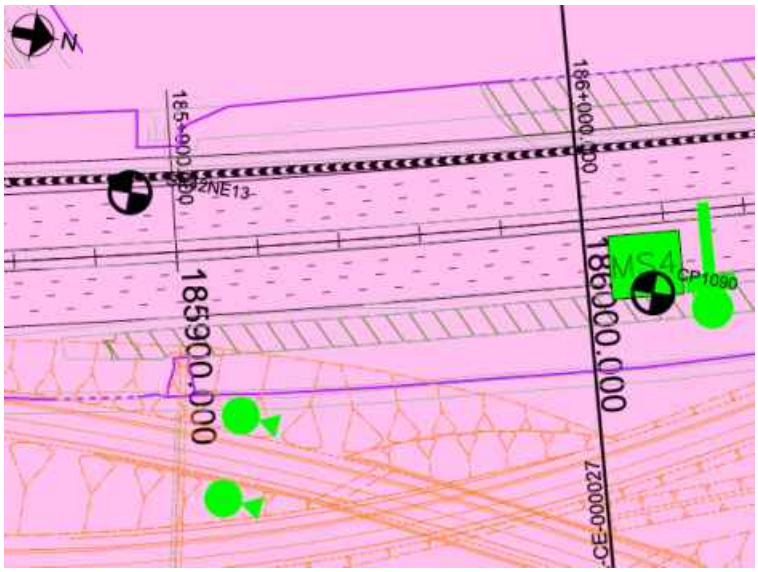


Figure 4.1: Borehole Location Plan – 185890-186000

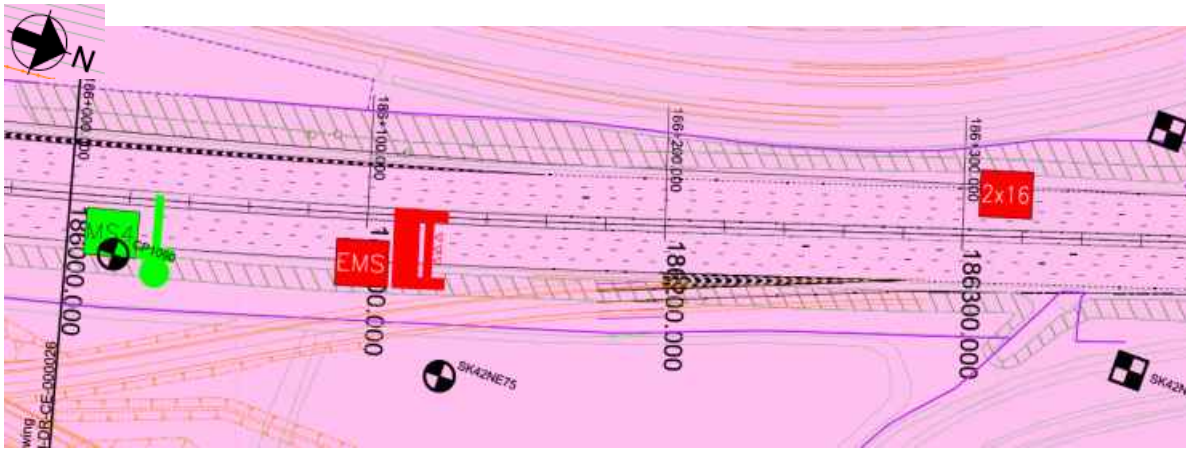


Figure 4.2: Borehole Location Plan – 186000-186360

Flood Risk:

The design flood level is 32.30mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

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Historical Boreholes:

Relevant Borehole Number	SK42NE13	CP1090	SK42NE75
Borehole Chainage	185889	186015	186127
Borehole Location	Northbound	Southbound	Southbound
National Grid Reference	E 447430, N 328260	E 447432, N 328391	E 447433, N 328508
Ground Level at Exploratory Hole	30.40mAOD	33.85mAOD	33.80mAOD
RAG Analysis	Amber	Green	Amber
Date Drilled	11/08/1961 – 12/08/1961	23/11/2006	03/02/1988
Termination Depth	9.14mbgl	11.39mbgl	3.00mbgl
Other suitable holes	SK42NE419, SK42NE426		

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	Hand Vane Strength Range (kN/m^2)
Embankment Fill	4.40	29.00	188
Glaciofluvial Deposits (coarse grained)	8.20	25.20	-
Mercia Mudstone – III/IV	>13.80	<20.00	-

(1) Ground level is assumed to be at the carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory hole SK42NE75, CP1090 and SK42NE13.

Hand vane strength testing has been undertaken within exploratory hole SK42NE419 at 1.0mbgl within the Embankment Fill.

Groundwater:

Groundwater was encountered in SK42NE419 at 2.60mbgl (28.60mAOD).

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Groundwater Design Level:

Limited local groundwater data is available. Therefore a groundwater level of 32.30mAOD (flood level) has been assumed for WALLAP analysis of the king sheet pile. When checking the global stability check of the earthwork and king sheet pile (analysed using SLOPE W) a Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

5 No. Atterberg Limit tests and 3 No. Natural Moisture Content tests were completed in the Embankment Fill, Glaciofluvial Deposits and Mercia Mudstone, with the results presented in the table below:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	2.0	11	15	35	24	CI
Glaciofluvial Deposits	0.8	27	28	54	27	CH
Mercia Mudstone III/IV	4.1	20	-	28	8	CL
Mercia Mudstone III/IV	5.3	21	-	23	2	ML
Mercia Mudstone III/IV	10.5	9	11	23	14	CL

2 No quick undrained traxial tests were completed in the Embankment Fill and Mercia Mudstone with the following results:

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	1.5	147
Mercia Mudstone III/IV	5.3	117

Lab Test Data – BRE Classification:

The table below presents the chemical test data undertaken within the exploratory boreholes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Glaciofluvial Deposits	Water Soluble Sulphate as SO4	Water	1	1.0	g/l SO4
Glaciofluvial Deposits	pH	Solid	1	7.0	-

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Assumed Ground Model For Design:

Ground model is based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-000034, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01.

The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment Fill	0-4.37	33.37-29.00	4.37	21	27	0	100	7.8	6.2	-	0.50	0.20	-	2.6	0.45	6.2*	-	-	DS-2 AC-2
Glaciofluvial Deposits (coarse grained)	4.37-8.17	29.00-25.20	3.80	21	38	-	-	-	19.2	-	-	0.25	-	8.0	-	-	1.0	50	DS-3 AC-3
Mercia Mudstone – III/IV (<10m bgl)	8.17-10.00	25.20-23.37	1.83	21	30	2	100	10.8	8.6	-	0.50	0.20	-	3.6	0.45	9	-	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10m bgl)	10.00->13.77	23.37-<20.00	>3.37	21	30	2	100	16.8	13.4	-	0.50	0.20	-	5.6	0.45	9	-	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are inferred from the geological long section HA549342-AMR-HGT-SWI-DR-GC-000027
(3) Due to limited localised GI data, typical values for bulk density, friction angle, cohesion, undrained shear strength, Young's modulus and Poisson's ratio derived in the AMAR GIR are used.
(4) Shear modulus is based on G = E/2(1+v).
(5) Adhesion factor for Embankment fill is based on BS8004 (equation 41).
(6) Nc is based on CIRIA C570. *Nc increases to '9' from 3.6m bgl. Embankment Fill is assumed to comprise reworked Mercia Mudstone.
(7) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).

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(8) Nq is based on relationship with ϕ' as shown in Tomlinson (Figure 7.10).
(9) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all Mercia Mudstone III/IV and Embankment Fill, and due to lack of reliable data for Glaciofluvial Deposits, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used as backfill in the design of king sheet pile walls; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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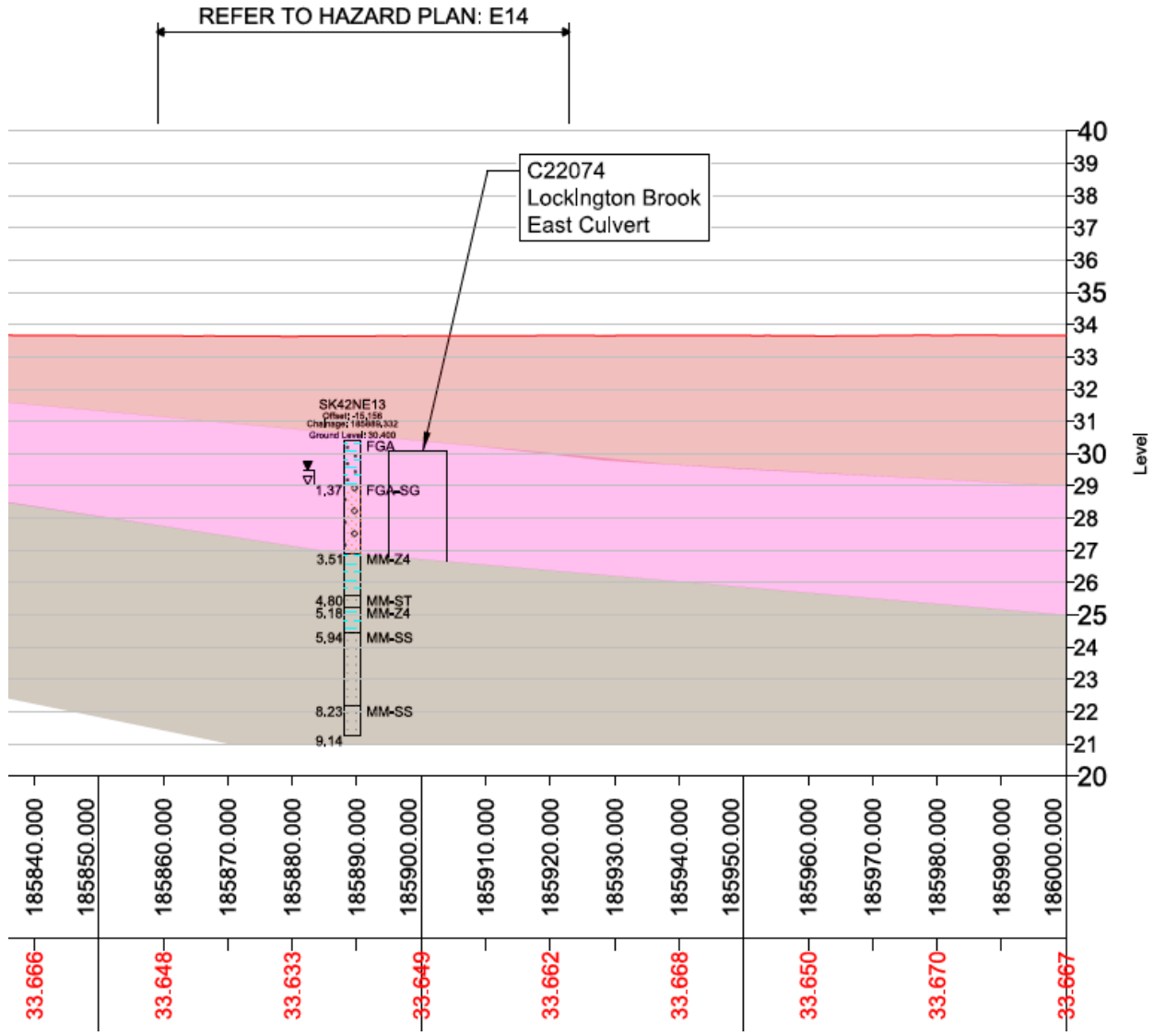


Figure 5.1: Geological Long Section – 185890-186000

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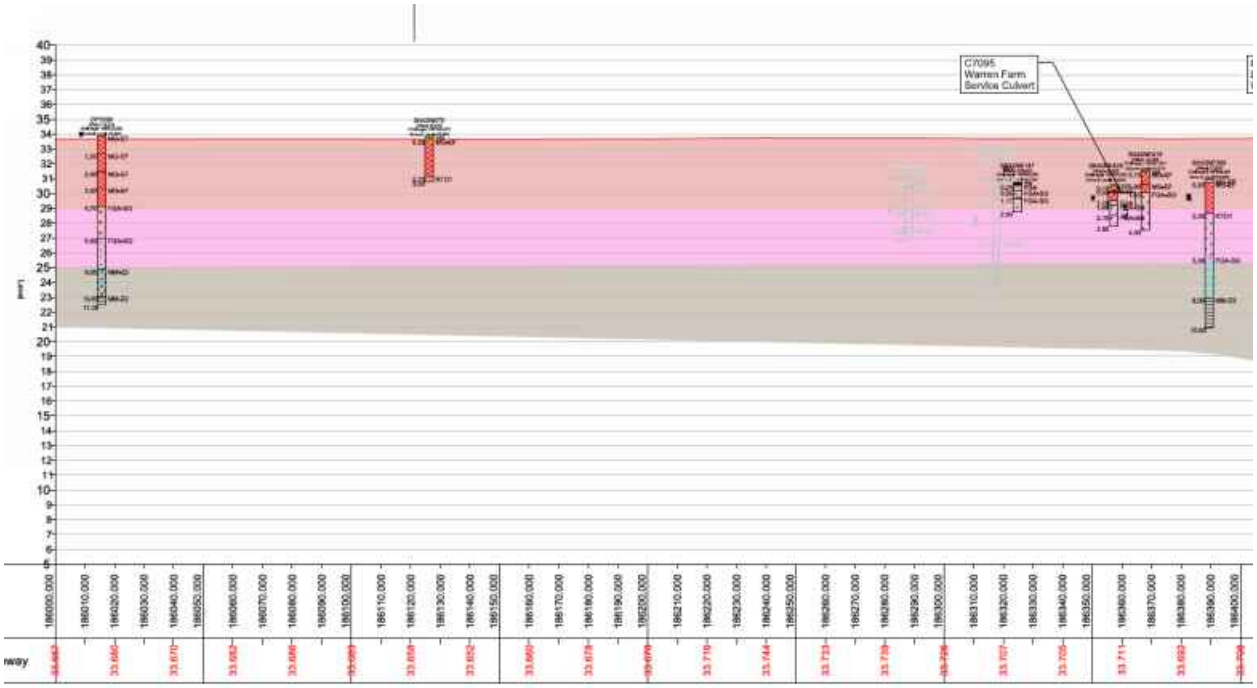


Figure 5.2: Geological Long Section – 186000-186360

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to encroachment on to the flood plain, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	King Section Type	Retained Height (m)	Embedded Depth (m)	King Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
185890	185950	AZ-24 S 390 GP	2.0	4.5	6.5	89	38	24	59
185950	185990	AZ-24 S 390 GP	2.1	4.4	6.5	89	38	24	59
185990	186040	AZ-24 S 390 GP	2.0	4.5	6.5	89	38	24	59
186040	186090	AZ-24 S 390 GP	2.3	5.2	7.5	89	21	35	95
186090	186230	AZ-24 S 390 GP	2.0	4.5	6.5	89	38	24	59
186230	186270	AZ-24 S 390 GP	2.5	5.0	7.5	89	21	35	95
186270	186360	AZ-24 S 390 GP	2.0	4.5	6.5	89	38	24	59

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

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Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
3 (1 x 3)	900	15.5	2.70	11	805	677

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- CPT-04 at chainage 186057, Northbound - CPT to a scheduled depth of 5m bgl.
- BH-G202A at chainage 186240, Northbound, dynamic sample with rotary follow to 19m bgl.

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HISTOICAL EXPLORATORY HOLES

Borehole Log

Borehole No. **CP1090** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447432.00 - 328391.00	Hole Type CP
Location:		Level: 33.85mbgl	Scale 1:50
Client: Highways England		Dates: 23/11/2006 - 23/11/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.50	101B						MADE GROUND. Light brown clayey very gravelly sand with occasional rootlets. Gravel is angular to subrounded fine to coarse of mudstone, sandstone and quartzite. Possible MG-EF
		1.00	102B						
						1.20	32.65		MADE GROUND. Stiff red brown locally grey green, occasionally gravelly clay. Gravel is fine to coarse angular to subangular of siltstone. MG-EF
		1.50 - 1.95	1U	50blows					
		2.00	2D						
		2.40	3D			2.40	31.45		MADE GROUND. Brown sandy gravel. Sand is medium. Gravel is medium to coarse, subrounded of quartz. MG-EF
		2.50	SPT (C)	N=28 (3,4/6,7,7,8)	Casing=2.50m Water=2.00m				
		2.50 - 3.00	4B						
		3.50	SPT (C)	50 (35 for 90mm/50 for 85mm)	Casing=3.50m Water=DRY	3.50	30.35		Possible MADE GROUND. Grey brown sand and gravel. Sand is coarse. Gravel is fine to coarse, angular to subangular of limestone and dolomite. MG-EF
		3.50 - 4.00	5B						*Between 3.50m and 4.70m; driller notes 'water running away'.*
		4.50	SPT (C)	50 (25 for 30mm/50 for 20mm)	Casing=4.50m Water=DRY	4.70	29.15		Brown SAND and GRAVEL. Sand is medium to coarse. Gravel is fine to coarse, subangular to rounded of sandstone, quartz and some coal. FGA-SG
		4.50 - 5.00	6B						
		5.50	SPT (C)	N=31 (3,5/6,7,9,9)	Casing=5.50m Water=4.20m				
		5.50 - 6.00	7B						
		6.50	SPT (C)	N=17 (4,4/4,5,4,4)	Casing=6.50m Water=3.00m				
		6.50 - 7.00	8B						
						6.90	26.95		Red brown sandy SILT to silty SAND with some gravel. Gravel is medium to coarse, subangular to subrounded of sandstone and quartz. FGA-SG
		7.50 - 7.95	U#B	30blows					
		7.50 - 8.00	9B						
		9.00	10D			9.00	24.85		Very stiff red brown locally grey green SILT/ CLAY with some mudstone lithorelics. Locally a grey green slightly silty fine grained sand. MM-Z2
		9.00	SPT (S)	N=40 (7,10/10,10,10,10)	Casing=9.00m Water=5.90m				
		9.00 - 9.50	11B						
									Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 3.50m to 4.70m (2.5 hours) and 10.80m to 11.30m (1 hour).;No visual or olfactory indication of contamination was observed.;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 2.50m.;

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Borehole Log

Borehole No. **CP1090** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447432.00 - 328391.00	Hole Type CP
Location:		Level: 33.85mbgl	Scale 1:50
Client: Highways England		Dates: 23/11/2006 - 23/11/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		10.50 10.50 10.50 - 11.00	12D SPT (S) 13B	50 (10,15/50 for 180mm)	Casing=10.50m Water=8.70m	10.80	23.05		SILT/CLAY (as previous sheet)
		11.30 11.30	14D SPT (S)	50 (25 for 50mm/50 for 40mm)	Casing=10.50m Water=9.00m	11.39	22.46		Very weak friable brown MUDSTONE recovered as sandy clay. With very thin (<0.5mm) white laminae. MM-Z2 End of borehole at 11.39 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 3.50m to 4.70m (2.5 hours) and 10.60m to 11.30m (1 hour).;No visual or olfactory indication of contamination was observed.;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 2.50m.;

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Borehole Log

Borehole No. **SK42NE13**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447430.00 - 328260.00	Hole Type CP
Location:		Level: 30.40mbgl	Scale 1:50
Client: Highways England		Dates: 11/08/1961 - 12/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.76	624D						Firm brown silty clay FGA
		1.37	625 W			1.37	29.03		Gravel FGA-SG
		1.52	626D						
		2.29	627D						
						3.51	26.89		Firm red & grey silty clay MM-Z4
		3.96	628D						
		4.11 - 4.57	629U	32blows					
						4.80	25.60		Sand & siltstone MM-ST
		5.18	630D			5.18	25.22		Stiff red clay MM-Z4
		5.33 - 5.79	631U	52blows					
		5.79	632D						
						5.94	24.46		Grey sand (weakly cemented) MM-SS
		6.71 - 7.16	633U	85blows					
		7.16	634D						
						8.23	22.17		Grey sandstone MM-SS
		8.38	635D						
		9.14	636D			9.14	21.26		End of borehole at 9.14 m

Remarks

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Borehole Log

Borehole No. **SK42NE75**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447433.00 - 328508.00	Hole Type CP
Location:		Level: 33.80mbgl	Scale 1:50
Client: Highways England		Dates: 03/02/1988 - 03/02/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.20	33.60		TOPSOIL TP Very stiff red brown locally very silty CLAY with occasional fine to medium gravel sized lithorelics and a little subrounded to subangular fine to medium assorted gravel. (FILL) Below 1.35m becoming locally fine sandy with occasional pockets and lenses of light grey green silt. MG-EF *subangular coarse gravel and cobbles of LIMESTONE strong to very strong* *angular fine to coarse gravel and cobble sized fragments of light grey green SILTSTONE strong.*
		1.35	SPT (S)	N=23 (2,2/4,6,6,7)	Water=-				
		2.70	SPT (S)	71 (7,10/71 for 150mm)	Water=-	2.70	31.10		Brown fine to medium SAND with a little to some subrounded to subangular fine to medium occasionally coarse assorted gravel. (Probable TERRACE DEPOSITS) RTD1
						3.00	30.80		End of borehole at 3.00 m

Remarks
Hand dug inspection pit from ground level to 1.00m

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Trial Pit Log

Trialpit No **SK42NE419** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447272.00 - 328710.00 Level: 31.51mbgl	Date 22/06/1992
Location:		Dimensions: 2.95m x 1.00m Inclination: 90° Orientation: 174° Depth: 4.00m	Scale 1:50
Client: Highways England			Logged

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
	0.30 0.40 - 0.50	1J 2J			0.10	31.41		HUMUS and TOPSOIL TP
	0.95 1.00	3J HV			0.90	30.61		Loose* orange brown silty fine to medium SAND with some locally much subrounded fine to coarse gravel of quartzite, sandstone and siltstone. Occasional pockets of stiff red brown extremely closely fissured clay. (MADE GROUND) MG-EF
	1.55 - 1.65	4J			1.45	30.06		Very stiff brown to red brown extremely closely to closely fissured very silty slightly sandy CLAY with rare subrounded fine to medium gravel of quartzite and sandstone (MADE GROUND) MG-EF
▼	2.55 - 2.65	5B						Dense* brown clayey silty fine to medium SAND with some subrounded fine to coarse gravel of quartzite, sandstone and siltstone. In parts light grey mottled and orange brown. (RIVER TERRCE DEPOSITS) - locally becoming medium to coarse sand and gravel FGA-SG
▽	3.20	6W						
	3.55 - 3.65	7B						
					4.00	27.51		End of pit at 4.00 m

Shift Information				Backfill			Water Strike						Depth Related Remarks		
Date & Time	Depth	Water	Remarks	Top	Base	Description	Struck	Rose to	Date	Time	Sealed	Remarks	Top	Base	Remarks
							3.20	2.6	22-06-1992	12:00		Encountered as slight seepage at 2.80m. No rise. Water			

Remarks:
1. No significant lateral variation in soil types.
2. Photograph of Face D only.
3. Logged on excavated material below 1.20m.
4. *Engineer's visual assessment.
5. Hand vane result is an average of three tests.
6. No watercourse near to pit from which to obtain water sample.

Stability: No support. Spalling below 2.90m.

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Trial Pit Log

Trialpit No **SK42NE426** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447352.00 - 328725.00 Level: 30.60mbgl	Date 24/06/1992
Location:		Dimensions: 8.30m (2.85m) Inclination: 90° Orientation: 162° Depth: 2.85m	Scale 1:50
Client: Highways England			Logged S.G.FLYNN

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
	0.20 - 0.30	1J			0.10	30.50		TOPSOIL. TP
	0.45 - 0.55	2B			0.40	30.20		Dense* orange brown and brown silty very sandy subrounded fine to medium GRAVEL of flint, quartzite, sandstone, siltstone (MADE GROUND). MG-EF
▼	1.05	3W						
	1.10	HV	164kPa		1.10	29.50		Loose* grey brown ashy fine to coarse SAND, in parts becoming very soft black organic sandy clay. Some glass bottles, brick and brick fragments, metal fragments. Odorous. (MADE GROUND) MG-EF
	1.20 - 1.30	4J			1.40	29.20		
	1.40 - 1.50	5J						
	2.10 - 2.20	6J			2.10	28.50		Very stiff light grey and orange brown sandy CLAY with a little subrounded fine to coarse gravel of quartzite, sandstone and siltstone - by about 1.30m becoming clayey fine to coarse SAND with much subrounded fine to coarse gravel (ALLUVIUM) FGA
					2.85	27.75		Dense* grey medium to coarse SAND with some subrounded fine to coarse gravel predominantly of quartzite - becoming brown by 1.80m (RIVER TERRACE DEPOSITS) FGA-SG
								Dense* brown medium to coarse SAND AND subrounded to rounded fine to coarse GRAVEL predominantly of quartzite, sandstone. Grading to sandy GRAVEL by 2.50m. Occasional orange brown fine to coarse sand pockets. (RIVER TERRACE DEPOSITS) FGA-SG
								End of pit at 2.85 m

1 2 3 4 5 6 7 8

Shift Information				Backfill			Water Strike						Depth Related Remarks		
Date & Time	Depth	Water	Remarks	Top	Base	Description	Struck	Rose to	Date	Time	Sealed	Remarks	Top	Base	Remarks
							1.05	1.05	24-06-1992	12:00		Encountered as a strike at 1.05m. Rose from 1.20 to 1.05m in			

Remarks:

1. Significant lateral variation in soil types.
2. Photographs of Pockets A and C.
3. Logged on excavation material below 1.00m.
4. Roughness visual assessment.
5. Hand vane on disturbed sample from excavator bucket is an average of three tests. Unable to penetrate very soft clay in made ground due to bottles, glass, etc.
6. On instructions of Engineers Representative trial pit deepened before reaching achievable depth due to repeated spalling below 1.50m and consequent undermining of working area.
7. Acting on the instructions of the Engineers Representative, trial pit was extended incrementally to define profile of made ground.

Repeated spalling below 1.50m and consequent undermining of working area.

Stability: No support. Constant spalling below 1.50m

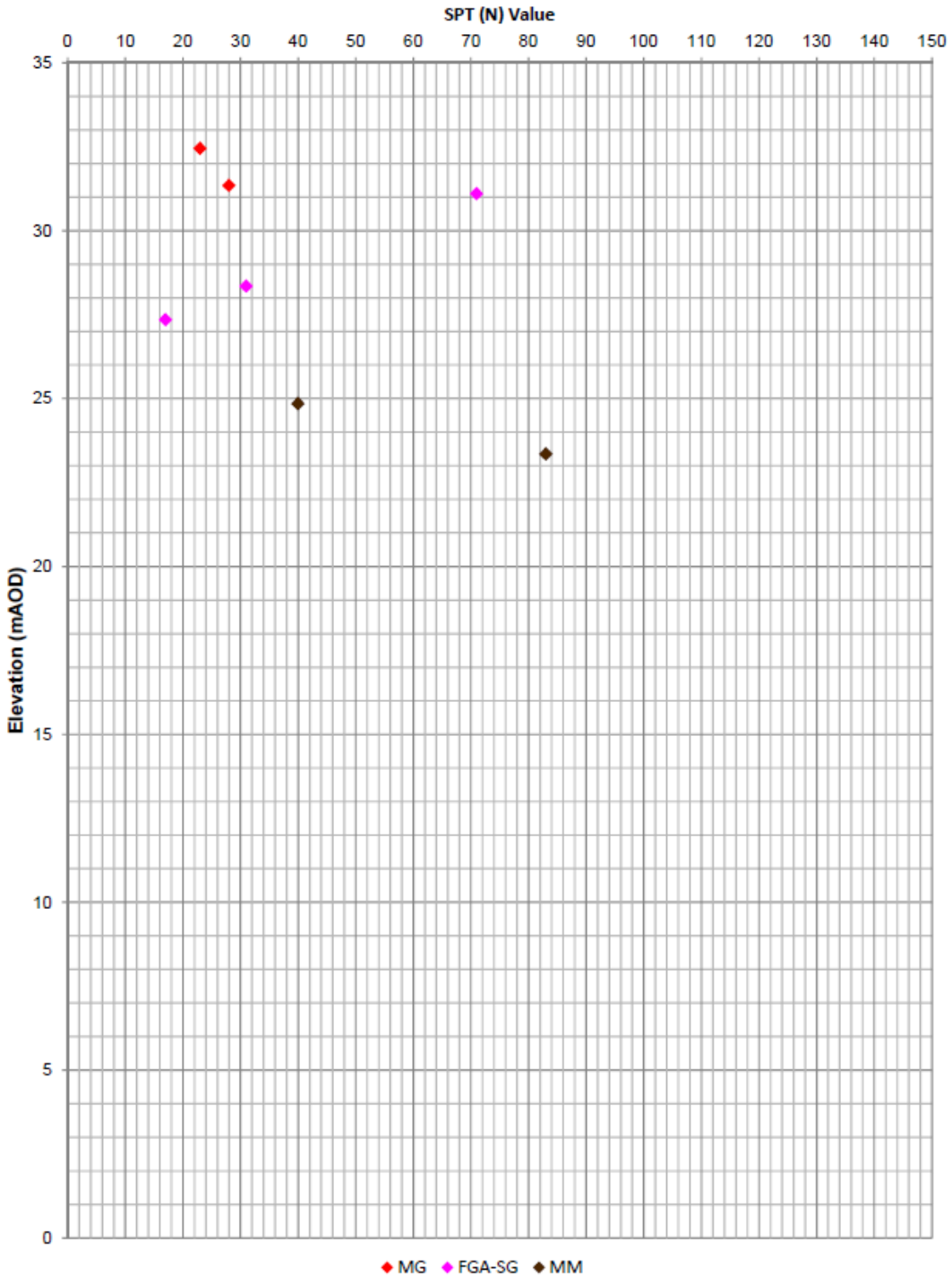
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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185890-186360NB**
Client: **Highways England**	Borehole ID: **CP1090, SK42NE13, SK42NE75**	

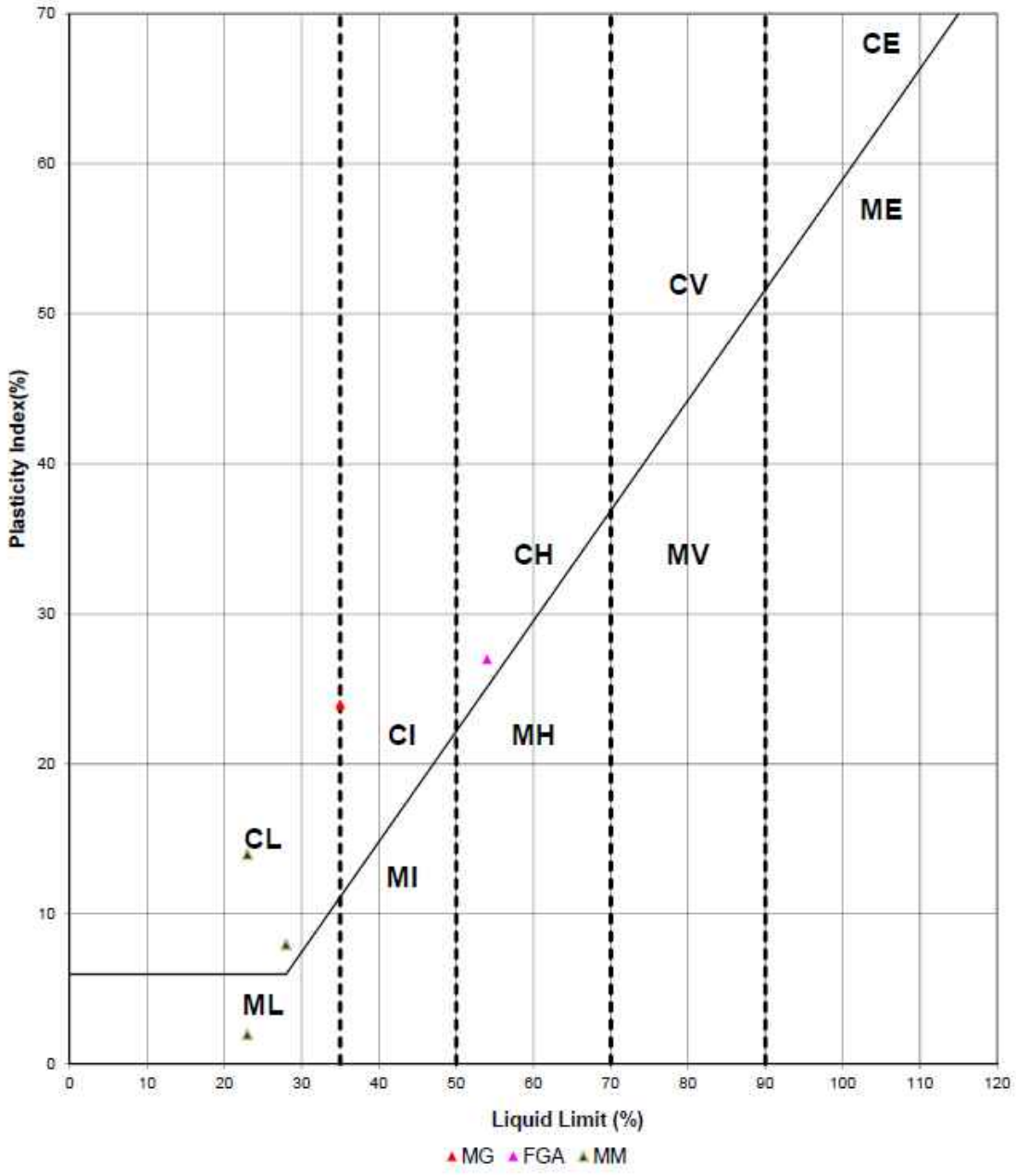


Extrapolated SPT (N) Values >150 have not been shown

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A Line Plot

Project ID: HA549342	Project Title: SMP - M1 J23A TO J25	Data Sheet: 185860-186360NB
Client: Highways England	Borehole ID: CP1090, SK42NE13 and SK42NE75	



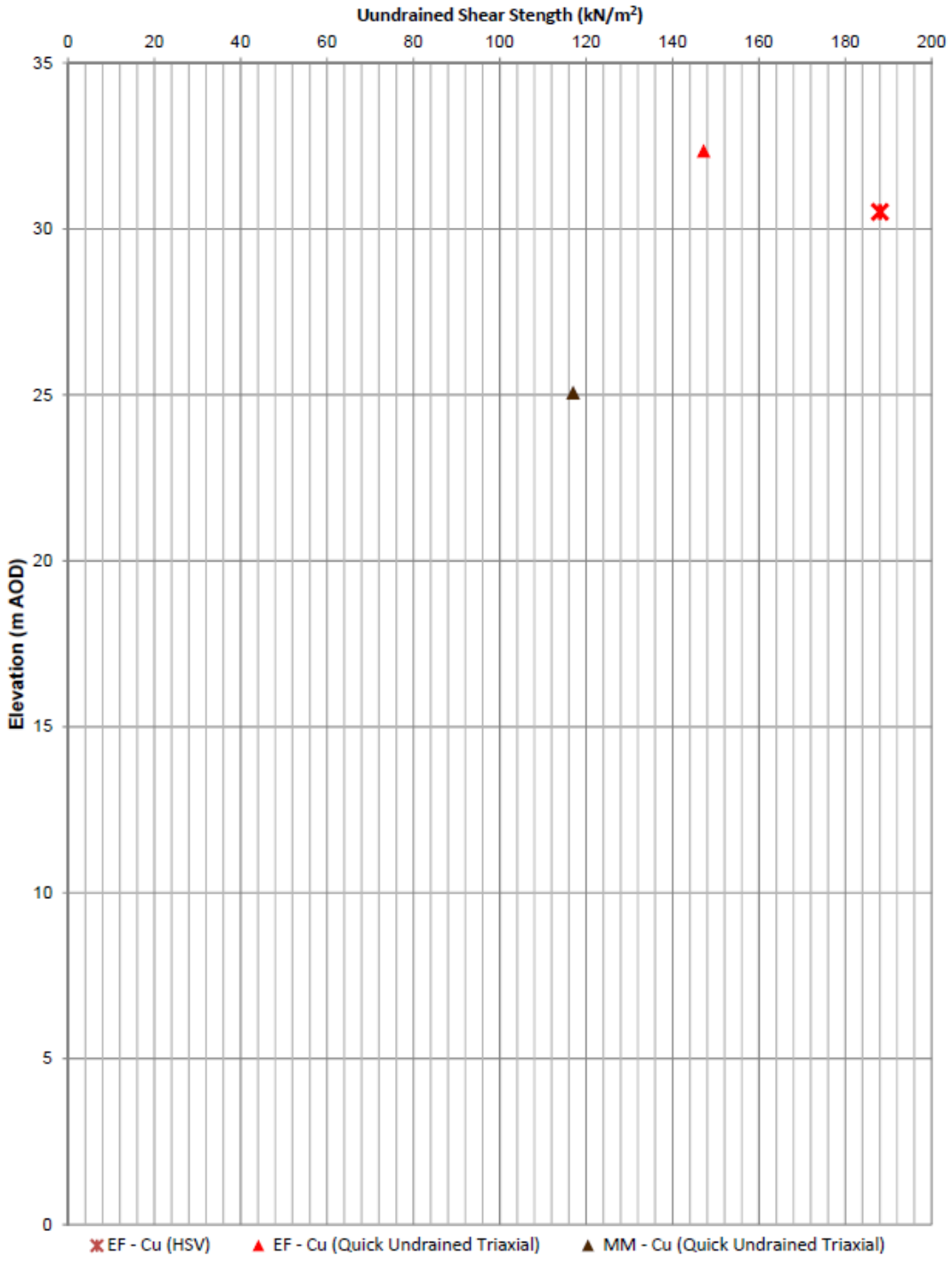
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185860-186360NB**
Client: **Highways England**	Borehole ID: **CP1090, SK42NE13 & SK42NE75**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-186500-186530-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	GANTRY_204[1]		
Structure Type	Super Cantilever		
Design Chainage	186500-186530		
Carriageway	Northbound		
Marker Post	186/5A+00 – 186/5A+30		
Existing Ground Level	Carriageway	33.2mAOD	
	Toe of embankment	29.7mAOD	
National Grid Reference	E 447244, N 328851 – E 447237, N 328872		
Earthwork Type	NB: Embankment	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: 7_M1_20909	SB: N/A	HAGDMS designation
Earthwork Height	NB: 3.5m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 20°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	02		

	Name	**Date**	**Signature**
Author	Scott Bishton	17/02/2017	[redacted]
Checked	Alice Bazen	27/04/2017	
Reviewed	Gary Summerfield	28/04/2017	
Approved	Tom Butleel	06/06/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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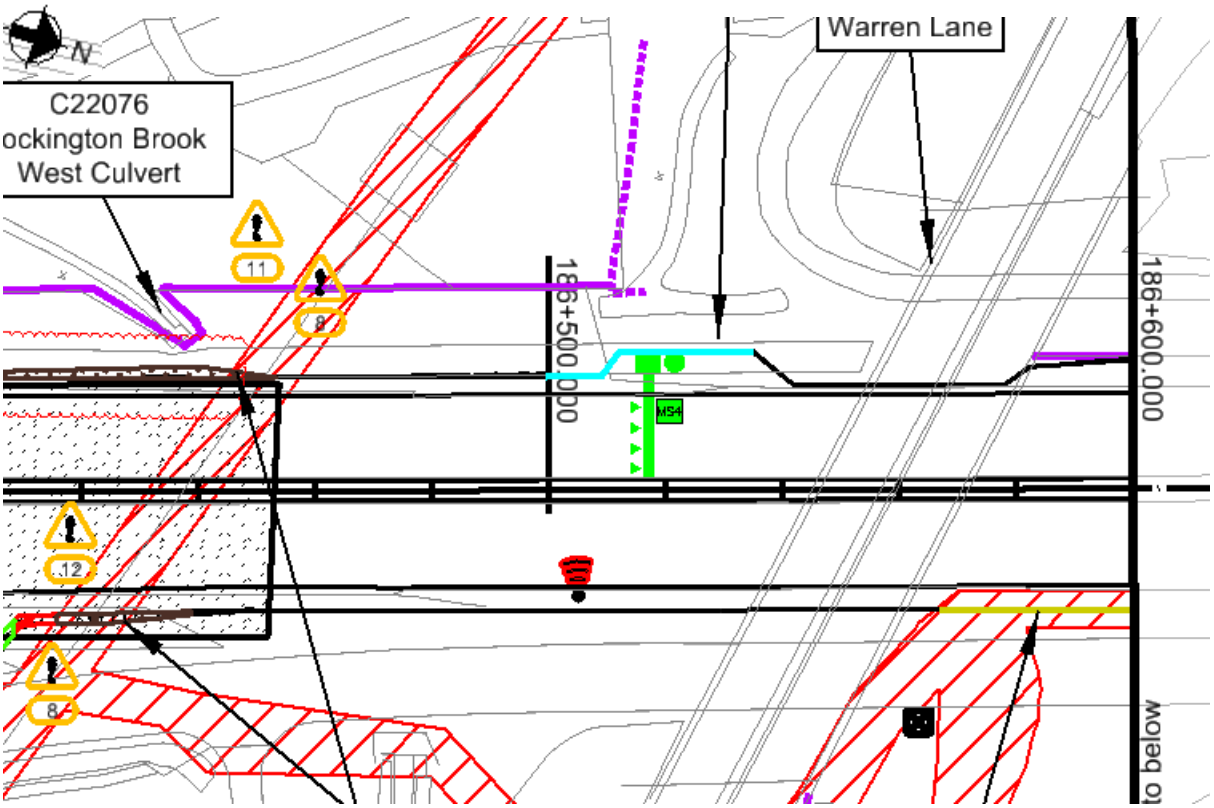


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate the earthworks widening for this location a king sheet pile retaining wall is proposed.

Proposed Major Structure:

A Super Cantilever Gantry to be installed on the northbound carriageway incorporating a new MS4 and AMI at chainage 186517.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130) has been supplied to AMAR indicating that the northbound side of the structure is to be located on an embankment of approximately 3.5m in height and a typical slope angle of 18°.

The critical cross section used is at Ch186530 because at this location the retained height and embankment height is greatest.

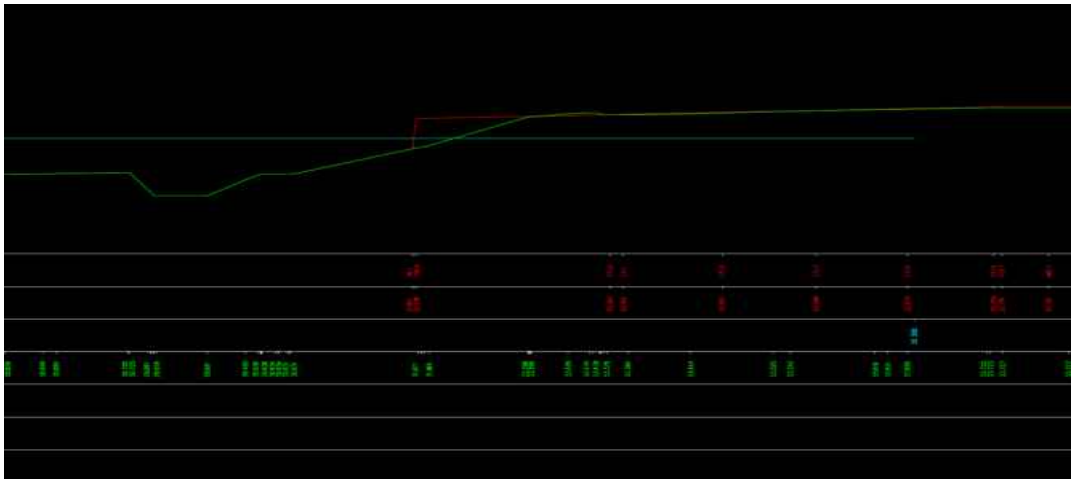


Figure 2: Topographic Critical Cross Section Ch186530

Utilities:

High Voltage Weston Power Overhead conductors run East-West about 80m South of the gantry location.

The proposed position of the Gantry 204 is in close proximity to the Lockington Brook West Culvert (C22076), it is as yet unknown the exact location of this culvert as it passes beneath the road.

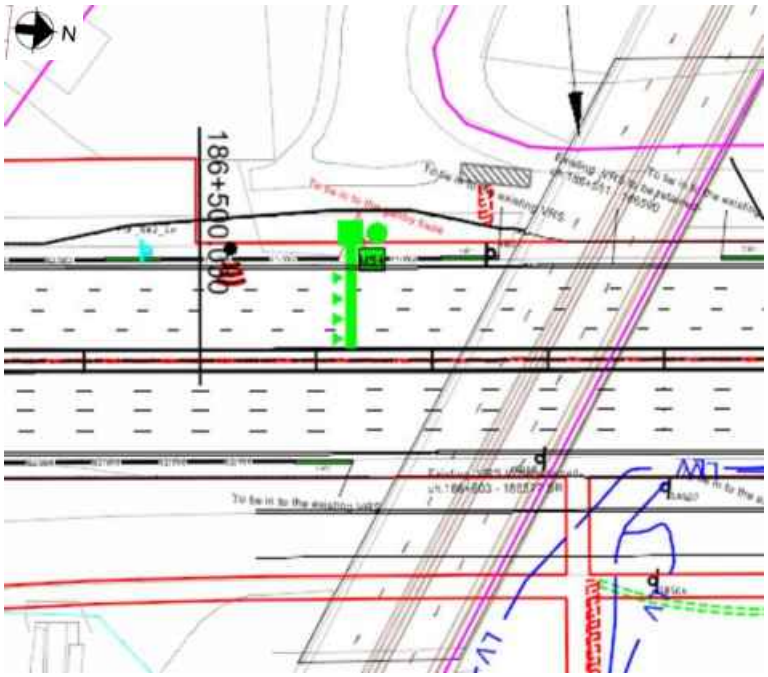


Figure 3: Utilities Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough, indicates that the site is underlain by:

Superficial Deposits: Holme Pierrepont Sand and Gravel Member (Glaciofluvial Deposits)

Solid Deposits: Branscombe Mudstone Formation (Mercia Mudstone Group)

Ground Investigation:

There is 1 No. historical exploratory holes recorded within the design chainage, with additional 8 no. relevant exploratory holes considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000027, Rev P01.

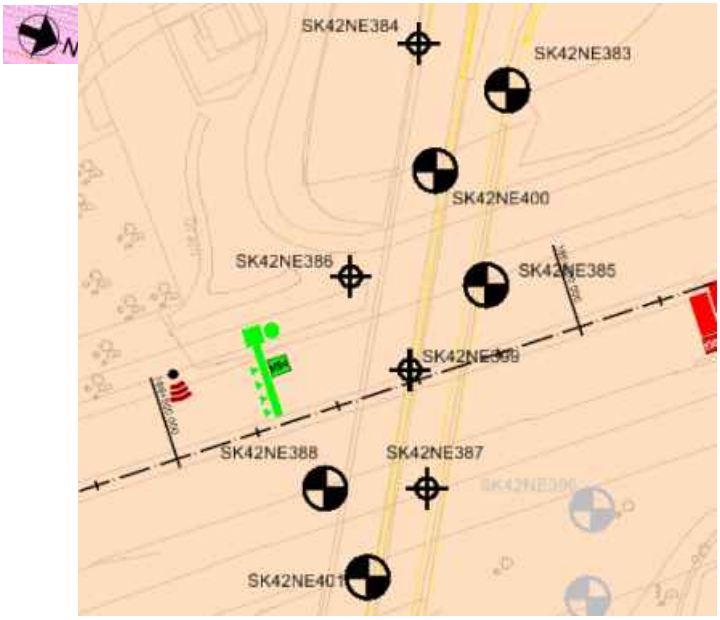


Figure 4: Borehole Location Plan

Flood Risk:

The design flood level is 32.30mAOD. Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	SK42NE386
Borehole Chainage	186552
Borehole Location	Northbound Carriageway
National Grid Reference	E 447223, N 328888
Ground Level at Exploratory Hole	30.84mAOD

RAG Analysis	Green
Date Drilled	10/06/1992 - 19/06/1992
Termination Depth	25.40 metres below ground level (mbgl)
Other suitable holes	SK42NE383, SK42NE384, SK42NE385, SK42NE387, SK42NE388, SK42NE399, SK42NE400, SK42NE401

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Embankment Fill	3.5	29.7	7-66 (30)
Glaciofluvial Deposits (coarse grained)	8.0	25.2	13-150[3] (35)
Mercia Mudstone – III/IV	-	-	31-150 (50)

1. Ground level is assumed to be at carriageway level.
2. Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
3. SPT capped at 150. Characteristic 'N' Values are given in brackets.
4. Embankment Fill (coarse grained) was recorded in 1 No. historical exploratory hole (SK42NE388), but not within the closer ones, therefore has been omitted from the ground model. Any in situ or lab data for Embankment Fill (coarse grained) was not used for derivation of geotechnical parameters for Embankment Fill .
5. Mercia Mudstone – I/II, Mercia Mudstone – Siltstone and Mercia Mudstone – Sandstone were recorded in historical exploratory holes within 100m of the location extents. However, given the absence of GI data inside the location extents and that these strata are encountered at depth (>15mbgl), a conservative assumption of Mercia Mudstone – III/IV at continuous depth is used. In situ or laboratory data from Mercia Mudstone – I/II, Mercia Mudstone – Siltstone or Mercia Mudstone – Sandstone was not used to derive geotechnical parameters for Mercia Mudstone – III/IV (e.g. SPTs were not used).

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within all historical exploratory holes mentioned above.

Groundwater:

Groundwater was encountered in the following boreholes:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
SK42NE383	River Terrace Deposits	2.55	29.84	20 mins	2.05	30.34
SK42NE384	Glaciofluvial Deposits	1.50	29.01	20 mins	1.40	29.11
SK42NE385	Embankment Fill	4.50	28.96	20 mins	4.38	29.08
SK42NE387	Glaciofluvial Deposits	3.60	28.41	20 mins	3.40	28.61
SK42NE388	Made Ground – Sand and Gravel	4.65	28.60	20 mins	4.40	28.85
SK42NE399	Embankment Fill	4.50	29.30	20 mins	-	-
SK42NE401	Glaciofluvial Deposits	1.70	28.63	-	-	-

Groundwater Design Level:

A groundwater level of 32.30mAOD (flood level) has been assumed for WALLAP analysis of the king sheet pile. When checking the global stability check of the earthwork and king sheet pile (analysed using SLOPE W) a Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

10 No. Atterberg Limit tests, 10 No. Natural Moisture Content tests were suitable for derivation of geotechnical parameters for the chosen ground model. The results of these tests are presented in the table below:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class*
Embankment Fill	1.2	14	35	19	16	CI
Embankment Fill	3.7	10	28	19	9	CL
Embankment Fill	1.2	18	36	14	22	CI
Embankment Fill	1	17	49	28	21	MI
Embankment Fill	1.5	2	35	14	21	CI
Embankment Fill	2	12.5	33	14	19	CL
Embankment Fill	3	12	33	16	17	CL
Embankment Fill	3.5	9	28	16	12	CL
Embankment Fill	4	9	33	15	18	CL
Mercia Mudstone – III/IV	5.8	23	28	16	12	CL

2 No. Traixial Tests were undertaken within the Embankment Fill with the following results:

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	0.8	22
Embankment Fill	1.2	153

Lab Test Data - BRE Classification:

No chemical laboratory testing data was available for this structure location.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000027 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment Fill	0-3.5	33.2-29.7	3.5	21	26	0	100	10.8	8.6	-	0.50	0.20	-	3.60	0.45	-	6.2*	-	DS-2 AC-2
Glaciofluvial Deposits (coarse grained)	3.5-8.0	29.7-25.2	4.5	21	37	-	-	-	49.2	-	-	0.25	-	19.70	-	1.0	-	50	DS-3 AC-3
Mercia Mudstone – III/IV	>8.0	<25.2	-	21	30	2	200	16.8	13.4	-	0.50	0.20	-	5.60	0.40	-	9.0	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are inferred from the geological long section HA549342-AMR-HGT-SWI-DR-GC-000027
(3) Due to limited localised GI data, typical values for bulk density, cohesion, and Poisson's ratio derived in the AMAR GIR are used.
(4) c_u of Embankment Fill was derived using the Stroud correlation. A typical PI of 17% gives an f1 value of 6.0, combined with a typical SPT 'N' value of 30, this gives a typical c_u of 165kN/m^2. The c_u values from triaxial test were 75 and 153kN/m^2. A typical c_u value of 100kN/m^2 was considered suitable as a conservative measure.
(5) ϕ' of Embankment Fill was determined using Table 2 in BS8002:2015 using typical PI of 17% gives 26°.
(6) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using typical SPT 'N' value of 30, Eu = 10.8MN/m^2. Therefore E' = 8.6MN/m^2.
(7) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using correlation with SPT 'N' values (Peck 1974). Using a typical 'N' value of 35 gives an angle of 37°.
(8) E' of Glaciofluvial Deposits (coarse grained) was determined using Bowles correlation E' = 1200 (N + 6) which (using typical 'N' value of 35) gives a value of 49.2MN/m^2.
(9) c_u of Mercia Mudstone – III/IV was derived using the Stroud correlation. In the absence of sufficient PI data, the typical f1 value of 5.0 for Mercia Mudstone (CIRIA C570) was adopted; combined with a typical SPT 'N' value of 50, this gives a c_u of 250kN/m^2. This value exceeds the range given in the AMAR GIR; therefore the upper bound of the range was adopted.

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(10) In the absence of sufficient local PI data for Mercia Mudstone – III/IV, ϕ' was taken as the characteristic value given in the AMAR GIR.
(11) Eu for Mercia Mudstone – III/IV was derived using SPT 'N' values (Bowles) where Eu = 300 (N+6); using a characteristic SPT 'N' value of 50 gives Eu = 16.8MN/m^2. E' of Mercia Mudstone – III/IV was derived using the relationship given by Wroth, 1972 where E'=2/3(1+v')E_u.
(12) Shear modulus is based on G = E/2(1+v).
(13) Adhesion Factor for Mercia Mudstone is based on BS8004 (equation 41).
(14) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl
(15) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).
(16) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1). For sandstone, Nq is derived based on a very dense siliceous cohesionless soil (Tomlinson Table 7.1).
(17) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used as backfill in the design of sheet piles in embankments; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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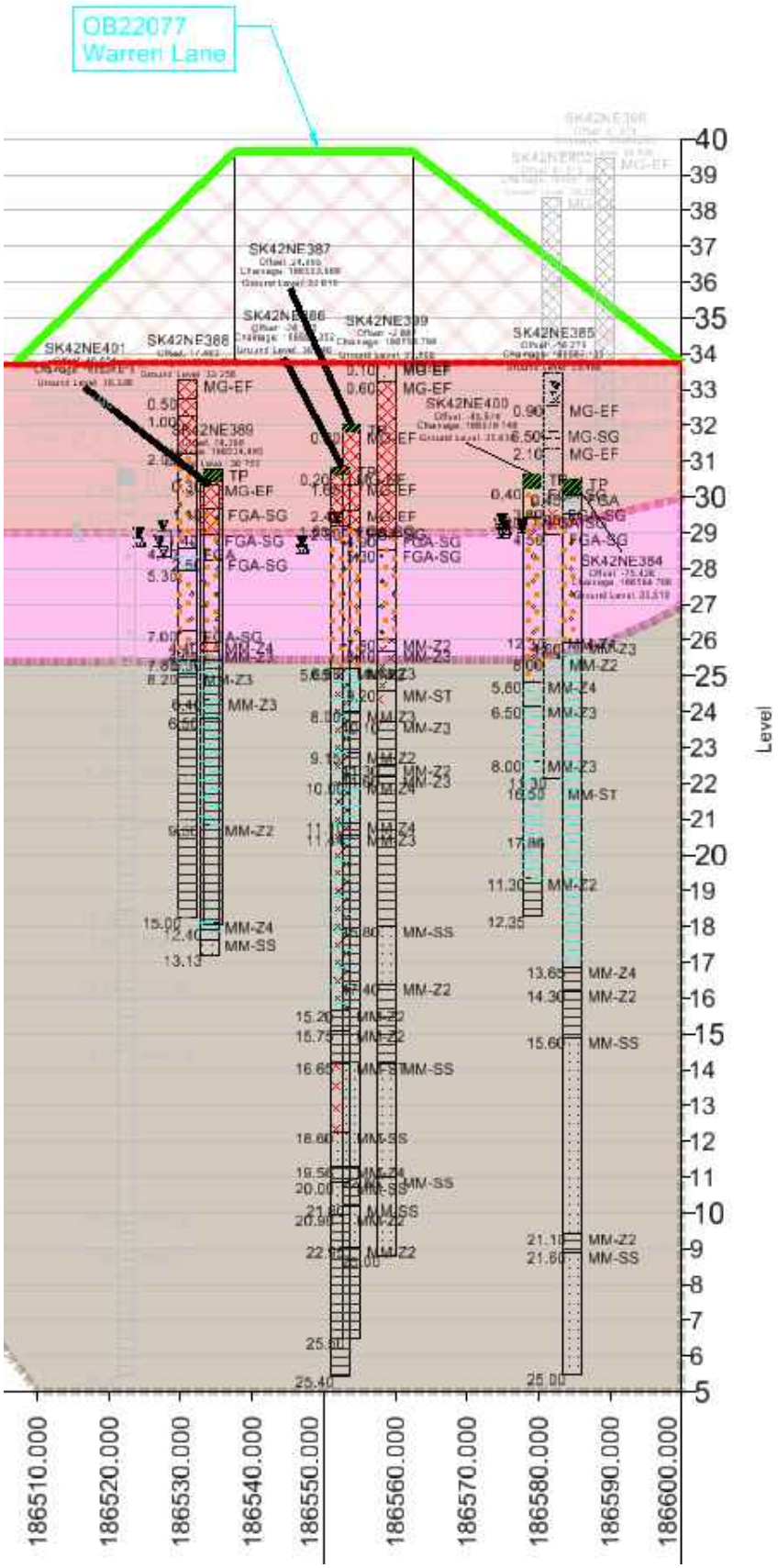


Figure 5: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to it encroaching on the flood plain, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	King Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
186500	186530	AZ-24 700 S390 GP	1.9	4.1	6.0	87	37	10	47

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.

Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	900	19	2.7	11	471	1476

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-G204 at chainage 186517, 24m deep dynamic sample / rotary core follow on exploratory hole, located in southbound existing hardstrip.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. SK42NE383 Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447179.00 - 328925.00	Hole Type CP
Location:		Level: 32.39	Scale 1:50
Client: Highways England		Dates: 29/06/1992 - 30/06/1992	Logged By S.G.Flynn

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 1.00	B				0.35	32.04		TOPSOIL TP
		1.00	S							Dense brown slightly silty very sandysubrounded fine to coarse GRAVEL of quartzite, siltzone, sandstone (River Terrace Deposits) RTD1
		1.01 - 2.00	B							
	▼	2.01 - 3.00	B				2.55	29.84		
	▽									Dense grey brown medium to coarse, becoming generally coarse, SAND with much subrounded fine to coarse gravel predominantly of quartzite. (Driller reports cobbles), (River Terrace Deposits) RTD1 *Very sandy gravel with cobbles*
		3.00	S							
		3.01 - 4.00	B							
		4.01 - 5.00	B							*By 4.00m becoming medium to coarse sand and subrounded fine to coarse gravel predominantly of quartzite*
		5.01 - 6.00	B				5.15	27.24		Stiff becoming very stiff, brown CLAY with 50-80% coase sand to fine gravel sized lithorelicts of very weak to weak mudstone. (Mercia Mudstone Group) MM-Z3
		6.01 - 7.00	B							*5.15-8.20m Stiff*
		7.00	S							
		7.01 - 8.00	B							
		8.01 - 9.00	B							*Below 8.00m with medium beds of very weak brown highly to moderately weathered MUDSTONE recovered as coarse sand to fine gravel sized angular fragments of very weak to weak mudstone*
		9.01 - 10.00	B							
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No.
SK42NE383
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447179.00 - 328925.00	Hole Type CP
Location:		Level: 32.39	Scale 1:50
Client: Highways England		Dates: 29/06/1992 - 30/06/1992	Logged By S.G.Flynn

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.01 - 11.00	B							
		11.10 - 11.25	B							
							11.65	20.74		End of borehole at 11.65 m

Remarks

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Rotary Core Log

Borehole No. SK42NE384

Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447168.00 - 328904.00	Hole Type CP+RC
Location:		Level: 30.51	Scale 1:50
Client: Highways England		Dates: 08/06/1992 - 11/06/1992	Logged By M.Bryans/A.J.Russell

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										TOPSOIL TP
		0.50	J				0.45	30.06		
		0.55 - 1.00	U							Probably stiff brown and red brown slightly sandy CLAY with occasional roundd fine gravel. including quartzite. (Alluvium) FGA
							1.00	29.51		
		1.14	J							Medium dense becoming very dense SAND AND subrounded fine to coarse GRAVEL including quartzite, sandstone,siltstone (River Trace Deposits) FGA-SG
	▼	1.15 - 1.60	B							
		1.50	W							
		1.80	J							
		2.15 - 2.60	B							*very sandy gravel*
		2.80	J							
		3.15 - 3.60	B							
		3.80	J							
		4.15 - 4.60	B							*From 4.15m silty sandy gravel with occasional cobbles*
							4.60	25.91		
		4.70	J							Very stiff and hard red brown CLAY with extremely closely spaced random irregular discontinuities and with the occasional thin soft clay and weak mudstone. (Mercia Mudstone Group) MM-Z3
		4.80 - 5.25	U							
		4.80 - 5.25	B							
		5.25 - 5.70	S							
		5.25 - 5.70	B							
		5.80	J							*weak red brown mudstone, recovered as angular fine to medium gravel sized fragments*
		6.00 - 6.45	S							
		6.00 - 6.45	B							
		6.80	J							*weak red brown mudstone*
		7.00 - 7.45	U							
		7.00 - 7.45	B							
		7.50 - 7.95	B							
		7.50 - 7.95	S							
		8.00	J							*moderately weak red brown mudstone*
		8.50 - 8.95	S							
		8.50 - 8.95	B							
		9.00	J							
		9.55 - 10.00	B							
										Continued on next sheet

Remarks

Borehole vertical and plastic. Flexible plastic sheet used 14.30-15.80m, partially recovered in core runs 15.30-15.50m and 15.50-15.80m. Diamond bit used.

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Rotary Core Log

Borehole No. SK42NE384
Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447168.00 - 328904.00	Hole Type CP+RC
Location:		Level: 30.51	Scale 1:50
Client: Highways England		Dates: 08/06/1992 - 11/06/1992	Logged By M.Bryans/A.J.Russell

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.30	J							
		10.50 - 10.80	B							
		10.50 - 10.80	S							weak mudstone
		11.50	J							
		12.00 - 12.45	S							recovered as grey green mottled red brown silty fine sand.
		12.00 - 12.45	B							
		13.00	J							
		13.64	J				13.65	16.86		Weak and moderately weak red brown thickly and thinley laminated MUDSTONE, recovered as angular gravel sized fragments. MM-Z4
		13.65 - 13.80	B							
		13.65 - 13.80	S							
		13.80 - 13.95	S							
		14.14	J				14.30	16.21		some hard red brown friable silty clay
		14.30 - 15.30		0						Weak red brown variegated grey green MUDSTONE, many subhorizontal and undulose partings and dustings of gypsum rarely subvertical with slickensiding. (Mercia Mudstone Group) MM-Z2
		15.30 - 15.80		100	0	0	15.60	14.91		assumed zone of core loss. Core recovered as angular gravel and cobble sized fragments. rare thick laminae of grey green argillaceous fine grained sandstone.
		15.80 - 17.30		98	97	95				Moderately strong grey green argillaceous fine grained SANDSTONE with medium spaced subhorizontal planar discontinuities. (Slightly weathered skerry band, Mercia Mudstone Group) MM-SS
		17.20	C							thinly laminated to medium bedded with red brown sandy mudstone and with many subhorizontal gypsum partings and occasional acicular veins (10-30mm)
		17.30	C							occasional subhorizontal gypsum veins (up to 8mm). From 18.00m, widely spaced discontinuities with some angular fine to coarse sand on discontinuity surfaces. 18.00-18.60m, oblique, juxtaposed gypsum veins (5-10mm).
		17.30 - 20.40		97	97	87				grey green sandstone, with occasional subhorizontal veins of gypsum (up to 3mm)
										closely to extremely closely spaced, subhorizontal undulose discontinuities red brown sandstone, occasional mottled grey green and with occasional subhorizontal curved

Continued on next sheet.

Remarks
Borehole vertical and plastic. Flexible plastic sheet used 14.30-15.80m, partially recovered in core runs 15.30-15.50m and 15.50-15.80m. Diamond bit used.

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Rotary Core Log

Borehole No. SK42NE384
Sheet 3 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447168.00 - 328904.00	Hole Type CP+RC
Location:		Level: 30.51	Scale 1:50
Client: Highways England		Dates: 08/06/1992 - 11/06/1992	Logged By M.Bryans/A.J.Russell

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		20.40	C							closely to extremely closely spaced, subhorizontal undulose discontinuities red brown sandstone, occasional mottled grey green and with occasional subhorizontal curved gypsum veins and acicular slightly undulose veins (up to 5mm).
		20.75	C							
		20.40 - 22.10		96	94	30	21.10	9.41		Moderately strong dark red brown MUDSTONE with extremely closely spaced, subhorizontal planar discontinuities. (Possibly drilling induced). MM-Z2
							21.60	8.91		many subhorizontal dustings and partings of gypsum, occasionally undulose stepped gypsum veins (up to 4mm)
		22.10 - 23.40		97	97	80				Moderately strong grey green argillaceous fine grained SANDSTONE, very thinly interbedded with red brown mudstone and with extremely closely to closely spaced subhorizontal planar undulose discontinuities many subhorizontal partings undulose of gypsum. (Slightly weathered, GII Mercia Mudstone Group) MM-SS
		23.40	C							red brown occasionally mottled grey green many 5mm subhorizontal, stepped gypsum veins, oblique juxtaposed 22.60-23.20m, red brown 23.40-23.80m, non-intact. From 23.80m, occasional sand sized gypsum crystals on discontinuities surfaces. At 23.80m, 35mm
		23.40 - 25.00		94	83	73				coarse sand size to fine gravel sized subrounded gypsum nodules.
										some 5-15mm horizontal acicular, stepped oblique juxtaposed, subhorizontal undulose gypsum wins and bands
		25.00	C				25.00	5.51		End of borehole at 25.00 m
		25.00	C							

Remarks
Borehole vertical and plastic. Flexible plastic sheet used 14.30-15.80m, partially recovered in core runs 15.30-15.50m and 15.50-15.80m. Diamond bit used.

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Rotary Core Log

Borehole No. SK42NE385
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447225.00 - 328920.00	Hole Type CP
Location:		Level: 33.46	Scale 1:50
Client: Highways England		Dates: 08/06/1992 - 09/06/1992	Logged By M.Bryans

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										TARMACADAM AND CONCRETE. (Drillers Description) (borehole bredrilled to 0.90m using rotary coringtechniques. (Made Ground). MG-EF
							0.90	32.56		
		1.20 - 1.65	U							Possibly firm, brown sandy CLAY with much subrounded fine to coarse gravel, predominantly of quartzite. (Made Ground). MG-EF
		1.65 - 1.70	J							
		1.70 - 2.15	B							
							2.10	31.36		
		2.70 - 3.15	B							Very dense brown slightly clayey SAND AND subrounded fine to coarse GRAVEL, including quartzite, sandstone and siltstone and occasional cobbles. (Made Ground). MG-EF
										2.70 to 3.15m very silty sandy gravel with some cobbles
										3.30-3.50m cobble
		3.70 - 4.15	B							
							3.80	29.66		Firm brown variegated red brown and grey sandy CLAY with some subrounded fine to coarse gravel , predominantly of quartzite and occasional cobbles. (Made Ground). MG-EF
		4.50 - 4.95	B				4.50	28.96		Medium dense becoming very dense brown fine to coarse SAND AND subrounded fine to course GRAVEL, predominantly of quartzite. (River Terrace Deposits) FGA-SG
		5.50 - 5.95	B							
		6.50 - 6.95	B							
		7.50 - 7.95	B							
							8.00	25.46		
		8.10	J							Generally weak, in parts moderately weak, red brown speckled grey green MUDSTONE with a little recovered soft, sandy silt matrix, generally recovered as angular fine gravel sized fragments. (Mercia Mudstone Group) MM-Z2
		8.30 - 8.70	U							
		8.80 - 9.25	B							
		10.00 - 10.30	B							
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No.
SK42NE385
Sheet 2 of 2

Project Name:	SMP - M1 J23A TO J25	Project No.	COCDFL1SMP01	Co-ords:	447225.00 - 328920.00
Location:				Level:	33.46
Client:	Highways England			Dates:	08/06/1992 - 09/06/1992

Hole Type: CP
Scale: 1:50
Logged By: M.Bryans

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							11.30	22.16		End of borehole at 11.30 m

Remarks

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Rotary Core Log

Borehole No. SK42NE386

Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447223.00 - 328888.00	Hole Type CP+RC
Location:		Level: 30.84	Scale 1:50
Client: Highways England		Dates: 10/06/1992 - 19/06/1992	Logged By M.Bryans/C.S.Owens

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.64		TOPSOIL with gravel TP
		0.50	J							Red brown, grey and brown clayey fine to course SAND AND angular to rounded fine to coarse GRAVEL, including quartzite, sandstone and tarmacadam. (Made Ground). MG-EF
		1.00	J							
		1.30 - 1.50	B							
		1.50	W							
		1.65 - 2.10	B				1.65	29.19		Dense and medium dense, becoming very dense brown silty fine to course SAND AND subrounded fine to course GRAVEL, predominantly of quartzite. (River Terrace Deposits) FGA-SG
		2.30	J							
		2.50 - 2.95	B							
		3.30	J							
		3.50 - 3.95	B							
		4.30	J							
		4.50 - 4.95	B							
		5.30	J							
		5.50 - 5.95	B							
		6.20	J				5.65	25.19		Very stiff and hard red brown, slightly mottled grey green, friable silty CLAY with extremely closely spaced random irregular discontinuities with occasional thin beds of weak and moderately weak mudstone and soft clay. (Mercia Mudstone Group) MM-Z3
		6.35 - 6.80	B							
		7.30	J							
		7.50 - 7.95	B							
		8.30	J							
		8.50 - 8.95	B							
		9.30	J							
		9.50 - 9.95	B							

Continued on next sheet

Remarks
Borehole located western toe of M1 Embankment (Northbound). Borehole vertical and stable.

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Rotary Core Log

Borehole No. SK42NE386

Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447223.00 - 328888.00	Hole Type CP+RC
Location:		Level: 30.84	Scale 1:50
Client: Highways England		Dates: 10/06/1992 - 19/06/1992	Logged By M.Bryans/C.S.Owens

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.30	J							
		10.50 - 10.95	B							10.5-10.95m weak grey green fine grained silty sandstone, recovered as angular fine gravel sized fragments ("skerry bands", GIII)
		11.50	J							
		12.00 - 12.45	B							
		13.00	J							
		13.50 - 13.95	B							
		14.50	J							at 14.5m with some crystals of gypsum
		15.00 - 15.23	B							
		15.20	J				15.20	15.64		Moderately weak red brown, slightly mottled grey green MUDSTONE with extremely closely spaced random irregular discontinuities and with many irregular, random veins (<5mm) of fibrous gypsum. (Moderately weathered, GIII, Mercia Mudstone Group) MM-Z2
		15.30 - 15.45	B							15.30-15.45m in parts very weak
		15.45 - 15.75	B				15.75	15.09		
		15.75 - 16.70		100	100	84				
							16.65	14.19		Moderately weak red brown mottled grey green MUDSTONE with randomly orientated gypsum veins (<5mm). Closely spaced discontinuities with some fine sand sized gypsum crystals on surfaces. (Moderately weathered, GIII, Mercia Mudstone Group) MM-Z2
		17.61	C							17.61m Cable Percussion complete. subhorizontal gypsum veins with slickensides
		16.70 - 19.70		100	90	68				Moderately strong light grey green and red brown SILTSTONE with randomly orientated gypsum veins (<5mm) and with closely spaced random irregular discontinuities. (Slightly to moderately weathered skerry band, Mercia Mudstone Group) MM-ST
							18.60	12.24		non-intact weak, recovered as angular fine to coarse gravel sized fragments with tabular gypsum fragments.
		19.26 - 19.55	C							Strong light grey green fine grained SANDSTONE with closely and medium spaced irregular rough discontinuities with randomly orientated gypsum veins. (Slightly weathered skerry band, Mercia Mudstone Group) MM-SS
		19.70	C				19.56	11.28		
							20.00	10.84		Continued on next sheet.

Remarks
Borehole located western toe of M1 Embankment (Northbound). Borehole vertical and stable.

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447223.00 - 328888.00	Borehole No. SK42NE386 Sheet 3 of 3
Location:		Level: 30.84	Hole Type CP+RC
Client: Highways England		Dates: 10/06/1992 - 19/06/1992	Scale 1:50
			Logged By M.Bryans/C.S.Owens

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		20.47	C				20.90	9.94		5mm subhorizontal acicular gypsum vein Weak red brown and grey green thinly laminated MUDSTONE with many randomly orientated thinly laminated gypsum veins. (Mercia Mudstone Group) MM-Z4 *recovered as non-intact, very weak gravel sized fragments and stiff clay infill*
		19.70 - 22.50 21.48 - 21.75	C	95	91	85				Moderately strong light grey green fine grained SANDSTONE with closely and medium spaced, random irregular discontinuities with random orientated gypsum veins. (Slightly weathered skerry band, Mercia Mudstone Group) MM-SS
		22.50 - 23.10		100	83	17				Moderately weak red brown MUDSTONE with many randomly orientated thinly laminated gypsum veins. Random irregular closely and medium spaced discontinuities with fine sand sized crystals on the surfaces. (Moderately weathered, GIII, Mercia Mudstone Group) MM-Z2
		23.10 - 25.40		100	99	69				*moderately strong fine grained sandstone with many partings of gypsum* *non-intact recovered as gravel sized fragments grey* *non-intact, recovered as gravel sized fragments in clay matrix* *recovered as weak red brown and grey with discontinuities infilled with soft clay with angular fine to coarse tabular gravel sized mudstone lithorelicts. 24.24m, juxtapose acicular gypsum laminations (5mm). 24.96-25.04m, non-intact, recovered as gravel si*
							25.40	5.44		End of borehole at 25.40 m

Remarks
Borehole located western toe of M1 Embankment (Northbound). Borehole vertical and stable.

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Rotary Core Log

Borehole No. SK42NE387
Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447273.00 - 328906.00	Hole Type CP+RC
Location:		Level: 32.01	Scale 1:50
Client: Highways England		Dates: 12/06/1992 - 16/06/1992	Logged By M.Bryans/C.S.Owens

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 1.00	B				0.20	31.81		TOPSOIL TP Recovered as dark brown sandy topsoil with some subrounded fine to course gravel and occasional cobbles. (Made Ground). MG-EF
		1.20 - 1.65	U							
		1.69	B				1.65	30.36		Dense brown clayey sandy angular to rounded fine to course GRAVEL with occasional cobbles. (Made Ground) MG-EF
		2.45	J				2.40	29.61		Grey and brown clayey sandy subrounded fine to course GRAVEL, including quartzite sandstone. (Made Ground) MG-EF
		2.50 - 2.95	U							
		3.01 - 4.00	B				2.90	29.11		Dense becoming very dense brown fine to course SAND AND subrounded fine to course GRAVEL, predominantly of quartzite with occasional cobbles. (River Terrace Deposits) FGA-SG
		4.00	S							*4.00-5.00m very sandy gravel with occasional cobbles*
		4.01 - 5.00	B							*4.37-4.55m cobble*
		5.01 - 6.00	B							
		6.01 - 6.80	B							*6.25-6.40m cobble*
		6.80	J				6.80	25.21		Hard red brown, slightly mottled grey green, friable silty CLAY with many extremely closely spaced random, irregular discontinuities. (Extremely weathered, GV, Mercia Mudstone Group) MM-Z3
		7.00 - 7.45	S							*7.00-7.45m: recovered with some angular fine to medium gravel sized fragments of weak and moderately weak mudstone*
		7.01 - 8.00	B							
		8.00 - 8.45	S				8.00	24.01		Very weak red brown MUDSTONE with some firm friable sandy clay matrix with extremely closely spaced, random, irregular discontinuities, recovered as sand to medium gravel sized fragments. (moderately weathered, GIII, Mercia Mudstone Group) MM-Z3
		8.01 - 9.00	B							
		9.01 - 9.50	B				9.15	22.86		Weak red brown MUDSTONE with extremely spaced, random irregular discontinuities, recovered as gravel sized fragments. (Slightly to moderately weathered, GII/III, Mercia Mudstone Group)
							10.00	22.01		Continued on next sheet.

Remarks
Borehole in of M1 Embankment (Southbound). Borehole vertical and stable. Tungsten carbide bit and flexible plastic sheeting used.

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Rotary Core Log

Borehole No. SK42NE387 Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447273.00 - 328906.00	Hole Type CP+RC
Location:		Level: 32.01	Scale 1:50
Client: Highways England		Dates: 12/06/1992 - 16/06/1992	Logged By M.Bryans/C.S.Owens

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.00 - 11.10		36	0	0				MM-Z2 Recovered as soft red brown CLAY with many fine to medium gravel sized lithorelicts of mudstone. (Mercia Mudstone Group) MM-Z4
		11.10	C				11.10	20.91		
							11.44	20.57		Recovered as angular fine to medium gravel sized fragments of weak red brown MUDSTONE with much soft clay matrix. (Mercia Mudstone Group) MM-Z4
		11.10 - 12.70		69	19	19				Very weak red brown thinly laminated MUDSTONE with random irregular closely and extremely closely spaced discontinuities infilled with soft clay. (Mercia Mudstone Group) MM-Z3
		12.30	C							*recovered non-intact as angular gravel sized fragments*
		12.70 - 14.30		78	63	58				*recovered non-intact as angular gravel sized fragments 14.50-14.58m, very weak grey green fine grained sandstone*
		14.30 - 15.90		81	64	38				*many random irregular partings of gypsum. Occasional slickensides on gypsum surfaces. 15.40-15.59m, weak. 15.90-16.20m, recovered as soft red brown clay with many angular fine to medium gravel sized lithorelicts of mudstone. 16.54-16.78m, weak grey green*
		15.90	C							
		16.55	C							
		16.60	C							
		15.90 - 17.80		89	81	45				
							17.80	14.21		Moderately strong light grey green fine grained SANDSTONE with very closely to closely spaced discontinuities. (Mercia Mudstone Group) MM-SS
		17.80 - 20.70		96	94	71				*weak grey green siltstone with occasional partings of gypsum* *red brown argillaceous sandstone with closely spaced gypsum bands (10mm)* *mottled red brown. Thinly interbedded with moderately weak and weak red brown mudstone with partings of gypsum*

Continued on next sheet

Remarks
Borehole in of M1 Embankment (Southbound). Borehole vertical and stable. Tungsten carbide bit and flexible plastic sheeting used.

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Rotary Core Log

Borehole No. SK42NE387
Sheet 3 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447273.00 - 328906.00	Hole Type CP+RC
Location:		Level: 32.01	Scale 1:50
Client: Highways England		Dates: 12/06/1992 - 16/06/1992	Logged By M.Bryans/C.S.Owens

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		20.40	C							
		20.70	C				20.70	11.31		Weak red brown MUDSTONE, recovered as angular fine to coarse gravel with some soft red brown clay matrix. (Mercia Mudstone Group) MM-Z4
										recovered non-intact as angular gravel and cobble sized fragments. 21.18-21.30m, moderately weak fine grained argillaceous sandstone. 21.50m, subhorizontal gypsum band (10mm)
							21.80	10.21		Moderately strong light grey green fine grained SANDSTONE. Closely spaced subhorizontal discontinuities infilled with non-intact angular gravel sized sandstone fragments. (Moderately weathered, skerry band, Mercia Mudstone Group) MM-SS
		20.70 - 23.80		100	67	24				
							22.95	9.06		Weak red brown thinly laminated MUDSTONE with many dustings and partings of gypsum. Closely and extremely closely sapced clay smeared discontinuities. Occasional subhorizontal acicular gypsum veins. (Mercia Mudstone Group) MM-Z2
		24.00	C							*grey green*
										subhorizontal acicular gypsum band (10mm)
		23.80 - 25.50		93	93	32				*grey green*
							25.50	6.51		End of borehole at 25.50 m

Remarks
Borehole in of M1 Embankment (Southbound). Borehole vertical and stable. Tungsten carbide bit and flexible plastic sheeting used.

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Rotary Core Log

Borehole No. SK42NE388

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447273.00 - 328882.00	Hole Type CP
Location:		Level: 33.25	Scale 1:50
Client: Highways England		Dates: 12/06/1992 - 14/06/1992	Logged By M.Bryans

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 1.00	B							Compacted dark brown soil and ashes. (Made Ground) MG-EF
		0.50	J				0.50	32.75		Firm red brown sandy CLAY with some angular to rounded fine to course gravel, including quartzite, sandstone and siltstone. (Made Ground). MG-EF
		1.00 - 1.45	U				1.00	32.25		Firm and stiff red brown CLAY with some angular fine to course gravel, predominantly of mudstone , occasionally siltstone. (Made Ground) MG-EF
		1.59	J							
		2.05 - 2.50	B				2.05	31.20		Dense dark orange brown slightly clayey fine to course SAND AND subrounded fine to course GRAVEL, including sandstone, sltstone, quartzite and with occasional cobbles. MG-SG
		2.55 - 3.00	B							
		2.99	J							below 3.00m some stiff red brown clay
		3.00	S							3.00-3.55m cobble
		3.01 - 3.55	B							
		3.99	W							
		4.00	W							
	▼	4.00 - 4.20	B							
		4.19	J							
	▽	4.20 - 4.65	B							
		4.40	W				4.70	28.55		Softdark grey slightly sandy CLAY with some angular fine to course gravel of quartzite, occasional rootlets. (Alluvium) FGA
		4.69	W							
		4.70 - 5.20	B							
		5.20 - 5.65	B				5.30	27.95		Very dense brown fine to course SAND AND subrounded fine to course GRAVEL, predominantly of quartzite with occasional cobbles. (River Terrace Deposits) FGA-SG
		5.70 - 6.00	B							
		6.00 - 6.45	B							5.60-6.00m cobble
										6.60-7.00m cobble
		7.00 - 7.45	B				7.00	26.25		Medium dense brown clayey fine to course SAND AND subroudedfine to course GRAVEL predominantly of quartzite with occasional cobbles and boulders. (River Terrace Deposits) FGA-SG
		7.79	J				7.80	25.45		7.40-7.80m boulder
		7.80 - 8.00	B							Recovered firm red brown silty CLAY with occasional lithorelictsof very weak mudstone. (Highly weathered, GIVc, Mercia Mudstone Group) MM-Z2
		8.00 - 8.45	B				8.20	25.05		
		8.50 - 9.00	B							Very weak and weak, in parts moderately weak, red brown MUDSTONE, recovered as angular gravel sized fragments. (Mercia Mudstone Group). MM-Z3
		9.00 - 9.38	B							
		10.00 - 10.55	B							Continued on next sheet.

Remarks
Borehole located on M1 verge of (Southbound).

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Rotary Core Log

Borehole No. SK42NE388
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447273.00 - 328882.00	Hole Type CP
Location:		Level: 33.25	Scale 1:50
Client: Highways England		Dates: 12/06/1992 - 14/06/1992	Logged By M.Bryans

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.55 - 10.93	B							
		11.50 - 12.00	B							11.50-12.45m probably stiff (recovered soft) red brown silty clay with many coarse sand to fine gravel sized lithorelicts of very weak mudstone. (Mercia Mudstone Group)
		12.00 - 12.45	B							
		13.00 - 13.55	B							
		13.55 - 14.00	B							
		14.20 - 14.55	B							
		14.55 - 15.00	B							
							15.00	18.25		End of borehole at 15.00 m

Remarks
Borehole located on M1 verge of (Southbound).

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Rotary Core Log

Borehole No. SK42NE399

Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447245.00 - 328902.00	Hole Type CP+RC
Location:		Level: 33.80	Scale 1:50
Client: Highways England		Dates: 05/06/1992 - 07/06/1992	Logged By M.Bryans/A.J.Russell

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.10	33.70		Tarmacadam MG-EF
							0.60	33.20		Concrete (Drillers dscription) MG-EF
		1.00 - 1.45	B							Generall stiff in parts soft and firm, red brown slightly sandy CLAY with a little angular to subrounded fine to medium gravel of sandstone and quartzite. Ocasional fine to medium gravel sized lithorelicts. (Made Ground) MG-EF
		1.50 - 1.95	B							
		2.00 - 2.45	B							2.00-2.40m silty very sandy gravel
		2.50 - 2.95	B							below 2.40m driller reports cobbles
		3.00 - 3.45	B							
		3.50 - 3.95	B							
		4.00 - 4.45	B							
	▼	4.30	W							
		5.00 - 5.45	B				4.90	28.90		Medium dense brown fine to coarse SAND with a little in part some subrounded generally fine to medium gravel of quartzite and sandstone. (River Terrace Deposits) FGA-SG
		6.00 - 6.45	B				5.30	28.50		Dense becoming very dense, brown medium to coarse SAND AND subrounded to rounded fine to coarse GRAVEL of siltstone, sandstone and quartz. Driller reports cobbles. (River Terrace Deposits) FGA-SG
										6.00-6.45m clayey gravelly sand
		7.60 - 7.80	B							
		7.79	J				7.80	26.00		Firm red brown slightly sandy very clayey SILT wit occasional to some weak angular fine gravel sized lithorelicts of very weak mudstone. (Mercia Mudstone Group) MM-Z2
		7.80 - 8.25	U				8.10	25.70		
		8.35	J							
		8.60 - 9.05	B							Very stiff hard red brown slightly sandy very clayey SILT with some angular fine to medium gravel sized weak and very weak lithorelictsof very weak mudstone. Light green grey in parts . (Mercia Mudstone Group) MM-Z3
		9.20 - 9.65	S				9.20	24.60		
		9.65 - 10.10	S							Hard and weak red brown SILTSTONE, moderately weathered recovered as angular fine to coarse gravel sized fragments. (Mercia
		9.65 - 10.10	S							

Continued on next sheet

Remarks

Predrilled to 1.00m by rotary. Lane 3: Northbound carriageway of M1. 24hr working. Borehole vertical and unstable.

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Rotary Core Log

Borehole No. SK42NE399
Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447245.00 - 328902.00	Hole Type CP+RC
Location:		Level: 33.80	Scale 1:50
Client: Highways England		Dates: 05/06/1992 - 07/06/1992	Logged By M.Bryans/A.J.Russell

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.10	23.70		Mudstone Group) MM-ST
		10.10 - 11.10		0						Very weak red brown friable weathered MARL, very soft in places. (Driller's description) MM-Z3 zone of core loss
		11.10 - 11.30		0			11.30	22.50		
		11.30 - 11.60		100	0	0				Very weak red brown MUDSTONE, recovered as subangular to angular fine becoming coarse gravel. (Mercia Mudstone Group) MM-Z2 recovered as non-intact
		11.60 - 12.10		0			11.60	22.20		
		12.10 - 12.60		0						Very weak red brown friable weathered MARL, very soft in places. (Driller's description) MM-Z3 zone of core loss
		12.60 - 13.10		0						
		13.10 - 13.60		0						
		13.60 - 14.10		0						
		14.10 - 14.60		0						
		14.60 - 15.60		0						
		15.60 - 15.80		0			15.80	18.00		
		15.80 - 17.40		64	54	36				Moderately strong grey green argillaceous fine grained SANDSTONE, many thin (1-2mm) subhorizontal (dipping 5 deg) veins of gypsum, occasionally subvertical. (Slightly weathered, Skerry Band, Mercia Mudstone Group) MM-SS
		17.40 - 17.90		100	23	22	17.40	16.40		Moderately weak red brown MUDSTONE, thinly laminated many thin (1-2mm) veins of gypsum along random planar discontinuities, extremely closely spaced. (Mercia Mudstone Group) MM-Z2 with some soft clay (GM) some 4mm veins moderately strong grey green argillaceous fine sandstone, many thin (1mm) gypsum veins From 18.60m, occasional 5mm veins From 19.77m, strong, some grey green speckling and laminations
		17.90 - 20.00		90	88	28				
							19.62	14.18		occasional subhorizontal, undulose extremely closely spaced discontinuities Medium to thinly interbedded strong green grey argillaceous SANDSTONE AND with weak to
		20.00	C							Continued on next sheet

Remarks
Predrilled to 1.00m by rotary. Lane 3: Northbound carriageway of M1. 24hr working. Borehole vertical and unstable.

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Rotary Core Log

Borehole No. SK42NE399
Sheet 3 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447245.00 - 328902.00	Hole Type CP+RC
Location:		Level: 33.80	Scale 1:50
Client: Highways England		Dates: 05/06/1992 - 07/06/1992	Logged By M.Bryans/A.J.Russell

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		20.00 - 22.00		98	84	62				moderately weak red brown thinly laminated MUDSTONE. (Slightly weathered, Skerry bands, to moderately weathered, GIII, Mudstone, Mercia Mudstone Group) MM-SS *mudstone with random incipient discontinuities* *mudstone with subhorizontal, extremely closely spaced discontinities with some soft clay*
		22.00 - 25.00		100	89	80	22.80	11.00		*mudstone with subhorizontal, extremely closely spaced discontinities with some soft clay* *sandstone with many gypsum veins* Strong green grey argillaceous fine SANDSTONE, many 1-25mm undulose subhorizontal gypsum veins along planar extremely closely sapced discontinuties. (Fresh to slightly weathered, Skerry band, Mercia Mudstone Group) MM-SS *From 22.60m, with much indistinctly interbedded red brown clay, occasional subhorizontal undulose discontinuities with coarse gypsum crystal growth* *At 24.02m, 4mm undulose subhorizontal gypsum vein* *From 24.30m, occasional thick red brown laminations becoming red brown argillaceous, many 1-2mm undulose gypsum veins; some 4-15mm veins* *From 24.50m, occasional locally cemented leached out to become poorly cemented, GIII*
							25.00	8.80		End of borehole at 25.00 m

Remarks
Predrilled to 1.00m by rotary. Lane 3: Northbound carriageway of M1. 24hr working. Borehole vertical and unstable.

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Rotary Core Log

Borehole No. SK42NE400

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447198.00 - 328908.00	Hole Type CP
Location:		Level: 30.63	Scale 1:50
Client: Highways England		Dates: 25/06/1992 - 26/06/1992	Logged By M.Bryans

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.10	B							TOPSOIL TP
							0.40	30.23		Medium dense brown SAND AND subrounded fine to coarse GRAVEL, predominantly of quartzite (Driller records "with clay") (Alluvium) FGA-SG
		1.01 - 2.00	B				1.20	29.43		Dense brown fine to coarse SAND AND subrounded fine to coarse GRAVEL, predominantly of quartzite, with occasional cobbles. (River Terrace deposits) FGA-SG
		2.00	W							
		2.01 - 3.00	B							
		3.01 - 4.00	B							
		4.01 - 5.00	B							*4.00-5.00m Low STP probably due to failure to maintain water balance during test*
		5.01 - 5.50	B							
		5.80 - 6.25	S				5.80	24.83		Stiff red brown friable CLAY with many coarse hand sized to fine gravel sized lithorelicts of very weak mudstone. (Mercia Mudstone Group) MM-Z4
		5.81 - 7.00	B							
							6.50	24.13		Hard red brown, occasionally mottled grey green, friable CLAY with 50-70% sand sized tofine gravel lithorelicts of very weak mudstone. (Mercia Mudstone Group) MM-Z3
		7.00	S							
		7.01 - 8.00	B							
		8.01 - 8.80	B				8.00	22.63		Very stiff red brown, occasionally mottled grey green, friable CLAY with many to 70% sand sized to fine gravel sized lithorelicts of very weak to weak mudstone. (Mercia Mudstone Group) MM-Z3
		8.80 - 9.25	U							
		9.25 - 9.30	J							
		9.31 - 10.50	B							

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE400
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447198.00 - 328908.00	Hole Type CP
Location:		Level: 30.63	Scale 1:50
Client: Highways England		Dates: 25/06/1992 - 26/06/1992	Logged By M.Bryans

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.51 - 11.50	B							
							11.30	19.33		Very weak and weak red brown, occasionally mottled grey green, silty MUDSTONE with , to 12.0m, some hard friable clay matrix; generally recovered as sand sized to fine gravel sized fragments. (Moderately weathered, GIII, Mercia Mudstone Group) MM-Z2
							12.35	18.28		End of borehole at 12.35 m

Remarks

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Rotary Core Log

Borehole No. SK42NE401

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447294.00 - 328892.00	Hole Type CP
Location:		Level: 30.33	Scale 1:50
Client: Highways England		Dates: 16/06/1992 - 20/06/1992	Logged By M.Bryans

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 1.00	B							Recovered stiff brown, red brown and grey slightly sandy CLAY with occasional subangular to rounded fine to coarse gravel, including quartzite and sandstone. (Made Ground) MG-EF
		1.00 - 1.45	U							
	▼	1.51 - 2.70	B				1.40	28.93		Dense and very dense brown fine to coarse SAND AND subrounded fine to coarse GRAVEL, predominantly of quartzite with occasional cobbles. (River Terrace Deposits) FGA-SG
										2.00-2.15m cobble
		2.71 - 3.50	B							
		3.51 - 4.40	B							
		4.40	J				4.40	25.93		Firm red brown slightly mottled light grey green friable slightly sandy CLAY with some fine gravel sizes lithorelicts and occasional rounded fine to medium gravel of quartzite. (Reworked Mercia Mudstone) MM-Z4
		4.61 - 5.50	B				4.65	25.68		
		5.51 - 6.50	B							Stiff becoming very stiff red brown friable CLAY with 60% fine gravel sized lithorelicts of very weak mudstone. In parts with extremely closely spaced random irregular discontinuities. (Mercia Mudstone Group) MM-Z3
		6.51 - 7.50	B				6.50	23.83		Hard red brown, slightly mottled light grey green, friable CLAY generally recovered as sand to fine gravel sized fragments of hard clay with occasional gravel sized pockets of light grey silt and with some up to fine gravel sized lithorelicts of very weak mudstone, (Mercia Mudstone Group) MM-Z3
		8.51 - 9.50	B							8.50-8.95m very stiff
		9.51 - 10.00	B				9.50	20.83		Very weak red brown, slightly mottled light grey green silty MUDSTONE generally recovered as coarse sand sized to fine gravel sized fragments.
										Continued on next sheet

Remarks
Hole redrilled adjacent to first hole after shell jammed at 8.00m

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Rotary Core Log

Borehole No. SK42NE401
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447294.00 - 328892.00	Hole Type CP
Location:		Level: 30.33	Scale 1:50
Client: Highways England		Dates: 16/06/1992 - 20/06/1992	Logged By M.Bryans

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.01 - 11.00	B							(Mercia Mudstone Group) MM-Z2
		11.01 - 11.70	B							below 11.00m with occasional probably hard and very stiff (recovered soft) clay matrix
		11.71 - 12.70	B							
							12.20	18.13		Soft grey green silty CLAY (probable "skerry" bands) MM-Z4
							12.40	17.93		
							12.70	17.63		Firm red brown silty CLAY MM-Z4
							13.13	17.20		Probably very weak light grey green fine grained silty SANDSTONE, recovered as silty fine sand. (Highly weathered, "skerry band", Mercia Mudstone Group) MM-SS
										End of borehole at 13.13 m

Remarks
Hole redrilled adjacent to first hole after shell jammed at 8.00m

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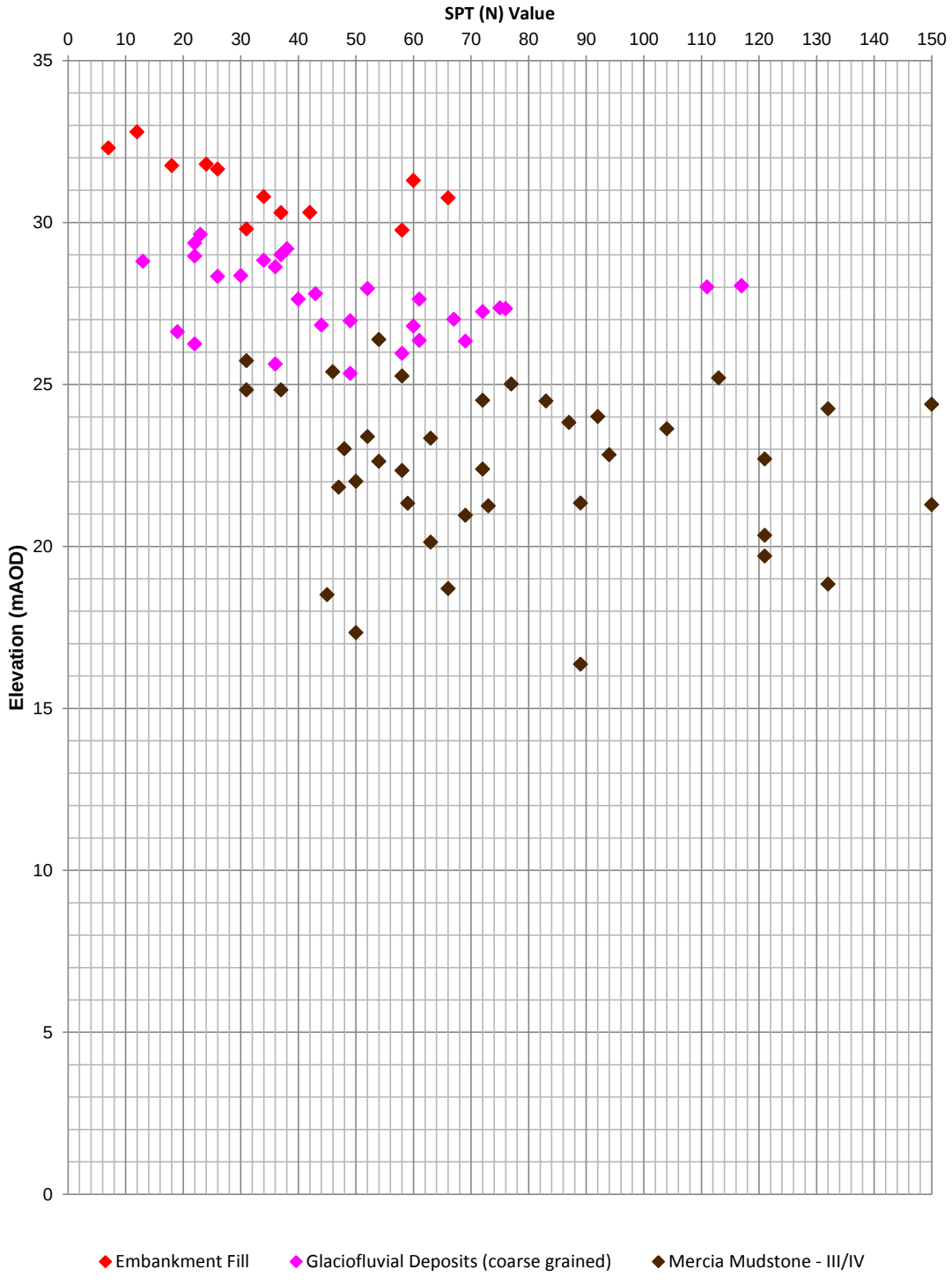
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PLOTS

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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186510-186530NB**
Client: **Highways England**	Borehole ID: **SK42NE383, SK42NE384, SK42NE385, SK42NE386, SK42NE387, SK42NE388, SK42NE399, SK42NE400, SK42NE401**	



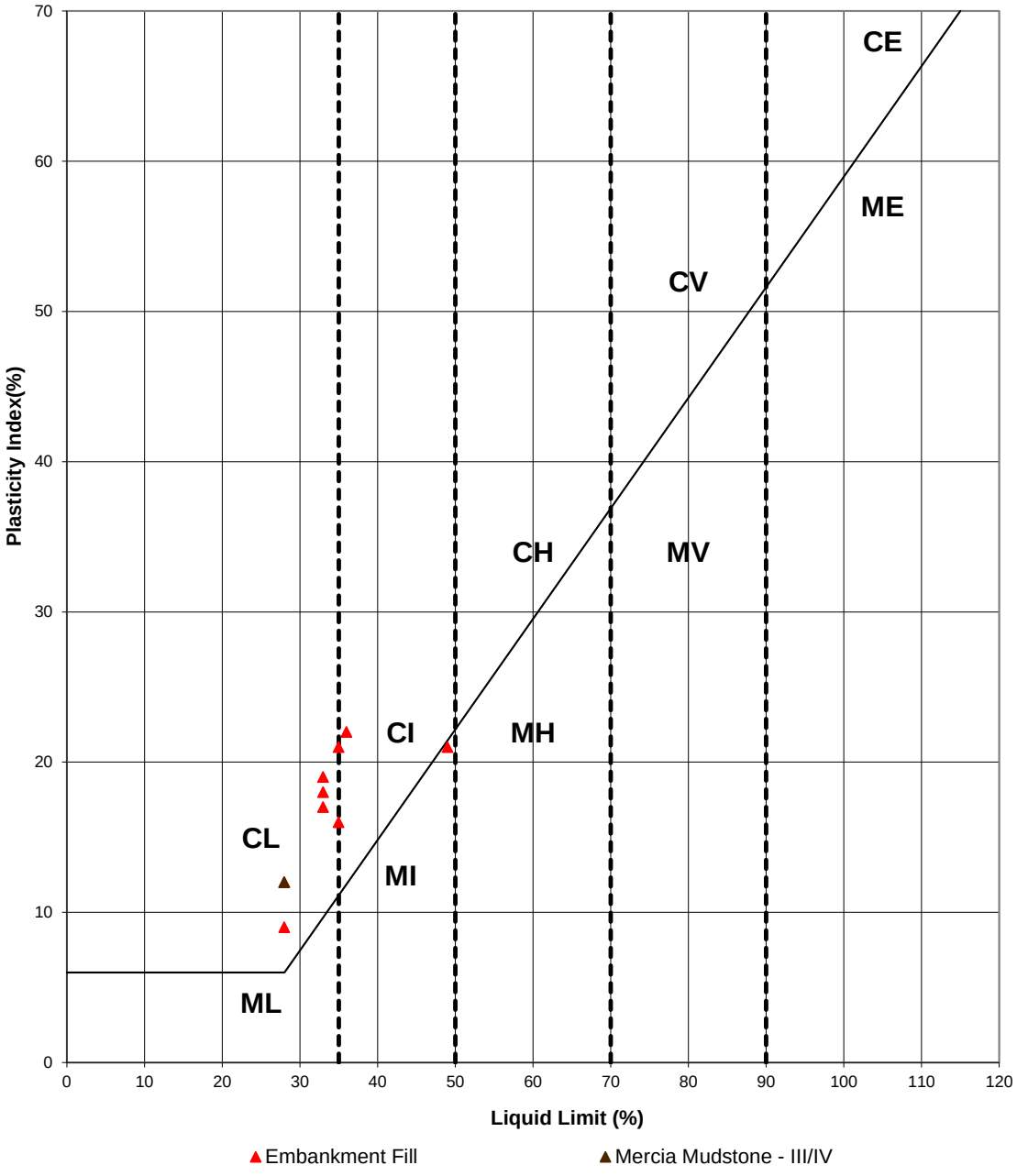
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 25/01/2017 Ref: HA549342-AMAR-HGT-186510-186530NB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186510-186530NB**
Client: **Highways England**	Borehole ID: **SK42NE385,SK42NE387, SK42NE388, SK42NE399, SK42NE400**	



Key

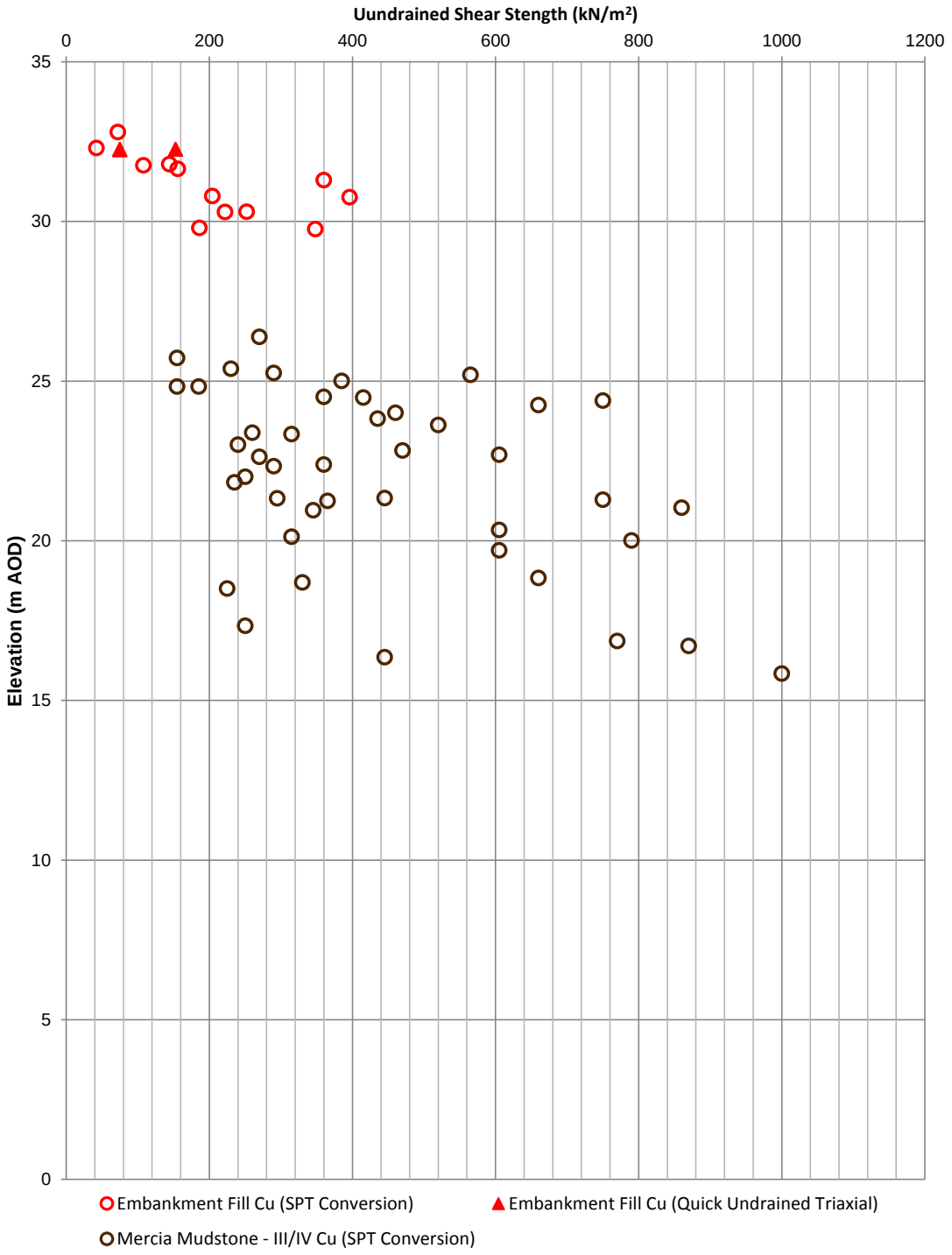
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 25/01/2017 Ref: HA549342-AMAR-HGT-186510-186530NB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186510-186530NB**
Client: **Highways England**	Borehole ID: **SK42NE383, SK42NE384, SK42NE385, SK42NE386, SK42NE387, SK42NE388, SK42NE399, SK42NE400, SK42NE401**	



Rev: P01 Date: 25/01/2017 Ref: HA549342-AMAR-HGT-186510-186530NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-186680-186760-GSS-000001		
Earthwork Widening Solution	Full Height Embankment Widening (1:2.0)		
Structure Number	E2-A1		
Structure Type	Emergency Refuge Area (ERA)		
Design Chainage	186680 - 186760		
Carriageway	Northbound		
Marker Post	186MP /6A +80 – 186MP / 7A +60		
National Grid Reference	E 447186, N 329011 – E 447165, N 329090		
Existing Ground Level at Location	Carriageway	33.64 – 35.36 mAOD	
	Toe of Embankment	30.42 – 31.32 mAOD	
Earthwork Type	NB: Embankment	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_22155	SB: N/A	HAGDMS designation
Earthwork Height	NB: 3.22m – 4.04m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 19.00^{o}	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Roheel Masrat	27/04/2017	[redacted]
Checked	Alice Bazen	19/04/2017	
Reviewed	Gary Summerfield	03/05/2017	
Approved	Tom Bulteel	06/06/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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DESK STUDY

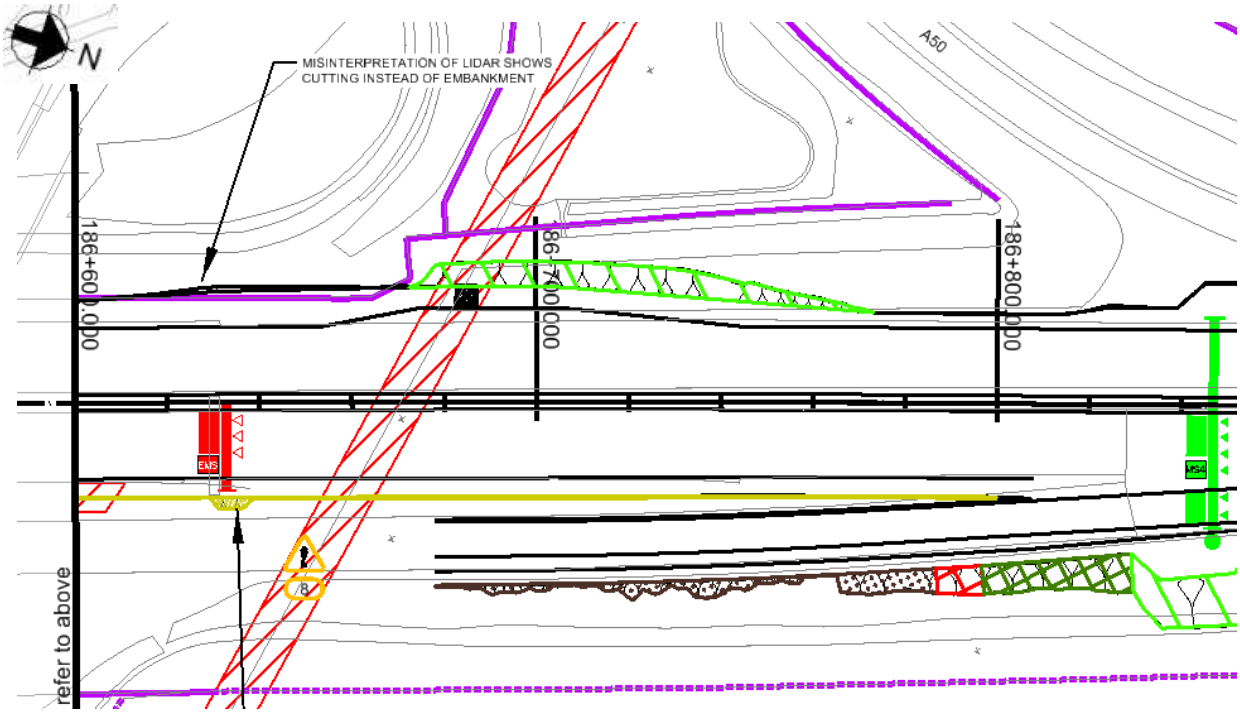


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Full Height Embankment Widening at 1 in 2 gradient due to verge widening.

Proposed Major Structures:

Emergency Refuge Area (ERA) E2-A1 is proposed on the northobound carriageway between chainage 186645 and 186755.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as embankment with heights ranging between 2.90 and 4.0m with an typical slope angle of 19 degrees

Two cross sections were considered when completing the design of the embankment widening. Cross section at ch 186680 was used as the maximum verge widening width of approximately 6.5m was recorded at this location. This was combined with the cross section at ch.186760, which shows an embankment with a height of 4.0m.

Design was completed to ensure the worst case scenarios were considered. Figure 2 and 3 present the cross sections used for design.

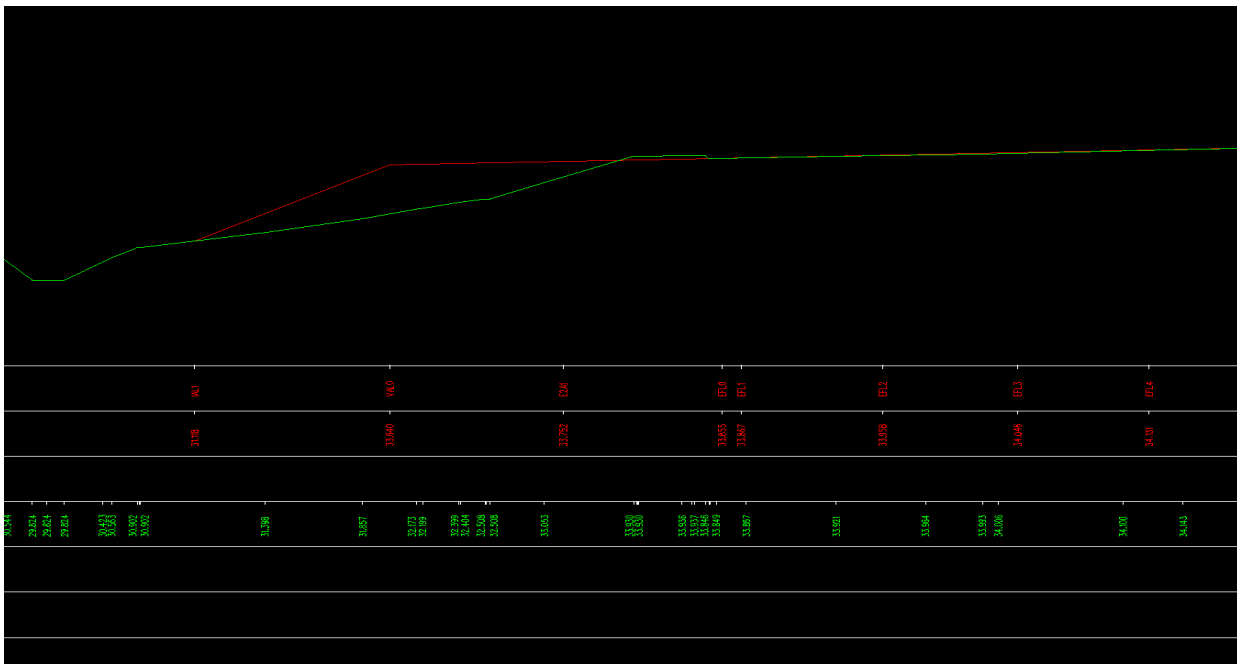


Figure 2.1: Topographic Cross Section Chainage 186680

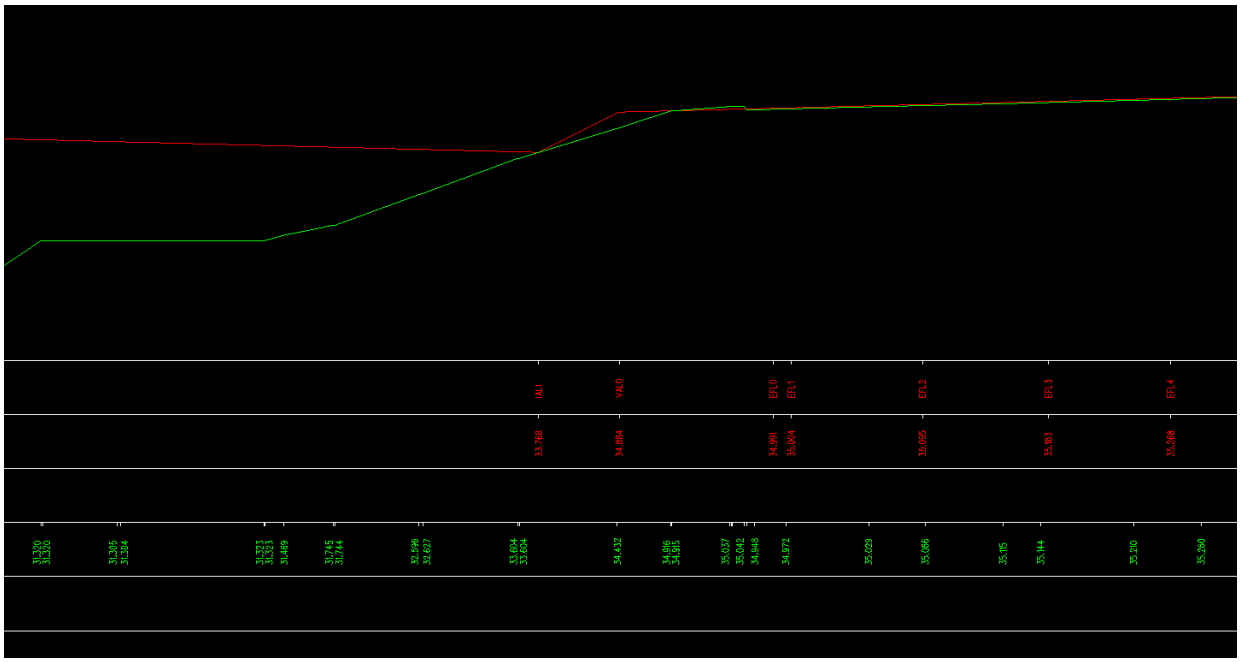


Figure 2.2: Topographic Cross Section Chainage 186760

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Utilities:

National Grid High Voltage overhead power line are running between ch.186675 and 186680 as illustrated in Figure 4 below. Refer to HA549342-AMAR-VUT-MLC-DR-CU-000005 for further information.

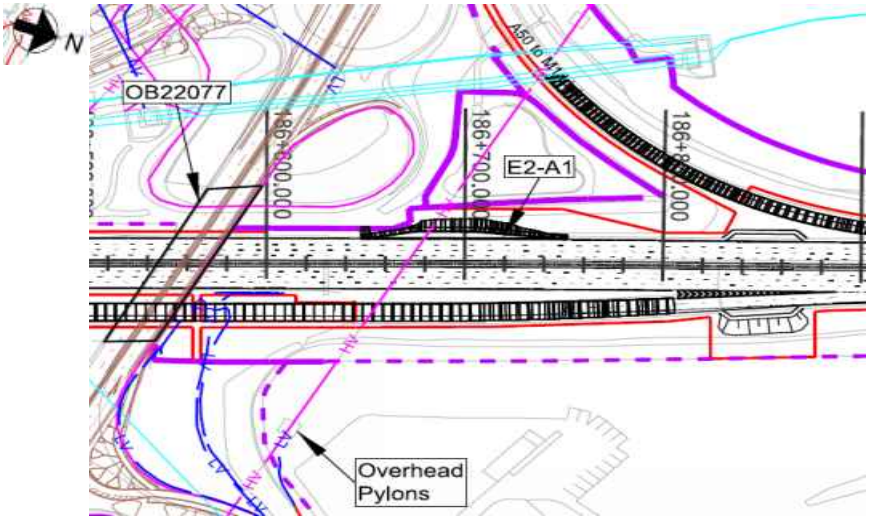


Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Hemington Member – silt and gravel / Holme Pierrepont Sand and Gravel Member – Sand and Gravel.

Solid Deposits: Branscombe Mudstone Formation - Mudstone

Ground Investigation:

There is 1 No. historical exploratory holes recorded within the design chainage, with additional 1 no. relevant exploratory holes considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000028, Rev P01.

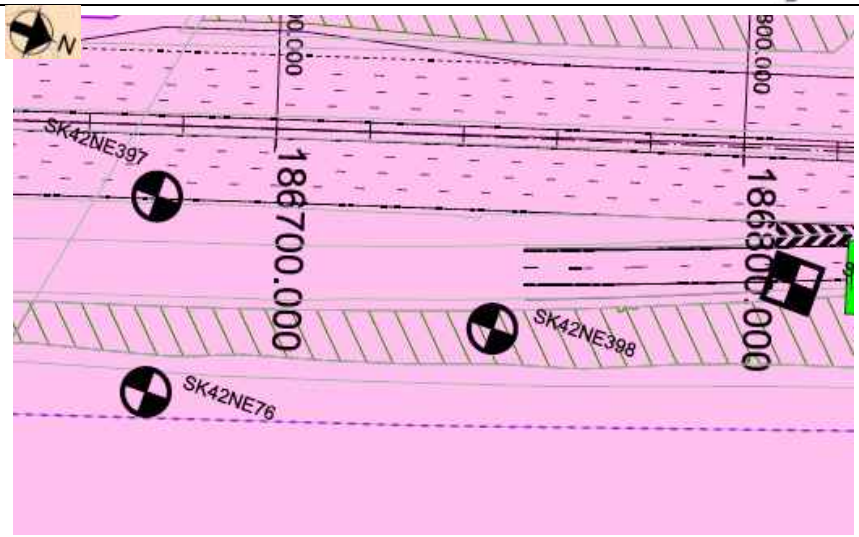


Figure 4: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42NE397	SK42NE398
Borehole Chainage	186675	186747
Borehole Location	Southbound	Southbound
National Grid Reference	E 447226, N 329018	E 447228, N 329095
Ground Level at Exploratory Hole	33.65mAOD	30.78mAOD
RAG Analysis	Amber	Amber
Date Drilled	12/06/1992	23/06/1992 – 24/06/1992
Termination Depth	10.00 metres below ground level (mbgl) (23.65mAOD)	10.10 metres below ground level (mbgl) (20.68mAOD)
Other suitable holes	None	

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Embankment Fill	4.90	30.46	15-16 (15)
River Terrace Deposits	9.48	25.88	15-68 (23)
Mercia Mudstone III/IV	>11.08	24.28	21-146 (21 93) (3)

(1) Ground level is assumed to be at the carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets. 2 Characteristic SPT 'N' Values specified for Mercia Mudstone as strength increases from 11.1mbgl. Refer to assumed ground model for design for further details.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone – III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPT's) was undertaken in boreholes SK42NE397 and SK42NE398.

Groundwater:

Groundwater was encountered in SK42NE397 at 4.40mbgl (29.25mAOD) and rose to 4.05mbgl (29.60mOAD).

Groundwater Design Level:

Due to limited local groundwater data available, a design groundwater level of 1.0m below toe of embankment has been assumed for the design.

GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

4 No. Atterberg Limit tests and 7 No moisture content tests were completed in the Embankment Fill, River Terrace Deposits and Mercia Mudstone layers with the results presented in the table below:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	0.5	19	33	16	17	CL
Embankment Fill	1.0	12	36	18	18	CI
Embankment Fill	1.5	18	-	-	-	-
Embankment Fill	1.6	18	33	15	18	CL
River Terrace Deposits	1.6	7	23	14	9	CL
Mercia Mudstone III/IV	8.6	23	-	-	-	-
Mercia Mudstone III/IV	9.2	13	-	-	-	-

1 No quick undrained triaxial tests were completed in SK42NE397 within the Mercia Mudstone layer:

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Mercia Mudstone III/IV	8.6	65

Lab Test Data – BRE Classification:

No chemical testing was undertaken between these locations.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill (Made Ground)	0.00 – 4.90	35.36 – 30.46	4.90	21	26	0	87	6.3	5.0	-	0.5	0.2	-	DS-2 AC-2
River Terrace Deposits	4.90 – 9.48	30.46 – 25.88	4.58	21	34	-	-	-		-	-	0.25	-	DS-3 AC-3
Mercia Mudstone III/IV (<10mbgl)	9.48 – 11.08	25.88 – 24.28	1.60	21	30	2	105	8.6	6.48	-	0.5	0.20	-	DS-2 AC-2
Mercia Mudstone (>10mbgl)	>11.08	<24.28	-	21	30	2	200	71.28	23.76	-	-	-	0.20	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) ϕ' of Embankment Fill was determined using Table 2 in BS8002:2015 using typical PI of 17% gives 26°.

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(4) c_u of Embankment Fill was derived using the Stroud correlation. A typical PI of 17% gives an f1 value of 5.8, combined with a typical SPT 'N' value of 15, this gives a typical c_u of 87kN/m^2.
(5) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using typical SPT 'N' value of 15, Eu = 6.3MN/m^2. Therefore E' = 5.04MN/m^2.

(6) ϕ' of River Terrace Deposits was determined using correlation with SPT 'N' values (Peck 1974). Using a typical 'N' value of 23 gives an angle of 34°.
(7) E' of River Terrace Deposits was determined using Bowles correlation E' = 1200 (N + 6) which (using typical 'N' value of 23) gives a value of 34.8MN/m^2.
(8) cu of Mercia Mudstone – III/IV (<10mbgl) was derived using the Stroud correlation. In the absence of sufficient PI data, the typical f1 value of 5.0 for Mercia Mudstone (CIRIA C570) was adopted; combined with a typical SPT 'N' value of 21, this gives a cu of 105kN/m2.
(9) ϕ' of Mercia Mudstone was adopted from the AMAR GIR due to lack of data present within this layer.
(10) Eu for Mercia Mudstone – III/IV (<10mbgl) was derived using SPT 'N' values (Bowles) where Eu = 300 (N+6); using a characteristic SPT 'N' value of 21 gives Eu = 8.1MN/m^2. E' of Mercia Mudstone – III/IV was derived using the relationship given by Wroth, 1972 where E'=2/3(1+v')E_u.- therefore E' = 6.48MN/m^2
(11) Eu for Mercia Mudstone – III/IV (>10mbgl) was derived using SPT 'N' values (Bowles) where Eu = 300 (N+6); using a characteristic SPT 'N' value of 93 gives Eu = 29.7MN/m^2. E' of Mercia Mudstone – III/IV was derived using the relationship given by Wroth, 1972 where E'=2/3(1+v')E_u.- therefore E' = 23.76MN/m^2
(12) cu of Mercia Mudstone – III/IV (>10mbgl) was derived using the Stroud correlation. In the absence of sufficient PI data, the typical f1 value of 5.0 for Mercia Mudstone (CIRIA C570) was adopted; combined with a typical SPT 'N' value of 93, this gives a cu of 465 kN/m2. This is outside the range in the GIR so the upper limit of 200kN/m^2 has been adopted.
(13) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

.

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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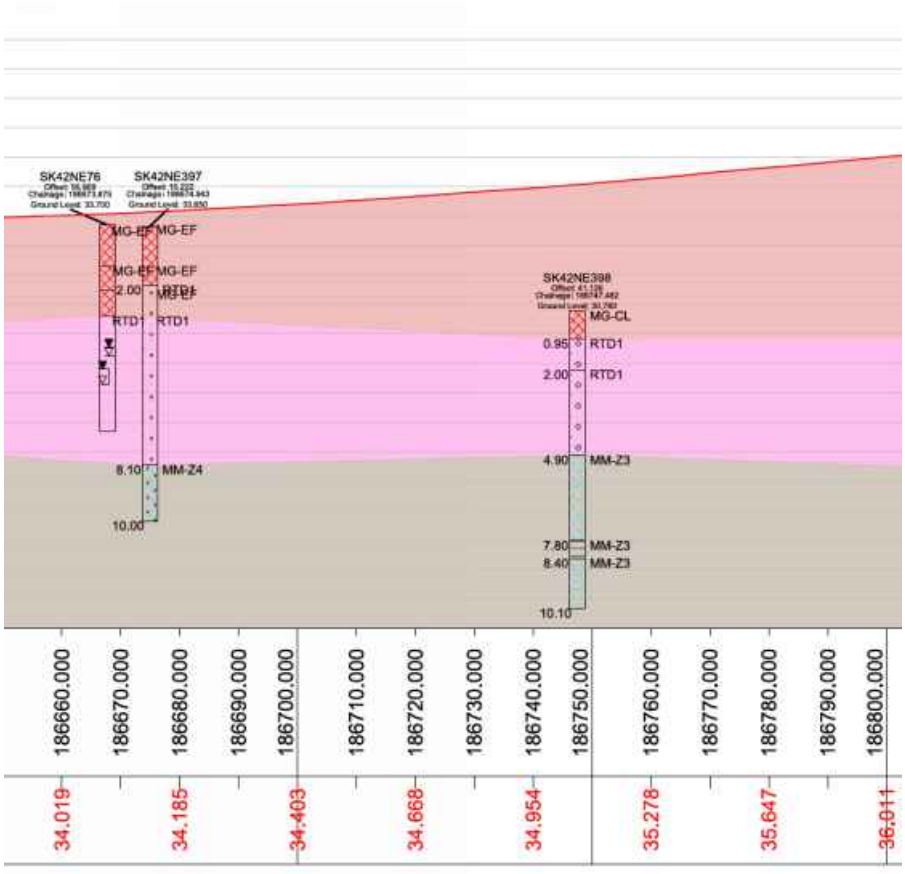


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Benching Detail	
			Base Width (m)	Batter Angle (o)
186680	186760	Full Height Embankment Widening (1:2.0)	3.2	26.6

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH – E2-A1.1 at chainage 186645, Northbound – Dynamic sample up to a maximum depth of 5.0m bgl.

- BH – E2-A1.2 at chainage 186755, Nortbound – Dynamic sample up to a maximum depth of 5.0m bgl.

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HISTORICAL EXPLORATORY HOLES

Borehole Log

Borehole No. **SK42NE397** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447226.00 - 329018.00	Hole Type CP
Location:		Level: 33.65mbgl	Scale 1:50
Client: Highways England		Dates: 12/06/1992 - 12/06/1992	Logged By M.Bryans

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.50	SPT (S)	15 (0 for 0mm/15,..)	Water=-				Stiff red brown CLAY with some angular fine to medium gravel, predominantly of hard clay and weak mudstone, occasionally siltstone. (Made Ground) MG-EF
		0.50 - 0.95	1B						
		1.00 - 1.45	2U	37blows					
		1.50	3J						
		1.60	SPT (S)	16 (0 for 0mm/16,..)	Water=-				
		1.60 - 2.05	4B			2.00	31.65		
		2.10	SPT (C)	58 (0 for 0mm/58,..)	Water=-				Very dense and dense brown fine to coarse SAND AND subrounded fine to coarse GRAVEL, including quartzite siltstone, sandtone. (River Terrace Deposits) RTD1
		2.10 - 2.55	5B						*2.10-2.55m sandy gravel*
		2.60	SPT (C)	39 (0 for 0mm/39,..)	Water=-				
		2.60 - 3.05	6B						
		3.10	SPT (C)	68 (0 for 0mm/68,..)	Water=-				
		3.10 - 3.55	7B						
		3.60	SPT (C)	60 (0 for 0mm/60,..)	Water=-				*3.60-4.05m in parts clayey*
	▼	3.60 - 4.05	8B						
	▽	4.40	9W						
		4.60	SPT (C)	50 (0 for 0mm/50,..)	Water=-				
		4.61 - 5.30	10B						
		6.10	SPT (C)	23 (0 for 0mm/23,..)	Water=-				*below 6.10m medium dense becoming dense sand with some much gravel*
		6.11 - 6.80	11B						
		7.60	SPT (C)	31 (0 for 0mm/31,..)	Water=-				
		7.60 - 8.05	12B						
						8.10	25.55		Very stiff red brown friable silty CLAY with many coarse sand sized lithorelicts of very weak mudstone. (Mercia Mudstone Group) MM-Z4
		8.60 - 9.05	13U	82blows					
		9.10	14J						
		9.20	1S						
		9.20	SPT (S)	66 (0 for 0mm/66,..)	Water=-				*below 9.20m very weak mudstone with some firm friable clay matrix, recovered as coarse sand sized to fine gravel sized fragments*
						10.00	23.65		End of borehole at 10.00 m

Remarks
Borehole located on M1 verge (Southbound).

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Borehole Log

Borehole No. **SK42NE398** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447228.00 - 329095.00	Hole Type CP
Location:		Level: 30.78mbgl	Scale 1:50
Client: Highways England		Dates: 23/06/1992 - 24/06/1992	Logged By S.G.Flynn

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 1.00	1B						TOPSOIL over firm dark brownvary sandy clay with much subrounded fine to coarse gravel. (Possible Made Ground) MG-CL
		1.00	1S			0.95	29.83		
		1.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				Medium dense brown slightly clayey fine to coarse SAND AND subrounded fine to coarse GRAVEL with occasional cobbles, predominantly of quartzite. (River Terrace deposits) RTD1
		1.01 - 2.00	2B						*1.80-1.95m cobble*
		2.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	2.00	28.78		Dense brown fine to coarse SAND AND subrounded fine to coarse GRAVEL , predominantly quartzite, with occasional cobbles . (River Terrace Deposits) RTD1
		2.01 - 3.00	4B						
		3.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.01 - 4.00	5B						*3.60-3.85m cobble*
		4.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.01 - 4.90	6B						
		4.90	7J			4.90	25.88		Stiff becoming very stiff red brown slightly mottled grey green friable silty CLAY with some sand sized to fine gravel sized lithorelicts of very weak mudstone. (Mercia Mudstone Group) MM-Z3
		5.00	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.01 - 6.00	8B						
		6.50	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		6.51 - 8.00	9B						
		8.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	7.80	22.98		Weak and moderately weak red brown, spotted grey green, silty MUDSTONE recovered as angular fine to medium gravel sized fragments. (Moderately waethered, GIII, Mercia Mudstone Group) MM-Z3
		8.01 - 9.50	10B						
		8.40	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	8.40	22.38		Hard red brown, slightly mottled grey green ,friable silty CLAY with extremely closely spaced random irregular discontinuities. (Mercia Mudstone Group) MM-Z3
		9.50	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				*9.50-10.00m much weak mudstone (GIII)*
		9.50 - 9.95	11B						
									Continued on next sheet

Remarks

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Borehole Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447228.00 - 329095.00	Borehole No. **SK42NE398** HISTORIC Sheet 2 of 2
Location:		Level: 30.78mbgl	Hole Type CP
Client: Highways England		Dates: 23/06/1992 - 24/06/1992	Scale 1:50
			Logged By S.G.Flynn

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
						10.10	20.68		End of borehole at 10.10 m

Remarks

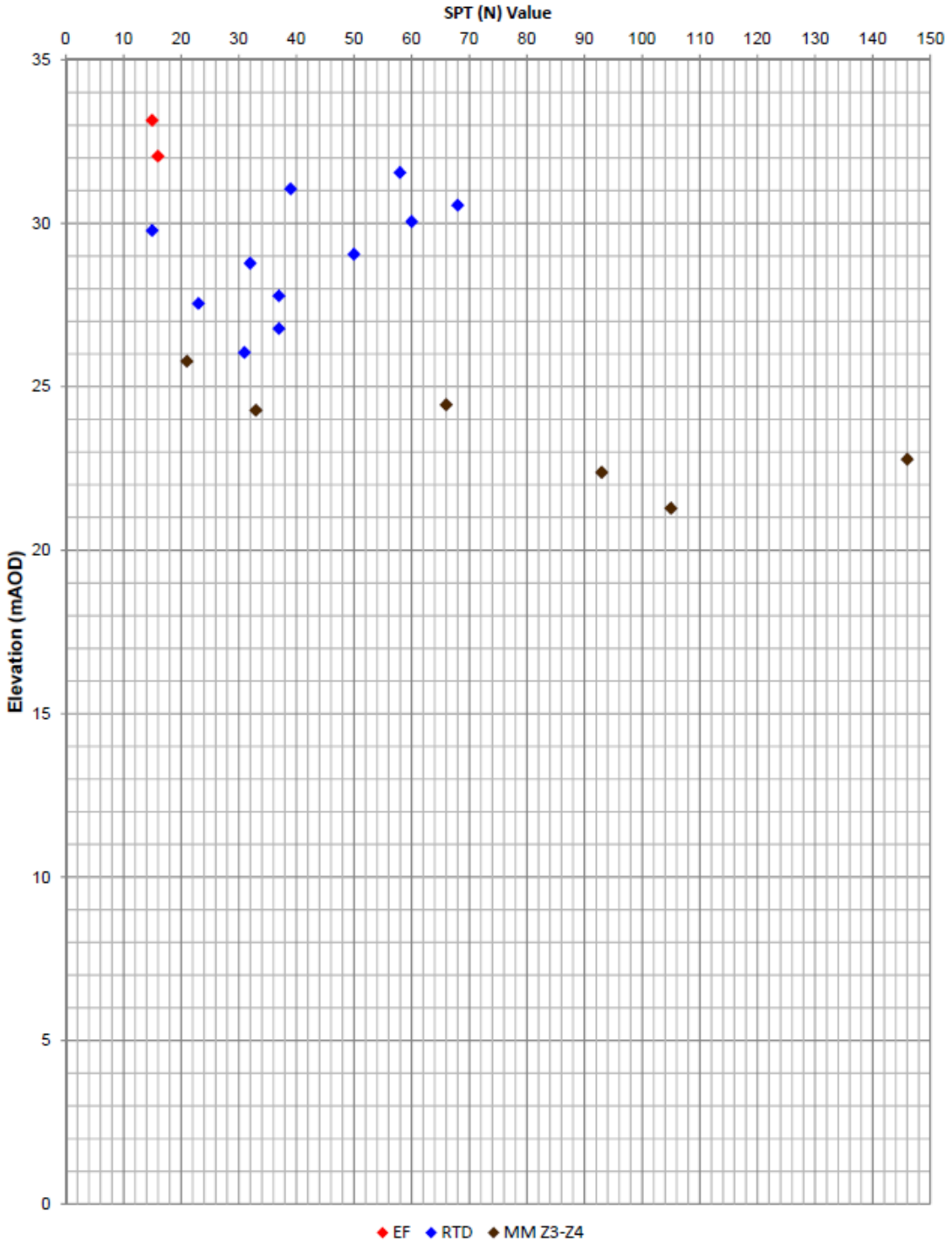
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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186680 - 186760 NB**
Client: **Highways England**	Borehole ID: **SK42NE397 and SK42NE398**	

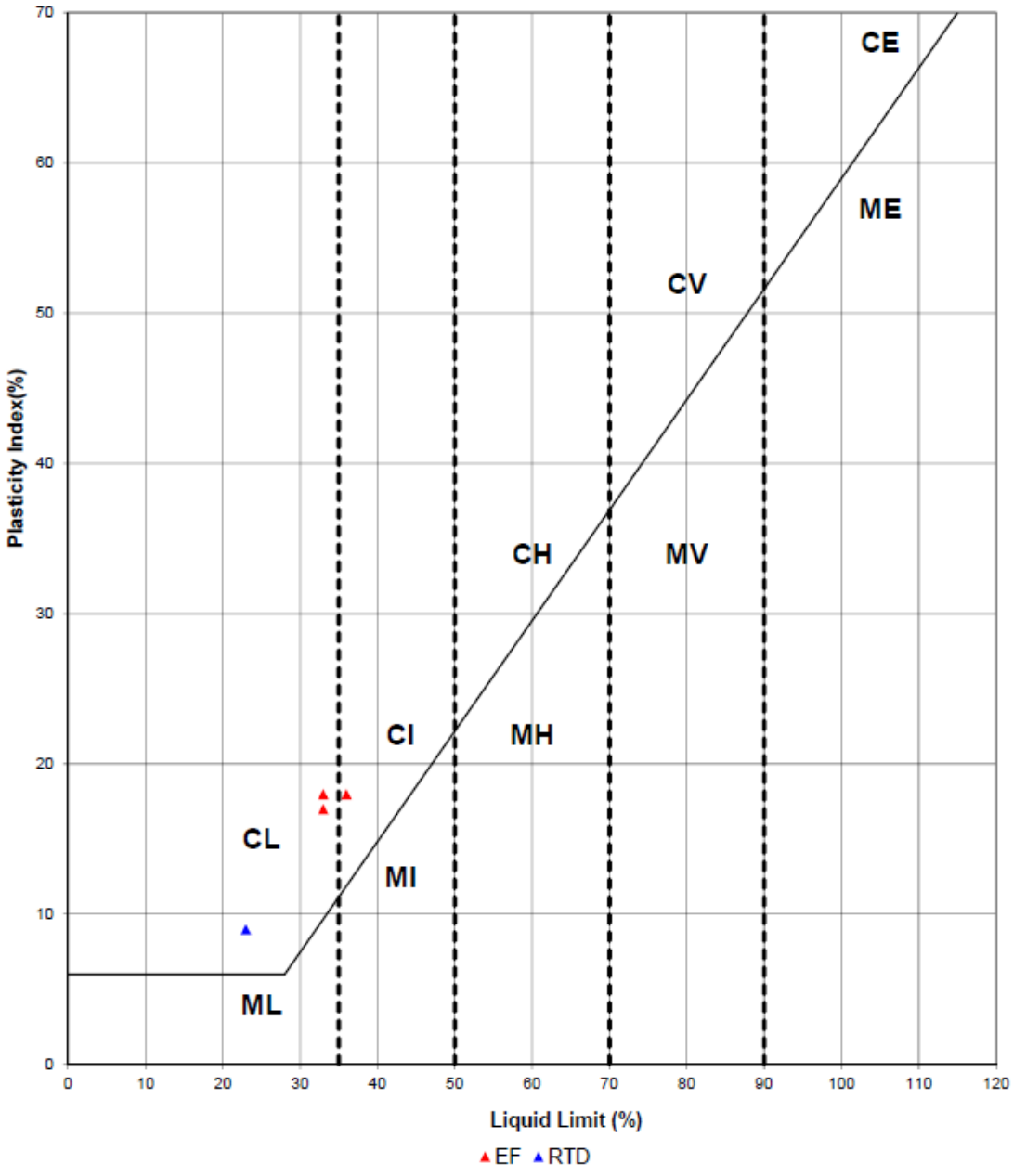


Extrapolated SPT (N) Values >150 have not been shown

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186680-186760 NB**
Client: **Highways England**	Borehole ID: **SK42NE397 and SK42NE398**	



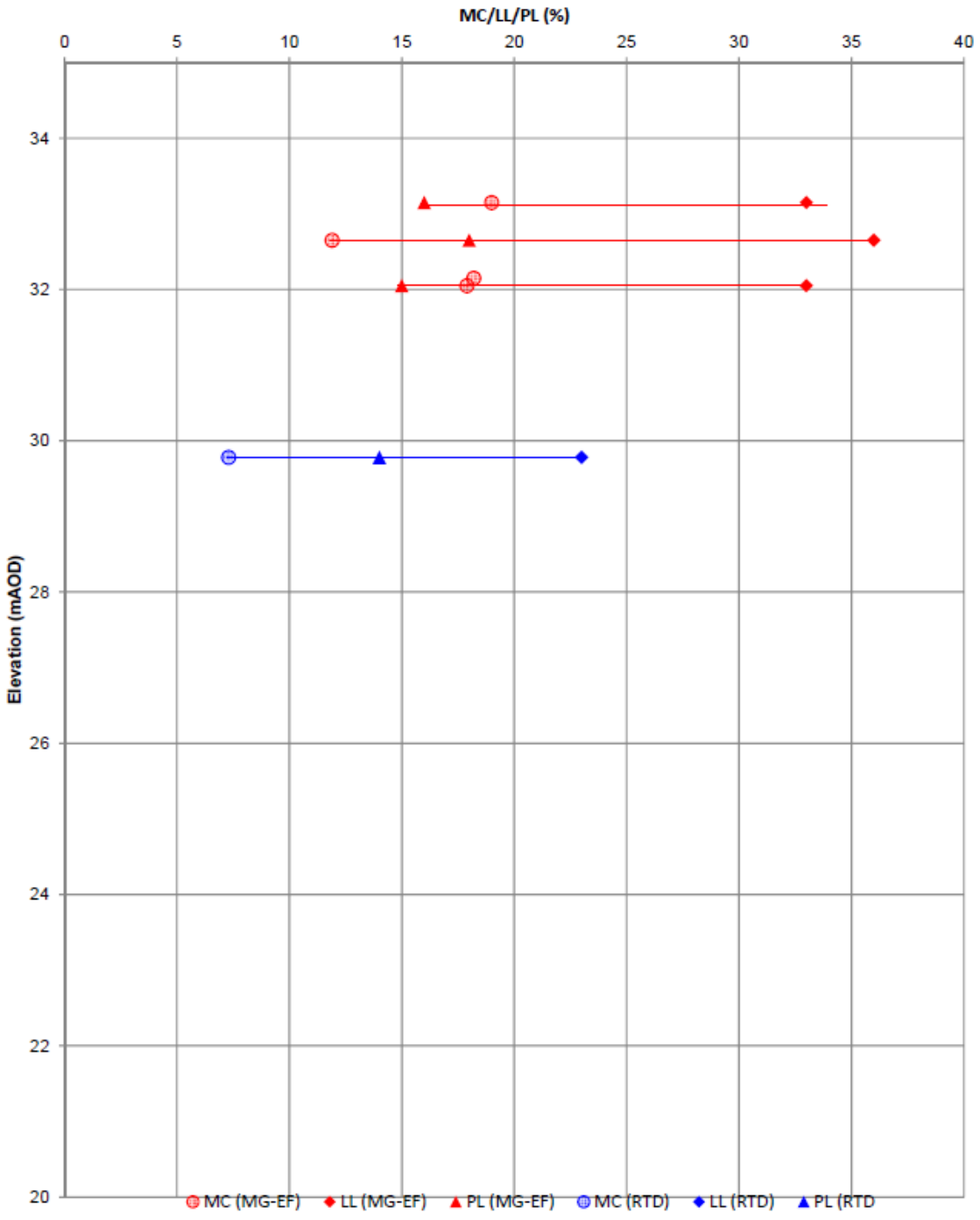
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

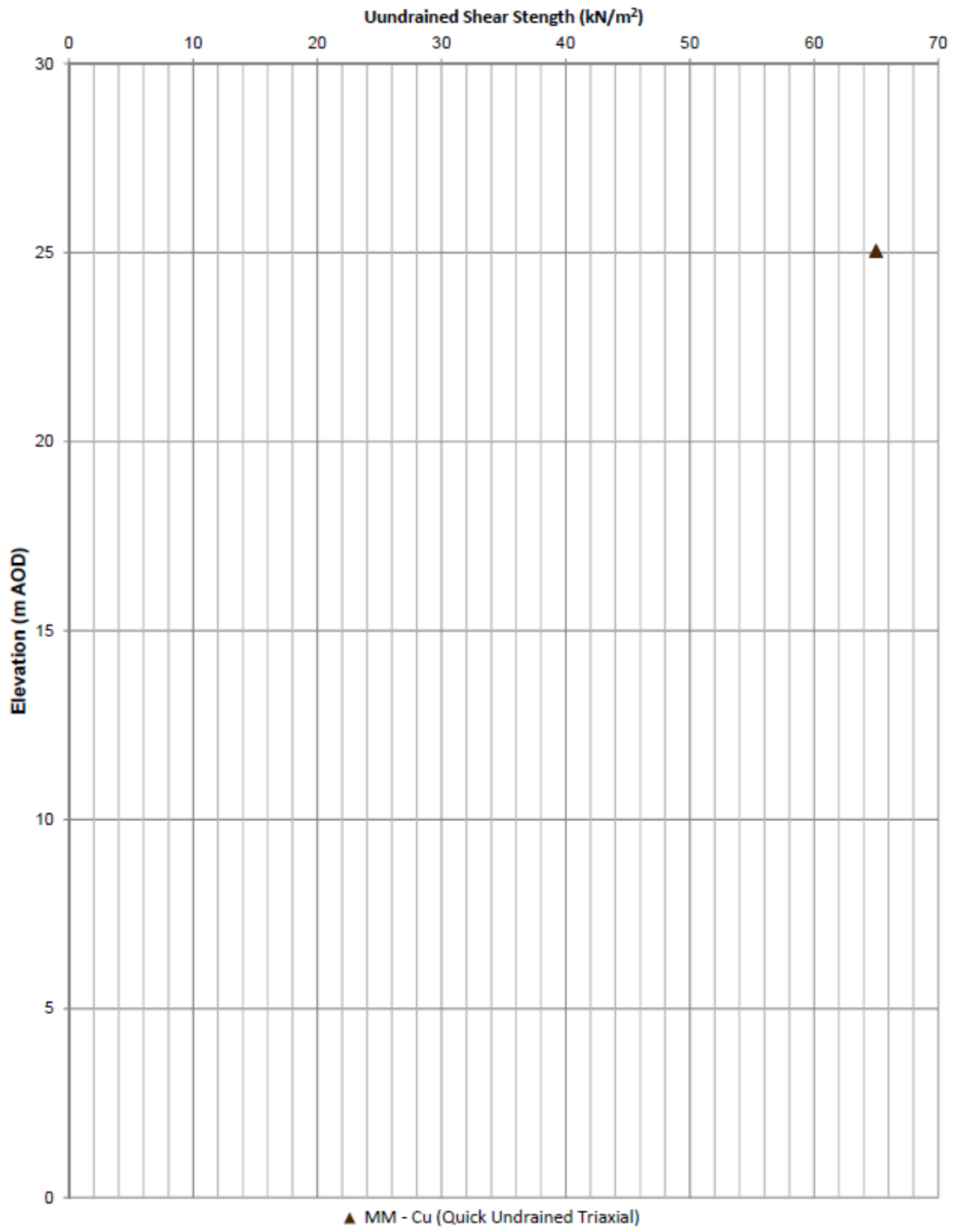
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186680-186760 NN**
Client: **Highways England**	Borehole ID: **SK42NE397 & SK42NE398**	



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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186680-186760 NB**
Client: **Highways England**	Borehole ID: **SK42NE397**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-187180-187940NB-GSS-000001		
Earthwork Widening Solution	Granular Wedge at Embankment Crest (1:2.0)		
Structure	Gantry 304		
Structure Type	Superspan Cantilever Gantry		
Design Chainage	187180 - 187940		
Carriageway	Northbound		
Marker Post	187MP /1A +80 – 187MP / 9A +40		
National Grid Reference	E 447026, N 329505 – E 446797 N 330208		
Existing Ground Level at Location	Carriageway	38.54 – 33.10 mAOD	
	Toe of Embankment	30.37 – 30.77 mAOD	
Earthwork Type	NB: Embankment	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_24434 & 7_M1_54198	SB: N/A	HAGDMS designation
Earthwork Height	NB: 2.33m – 8.17m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 20^{o}	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	19/04/2017	[redacted]
Checked	Alice Bazen	20/04/2017	
Reviewed	Gary Summerfield	20/04/2017	
Approved	Tom Bulteel	06/06/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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DESK STUDY

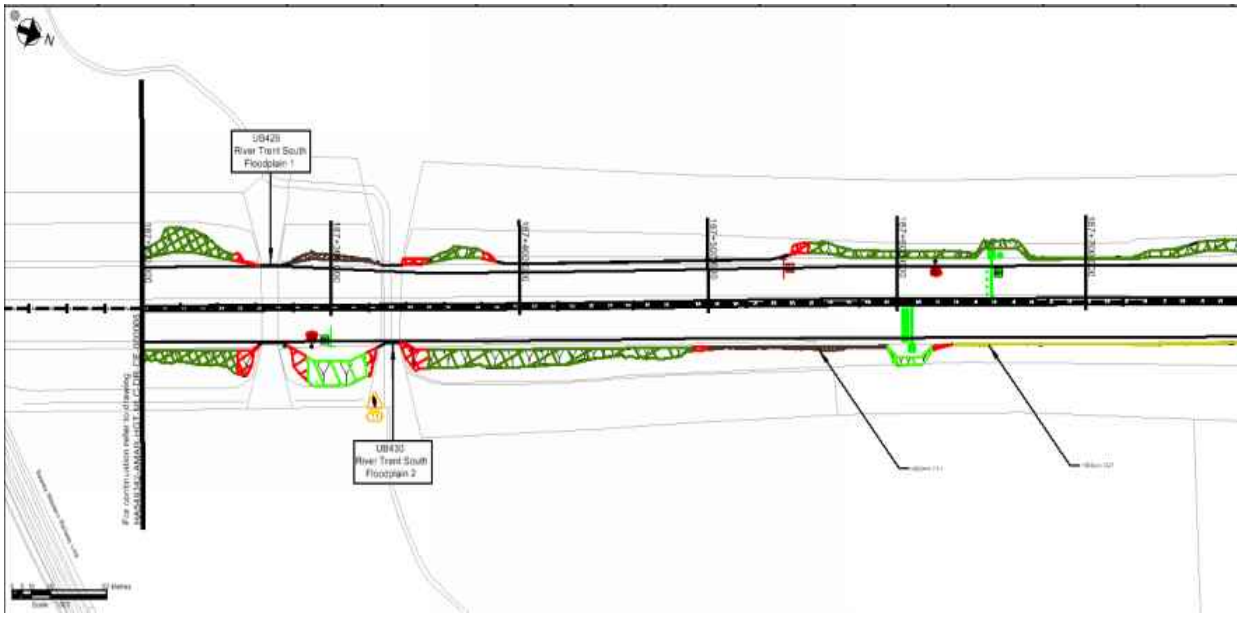


Figure 1.1: Location Plan 187180-187800

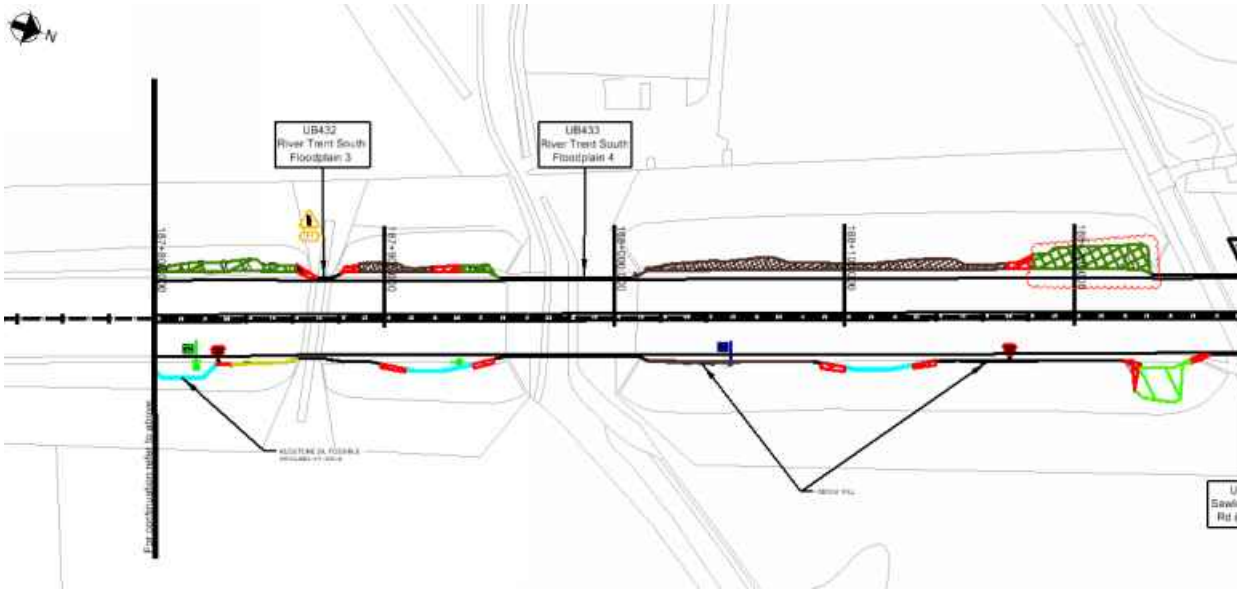


Figure 1.2: Location Plan 187800-187940

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- 187180-187250 – Granular Wedge at Embankment Crest

- 187350-187380 - Granular Wedge at Embankment Crest
- 187550-187860 – Granular Wedge at Embankment Crest
- 187930-187940 – Granular Wedge at Embankment Crest

Proposed Major Structures:

A Superspan Cantilever Gantry (304) is proposed at Chainage 187650.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating an earthwork classified as embankment with heights ranging between 2.3m and 8.2m with a typical slope angle of 20 degrees.

The critical cross sections (i.e. the cross section with the greatest earthwork height) used is Ch187220, Ch.187860 and Ch.187940.

4 critical cross sections were selected to complete the design of the granular wedge due to the varying embankment heights and flood levels between the above chainages.

187190-187250 (187220)

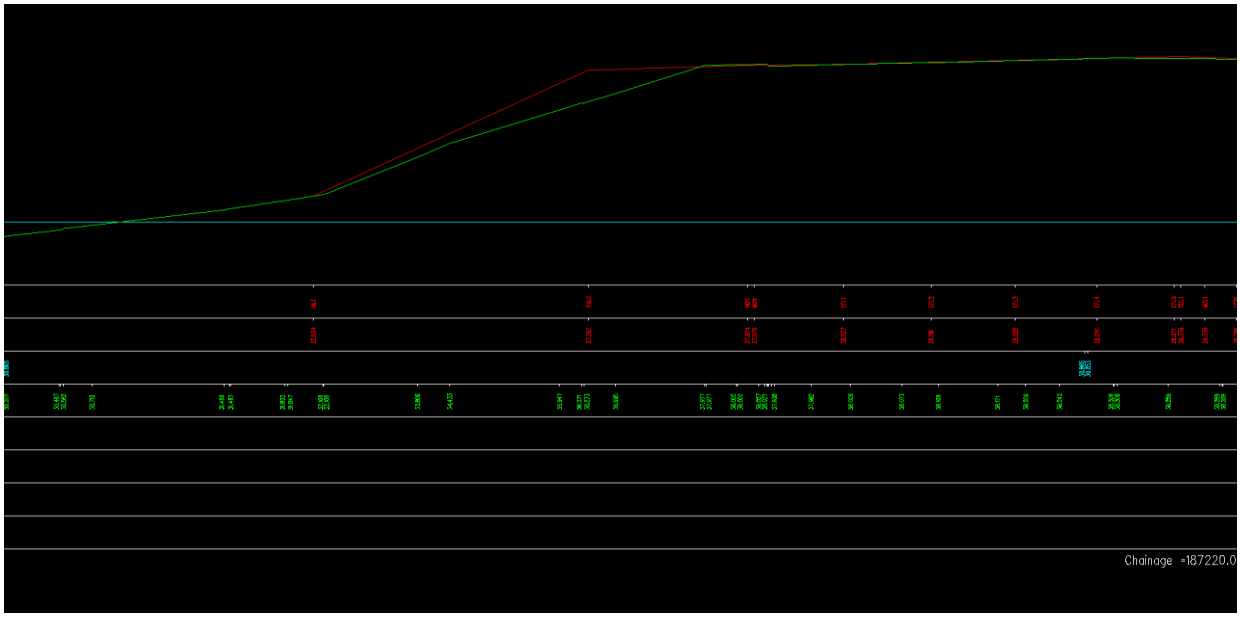


Figure 2.1: Topographic Cross Section Chainage 187220

187350-187380 (187370)

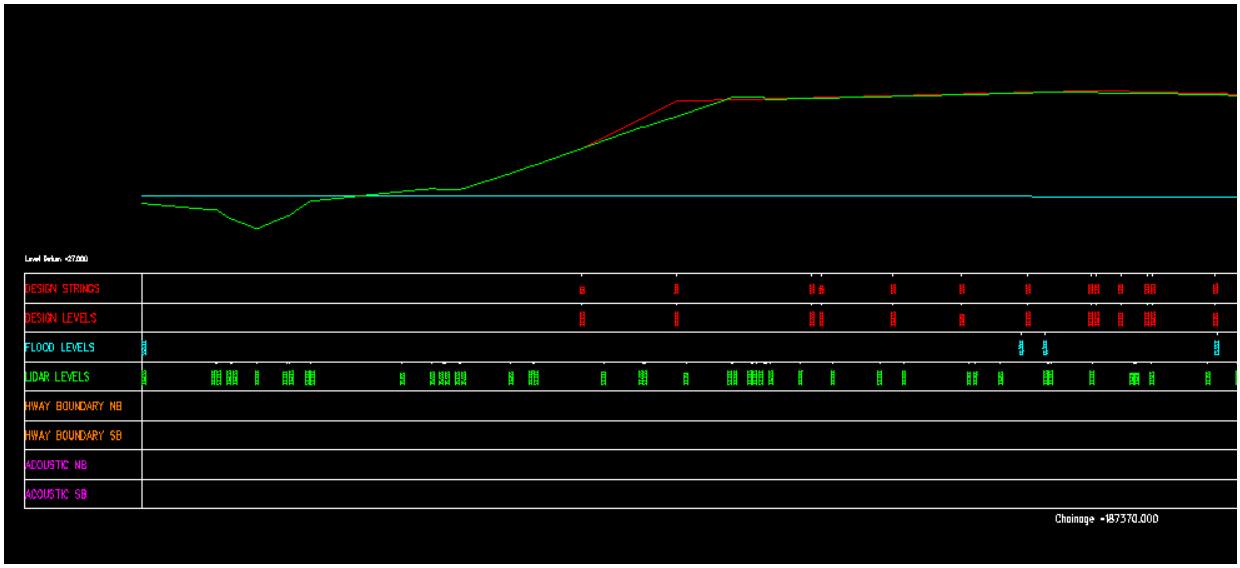


Figure 2.2: Topographic Cross Section Chainage 187370

187550-187860 (187860)

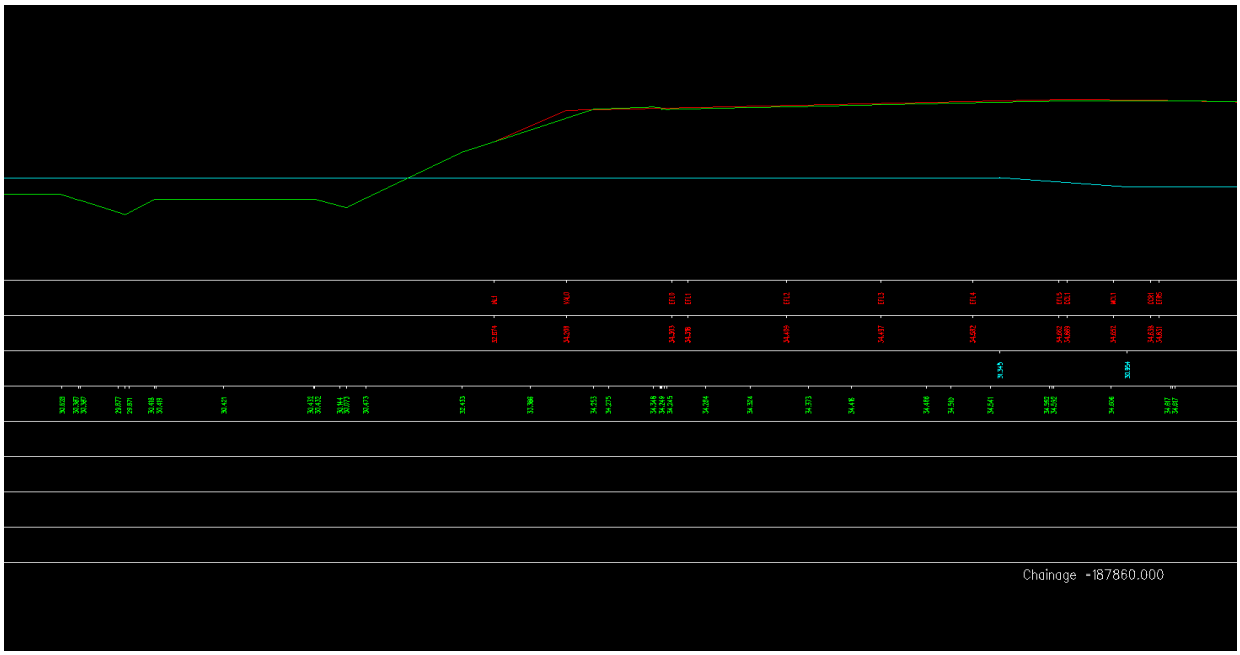


Figure 2.3: Topographic Cross Section Chainage 187860

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187930-187940 (187940)

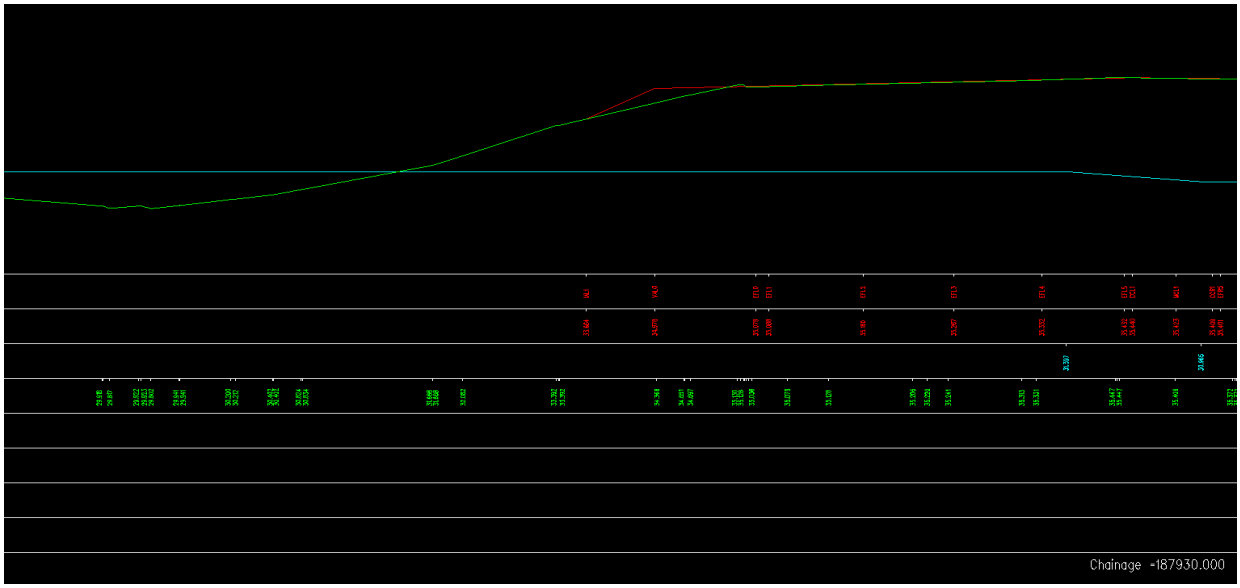


Figure 2.44: Topographic Cross Section Chainage 187930

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Hemmington Member – Silt and Gravel.

Solid Deposits: Branscombe Mudstone Formation – Mudstone / Edwalton Member – Mudstone

Ground Investigation:

There are 3 No. historical exploratory holes recorded within the design chainage, with 1 No. relevant exploratory hole considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HCT-SWI-DR-CE-000028, Rev P01.

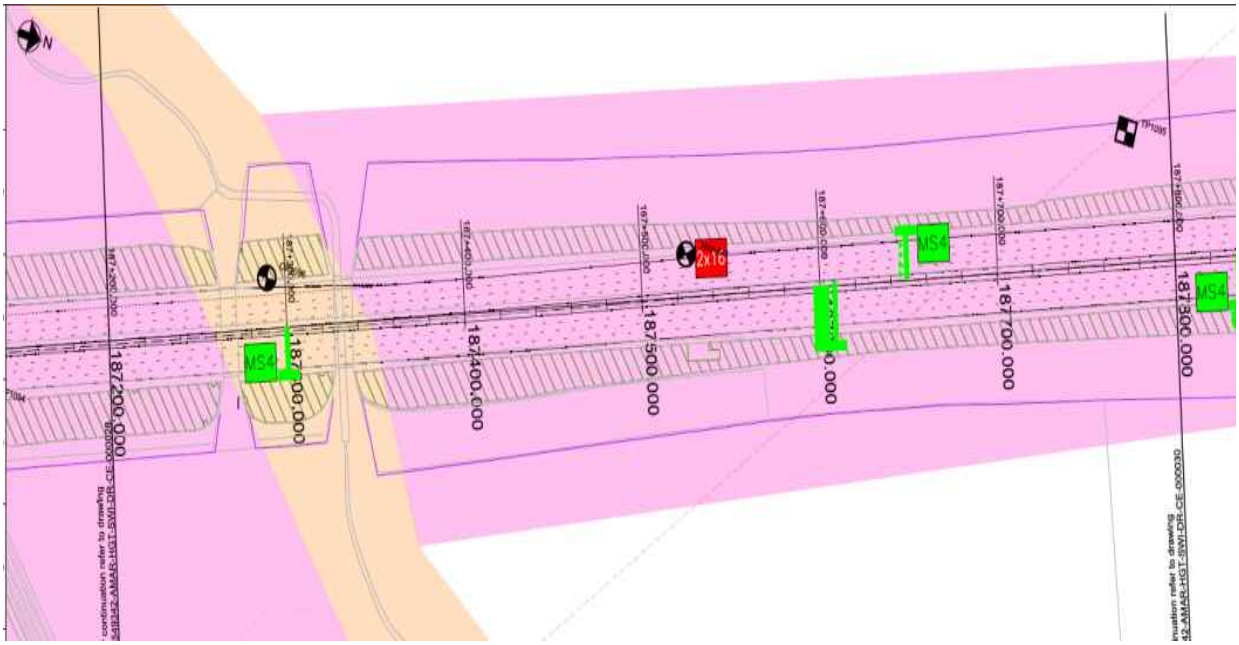


Figure 5.1: Borehole Location Plan 187200-187800

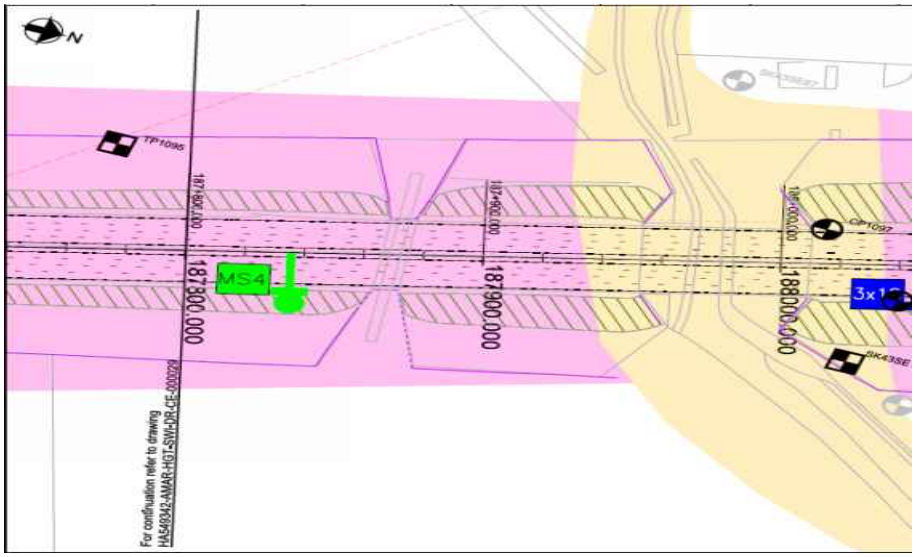


Figure 5.2: Borehole Location Plan 187800-188020

Flood Risk:

Flood levels have been broken down per earthwork and are presented below;

Start Chainage	End Chainage	Flood Level (mAOD)
187190	187250	30.85 – 30.89
187550	187860	31.11 – 31.35
187930	187940	31.34

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	CP1096	NWHM1	CP1097
Borehole Chainage	187290	1874526	188015
Borehole Location	Northbound	Northbound	Northbound
National Grid Reference	E 447000, N 329591	E 446930, N 329816	E 446777, N 330281
Ground Level at Exploratory Hole	36.70mAOD	34.20mAOD	35.95mAOD
RAG Analysis	Green	Amber	Green
Date Drilled	17/10/2006 - 18/10/2006	16/09/1999 – 19/09/1999	19/10/2006
Termination Depth	17.21 metres below ground level (mbgl)	6.00 metres below ground level (mbgl)	14.22 metres below ground level (mbgl)
Other suitable holes	TP1095		

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LIDAR Survey

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Embankment Fill / Made Ground	8.17	30.37	9-79 (14)
Glaciofluvial Deposits	14.04	24.50	33-136 (33)
Mercia Mudstone - III/IV	Not Proven	Not Proven	39-143 (39)

(1) Ground level is assumed to be at carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Mercia Mudstone Siltstone was encountered in the historical exploratory boreholes. Given the uncertainties on ground

conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPT's) was undertaken in boreholes NWHM1, CP1096 and CP1097.

Groundwater:

No ground water was encountered within the exploratory boreholes.

Groundwater Design Level:

No local groundwater is available therefore design groundwater level at the Flood Risk Level has been assumed within the embankment, with the piezomteric line drawing down to ground level at the toe of the embankment. The table below presents the values used during design:

Start Chainage	End Chainage	Flood Level (mAOD)
187190	187250	30.89
187550	187860	31.35
187930	187940	31.34

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

4 No. Atterberg Limit tests and 4 No moisture content tests were completed in the Embankment Fill and Mercia Mudstone layers with the results presented in the table below:

Stratum	Depth to Top of Test (mbgl)	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Classification
Embankment Fill	3.7	19	37	20	17	CI
Embankment Fill	3.7	17	36	18	18	CI
Alluvium*	7.2	41	58	37	21	MH
Mercia Mudstone - Siltstone	13.5	34	39	31	8	MI

*Alluvium was encountered in CP1097 which is located approximately 75m from the extents of the earthwork, and is not present within any of the borehole. As a result, this band of alluvium is not considered to be part of the ground model between 187190 and 197940.

4 No quick undrained triaxial tests were completed in the Embankment Fill/Mercia Mudstone layers with the following results:

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	1.2	110
Embankment Fill	3.2	44
Embankment Fill	3.2	63
Mercia Mudstone	13.0	174

Lab Test Data – BRE Classification:

The Table below presents a summary of the BRE Test results:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Sulphate	Water	2	0.01-0.09	g/l
Embankment Fill	pH	Water	2	7.14-7.63	-
Glaciofluvial Deposits	Sulphate	Water	2	490-590	mg/l

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Glaciofluvial Deposits	pH	Water	4	7.63-8.25	-
Alluvium	pH	Water	2	7.14-8.31	-
Alluvium	Sulphate	Water	2	410-810	mg/l

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Assumed Ground Model For Design :

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

The below table outline the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment Fill (Made Ground)	0.00 – 8.17	38.54 – 30.37	8.17	21	27	0	81	6.0	4.80	-	0.5	0.20	-	2.0	0.54	-	6.2*	-	DS-2 AC-2
Glaciofluvial Deposits	8.17 – 14.04	30.37 – 24.5	5.87	21	37	-	-	-	46.80	-	-	0.25	-	18.72	-	1.0	-	50	DS-3 AC-3
Mercia Mudstone – III/IV(>10mbgl)	>14.04	<24.50	-	21	30	2	200	16.8	13.4	-	0.5	0.2	-	31.25	0.14	-	9.0	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) ϕ' of Embankment Fill was determined using Table 2 in BS8002:2015 using typical PI of 18% gives 27°.
(4) c_u of Embankment Fill was derived using the Stroud correlation. A typical PI of 18% gives an f1 value of 5.8, combined with a typical SPT 'N' value of 14, this gives a typical c_u of 81kN/m^2.
(5) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using typical SPT 'N' value of 14, Eu = 3.9MN/m^2. Therefore E' = 5.04MN/m^2.
(6) ϕ' of River Terrace Deposits was determined using correlation with SPT 'N' values (Peck 1974). Using a typical 'N' value of 33 gives an angle of 37°.

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(7) E' of River Terrace Deposits was determined using Bowles correlation E' = 1200 (N + 6) which (using typical 'N' value of 33) gives a value of 46.80MN/m^2.
(8) Due to limited data present geotechnical parameters of Mercia Mudstone III/IV (>10mbgl) was based on values derived in the AMAR GIR
(9) Shear modulus is based on G = E/2(1+v).
(10) Adhesion factor is based on BS8004 (equation 41). Note, Adhesion factor for Mercia Mudstone Siltstone is based on assumed Cu value of 200kN/m^2.
(11) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).
(12) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl. Embankment Fill is assumed to comprise reworked Mercia Mudstone.
(13) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1).
(14) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Mercia Mudstone III/IV, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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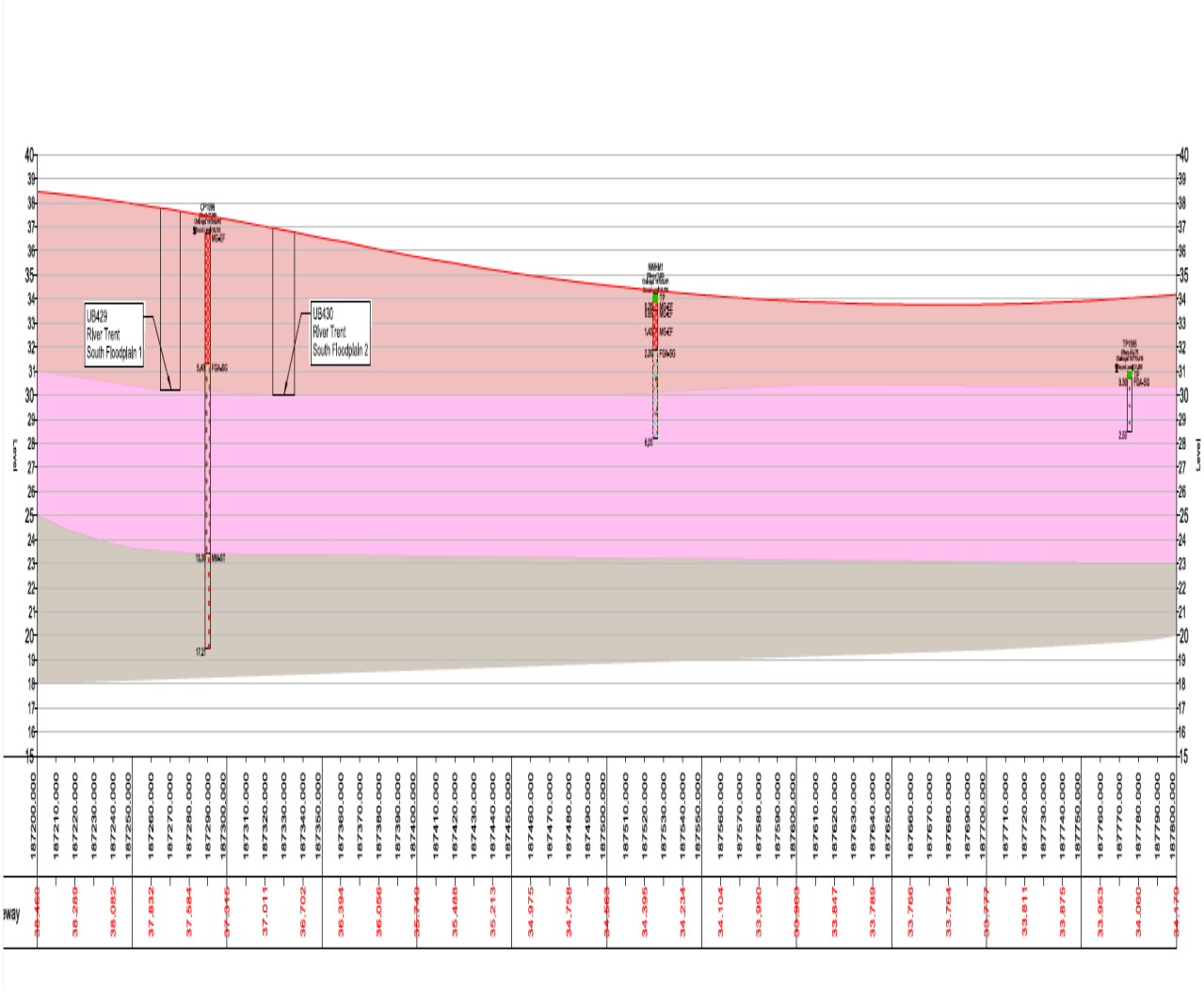


Figure 6.1: Geological Long Section 187190-187800

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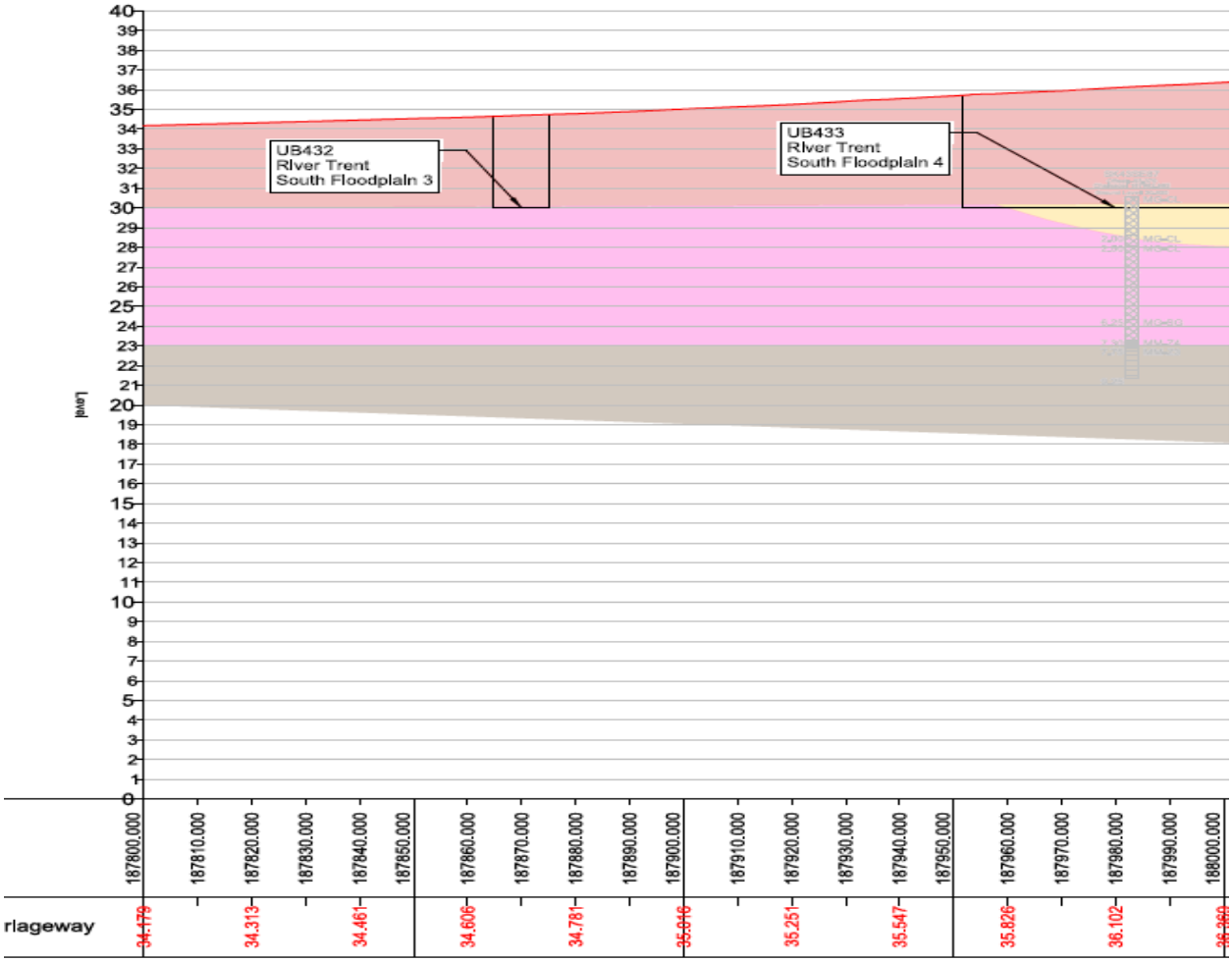


Figure 6.2: Geological Long Section 187800-187940

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Benching Detail	
			Base Width (m)	Batter Angle (o)
187190	187250	Granular Wedge at Embankment Crest (1:2.0)	5.0	26.6
187350	187380	Granular Wedge at Embankment Crest (1:2.0)	2.5	26.6
187550	187790	Granular Wedge at Embankment Crest (1:2.0)	4.5	45
187930	187940	Granular Wedge at Embankment Crest (1:2.0)	2.1	26.6

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	900	12.5	2.7	10	460	1517

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-R-FTNB2_600y at chainage 187368, northbound, dynamic sample with rotary follow on to 11m bgl;
  CPT-05 at chainage 187551, northbound, CPT to 6mbgl;
  BH-G304 at change 187650, northbound, dynamic sample with rotary follow to 18m bgl;
- CPT-06 at chainage 187767, northbound CPT to 6mbgl

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HISTORICAL EXPLORATORY HOLES

Borehole Log

Borehole No. **CP1096** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 329591.00	Hole Type CP
Location:		Level: 36.70mbgl	Scale 1:50
Client: Highways England		Dates: 17/10/2006 - 18/10/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									MADE GROUND. Grass over firm brown locally green grey sandy gravelly silt, locally clay/silt. Gravel is subangular medium to coarse of siltstone with occasional subangular cobbles of siltstone. MG-EF
		1.20 - 1.65	2U	49blows					*At 1.20m; stiff*
		1.70	3D						
		1.80	4CD						
		2.20	5D						
		2.20	PID	0ppmv					*Below 2.20m; slightly friable slightly sandy gravelly clay. Gravel is fine to coarse subangular of quartz and siltstone.*
		2.20	SPT (S)	N=16 (1,2/2,5,4,5)	Casing=1.50m Water=DRY				
		2.20 - 2.70	6B						
		2.80	7CD						
		3.20 - 3.65	8U	31blows					
		3.70	9D						
		3.80	10CD						
		4.20	11D						
		4.20	PID	0ppmv					*At 4.20m; silt/clay.*
		4.20	SPT (S)	N=9 (1,1/2,2,2,3)	Casing=2.50m Water=DRY				
		4.20 - 4.70	12B						
		4.80	13CD						
		5.20 - 5.65	14U	100blows					
						5.40	31.30		Very dense becoming dense brown slightly sandy to sandy GRAVEL. Gravel is fine to coarse subangular to rounded of quartz, sandstone, siltstone and coal with subrounded cobbles of quartz. FGA-SG
		5.70	15D						
		5.80	16CD						
		5.80	SPT (C)	50 (25 for 125mm/50 for 125mm)	Casing=2.50m Water=DRY				
		5.80 - 6.30	17B						
		6.80	18CD						
		6.80	SPT (C)	50 (2,8/50 for 190mm)	Casing=6.80m Water=ADDED				
		6.80 - 7.30	19B						
		7.60	401 W						
		7.70	1L						
		7.70	32W						
		7.80	SPT (C)	50 (4,8/50 for 255mm)	Casing=7.80m Water=ADDED				
		7.80 - 8.30	20B						
		7.90	201 W						
		7.90	26W						
		8.80	SPT (C)	N=33 (3,6/7,9,8,9)	Casing=8.80m Water=ADDED				
		8.80 - 9.30	21B						

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.20m.;The borehole was advanced by chiselling methods from 6.00m and 6.20m (0.75 hours) and 16.60m and 17.00m (1 hour).;A hand held Photo-Ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.;

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Borehole Log

Borehole No. **CP1096** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 329591.00	Hole Type CP
Location:		Level: 36.70mbgl	Scale 1:50
Client: Highways England		Dates: 17/10/2006 - 18/10/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		10.30	SPT (C)	N=49 (2,5/9,10,14,16)	Casing=10.30m Water=ADDED				*GRAVEL (as previous sheet)*
		10.30 - 10.80	22B						
		11.80	SPT (C)	N=37 (4,6/7,9,9,12)	Casing=11.80m Water=ADDED				
		11.80 - 12.30	23B						
		13.30	SPT (S)	N=39 (7,8/8,10,11,10)	Casing=13.30m Water=ADDED	13.30	23.40		Brown and grey green SILTSTONE recovered as very weak to weak fine to medium subangular to angular gravel size fragments. MM-ST
		13.30 - 13.75	24D						
		13.30 - 13.80	25B						
		14.80 - 15.25	27U	69blows					
		15.30	28D						*At 15.30m; rare coarse subrounded gravel of quartz.*
		16.30	29D						
		16.30	SPT (S)	50 (6,8/50 for 210mm)	Casing=16.30m Water=9.40m				
		16.60 - 17.00	30B						
		17.00	31D						
		17.00	SPT (S)	50 (25 for 105mm/50 for 105mm)	Casing=16.50m Water=9.50m	17.21	19.49		*At 17.00m; laminated, with occasional laminae of gypsum.* End of borehole at 17.21 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 6.20m.;The borehole was advanced by chiselling methods from 6.00m and 6.20m (0.75 hours) and 16.60m and 17.00m (1 hour).;A hand held Photo-Ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.;

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Borehole Log

Borehole No. **CP1097** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446777.00 - 330281.00	Hole Type CP
Location:		Level: 35.95mbgl	Scale 1:50
Client: Highways England		Dates: 19/10/2006 - 19/10/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									MADE GROUND. Soft to firm red brown and green clay/silt with occasional fine to coarse angular to subangular siltstone gravel sized fragments of siltstone. MG-EF
		1.20 - 1.65	2U	40blows					
		1.70	3D						
		1.80	4CD						
		2.20	SPT (S)	N=14 (2,2/3,4,3,4)	Casing=1.70m Water=DRY				
		2.20 - 2.65	5D						
		2.20 - 2.70	6B						
		2.80	7CD						
		3.20 - 3.65	8U						
		3.70	9D						Below 3.70m: occasionally grey blue.
		3.80	10CD						
		4.20	SPT (S)	N=17 (2,3/3,5,4,5)	Casing=3.20m Water=DRY				
		4.20 - 4.65	11D						
		4.20 - 4.70	12B						
		4.80	13CD						
		5.00	SPT (C)	50 (6,12/50 for 190mm)	Casing=3.20m Water=DRY	5.00	30.95		MADE GROUND. Dense to very dense brown sand and gravel. Sand is coarse, gravel is fine to coarse angular to subrounded of quartz and siltstone with occasional subangular to subrounded cobbles. With rare cobble sized pockets of blue grey clay. MG-EF
		5.00 - 5.50	14B						
		5.80	15CD						
		6.00	SPT (C)	50 (25 for 40mm/50 for 50mm)	Casing=6.00m Water=ADDED				
		6.00 - 6.50	16B						
		6.17	201 W			6.60	29.35		Firm to stiff brown and blue grey locally mottled orange brown gravelly CLAY, locally clay/silt. ALV
		6.21	401 W						
		6.50	1W						
		6.50	32W						
		6.60	17D						
		6.60	18CD						
		6.70 - 7.15	19U	27blows					
		7.20	20D			7.90	28.05		Dense brown coarse SAND and GRAVEL locally gravelly sand. Sand is mainly coarse, gravel is fine to coarse subangular to rounded of quartz, sandstone and siltstone with occasional flint. FGA-SG
		7.70	SPT (S)	N=36 (2,5/6,6,10,14)	Casing=7.70m Water=DAMP				
		7.70 - 8.15	21D						
		7.70 - 8.20	22B						
		9.20	SPT (C)	N=40 (4,6/6,9,11,14)	Casing=9.20m Water=ADDED				
		9.20 - 9.70	23B						
									Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 6.00m.;The borehole was advanced by chiselling methods from 6.00m to 6.30m (0.75 hours) and 13.70m to 14.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **CP1097** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446777.00 - 330281.00	Hole Type CP
Location:		Level: 35.95mbgl	Scale 1:50
Client: Highways England		Dates: 19/10/2006 - 19/10/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									SAND and GRAVEL (as previous sheet)
		10.70	SPT (C)	50 (4,7/50 for 285mm)	Casing=10.70m Water=ADDED				*At 10.70m: sandy gravel.*
		10.70 - 11.20	24B						
		12.20	SPT (C)	N=42 (2,4/7,11,12,12)	Casing=12.20m Water=ADDED				
		12.20 - 12.70	25B						
		12.90	26D			12.90	23.05		
		13.00 - 13.45	27U	100blows					Stiff to very stiff red brown locally grey green slightly sandy SILT/CLAY with occasional medium subrounded lithorelics of siltstone. With subrounded medium quartz gravel. MM-Z4
		13.50	28D			13.50	22.45		
		13.60	SPT (S)	50 (8,17/50 for 135mm)	Casing=13.60m Water=8.70m				Recovered as grey green fine and medium angular gravel size fragments of SILTSTONE with frequent laminae <1mm of gypsum. MM-ST
		13.60 - 13.88	29D						
		13.60 - 14.00	30B						
		14.00	SPT (S)	50 (25 for 100mm/50 for 115mm)	Casing=13.60m Water=9.00m	14.22	21.73		End of borehole at 14.22 m
		14.00 - 14.21	31D						

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 6.00m.;The borehole was advanced by chiselling methods from 6.00m to 6.30m (0.75 hours) and 13.70m to 14.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. **NWHM1** HISTORIC Sheet 1 of 1		
Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446929.60 - 329816.11
Hole Type RC		
Location:	Level: 34.20mbgl	Orientation: ° Inclination: 90°
Scale 1:50		
Client: Highways England	Dates: 16/09/1999 - 19/09/1999	Logged By NBR

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.35	01D					0.35	33.85		TOPSOIL. TP
		0.35 - 0.65	D								
		0.65 - 0.70	02D					0.65	33.55		MADE GROUND: Reddish brown very silty clay with some fine to medium subangular gravel sized fragments of mudstone. (Reworked Mercia Mudstone) MG-EF
		0.65 - 0.70	D								
		0.70 - 1.50	98	27	0	0					
								1.40	32.80		MADE GROUND: Brown sandy clay with much fine to coarse angular gravel sized fragments of limestone. MG-EF
		1.50 - 2.30	98	50	0	0					Very stiff brown mottled reddish brown very sandy CLAY with much fine to coarse angular to subrounded gravel sized fragments of sandstone, siltstone, mudstone, quartz and coal. MG-EF
		~~2.30~~	~~SPT(S)~~				102 (10,18/102 for 225mm)	2.30	31.90		
		2.67 - 3.30	97	0	0	0					Very dense brown clayey sandy fine to coarse subangular to rounded GRAVEL of quartz, sandstone and siltstone. (River Terrace Deposits) FGA-SG
		~~3.30~~	~~SPT(S)~~				78 (18,29/78 for 150mm)				
		3.60 - 4.30	97	0	0	0					
		~~4.30~~	~~SPT(S)~~				83 (12,25/83 for 150mm)				
		4.60 - 5.00	98	100	0	0					
		5.00 - 6.00		0	0	0					
								6.00	28.20		End of borehole at 6.00 m

1 2 3 4 5 6 7

Shift Information

Date & Time	Depth	Water	Casing	Remarks
16/09/1999 17:30	1.50	0.00	1.50	
17/09/1999 07:30	1.50	0.00	1.50	
17/09/1999 17:30	5.00	0.00	5.00	
19/09/1999 07:30	5.00	0.00	6.00	
19/09/1999 17:30	6.00	0.00	6.00	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

1. Inspection pit excavated to 0.70m. 2. H40 rig replaced by Hands England at 5.00m. 3. Openhole from 5.00m to 6.00m. 4. Borehole collapsing from 6.00mto 5.00m. 5. Borehole M1 terminated at 6.00m. Position grouted up to 0.50mbgl. Topsoil replaced. 6. Marker Post Ref 187/5 +50N.

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Trial Pit Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446817.00 - 330042.00 Level: 31.00mbgl	Trialpit No **TP1095** HISTORIC Sheet 1 of 1 Date 09/01/2007
Location:		Dimensions: 3.50m (2.70m) Inclination: 90° Orientation: ° Depth: 2.50m	Scale 1:50 Logged RMS
Client: Highways England			

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
	0.15	1D			0.30	30.70		Grass over brown clayey TOPSOIL with many rootlets and occasional roots up to 5mm thick. (Stratum I)
	0.15	2B						TP
	0.15	8CDKV						Red brown slightly clayey gravelly fine to coarse SAND. Gravel is subangular to rounded fine to coarse of quartz, with occasional mudstone and sandstone. (Stratum II)
	0.50	3B						FGA-SG
	0.50	9CDKV						*From 0.75m; slightly clayey sand and gravel*
	1.00	4D						*From 1.50m; sandy gravel with rounded coarse gravel of quartz.*
	1.50	10CDKV						
	1.50	5B						
	2.00	6D						
	2.50	11CDKV			2.50	28.50		End of pit at 2.50 m
	2.50	7B						

Shift Information

Date & Time	Depth	Water	Remarks
09/01/2007 08:00	0.00		
09/01/2007 18:00	2.50		

Backfill

Top	Base	Description

Water Strike

Struck	Rose to	Date	Time	Sealed	Remarks
0.00					

Depth Related Remarks

Top	Base	Remarks

Remarks: Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. Services were not encountered.;Trial pit was terminated at 2.50m due to water inflow and trial pit instability.;No visual or olfactory indication of contamination was observed.;On completion the trial pit was backfilled with compacted arisings. ;

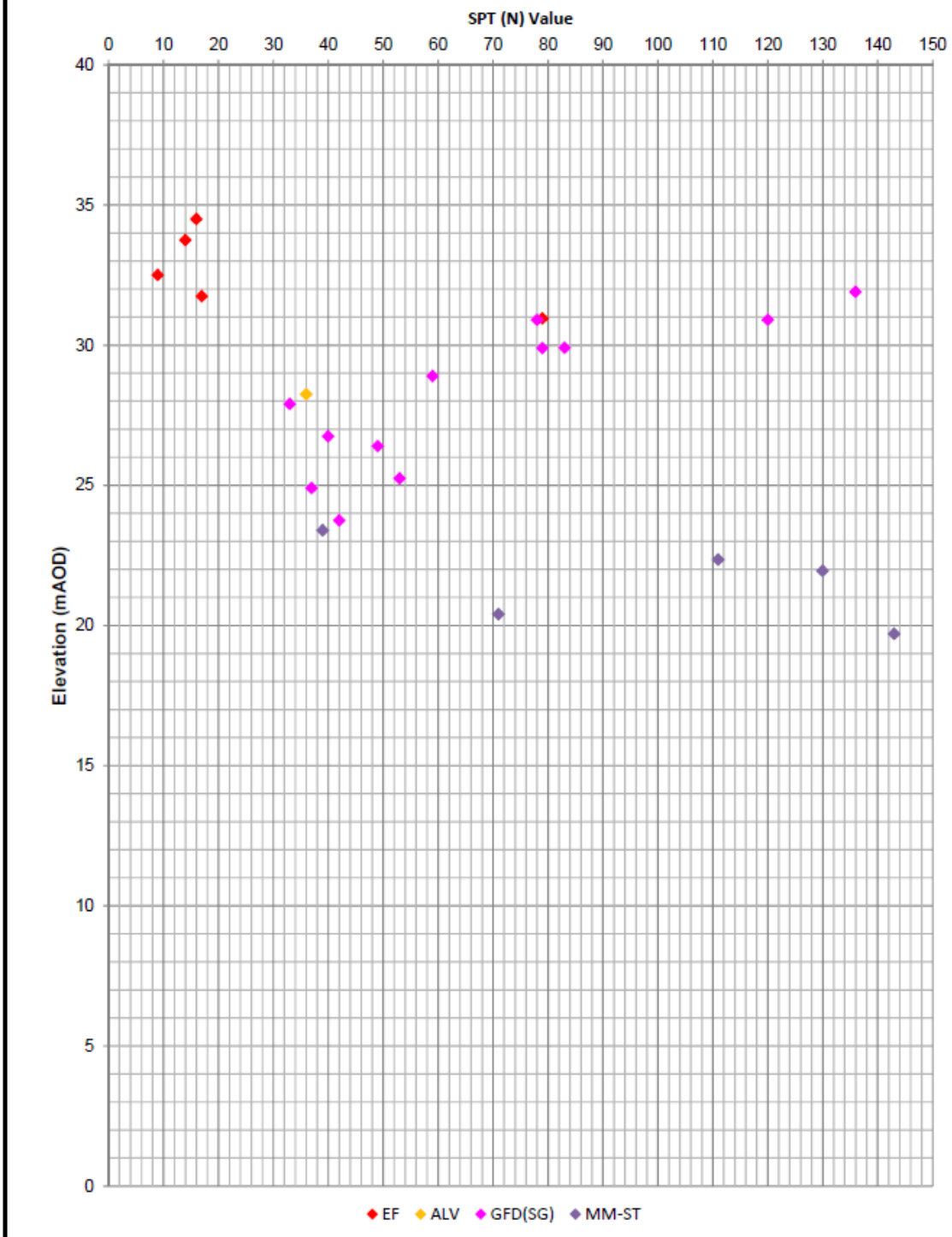
Stability: Pit collapsed on faces A and C from 2.00m to 2.70m, followed by collapses on all faces.

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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **187180-187940 NB**
Client: **Highways England**	Borehole ID: **CP1096, NWHM1 & CP1097**	

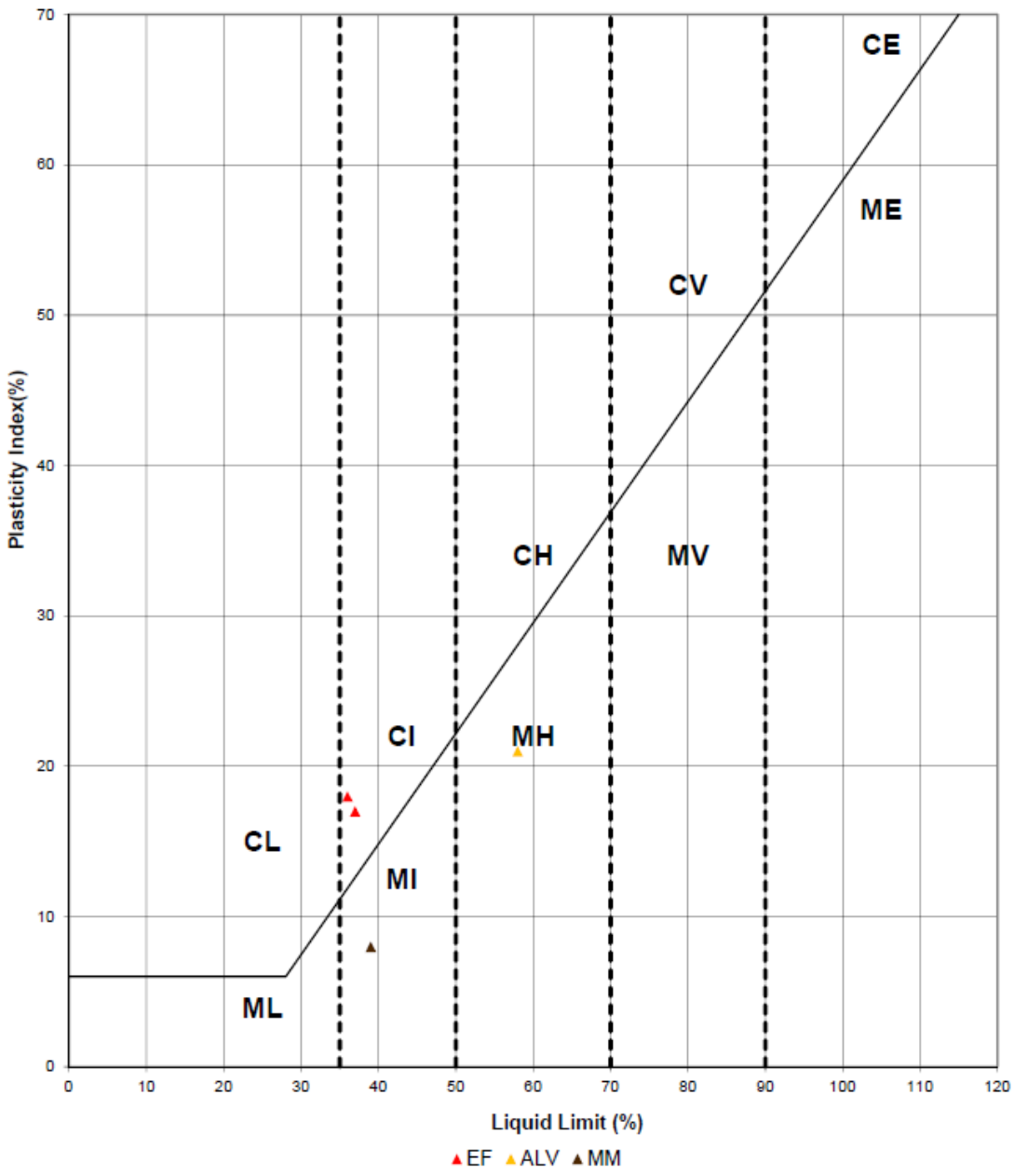


Extrapolated SPT (N) Values >150 have not been shown

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **187180-187940 NB**
Client: **Highways England**	Borehole ID: **CP1096, CP1096 and TP1095**	



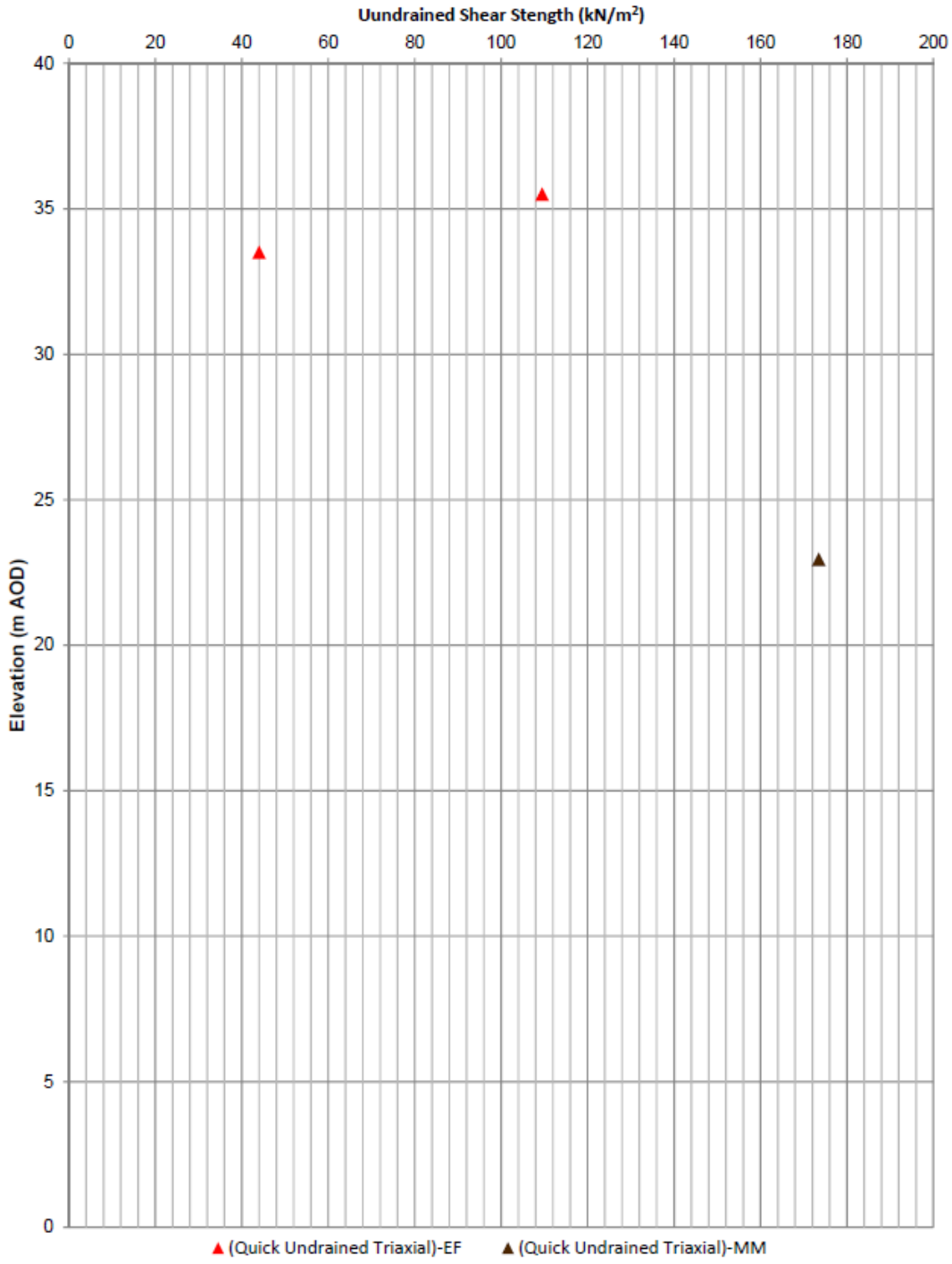
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **187180-187940 NB**
Client: **Highways England**	Borehole ID: **CP1096 & CP1097**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-188520-188550NB-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	GANTRY_307		
Structure Type	MS4 Cantilever Gantry +CCTV		
Design Chainage	188520 – 188550		
Carriageway	Northbound		
Marker Post	188/5A+20A – 188/5+50A		
National Grid Reference	E 446617, N 330761 – E 446610, N 330788		
Existing Ground Level at Structure Location	38.5mAOD		
Earthwork Type	NB: Embankment	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_24431	SB: N/A	HAGDMS designation
Earthwork Height	NB: 8.4m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 18°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Roheel Masrat	16/12/2017	[redacted]
Checked	Scott Bishton	28/04/2017	
Reviewed	Gary Summerfield	28/04/2017	
Approved	Thomas Bulteel	05/05/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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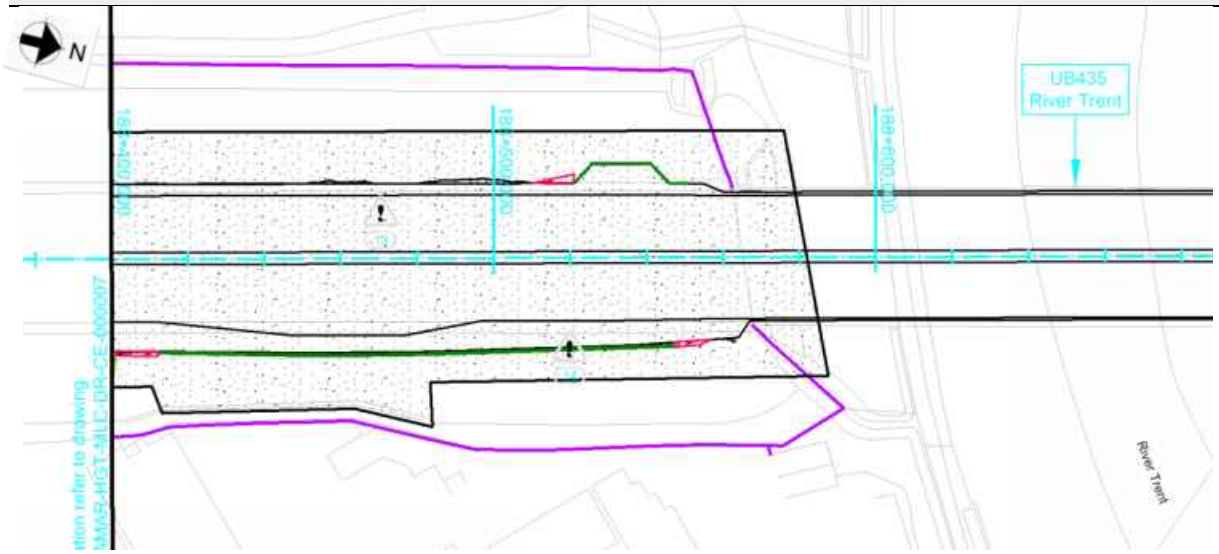


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch185520-188550, King Sheet Pile Retaining Wall.

Proposed Major Structures:

A new cantilever Gantry structure (Gantry 307), which will incorporate a new MS4 at Ch188529.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is to be located on an embankment of 8.3-8.9m height and a typical slope of 18°. The critical cross section at Ch188520 is the location with the greatest retained height.



Figure 2: Topographic Critical Cross Section Ch188520

Utilities:

BT Comms cables are recorded at the edge of the hardshoulder, parallel to the carriageway.

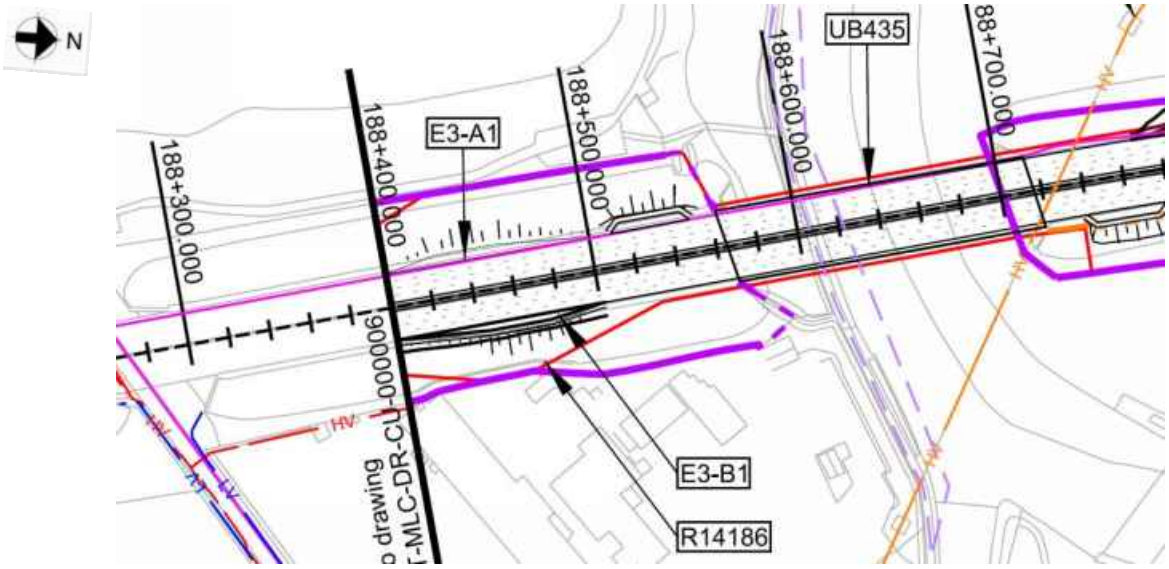


Figure 3: Utilities Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough, indicates that the site is underlain by:

Superficial Deposits: Hemington Member (Silt and Gravel – Glaciofluvial Deposits)

Solid Deposits: Edwalton Member (Mudstone and siltstone – Mercia Mudstone Group)

Ground Investigation:

There are 2 No. historical exploratory holes recorded within the design chainage; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000031, Rev P01.

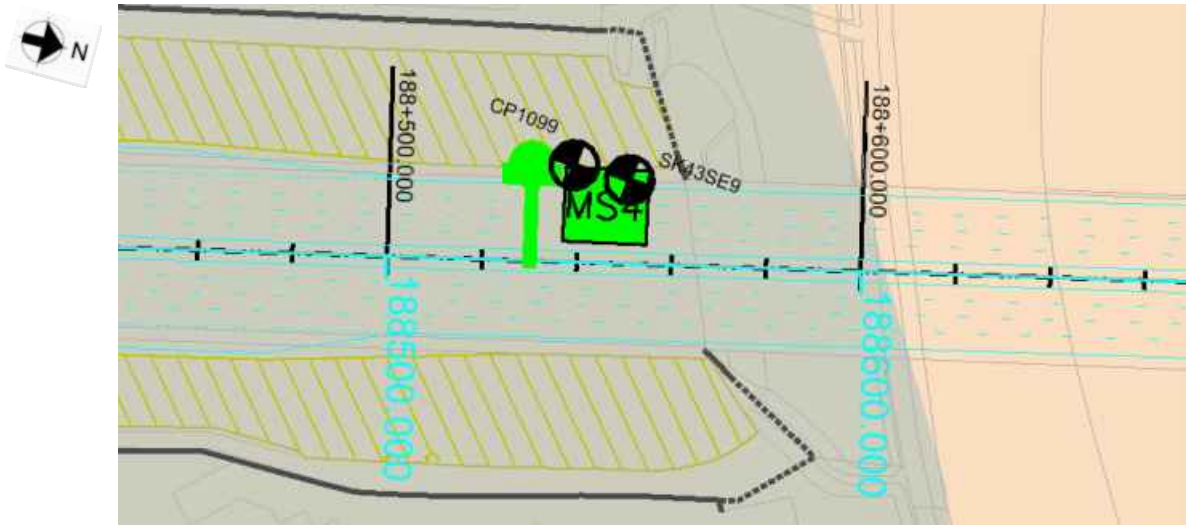


Figure 4: Borehole Location Plan

Flood Risk:

The design flood level is 31.9mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	CP1099	SK43SE9
Borehole Chainage	188539	188551
Borehole Location	Northbound (carriageway)	Northbound (carriageway)
National Grid Reference	E 446611, N 330778	E 446610, N 330790
Ground Level at Exploratory Hole	38.60metres above Ordnance Datum (mAOD)	31.00mAOD
RAG Analysis	Green	Amber
Date Drilled	24/10/2006 – 25/10/2006	15/02/1962 – 23/02/1962
Termination Depth	19.05 metres below ground level (mbgl)	15.24mbgl
Distance from Structure	10m	20m
Other suitable holes	None	

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Embankment Fill (fine grained)	8.4	30.1	17-32 (17)
Embankment Fill (coarse grained)	9.0	29.5	150 (150)
River Terrace Deposits (coarse grained)	14.2	24.3	38-83 (50)
Glaciofluvial Deposits (coarse grained)	19.3	22.0	38 (38)
Mercia Mudstone – III/IV	Not Proven	Not proven	29-150 (29)

(1) Ground level is assumed to be at carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within historical exploratory holes CP1099 and SK43SE9.

Groundwater:

The following groundwater data was recorded in the historical exploratory holes:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		mbgl	mAOD	Time	mbgl	mAOD
SK43SE9	River Terrace Deposits	1.22	29.8	15hours	0.61	30.4

In historical exploratory hole SK43SE9 a water strike was recorded at 29.8mAOD in the River Terrace Deposits which rose to 30.4mAOD after 15hours in the River Terrace Deposits.

Groundwater Design Level:

A groundwater level of 31.9mAOD (flood level) has been assumed for WALLAP analysis of the king sheet pile. When checking the global stability check of the earthwork and king sheet pile (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

3 No. Atterberg Limit tests and 3 No. Natural Moisture Content tests were recorded in historical exploratory holes for this location with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill (fine grained)	4.2	9.07	25	12	13	CL
Embankment Fill (fine grained)	7.7	6.26	25	12	13	CL
Mercia Mudstone – III/IV	18.4	15.34	29	20	9	CL

Lab Test Data - Chemical:

The following chemical testing was undertaken in the historical exploratory hole SK43SE9:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	pH	Solid (water extract)	1	8.5	-
Embankment Fill	Sulphate	2:1 Solid/Water extract	1	0.04	g/l

Chemical testing of a water sample taken at 9.8mbgl from historical exploratory hole CP1109 was not considered representative of the hole location (Embankment Fill was recorded as dry and water was added during the drilling in River Terrace Deposits).

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000031 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outlines the assumed anticipated ground model:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)		Poisson's Ratio		BRE Classification
								E_u	E'	v_u	v'	
Embankment Fill (fine grained)	0.0-8.4	38.5-30.1	8.4	21	27	0	85	6.9	5.5	0.50	0.20	DS-1 AC-1
Embankment Fill (coarse grained)	8.4-9.10	30.1-29.5	0.6	19	36	-	-	-	30.0	-	0.25	DS-2 AC-2
River Terrace Deposits (coarse grained)	9.0-14.2	29.5-24.3	5.2	20	40	-	-	-	67.2	-	0.35	DS-3 AC-3
Glaciofluvial Deposits (coarse grained)	14.2-19.3	24.3-22.0	2.3	21	38	-	-	-	53.0	-	0.25	DS-3 AC-3
Mercia Mudstone – III/IV	>19.3	<22.0	-	21	30	2	145	10.5	8.4	0.50	0.20	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded in historical boreholes CP1099 and SK43SE9.
(3) Typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) c_u of Embankment Fill (fine grained) can be derived using the Stroud correlation. In the absence of sufficient PI data, an f1 value of 5.0 was used (based on CIRIA C570 for Mercia Mudstone, of which the embankment comprises reworked Mercia Mudstone). The conservative SPT 'N' value of 17 was used.

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(5) In the absence of sufficient PI data, the characteristic ϕ' of Embankment Fill (fine grained) given in the AMAR GIR was used.
(6) E' of Embankment Fill (fine grained) was based relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the conservative SPT 'N' value of 17, Eu = 6.9MN/m^2. Therefore E' = 5.5MN/m^2.
(7) Bulk density of Embankment Fill (coarse grained) was based on guidance in BS8002 for a dense to very dense sand.
(8) ϕ' of Embankment Fill (coarse grained) was based on BS8002 guidance for a siliceous sand and gravel with sub-angular to sub-rounded particles, medium- to multi-graded uniformity coefficient and a moderate density index.
(9) E' of Embankment Fill (coarse grained) was based on CIRIA 103 guidance for a dense sand using the conservative value in the range given.
(10) v' of Embankment Fill (coarse grained) was based on CIRIA 103 guidance for a dense sand.
(11) ϕ' of River Terrace Deposits (coarse grained) was determined using correlation with SPT (Peck 1974) 'N' values based on a typical 'N' value of 50.
(12) E' of River Terrace Deposits (coarse grained) was determined using Bowles correlation E' = 1200 (N + 6) which (using typical 'N' value of 50) gives a value of 67.2MN/m^2.
(13) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using correlation with SPT (Peck 1974) 'N' values based on a recorded 'N' value of 38. This value is acceptable despite there only being 1 No. recorded SPT 'N' value because the derived ϕ' is equal to the characteristic value given in the AMAR GIR.
(14) E' of Glaciofluvial Deposits (coarse grained) can be determined using Bowles correlation E' = 1200 (N + 6) which (using recorded 'N' value of 38) gives a value of 53MN/m^2.
(15) c_u of Mercia Mudstone – III/IV can be derived using the Stroud correlation. A PI of 9% gives an unrealistically high f1 value, therefore the typical f1 value of 5.0 for Mercia Mudstone (CIRIA C570) is adopted; combined with a conservative SPT 'N' value of 29, this gives a c_u of 145kN/m^2.
(16) In the absence of sufficient PI data, the characteristic ϕ' of Mercia Mudstone – III/IV given in the AMAR GIR was used.
(17) E' of Mercia Mudstone – III/IV is based relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. E_u for Mercia Mudstone – III/IV can be derived using 'N' values (Bowles) where Eu = 300 (N+6); using a conservative 'N' value of 29 gives Eu = 10.5MN/m^2 and E' = 8.4MN/m^2.
(18) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Embankment Fill (coarse grained), River Terrace Deposits (coarse grained), Glaciofluvial Deposits (coarse grained) or Mercia Mudstone – III/IV, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of king sheet pile wall in embankments; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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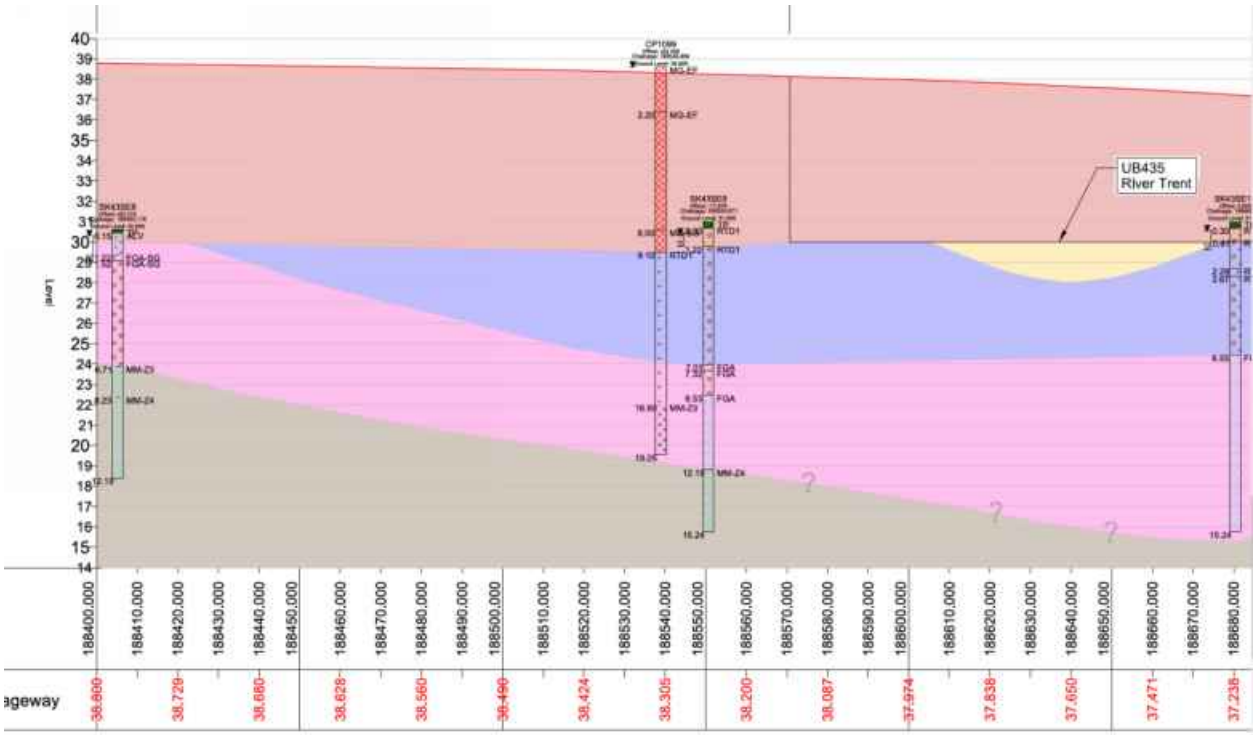


Figure 5: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to proximity to HE boundary, floodplain constraint and category 'Red' vegetation, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	King Section Type	Retained Height (m)	Embedded Depth (m)	King Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
188520	188550	AZ-24 700 S 390 GP	2.7	8.3	11.0	87	52	49	196

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.

Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	750	15.0	2.25	8	180	646

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-G307 at Ch188529, northbound, dynamic sample with rotary follow to 20mbgl.

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HISTORICAL EXPLORATORY HOLES

Rotary Core Log

Borehole No. **CP1099** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446611.00 - 330778.00	Hole Type CP
Location:		Level: 38.60	Scale 1:50
Client: Highways England		Dates: 24/10/2006 - 25/10/2006	Logged By RMS/JS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		1.20 - 1.65	U							MADE GROUND: Brown slightly silty sand. Sand is fine to coarse. With occasional gravel of subangular fine to coarse weathered weak sandstone. MG-EF
		1.70	D							
		2.20 - 2.65	D				2.20	36.40		MADE GROUND: Stiff brown mottled green slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is subangular to subrounded coarse of sandstone, siltstone, mudstone and coal. With occasional rootlets and gypsum. Slight organic odour. MG-EF
		2.20 - 2.70	B							
		3.20 - 3.65	U							
		3.70	D							
		4.20 - 4.65	D							
		4.20 - 4.70	B							
		5.20 - 5.65	U							
		5.70	D							
		6.20 - 6.65	D							
		6.20 - 6.70	B							
		7.20 - 7.65	U							
		7.70	D							
		8.00 - 8.50	B				8.00	30.60		MADE GROUND: Very dense brown clayey sand with gravel of angular to subrounded fine to coarse mudstone, limestone and sandstone. Occasional subrounded cobbles of the same. MG-SG
		9.30 - 9.80	B				9.10	29.50		Dense brown SAND and GRAVEL. Sand is mainly medium to coarse, gravel is angular to subrounded fine to coarse of mixed lithologies. Occasional to some subrounded cobbles. RTD1
		9.80	W							

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 8.00m to 9.00m (2.5 hours), 11.00m to 11.30m (0.5 hours) and 18.50m to 18.90m (1 hour).;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 9.30m to 16.60m.;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1099 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446611.00 - 330778.00	Hole Type CP
Location:		Level: 38.60	Scale 1:50
Client: Highways England		Dates: 24/10/2006 - 25/10/2006	Logged By RMS/JS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.80 - 11.30	B							SAND and GRAVEL (as previous sheet)
		12.30 - 12.70	B							
		13.80 - 14.30	B							
		15.30 - 15.80	B							
		16.60	D				16.60	22.00		
		16.70 - 17.15	D							Stiff to very stiff brown slightly sandy SILT with occasional angular to subangular fine to coarse lithorelics of weathered siltstone and sandstone. MM-Z3
		16.70 - 17.20	B							
		18.20 - 18.40	U							
		18.40	D							Below 18.40m recovered as brown slightly sandy fine to coarse angular to subangular gravel sized fragments of finely laminated weathered SILTSTONE. With occasional lamnae of gypsum (<2mm)
		18.45	D							
		18.45 - 18.90	B							
		18.90	D							
							19.05	19.55		End of borehole at 19.05 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 8.00m to 9.00m (2.5 hours), 11.00m to 11.30m (0.5 hours) and 18.50m to 18.90m (1 hour).;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 9.30m to 16.60m.;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. SK43SE9
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446610.00 - 330790.00	Hole Type CP
Location:		Level: 31.00	Scale 1:50
Client: Highways England		Dates: 15/02/1962 - 23/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	D				0.30	30.70		Top soil TP
		0.61	D							Sandy subsoil RTD1
							1.22	29.78		Gravel & sand RTD1
		1.52	D							
		1.83 - 2.29	SPTL							
		1.83 - 2.29	S B							
		3.05	D							
		3.66 - 4.11	SPTL							
		3.66 - 4.11	S B							
		4.57	D							
		5.18 - 5.64	B							
		5.18 - 5.64	SPTL S							
		6.10	D							
							7.01	23.99		Organic material FGA
		7.16	D				7.32	23.68		Silt & gravel FGA
		7.62	D							
		7.62 - 8.08	B							
		7.62 - 8.08	SPTL S							
		8.53	D				8.53	22.47		Red & grey marl FGA
		8.84 - 9.30	U							
										Continued on next sheet

Remarks
No core possible in Marl & Gypsum

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Rotary Core Log

Borehole No. SK43SE9
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446610.00 - 330790.00	Hole Type CP
Location:		Level: 31.00	Scale 1:50
Client: Highways England		Dates: 15/02/1962 - 23/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.06	D							
		10.52 - 10.67	U							
		10.67	D							
		12.19	D				12.19	18.81		Red marl and gypsum MM-Z4
		12.19 - 12.29	U							
		13.72	D							
		13.72 - 13.77	U							
		15.24	D				15.24	15.76		End of borehole at 15.24 m

Remarks
No core possible in Marl & Gypsum

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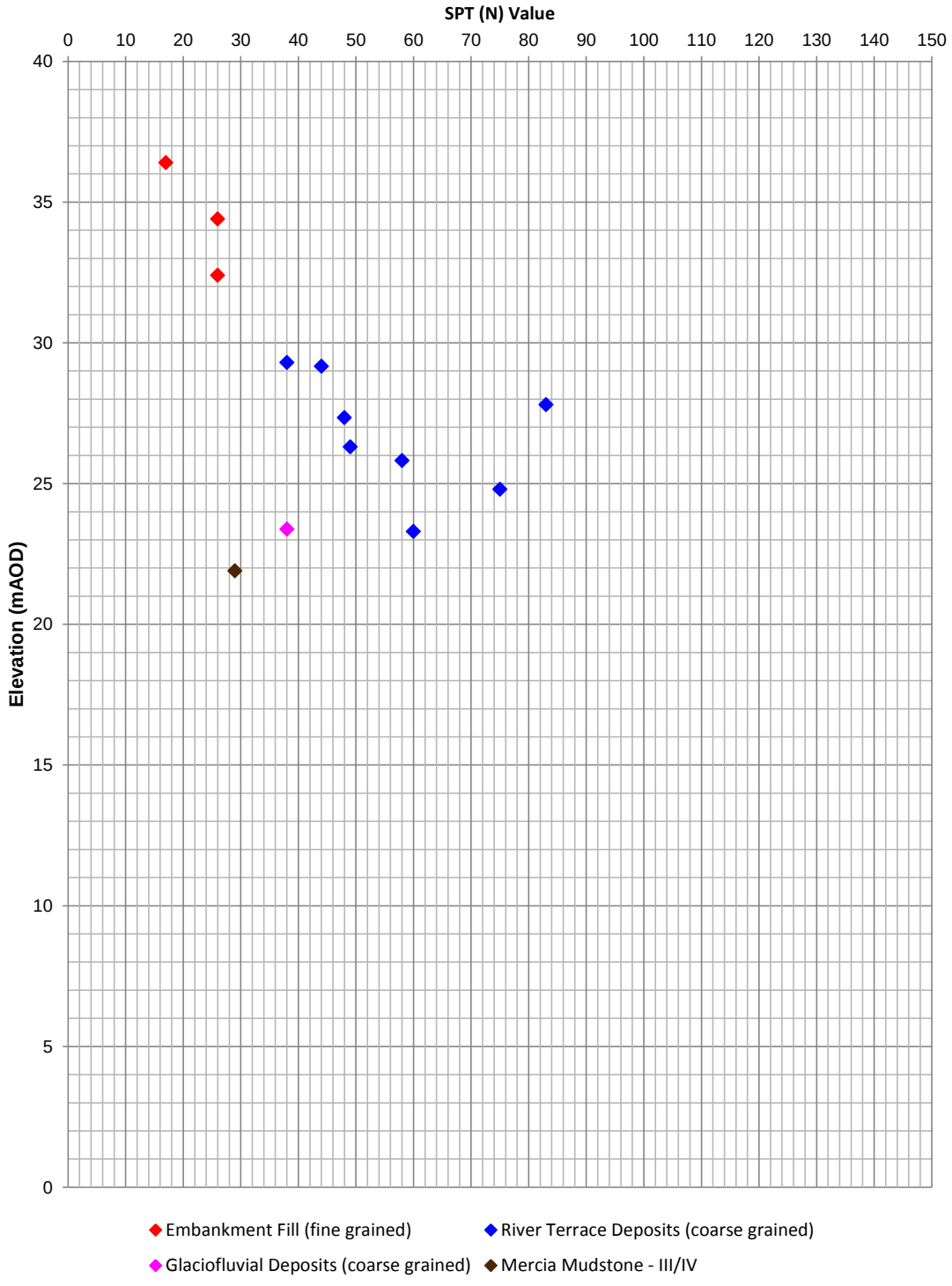
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PLOTS

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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188520-188550NB**
Client: **Highways England**	Borehole ID: **CP1099, SK43SE9**	



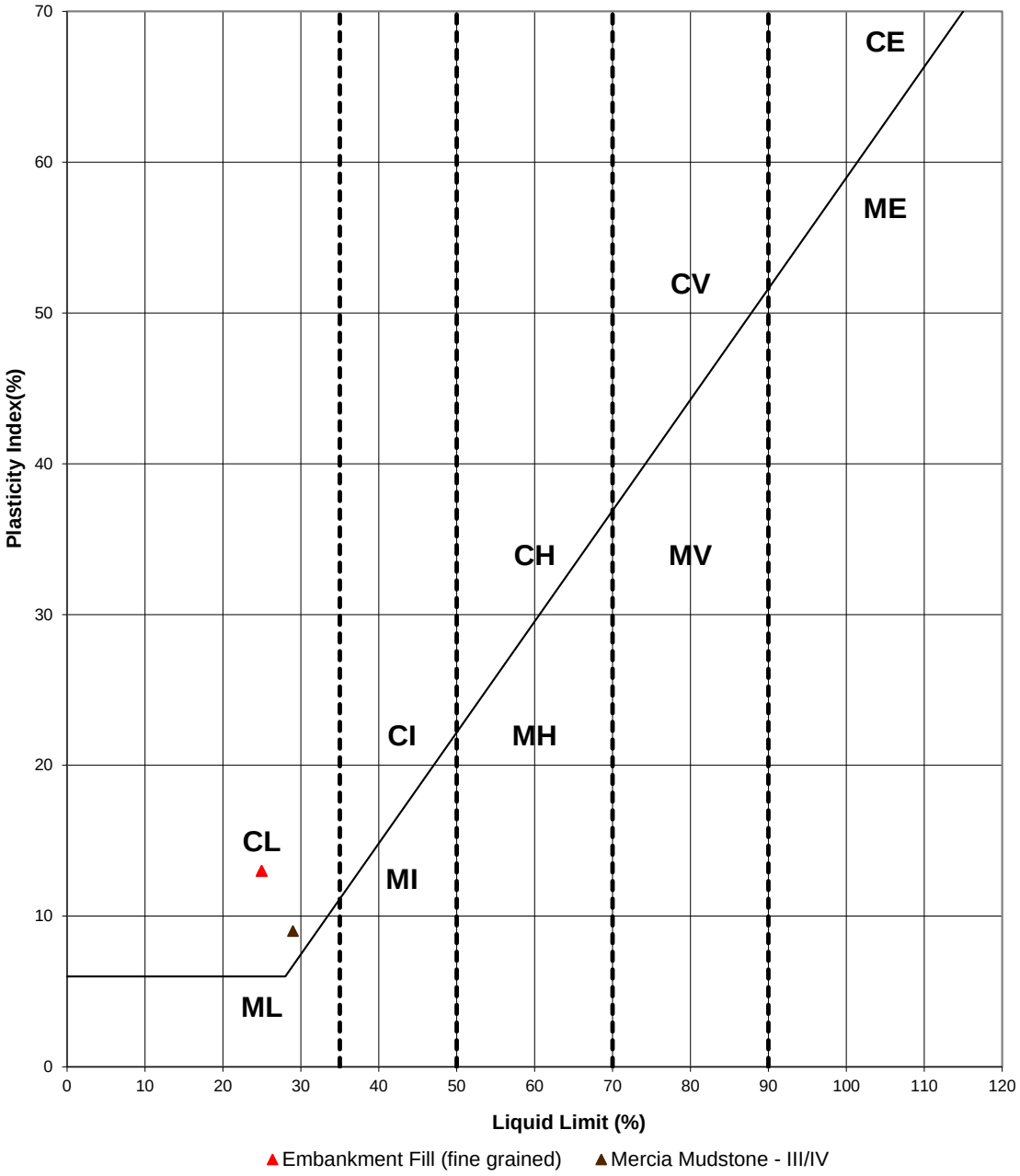
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 24/01/2017 Ref: HA549342-AMAR-HGT-188520-188550NB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188520-188550NB**
Client: **Highways England**	Borehole ID: **CP1099**	



Key

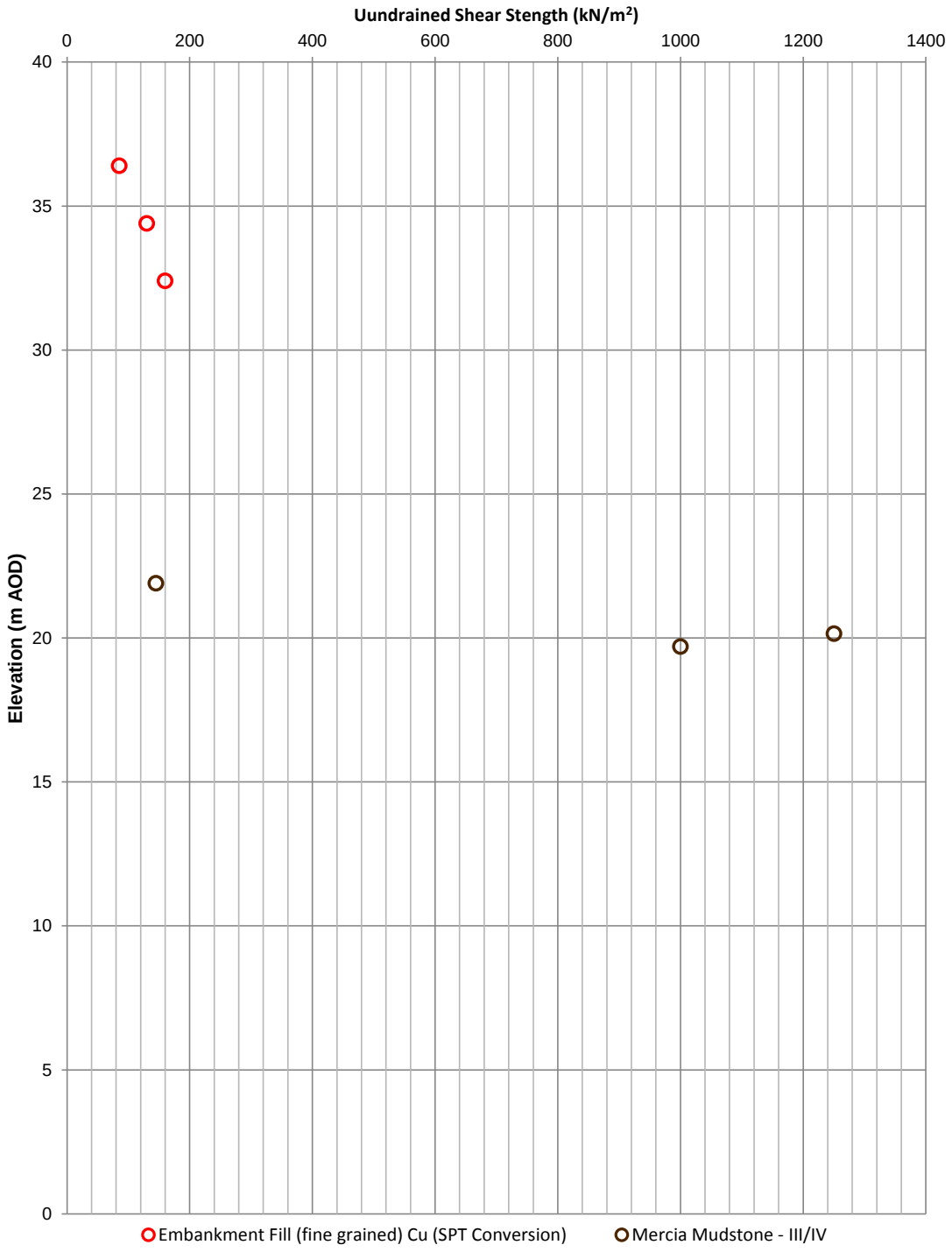
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 24/01/2017 Ref: HA549342-AMAR-HGT-188520-188550NB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188520-188550NB**
Client: **Highways England**	Borehole ID: **CP1099**	



Rev: P01 Date: 24/01/2017 Ref: HA549342-AMAR-HGT-188520-188550NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-188720-188890NB-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	ERA E3-A1[1]		
Structure Type	Emergency Refuge Area		
Design Chainage	188720-188890		
Carriageway	Northbound		
Marker Post	188/7+20 – 188/8+90		
National Grid Reference	E 446558, N 330951 – E 446511, N 331117		
Existing Ground Level at Location	Carriageway	37.0mAOD	
	Toe of Embankment	30.6mAOD	
Earthwork Type	NB: Embankment	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_54261	SB: N/A	HAGDMS designation
Earthwork Height	NB: 5.6-6.4m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 19-26^{o}	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	28/04/2017	[redacted]
Checked	Alice Bazen	17/02/2017	
Reviewed	Gary Summerfield	2/05/2017	
Approved	Thomas Bulteel	09/05/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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DESK STUDY

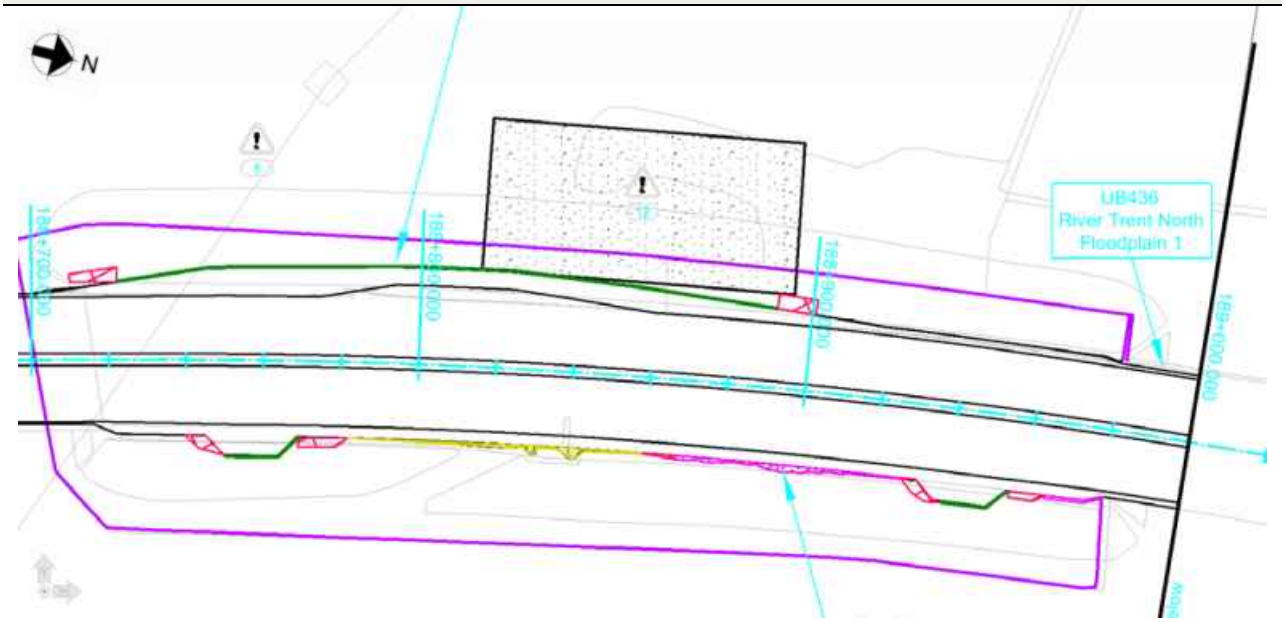


Figure 1: Location Plan

Proposed Earthworks Widening:

A king sheet pile retaining wall, situated on the northbound carriageway is proposed. The king sheet pile wall varies in retained height across its extents; therefore it was subdivided into the following sections for design and construction purposes:

- Ch188720-188740 – retained height ≤2.0m;
- Ch188740-188850 – retained height >2.0m;
- Ch188850-188890 – retained height ≤2.0m.

Proposed Major Structures:

The following major structure will be constructed within the location extents:

- Ch188765-188865 – ERA E3-A1.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork is classified as an embankment with the following variations in height and slope gradient:

- Ch188720-188740 – embankment height 6.0-6.4m, typical slope gradient 19°;
- Ch188740-188850 – embankment height 5.6-5.8m, typical slope gradient 26°;
- Ch188850-188890 – embankment height 5.9-6.1m, typical slope gradient 19°.

The critical cross section for ≤2.0m retained height is at Ch188740.

The critical cross section for >2.0m retained height is at Ch188830.

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Figure 2.1: Topographic Critical Cross Section Ch188740 (retained height ≤2.0m)



Figure 2.2: Topographic Critical Cross Section Ch188830 (retained height >2.0m)

Utilities:

An overhead High Voltage Western Power cable runs NW-SE across the carriageway around Ch188730. Additionally an overhead Mid Voltage Western Power cable runs parallel to the carriageway at the embankment crest across the location extents.

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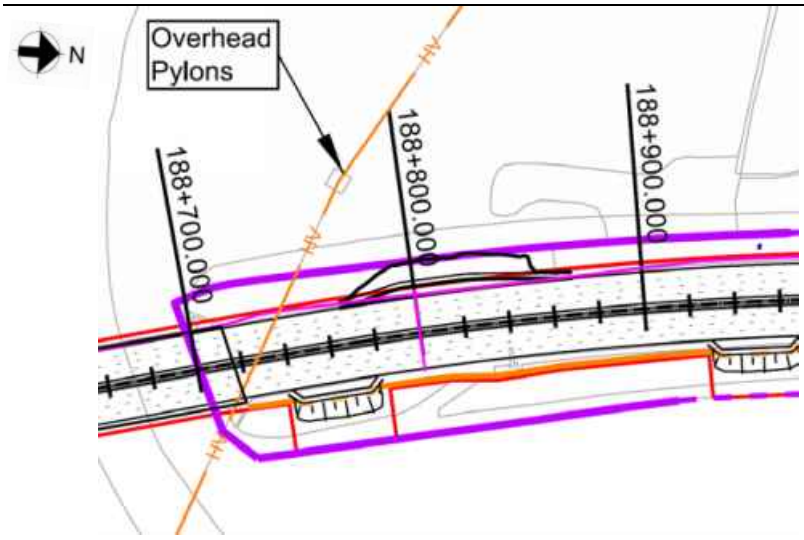


Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough, indicates that the site is underlain by:

Superficial Deposits: Alluvium

Solid Deposits: Edwalton Member (Mercia Mudstone)

Ground Investigation:

1 No. historical exploratory hole is recorded within the design chainage, with additional 2 No. relevant historical exploratory holes, as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000031, Rev P01.

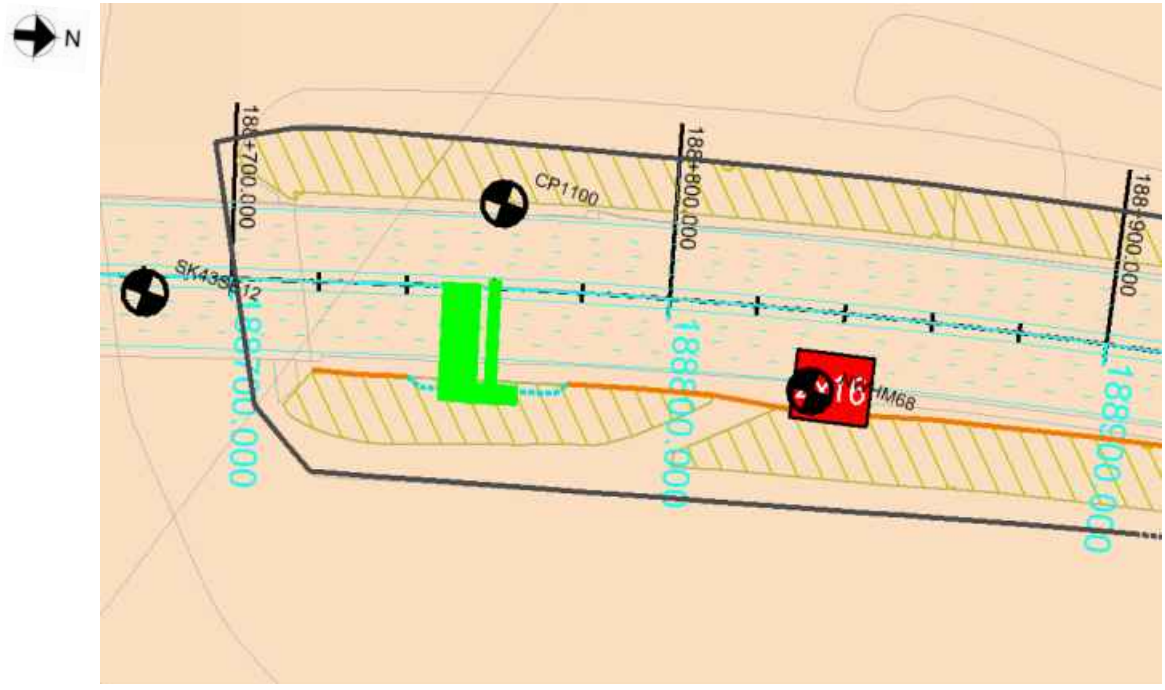


Figure 3: Borehole Location Plan

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Flood Risk:

The design flood level is 32.2mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	CP1100
Borehole Chainage	190682
Borehole Location	Northbound verge
National Grid Reference	E 447131, N 333059
Ground Level at Exploratory Hole	32.95metres above Ordnance Datum (mAOD)
RAG Analysis	Green
Date Drilled	03/11/2006 – 06/11/2006
Termination Depth	15.35metres below ground level (mbgl)
Other suitable holes	NWHM68, SK43SE12

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Embankment Fill	6.4	30.6	19-150 (24)
River Terrace Deposits (coarse grained)	11.3	25.7	25-150 (40)
Glaciofluvial Deposits (fine grained)	12.7	24.3	150
Glaciofluvial Deposits (coarse grained)	15.5	21.5	88-150 (88)
Glaciofluvial Deposits (fine grained)	16.5	20.5	-
Mercia Mudstone – III/IV	-	-	-

(1) Ground level is assumed to be at the carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in historical exploratory holes CP1100, NWHM68 and SK43SE12.

Groundwater:

The following groundwater data was recorded in the historical exploratory holes:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		mbgl	mAOD	Time	mbgl	mAOD
NWHM68	River Terrace Deposits (coarse grained)	6.3	29.0	-	-	-
SK43SE12	River Terrace Deposits (coarse grained)	1.4	29.6	150mins	0.6	30.4

(1) Borehole CP1100 was recorded as dry.

Groundwater Design Level:

A groundwater level of 32.2mAOD (flood level) has been assumed for WALLAP analysis of the king sheet pile wall. When checking the global stability check of the earthwork and king sheet pile wall (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

2 No. Atterberg Limit tests were recorded with the results presented in the table below:

Stratum	Depth (mAOD)	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Classification
Embankment Fill	32.6	10	31	16	15	CL
Glaciofluvial Deposits (fine grained)	22.9	9	29	14	15	CL

1 No. quick undrained triaxial test was recorded with the result presented in the table below:

Stratum	Depth (mAOD)	Undrained Shear Strength (kN/m2)
Glaciofluvial Deposits (fine grained)	23.4	106

Lab Test Data - Chemical:

The following chemical testing data was available from the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	pH	Water	1	8.3	-
Embankment Fill	pH	Solid	1	8.6	-
Embankment Fill	Sulphate (Total) as SO_4	Water	1	0.11	g/l
Embankment Fill	Sulphate (Total) as SO_4	Solid	1	0.06	%

Assumed Ground Model For Design:

Ground model is based on Geological Long Section HA549342-AMAR-HGT-SWI-DR-CE-000031, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γ_b (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0.0 – 6.4	37.0 – 30.6	6.4	21	27	0	100	9.0	7.2	-	0.50	0.20	-	DS-1 AC-1
River Terrace Deposits (coarse grained)	6.4 – 11.3	30.6 – 25.7	4.9	20	38	-	-	-	55.2	-	-	0.25	-	DS-3 AC-3
Glaciofluvial Deposits (fine grained)	11.3 – 12.7	25.7 – 24.3	1.4	21	27	0	106	7.8	6.2	-	0.50	0.20	-	DS-3 AC-3
Glaciofluvial Deposits (coarse grained)	12.7-15.5	24.3 – 21.5	2.8	21	38	-	-	-	55.2	-	-	0.25	-	DS-3 AC-3
Glaciofluvial Deposits (fine grained)	15.5-16.5	21.5 – 20.5	1.0	21	27	0	106	7.8	6.2	-	0.50	0.20	-	DS-3 AC-3
Mercia Mudstone – III/IV	>16.5	<20.5	-	21	30	2	150	16.8	13.4	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where

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data was available) for the proposed location only.

(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.

(3) Due to limited localised GI data typical value for Cu and ϕ' derived in the AMAR GIR are used.

(4) Eu of Embankment Fill is based relationship by Bowles where Eu =300(N=6), for a characteristic SPT 'N' value of 24, Eu = 9.0MN/m^2. E' of Embankment Fill is based relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Therefore E' = 7.2MN/m^2.

(5) ϕ' of River Terrace Deposits can be determined using correlation with SPT (Peck 1974). A characteristic SPT 'N' value of 40, giving a ϕ' of 38^o.

(6) E' of River Terrace Deposits can be determined using Bowles correlation E' = 1200 (N + 6) which (using a characteristic SPT 'N' value of 40) gives a value of 55.2MN/m^2.

(7) 1 No. quick undrained triaxial test was undertaken within Glaciofluvial Deposits (fine grained) with recorded undrained shear strength of 106kN/m^2; this was considered to be a suitable value for the stratum.

(8) ϕ' of Glaciofluvial Deposits (fine grained) was determined using Table 2 in BS8002:2015 using the recorded PI of 15% gives 27°.

(9) Due to the lack of local SPT data for Glaciofluvial Deposits (fine grained), the AMAR GIR characteristic parameters for Eu and E' were adopted.

(10) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using correlation with SPT (Peck 1974) 'N' values based on a characteristic value of 88. However, this result exceeded the correlation graph by Peck 1974; therefore the characteristic value given in the AMAR GIR for this stratum was adopted.

(11) E' of Glaciofluvial Deposits (coarse grained) was determined using Bowles correlation E' = 1200 (N + 6) which (using the characteristic 'N' value of 8) gave a value of 112.8MN/m^2. This value exceeded the range given in the AMAR GIR; therefore the upper bound of the range was adopted.

(12) Due to the lack of local geotechnical data for the Mercia Mudstone – III/IV, the characteristic geotechnical parameters derived in AMAR GIR were adopted.

(13) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for River Terrace Deposits, Glaciofluvial Deposits or Mercia Mudstone, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of king and intermediate sheet piles in embankments; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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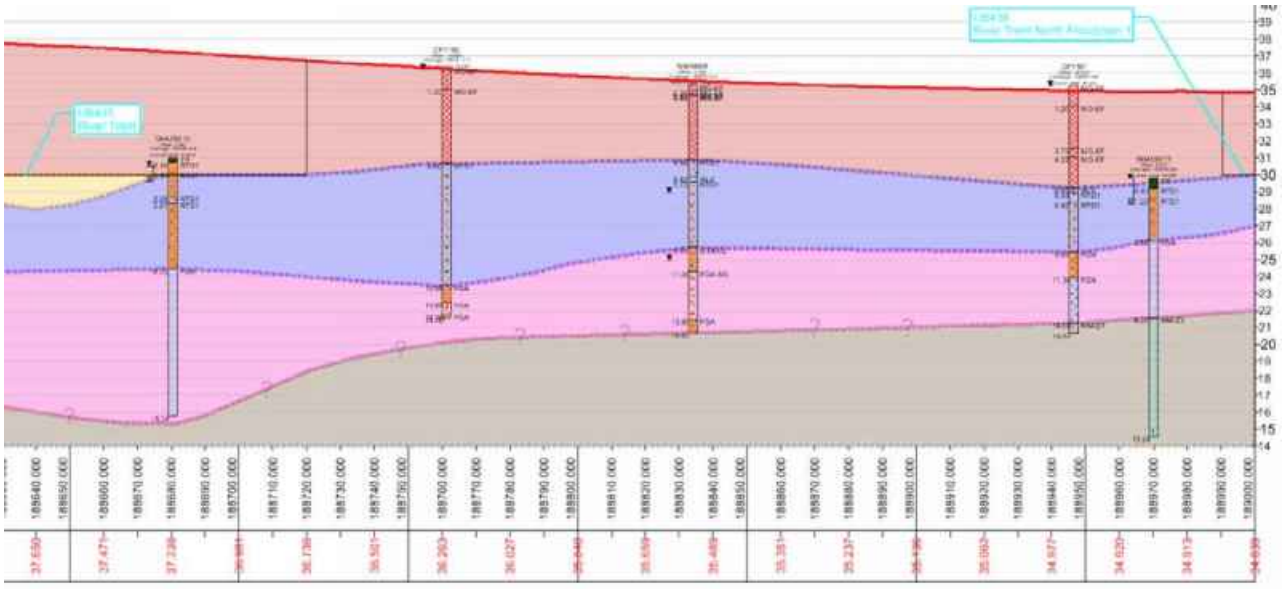


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthworks Widening Solution:

Earthwork regrade was considered at this location, however due to encroachment on the floodplain, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	King Section Type	Retained Height (m)	Embedded Depth (m)	king Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
188720	188740	AZ-24 S 390 GP	2.0	6.0	8.0	84	52	19	66
188740	188850	AZ-24 S 390 GP	2.8	6.2	9.0	86	46	39	147
188850	188865	AZ-24 S 390 GP	2.0	7.0	9.0	84	52	23	108
188865	188890	AZ-24 S 390 GP	2.0	6.0	8.0	84	48	19	66

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level except at chainage 188740 to 188850 where a minimum embedment depth of 1.5m below ground level is required.

Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

Proposed Structural Solution:

N/A

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FURTHER GROUND INVESTIGATION

Additional GI for this location will be undertaken to confirm ground conditions. The following is scheduled:

- BH-E3-A1 at Ch188865, northbound, dynamic sample, with rotary follow on to 11mbgl.

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HISTORICAL EXPLORATORY HOLES

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Borehole Log

Borehole No. **CP1100** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446543.00 - 330990.00	Hole Type CP
Location:		Level: 36.25mbgl	Scale 1:50
Client: Highways England		Dates: 26/10/2006 - 26/10/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.50	1B						MADE GROUND. Brown very gravelly sand. Sand is fine and medium. Gravel is angular to subrounded fine to coarse, of sandstone, mudstone, limestone and concrete with some subangular cobbles of concrete. MG-EF
		1.20 - 1.65	2U	67blows		1.20	35.05		MADE GROUND. Stiff to very stiff purple brown slightly sandy, friable silt, clay and silt/ clay fill. Occasional to some fragments of siltstone and mudstone and occasional to some angular to subangular fine to coarse, gravel of sandstone. MG-EF
		1.70	3D						
		2.20	SPT (S)	N=24 (3,4/4,9,5,6)	Water=DRY				
		2.20 - 2.65	4D						
		2.20 - 2.70	5B						
		3.20 - 3.65	6U	84blows					
		3.70	7D						
		4.20	SPT (S)	N=40 (6,13/9,10,10,11)	Casing=2.80m Water=DRY				
		4.20 - 4.65	8D						
		4.20 - 4.70	9B						
		5.20 - 5.55	10U	100blows					
		5.60	11D			5.60	30.65		
		5.60	SPT (C)	50 (25 for 145mm/50 for 100mm)	Casing=4.20m Water=DRY				Dense to very dense, brown SAND and GRAVEL. Sand is fine to coarse, gravel is angular to subrounded fine to coarse of mixed lithologies including rare granite. RTD1
		5.60 - 6.10	12B						
		6.60	SPT (C)	N=41 (3,4/7,9,12,13)	Casing=6.60m Water=ADDED				
		6.60 - 7.10	13B						
		7.60	SPT (C)	50 (4,9/50 for 295mm)	Casing=7.60m Water=ADDED				Below 7.60m, some subrounded cobbles.
		7.60 - 8.10	14B						
		9.10	SPT (C)	N=40 (2,5/6,9,11,14)	Casing=9.10m Water=ADDED				
		9.10 - 9.60	15B						
									Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring 6.60m to 12.80m.;The borehole was advanced by chiselling methods from 13.80m to 14.20m (1 hour) and from 14.20m to 14.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **CP1100** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446543.00 - 330990.00	Hole Type CP
Location:		Level: 36.25mbgl	Scale 1:50
Client: Highways England		Dates: 26/10/2006 - 26/10/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									SAND and GRAVEL (as previous sheet)
		10.60	SPT (C)	N=34 (1,3/6,7,9,12)	Casing=10.60m Water=ADDED				Below 10.60m: some to many cobbles.
		10.60 - 11.10	16B						
		12.10	SPT (C)	N=48 (3,4/7,10,14,17)	Casing=12.10m Water=ADDED				
		12.10 - 12.60	17B						
		12.80	18D			12.80	23.45		Stiff brown sandy slightly gravelly SILT. Gravel is subangular to subrounded medium to coarse, of sandstone, mudstone, siltstone, quartz and coal. FGA
		12.90 - 13.35	19U	100blows					
		13.40	20D						
		13.80	SPT (S)	50 (25 for 135mm/50 for 170mm)	Casing=13.80m Water=9.40m	13.80	22.45		Brown gravelly SAND with some cobble sized pockets of grey brown sandy silt and sandy clay. Sand is fine and medium. Gravel is angular to subrounded fine and medium, of quartz, siltstone, mudstone, coal and sandstone with some subangular cobbles. Silt is locally gravelly to very gravelly. Clay is locally slightly gravelly. FGA-SG
		13.80 - 14.10	21D						
		13.80 - 14.20	22B						
		14.20	SPT (S)	50 (25 for 115mm/50 for 125mm)	Casing=13.80m Water=9.50m	14.50	21.75		
						14.70	21.55		Grey brown, locally dark grey brown sandy gravelly SILT/CLAY. Gravel is subangular to subrounded fine to coarse, of sandstone, siltstone, quartz and coal. FGA
		14.20 - 14.44	23D						
		14.20 - 14.50	24B						
		14.50	SPT (S)	50 (25 for 85mm/50 for 95mm)	Casing=13.80m Water=9.50m				
		14.50 - 14.68	25D						

End of borehole at 14.70 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring 6.60m to 12.80m.;The borehole was advanced by chiselling methods from 13.80m to 14.20m (1 hour) and from 14.20m to 14.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **NWHM68** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446559.25 - 331070.13	Hole Type CP
Location:		Level: 35.28mbgl	Scale 1:50
Client: Highways England		Dates: 09/09/1999 - 13/09/1999	Logged By BS

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.00	01D		Dia.=0mm				MADE GROUND: Topsoil with some fine to coarse gravel, on to terram. MG-EF
		0.00	D		Dia.=0mm				
		0.30	02D		Dia.=0mm	0.30	34.98		
		0.30	D		Dia.=0mm	0.50	34.78		MADE GROUND: Red brown sand with occasional gravel and cobbles. MG-EF
		0.50	03D		Dia.=0mm	0.60	34.68		
		0.50	D		Dia.=0mm				
		0.60	04D		Dia.=0mm				MADE GROUND: Grey fine to coarse subangular gravel of limestone. MG-EF
		0.60	D						
		1.00	05D		Dia.=0mm				
		1.00	D						MADE GROUND: Firm to stiff locally stiff red brown locally mottled grey slightly sandy clay with a little fine and medium subangular gravel of mudstone. (Mercia Mudstone Fill) MG-EF
		1.20	06D		Dia.=0mm				
		1.20	D		Dia.=0mm				
		1.50	SPT (S)	50 (25 for 10mm/50 for 30mm)	Casing=0.00m Water=0.00m				
		2.00 - 2.50	07B		Dia.=0mm				
		2.00 - 2.50	B		Dia.=0mm				
		2.50	SPT (S)	N=33 (3,3/5,6,10,12)	Casing=0.00m Water=0.00m				
		3.00 - 3.50	08B		Dia.=0mm				
		3.00 - 3.50	B		Dia.=0mm				
		3.50	SPT (S)	N=19 (2,3/4,4,5,6)	Casing=0.00m Water=0.00m				
		4.00	B						
		4.00 - 4.40	09B		Dia.=0mm				
		4.40	10D		Dia.=0mm	4.40	30.88		
		4.40	D		Dia.=0mm				Very dense reddish brown medium SAND with some to much fine to coarse subangular to rounded gravel of sandstone and quartz. (River Terrace Deposits) RTD1
		4.50	SPT (C)	50 (3,10/50 for 210mm)	Casing=0.00m Water=0.00m				
		4.50 - 4.90	11B		Dia.=0mm				
		4.50 - 4.90	B		Dia.=0mm				
		5.40	12D		Dia.=0mm	5.40	29.88		
		5.40	D		Dia.=0mm				Firm dark grey green organic (peaty) CLAY with traces of fibrous matter. Organic odour. (Alluvium) ALV
		5.50	SPT (S)	N=28 (2,3/5,6,8,9)	Casing=0.00m Water=0.00m	5.70	29.58		
		6.00	B						
	▼	6.00 - 6.50	13B		Dia.=0mm				Medium dense brown medium SAND and GRAVEL: Gravel content fine to coarse subangular to rounded of limestone, sandstone and quartz. (River Terrace Deposits) RTD1
		6.50	SPT (C)	N=29 (2,4/6,7,7,9)	Casing=0.00m Water=0.00m				
		6.50 - 7.00	14B		Dia.=0mm				
		6.50 - 7.00	B		Dia.=0mm				
		7.50	B						
		7.50	SPT (C)	N=38 (3,5/7,9,10,12)	Casing=0.00m Water=0.00m				
		7.50 - 8.00	15B		Dia.=0mm				
		8.50	16D		Dia.=0mm				
		8.50	D		Dia.=0mm				
		9.00	SPT (C)	N=25 (3,4/4,5,7,9)	Casing=0.00m Water=0.00m				
		9.00 - 9.50	17B		Dia.=0mm				
		9.00 - 9.50	B		Dia.=0mm				
		9.60	18D		Dia.=0mm	9.60	25.68		
		9.60	D		Dia.=0mm				Firm to stiff and stiff red brown slightly sandy CLAY with a little fine and medium
		9.70	19U	50blows	Dia.=100mm				
		9.70	B						Continued on next sheet

Remarks

1. Hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. Upon completion of borehole at 14.60m borehole grouted from base to0.50m. Topsoil replaced. 3. Marker Post Ref 188/9 -50S.

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Borehole Log

Borehole No. **NWHM68** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446559.25 - 331070.13	Hole Type CP
Location:		Level: 35.28mbgl	Scale 1:50
Client: Highways England		Dates: 09/09/1999 - 13/09/1999	Logged By BS

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
	▼	9.70	SPT (S)	50 (25 for 10mm/50 for 0mm)	Casing=0.00m Water=0.00m				subangular to rounded gravel of sandstone and mudstone, rare coal traces. (Glacial Till) GTA-CL
		9.70	U	50blows	Dia.=100mm				
		9.70 - 10.00	20B		Dia.=0mm				
		10.50	21D		Dia.=0mm				
		10.50	D		Dia.=0mm	11.00	24.28		
		11.00	22D		Dia.=0mm				Dense grey brown clayey SAND and GRAVEL:- Gravel content fine to coarse subangular to rounded of sandstone, quartz and limestone. FGA-SG
		11.00	D		Dia.=0mm				
		11.50	23D		Dia.=0mm				
		11.50	D		Dia.=0mm				
		12.00	24D		Dia.=0mm				
		12.00	D						
		12.50	B						
		12.50 - 13.50	25B		Dia.=0mm				
		13.80	26D		Dia.=0mm	13.80	21.48		
		13.80	D		Dia.=0mm				Very stiff grey sandy locally slightly sandy CLAY with a little fine to coarse subangular to rounded gravel of sandstone, mudstone, coal and limestone. (Glacial Till) FGA
		13.90	27U	50blows	Dia.=100mm				
		13.90	U	50blows	Dia.=100mm				
		14.60	28D		Dia.=0mm	14.60	20.68		End of borehole at 14.60 m
		14.60	D		Dia.=0mm				

Remarks

1. Hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. Upon completion of borehole at 14.60m borehole grouted from base to0.50m. Topsoil replaced. 3. Marker Post Ref 188/9 -50S.

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446590.00 - 330920.00	Borehole No. SK43SE12 Sheet 1 of 2
Location:		Level: 31.00	Hole Type CP
Client: Highways England		Dates: 06/02/1962 - 09/02/1962	Scale 1:50
			Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	30.70		Topsoil TP
		0.61	W							Sandy subsoil RTD1
		0.76	D				0.91	30.09		
		1.22	B							Gravel RTD1
		1.22 - 1.68	SPTL							
		1.52	S							
			D							
							2.29	28.71		Silt RTD1
		2.44	D				2.67	28.33		
		3.05	D							Sand & gravel RTD1
		3.05 - 3.51	SPTL							
		3.35	S							
			B							
		4.57	D							
		5.18	B							
		5.18 - 5.64	SPTL							
			S							
		6.10	D							
							6.55	24.45		Brown boulder clay FGA
		6.71	D							
		7.62 - 8.08	U							
		8.08	D							
		9.14 - 9.53	U							
		9.60	D							
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK43SE12** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446590.00 - 330920.00	Hole Type CP
Location:		Level: 31.00	Scale 1:50
Client: Highways England		Dates: 06/02/1962 - 09/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.97 10.97 - 11.51	D U							
		12.50 12.65 - 13.03	D U							
		14.02	D							
		14.78 - 15.14	U							
		15.24	D				15.24	15.76		End of borehole at 15.24 m

11 12 13 14 15 16 17 18 19 20

Remarks

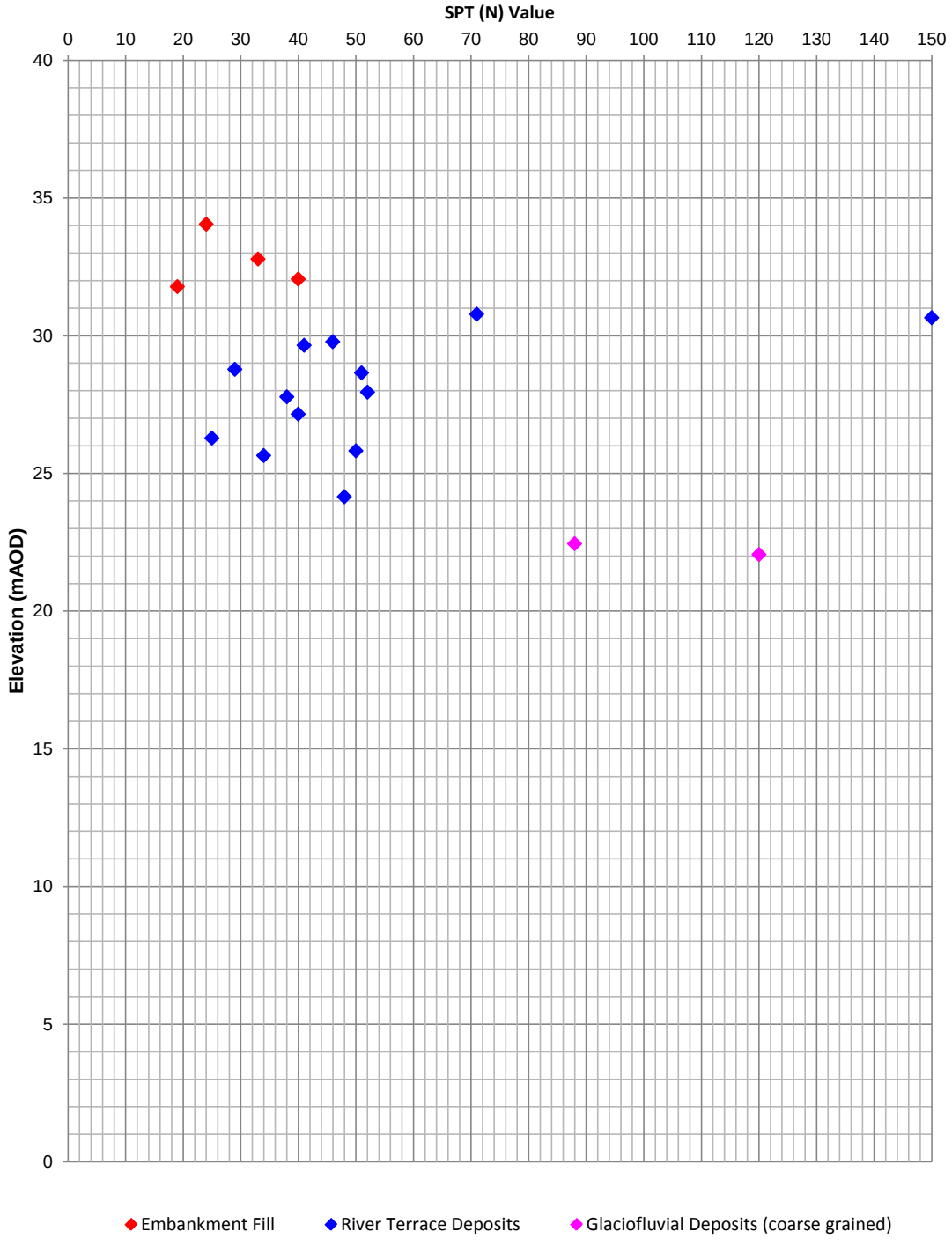
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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188720-188890NB**
Client: **Highways England**	Borehole ID: **CP110, NWHM65, SK43SE12**	



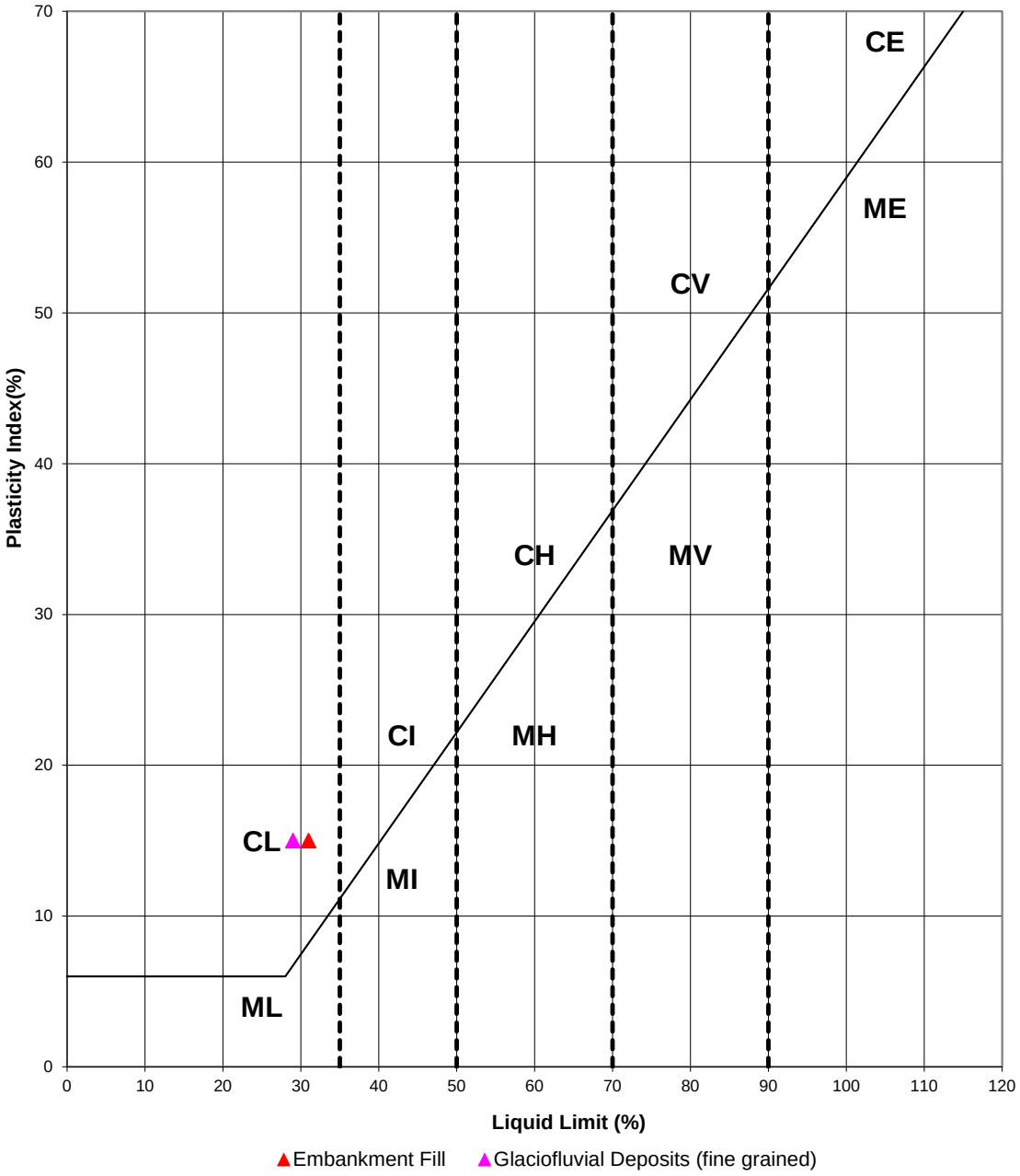
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 10/01/2017 Ref: HA549342-AMAR-HGT-188720-188890NB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188720-188890NB**
Client: **Highways England**	Borehole ID: **CP1100**	



Key

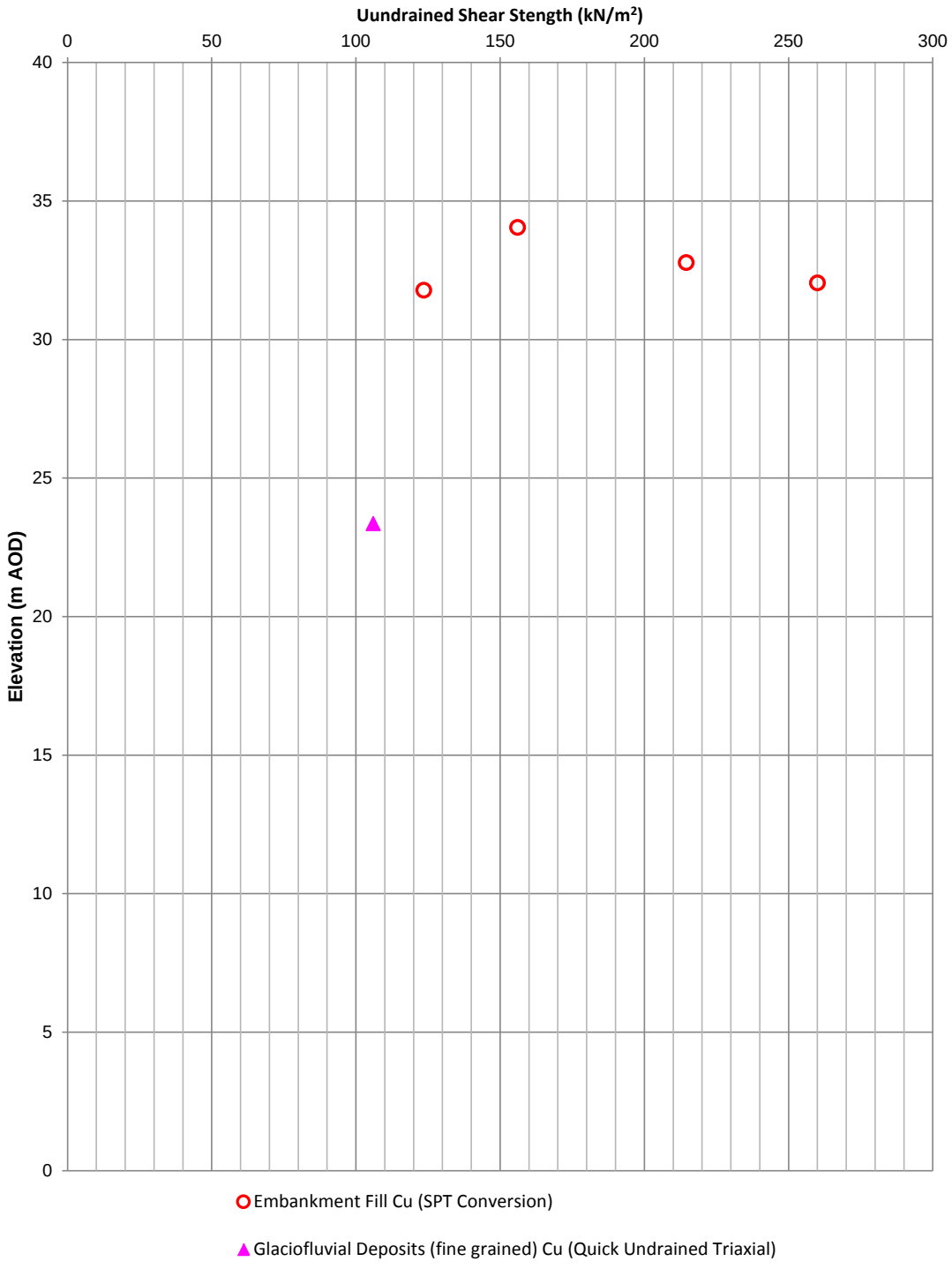
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 10/01/2017 Ref: HA549342-AMAR-HGT-188720-188890NB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **NB188720-188890**
Client: **Highways England**	Borehole ID: **CP1100, NWHM68, SK43SE12**	



Rev: P01 Date: 10/01/2017 Ref: HA549342-AMAR-HGT-NB188720-188890-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-189780-189800NB-GSS-000001		
Earthworks Widening Solution	Granular Wedge at Embankment Crest (1:2.0)		
Structure Number	GANTRY_311[1]		
Structure Type	Superspan Portal		
Design Chainage	189780-189800		
Carriageway	Northbound		
Marker Post	189/7+80 – 189/8+00		
National Grid Reference	E 446556, N 332004 – E 4465632, N 332023		
Existing Ground Level at Location	Carriageway	36.1-36.5mAOD	
	Toe of Embankment	31.0-31.4mAOD	
Earthwork Type	NB: Embankment	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: 7_M1_21900	SB: N/A	HAGDMS designation
Earthwork Height	NB: 4.7-5.5m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 14-19°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	27/04/2017	[redacted]
Checked	Roheel Masrat	11/03/2017	
Reviewed	Gary Summerfield	12/03/2017	
Approved	Tom Bulteel	06/06/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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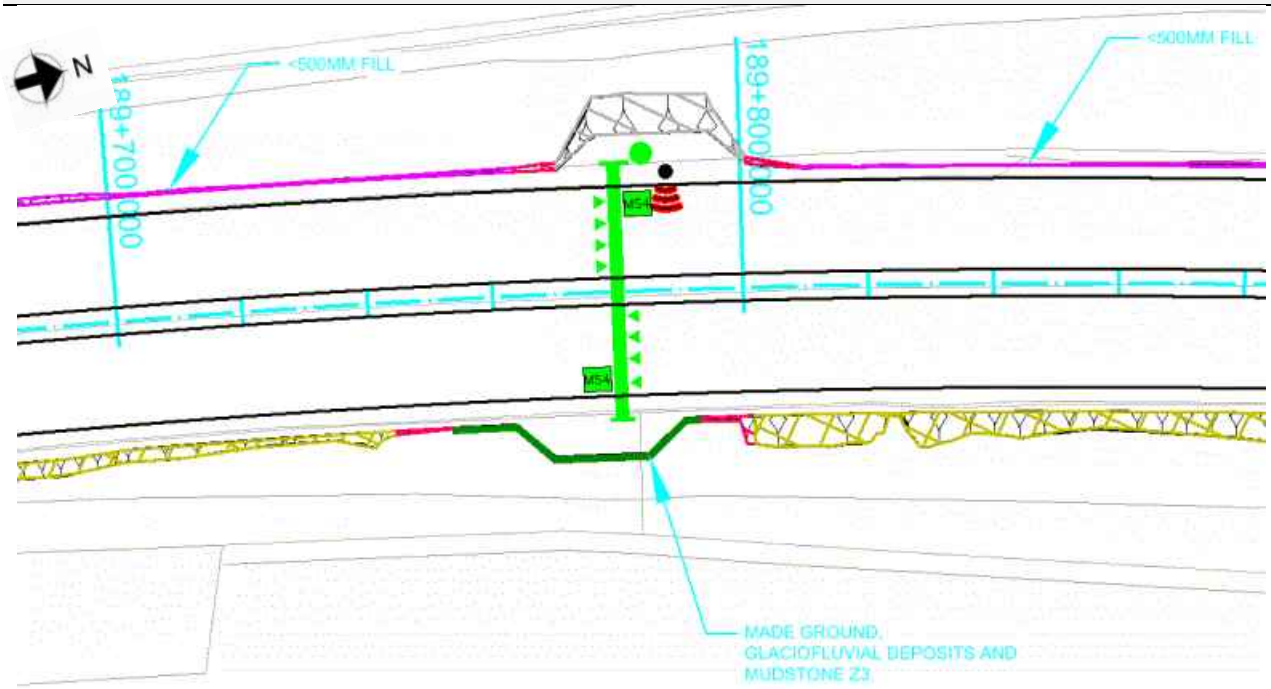


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch189780-189800, Granular Wedge at Embankment Crest (1:2.0)

Proposed Major Structures:

A New Superspan Portal Gantry (GANTRY_311) is proposed at Ch189780.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is an embankment. The earthwork ranges in height approximately from 4.7m to 5.5m and has a slope angle of 14-19°.

The critical cross section Ch189790 was chosen based on greatest earthwork height where build out due to gantry construction is significant.

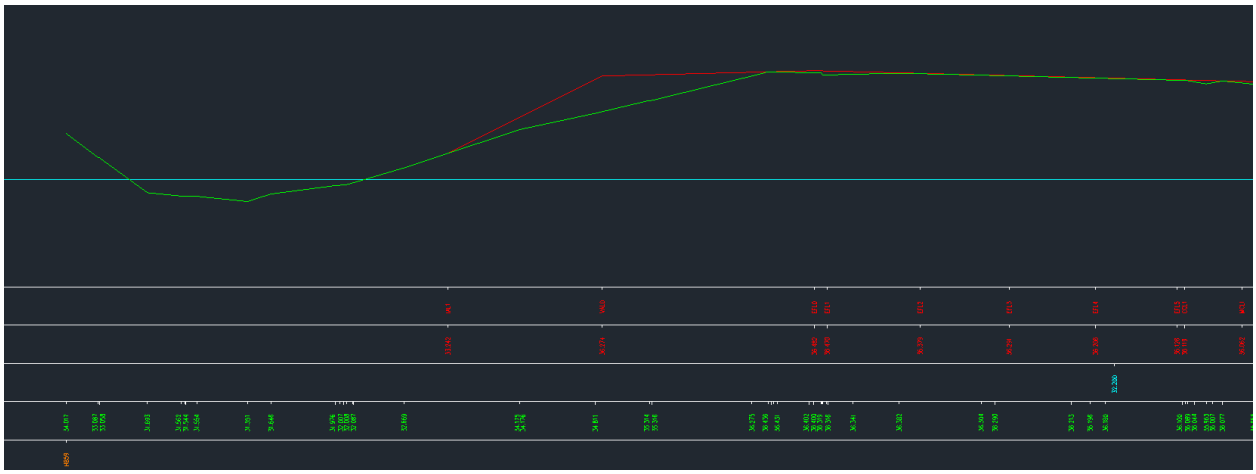


Figure 2: Topographic Critical Cross Section Ch189780

Utilities:

In the immediate area a BT Communication line runs parallel to the hard shoulder; a second cable also running parallel to hard shoulder is set back 8m from back of gantry, finally a third cable runs at 45° to hard shoulder along the back of the gantry. In the field beside the location there are Western Power buried high voltage lines.

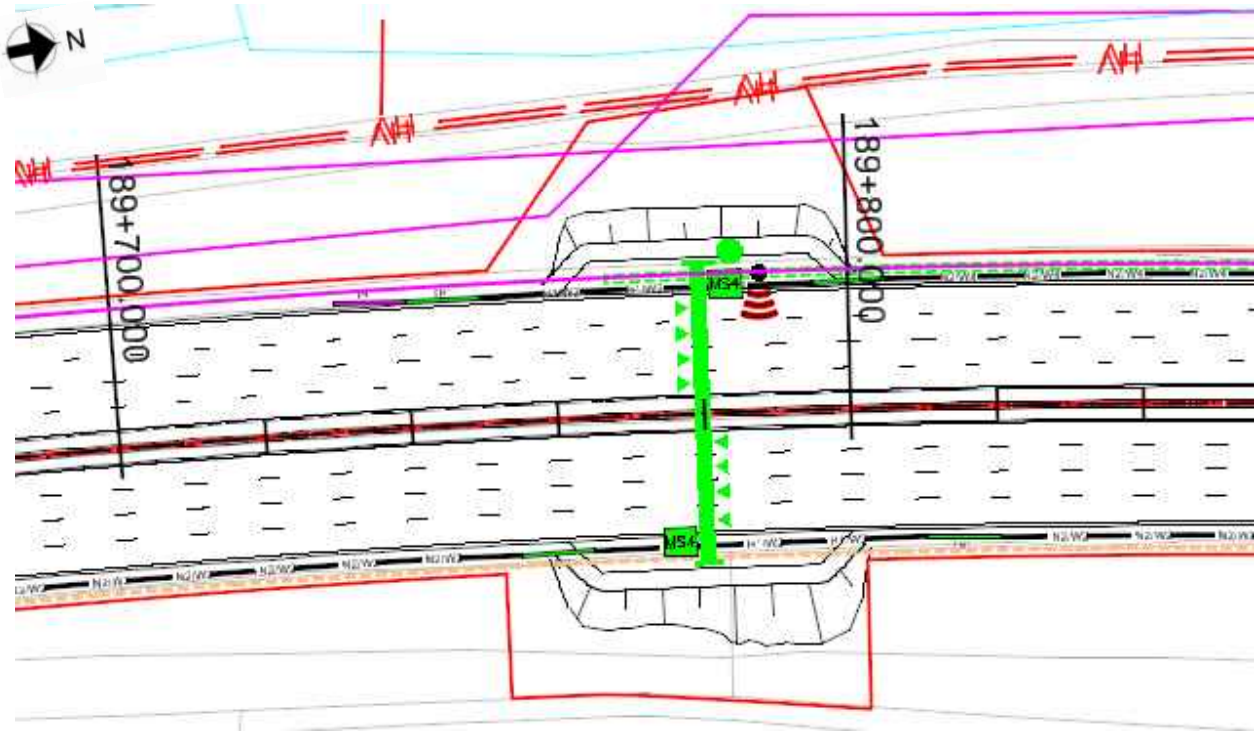


Figure 3: Utilities Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Hemington Member (Glaciofluvial Deposits);

Solid Deposits: Edwalton Member (Mercia Mudstone Group)

Ground Investigation:

No historical exploratory holes were recorded within the design chainage; however, 1 No. historical exploratory hole was considered relevant, of which is shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000033, Rev P01.

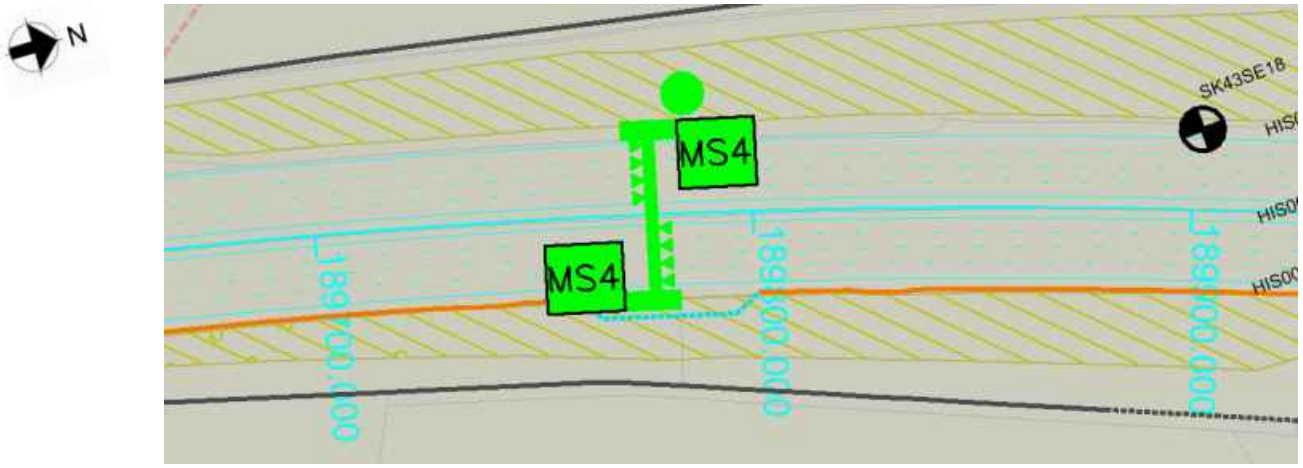


Figure 4: Borehole Location Plan

Flood Risk:

The design flood level is 31.2mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR, Document Ref. HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	SK43SE18
Borehole Chainage	189903
Borehole Location	Northbound (2.2m from VRS)
National Grid Reference	E 446600, N 332120
Ground Level at Exploratory Hole	32.10mAOD (metres above Ordnance Datum)
RAG Analysis	Amber
Date Drilled	17/01/1962 to 24/01/1962
Termination Depth	9.14mbgl (metres below ground level)
Other suitable holes	None

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey data:

Stratum	Depth to Base (m bgl)	Depth to Base (m AOD)	SPT (N) Value
Embankment Fill	5.0	31.4	None recorded
Glaciofluvial Deposits (coarse grained)	10.1	26.3	54-67 (60)
Mercia Mudstone – III/IV	Not proven	Not proven	None recorded

(1) Ground level is assumed to be at carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of Embankment Fill may vary.
(3) Depths to base of strata are derived from topographical data for Embankment Fill and from historical borehole SK43SE18 for natural strata.
(4) Characteristic SPT 'N' values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory hole SK43SE18.

Groundwater:

The following groundwater data was recorded in the historical exploratory hole:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		mbgl	mAOD	Time	mbgl	mAOD
SK43SE18	Glaciofluvial Deposits (coarse grained)	1.52	30.58	20mins	0.76	31.34

Groundwater Design Level:

No Local groundwater is available therefore design groundwater level of 31.2mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

No local geotechnical laboratory testing data is available for this structure location.

Lab Test Data – BRE Classification:

No chemical laboratory testing data is available for this structure location

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Assumed Ground Model For Design:

Ground model based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-CE-000033, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01. The below table outlines the assumed anticipated ground model, to be confirmed by 'Just in Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment fill	0-5.0	36.4-31.4	5.0	21	27	0	100	7.8	6.2	-	0.50	0.20	-	2.6	0.45	-	6.2*	-	DS-2 AC-2
Glaciofluvial Deposits (coarse grained)	5.0-10.1	31.4-26.3	5.1	21	38	-	-	-	19.2	-	-	0.25	-	7.7	-	1.0	-	50	DS-3 AC-3
Mercia Mudstone – III/IV	>10.1	<26.3	-	21	30	2	100	16.8	13.4	-	0.50	0.20	-	5.6	0.45	-	9.0	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Given the limited amount of local GI data, typical geotechnical parameters derived in the AMAR GIR are adopted.
(3) Shear modulus is based on G = E/2(1+v).
(4) Adhesion Factor is based on BS8004 (equation 41).
(5) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl
(6) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1).
(7) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).
(8) In the absence of BRE test data the classification used for the strata in the AMAR GIR were adopted.

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Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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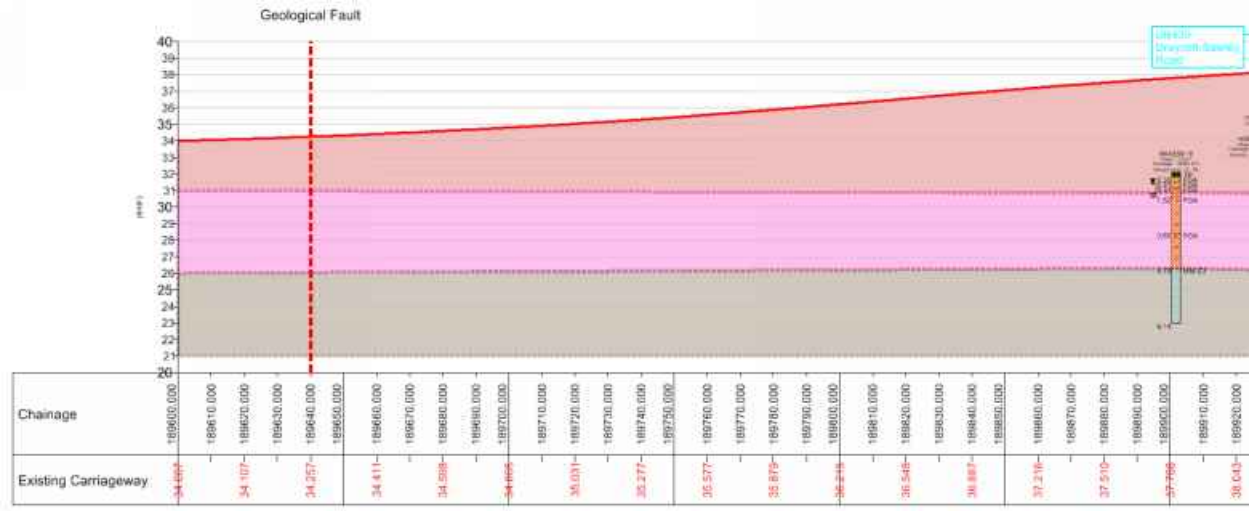


Figure 5: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solution is proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (°)
189780	189800	Granular Wedge at Embankment Crest (1:2.0)	2.5	1(V):3(H) 18°

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Structure Ref.	Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
GANTRY _311(NB)	4 (2x2)	900	15.5	2.25	8	575	433

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FURTHER GROUND INVESTIGATION

'Just in Time' Validation Ground Investigation is required at this location to confirm ground conditions. The following has been proposed:

- BH – G311A at Ch189780, northbound, dynamic sample with rotary follow on to 21m bgl.

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HISTORICAL EXPLORATORY HOLES

amey ARUP

Borehole Log

Borehole No. **SK43SE18**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords:	446600.00 - 332120.00	Hole Type CP
Location:		Level:	32.10mbgl	Scale 1:50
Client: Highways England		Dates:	17/01/1962 - 24/01/1962	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	1D			0.30	31.80		Topsoil TP
		0.46	2D			0.61	31.49		Brown sandy subsoil FGA
		0.76	3D			0.91	31.19		Mottled sandy clay FGA
		1.07	4D			1.52	30.58		Yellow clayey sand FGA-SG
		1.68	5D						Coarse brown gravelly sand FGA-SG
		1.68	SPT (S)	N=54 (75,12/15,15,11,13)	Water=-				
		1.68 - 2.13	12B						
		1.68 - 2.13	18SP TLS						
		2.13	6D						
		3.05	SPT (S)	N=62 (75,12/14,14,16,18)	Water=-				
		3.05 - 3.51	13B						
		3.05 - 3.51	19SP TLS			3.66	28.44		Gravel & sand (grey) FGA-SG
		3.51	7D						
		4.57	SPT (S)	N=67 (75,8/14,14,18,21)	Water=-				
		4.57 - 5.03	14B						
		4.57 - 5.03	20SP TLS						
		5.03	8D						
		6.10	9D			5.79	26.31		Red marl MM-Z3
		6.10 - 6.40	15U	221blows					
		7.32 - 7.62	16U	338blows					
		7.62	10D						
		8.69 - 9.14	17U	222blows					
		9.14	11D			9.14	22.96		End of borehole at 9.14m

Remarks
From 3.66m B.S. Gravel & sand blowing back up inside casing, still coming in until cased to 7.32m

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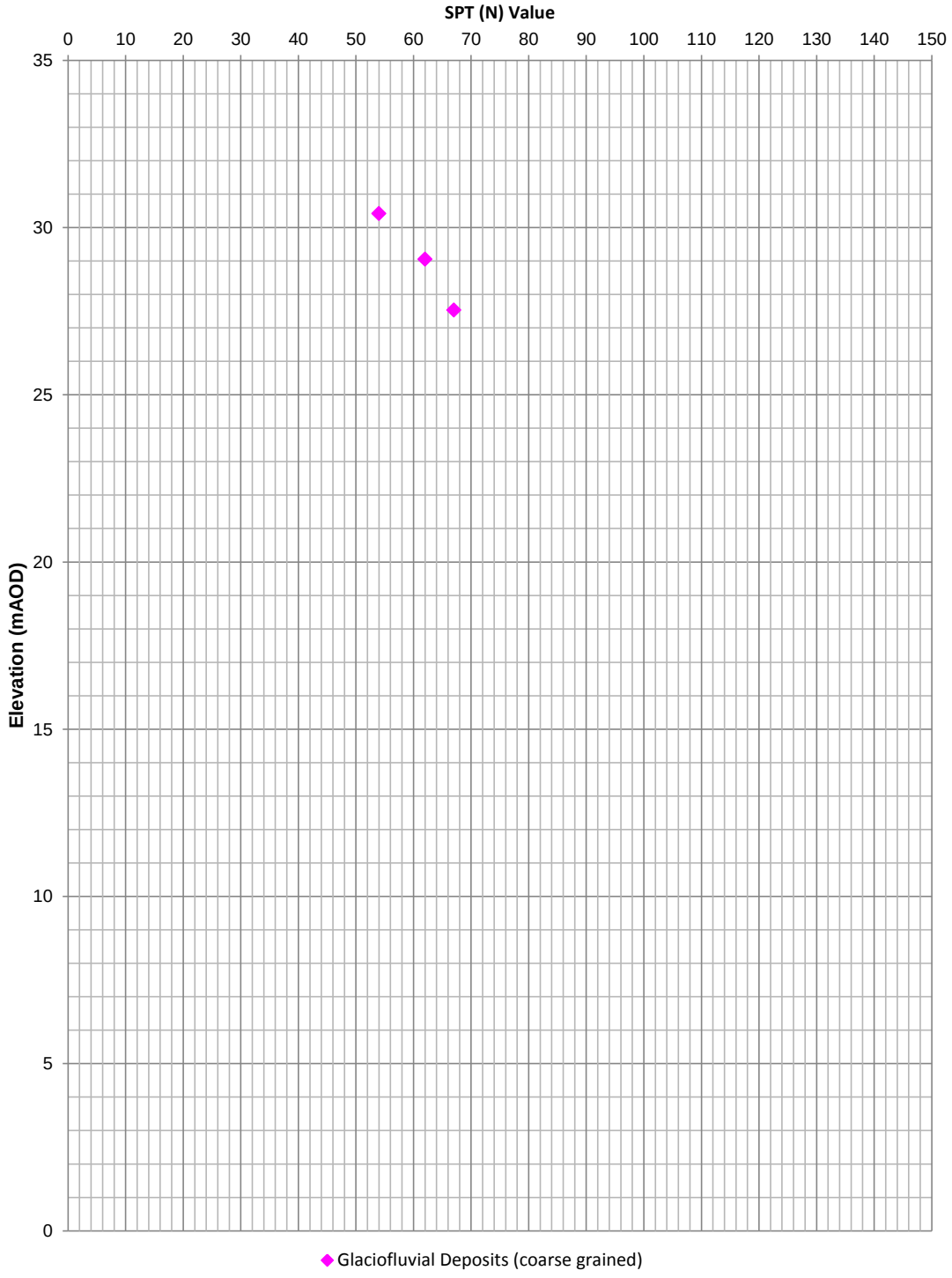
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PLOTS

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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **189780-189800NB**
Client: **Highways England**	Borehole ID: **SK43SE18**	



Rev: P01 Date: 09/03/2017 Ref: HA549342-AMAR-HGT-189780-189800NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-190530-190560NB-GSS-000001		
Earthworks Widening Solution	Granular Wedge at Embankment Crest (1:2.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	190530-190560		
Carriageway	Northbound		
Marker Post	190/5+30 – 190/5+60		
National Grid Reference	E 446909, N 332670 – E 446919, N 332685		
Existing Ground Level at Location	Carriageway	37.6-37.9mAOD	
	Toe of Embankment	30.5-30.7mAOD	
Earthwork Type	NB: Embankment	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: 7_M1_24388	SB: N/A	HAGDMS designation
Earthwork Height	NB: 7.1-7.5m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 8-25°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Scott Bishton	27/04/2017	[redacted]
Checked	Roheel Masrat	03/05/2017	
Reviewed	Gary Summerfield	04/05/2017	
Approved	Thomas Bulteel	06/06/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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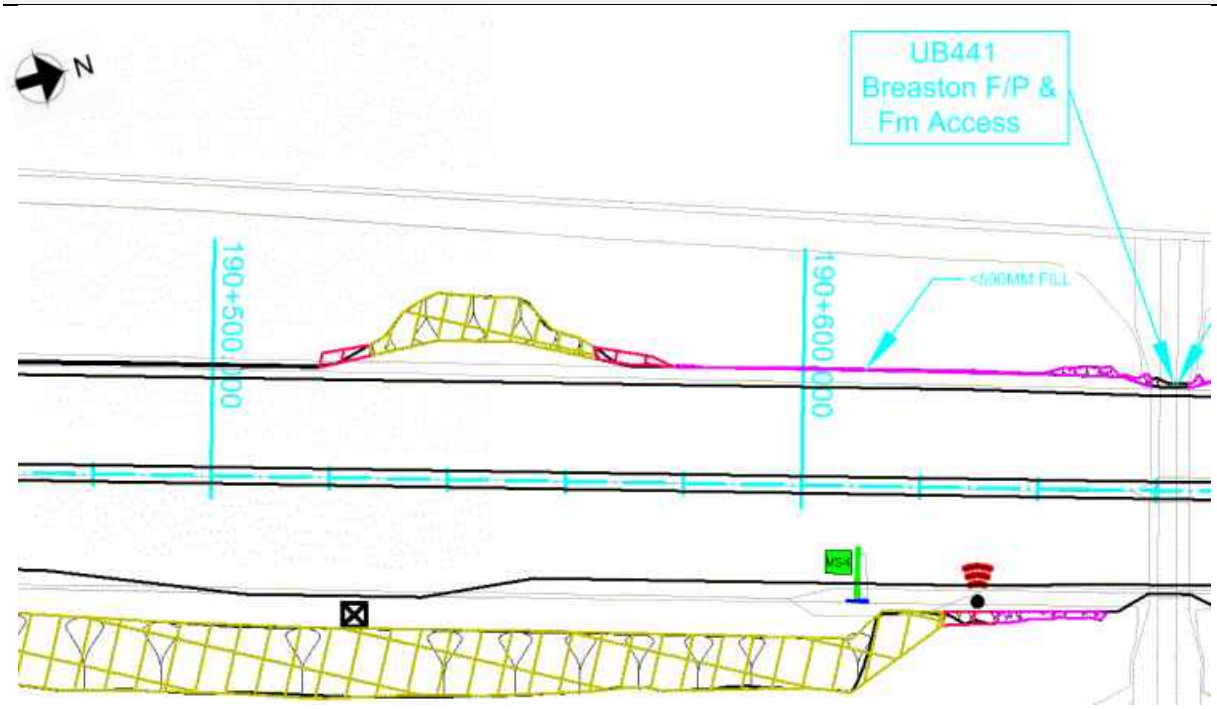


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch190530-190560, Granular Wedge at Embankment Crest (1:2.0).

Proposed Major Structures:

None.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is an embankment. The earthwork ranges in height approximately from 7.1m to 7.5m and has a slope angle of 8-25°.

The critical cross section Ch190550 was chosen based on greatest size of proposed granular wedge. At this location the embankment height is 7.1m; therefore the thickness of Embankment Fill is assumed to be 7.1m in the ground model.

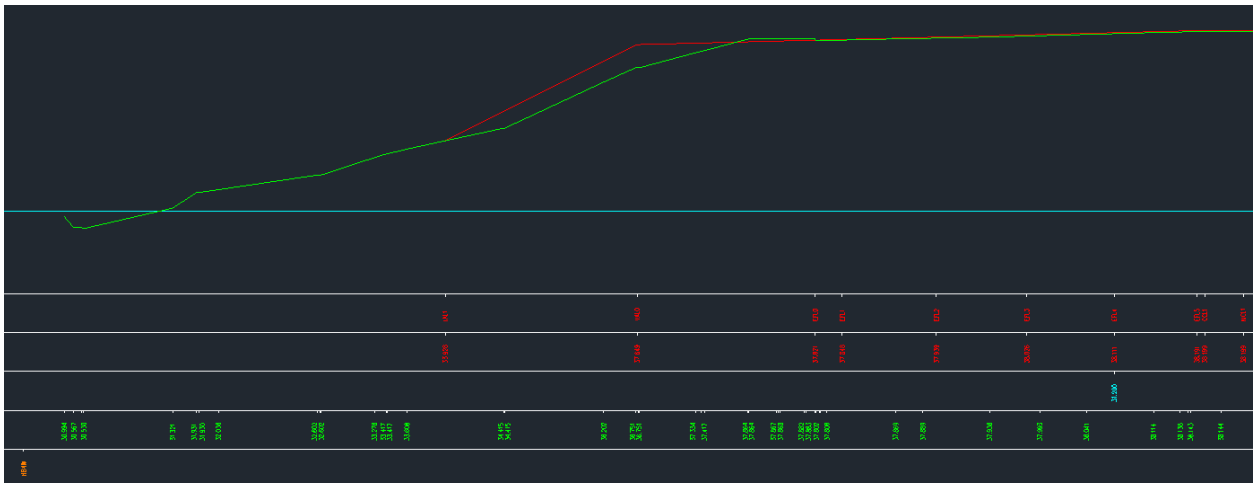


Figure 2: Topographic Critical Cross Section Ch190550

Utilities:

BT Communication line runs parallel to the hard shoulder within the existing verge.

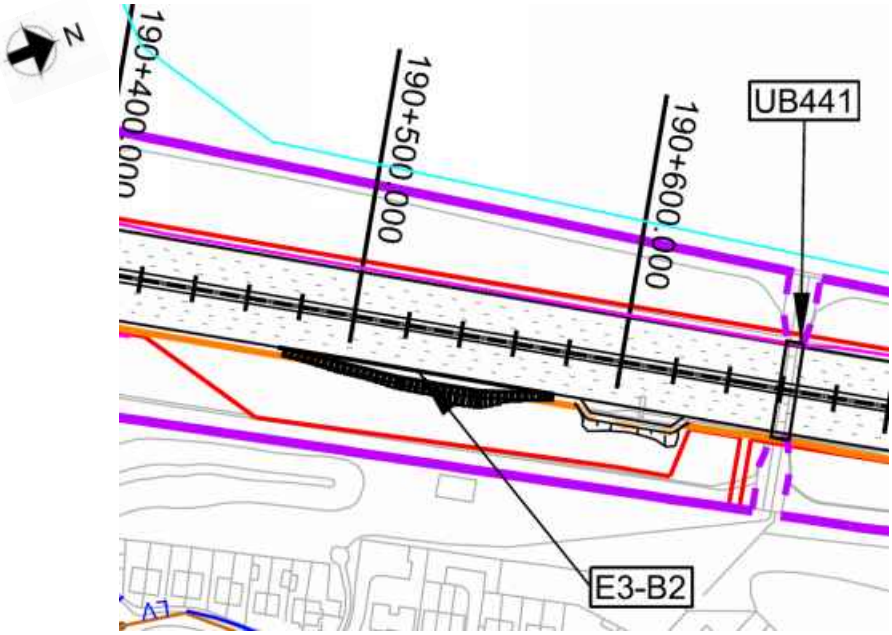


Figure 3: Utilities Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Hemington Member (Glaciofluvial Deposits);

Solid Deposits: Edwalton Member (Mercia Mudstone Group)

Ground Investigation:

No historical exploratory holes were recorded within the chainage extents. 9 No. historical exploratory hole were considered relevant, of which are shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000033, Rev P01.

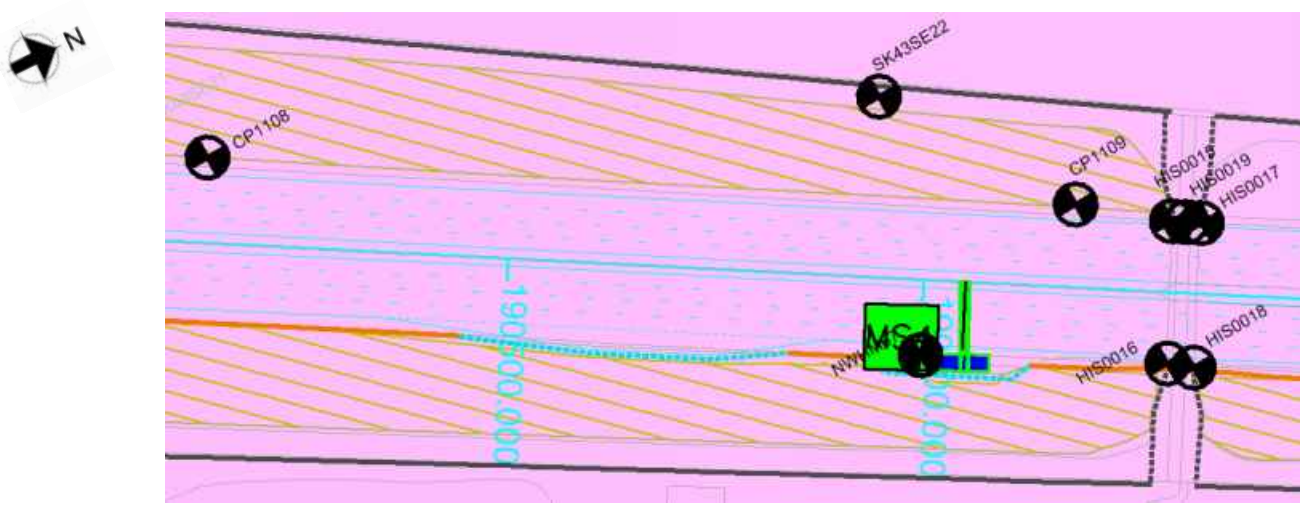


Figure 4: Borehole Location Plan

Flood Risk:

The design flood level is 31.2mAOD.

Historical Boreholes:

Relevant Borehole Number	CP1109	SK43SE22
Borehole Chainage	190634	190585
Borehole Location	Northbound verge	Embankment toe
National Grid Reference	E 446966, N 332758	E 446920, N 332730
Ground Level at Exploratory Hole	36.3mAOD	31.50mAOD
RAG Analysis	Green	Amber
Date Drilled	02/11/2006 – 02/11/2006	03/03/1926 – 06/03/1962
Termination Depth	14.50mbgl	7.77mbgl
Other suitable holes	HIS0015-HIS0019	

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey data:

Stratum	Depth to Base (m bgl)	Depth to Base (m AOD)	SPT (N) Value
Embankment Fill	7.1	30.5	12-49 (20)
Glaciofluvial Deposits (fine grained)	8.2	29.4	25
Glaciofluvial Deposits (coarse grained)	12.9	24.7	14-120 (17)
Mercia Mudstone – III/IV	Not proven	Not proven	24-40 (24)

(1) Ground level is assumed to be at carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of Embankment Fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes CP1108, CP1109, HIS0015-0019, NWHM67 and SK43SE22.

Groundwater:

The following groundwater strikes were recorded within the historical exploratory holes:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		mbgl	mAOD	Time	mbgl	mAOD
HIS0015	Glaciofluvial Deposits (coarse grained), rising into Glaciofluvial Deposits (fine grained)	1.52	29.18	Unspecified	1.22	29.48
HIS0016	Glaciofluvial Deposits (coarse grained)	1.83	28.97	-	-	-
HIS0017	Glaciofluvial Deposits (coarse grained)	3.05	27.75	Unspecified	1.22	29.58
HIS0018	Glaciofluvial Deposits (coarse grained), rising into Glaciofluvial Deposits (fine grained)	1.83	28.97	Unspecified	1.22	29.58
HIS0019	Glaciofluvial Deposits (coarse grained)	3.05	27.75	-	-	-
SK43SE22	Glaciofluvial Deposits (fine grained)	2.44	29.06	20minutes	0.76	30.74

(1) No groundwater information was available for historical exploratory hole NWHM67.
(2) The following note was included for historical exploratory holes CP1108 and CP1109: "Groundwater was not apparent during boring but may have been masked by the addition of water".

Groundwater Design Level:

Design groundwater level of 31.2mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

6 No. Atterberg Limit Tests and 6 No. Moisture Content Tests were undertaken within historical exploratory holes with the following results for the strata noted in the ground model:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	2.0	16.2	35	16	19	CL/CI
Embankment Fill	3.7	14.0	32	14	18	CL
Embankment Fill	4.0	14.1	33	12	21	CL
Embankment Fill	5.7	16.9	34	17	17	CL
Mercia Mudstone – III/IV	12.2	21.9	33	19	14	CL
Mercia Mudstone – III/IV	15.0	32.0	34	24	10	ML

16 No. Quick Undrained Triaxial Tests were undertaken with the following results:

Stratum	Depth to Top of Test (m bgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	1.5	105
Embankment Fill	3.2	145
Embankment Fill	5.2	12
Glaciofluvial Deposits (fine grained)	0.5	89
Glaciofluvial Deposits (fine grained)	0.5	69
Glaciofluvial Deposits (fine grained)	0.6	41
Glaciofluvial Deposits (fine grained)	0.9	31
Mercia Mudstone – III/IV	11.7	98
Mercia Mudstone – III/IV	5.8	84
Mercia Mudstone – III/IV	7.5	144
Mercia Mudstone – III/IV	7.5	69
Mercia Mudstone – III/IV	5.9	69
Mercia Mudstone – III/IV	6.1	101
Mercia Mudstone – III/IV	7.6	158
Mercia Mudstone – III/IV	5.8	132
Mercia Mudstone – III/IV	7.5	55

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Lab Test Data – BRE Classification:

The following BRE Classification chemical testing data was available from the historical exploratory holes for the strata noted in the ground model:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	pH	Solid (water extract)	2	8.6-9.4	-
Embankment Fill	pH	Solid	1	8.9	-
Embankment Fill	Sulphate (Total) as SO4	Solid	2	0.02-0.08	%SO4
Embankment Fill	Water Soluble Sulphate as SO4	Solid (2:1 soil/water extract)	2	0.05-0.08	g/l SO4
Glaciofluvial Deposits (fine grained)	pH	Water	1	7.5	-
Glaciofluvial Deposits (fine grained)	pH	Solid (water extract)	4	6.7-7.1	-
Glaciofluvial Deposits (fine grained)	Sulphate (Total) as SO4	Solid (water extract)	4	0.01-0.12	%SO4
Glaciofluvial Deposits (fine grained)	Water Soluble Sulphate as SO4	Water	1	0.40	g/l SO4
Glaciofluvial Deposits (coarse grained)	pH	Water	1	7.3	-
Glaciofluvial Deposits (coarse grained)	Water Soluble Sulphate as SO4	Water	1	0.61	g/l SO4
Mercia Mudstone – III/IV	pH	Solid (water extract)	11	7.2-8.1	-
Mercia Mudstone – III/IV	Sulphate (Total) as SO4	Solid (water extract)	10	0.07-0.19	%SO4
Mercia Mudstone – III/IV	Sulphate (Total) as SO4	Solid (water extract)	1	0.01	%SO4
Mercia Mudstone – III/IV	Water Soluble Sulphate as SO4	Solid (2:1 soil/water extract)	1	1.80	g/l SO4
Mercia Mudstone – Sandstone	pH	Water	2	7.5-7.5	-
Mercia Mudstone – Sandstone	Sulphate (Total) as SO4	Solid (water extract)	2	1.06-1.64	g/l SO4

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Assumed Ground Model For Design:

Ground model based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-CE-000033, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01. The below table outlines the assumed anticipated ground model, to be confirmed by 'Just in Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment fill	0-7.1	37.6-30.5	7.1	21	27	0	100	7.8	6.2	-	0.50	0.20	-	DS-1 AC-1
Glaciofluvial Deposits (fine grained)	7.1-8.2	30.5-29.4	1.1	21	26	0	40	9.3	7.4	-	0.50	0.20	-	DS-1 AC-1
Glaciofluvial Deposits (coarse grained)	8.2-12.9	29.4-24.7	4.7	21	32	-	-	-	27.6	-	-	0.25	-	DS-1 AC-1

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Given the limited amount of local PI data, the ϕ' of Embankment Fill, Glaciofluvial Deposits (fine grained) and Mercia Mudstone – III/IV were taken as the characteristic values given in the AMAR GIR.
(4) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a characteristic SPT 'N' value of 17, ϕ' was found to be 32°.
(5) c_u of Embankment Fill, Glaciofluvial Deposits (fine grained) and Mercia Mudstone – III/IV was determined based on recorded undrained triaxial tests and c_u derived using the Stroud correlation. Due to the limited amount of local PI data, a typical f1 value of 5.0 was used. An undrained shear strength of 100kN/m^2 was adopted for Embankment Fill and Mercia Mudstone-III/IV and 40kN/m^2 for Glaciofluvial Deposits (Fine Grained).
(6) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the characteristic SPT 'N' value of 20, Eu = 7.8MN/m^2. Therefore E' = 6.2MN/m^2.
(7) E' of Glaciofluvial Deposits (fine grained) was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the recorded SPT 'N' value of 25, Eu = 9.3MN/m^2. Therefore E' = 7.4MN/m^2.
(8) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a characteristic SPT 'N' value of 17, E' = 27.6MN/m^2.
(9) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the characteristic SPT 'N' value of 24, Eu = 9.0MN/m^2.

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Therefore E' = 7.2MN/m^2.

(10) BRE Classification is determined using criteria set out in BRE Special Digest 1.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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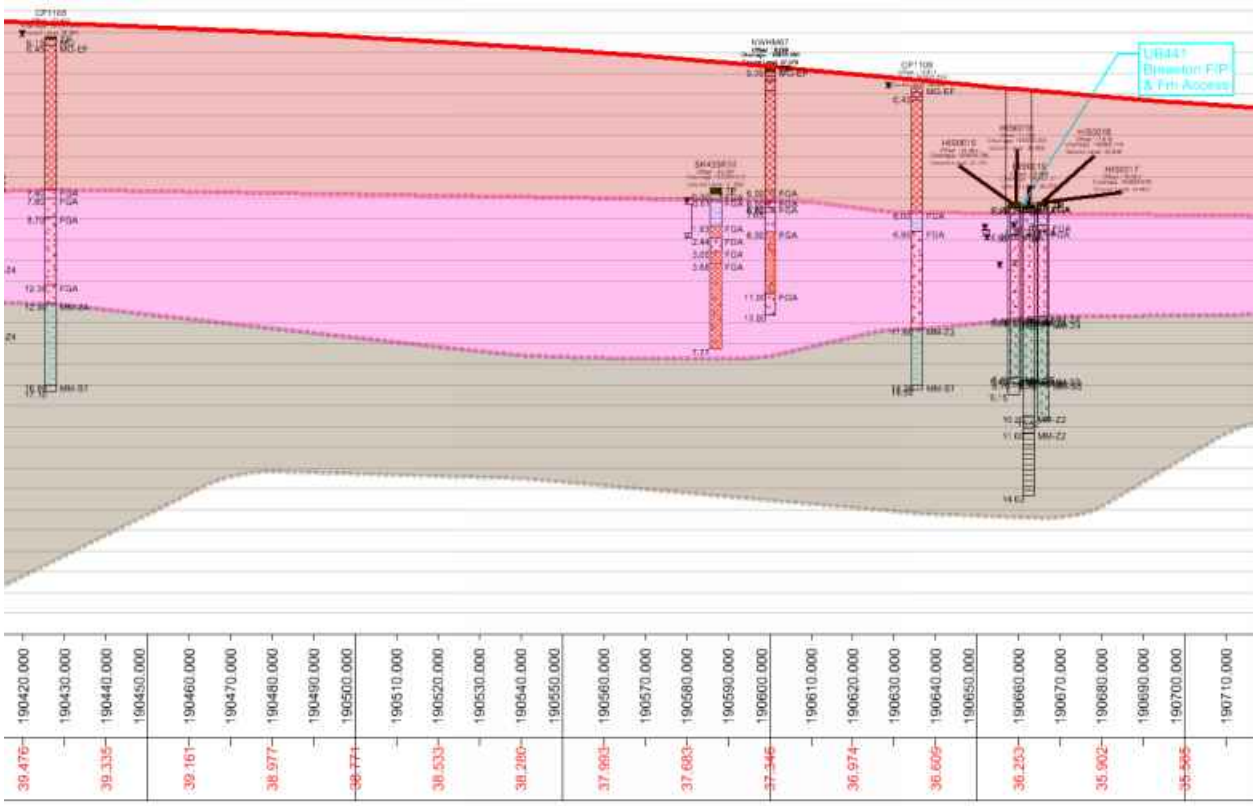


Figure 5: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solution is proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (°)
190530	190560	Granular Wedge at Embankment Crest (1:2.0)	4.5	1(V):2(H) 26.6°

Proposed Structural Solution:

N/A.

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FURTHER GROUND INVESTIGATION

'Just in Time' Validation Ground Investigation is required at this location to confirm ground conditions. The following has been proposed:

- BH-R-NB4_1 at Ch190541, northbound, dynamic sample with rotary follow on to 13mbgl.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **CP1108** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446852.00 - 332583.00	Hole Type CP
Location:		Level: 38.80	Scale 1:50
Client: Highways England		Dates: 01/10/2006 - 01/10/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.15	38.65		TOPSOIL. TP
		0.45 - 1.20	B				0.45	38.35		MADE GROUND. Hard core (driller's description). MG
		1.50 - 1.95	U							MADE GROUND. Firm to stiff becoming very stiff red brown gravelly clay with occasional gravel sized pockets of organic material. Gravel is subangular to subrounded, fine to coarse of mudstone, siltstone and sandstone. MG-EF
		2.00	D							
		2.50	D							From 2.50m, some grey mottling
		2.50 - 3.00	B							
		3.50 - 3.95	U							
		4.00	D							Between 4.00m to 5.50m, friable
		4.50	D							
		4.50 - 5.00	B							
		5.50 - 6.00	U#B							
		6.50	D							
		6.50 - 7.00	B							
		7.40	B				7.40	31.40		Grey brown clayey SAND. Possible FGA-SG
		7.50 - 7.95	U							
		8.00	D				7.80	31.00		Grey brown clayey slightly gravelly SAND. Gravel is subangular to subrounded, fine to coarse of sandstone and mudstone. FGA-SG
		9.00 - 9.50	B				8.70	30.10		Brown clayey SAND and subangular to subrounded, fine to coarse GRAVEL of mudstone and sandstone. FGA-SG

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.70m. The borehole was advanced by chiselling methods from 17.00m to 17.10m (1 hour). A hand held Photo-ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.

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Rotary Core Log

Borehole No. CP1108 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446852.00 - 332583.00	Hole Type CP
Location:		Level: 38.80	Scale 1:50
Client: Highways England		Dates: 01/10/2006 - 01/10/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 - 11.00	B							SAND and GRAVEL (as previous sheet)
		12.00 - 12.50	B				12.00	26.80		Brown grey gravelly SAND. Gravel is subrounded to rounded, fine to coarse of quartz. Sand is coarse. FGA-SG
		12.90	D				12.90	25.90		Firm red brown locally mottled grey green slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse possibly lithorelics of mudstone and siltstone. MM-Z4
		13.50 - 14.00	U#B							
		15.00	D							
		15.00 - 15.50	B							
		16.50 - 16.90	U#B							
		17.00	D				16.80	22.00		Recovered as grey subangular to subrounded, fine to coarse gravel sized fragments of weak SANDSTONE and SILTSTONE. MM-ST
							17.10	21.70		End of borehole at 17.10 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.70m. The borehole was advanced by chiselling methods from 17.00m to 17.10m (1 hour).A hand held Photo-ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.

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Rotary Core Log

Borehole No. **CP1109** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446966.00 - 332758.00	Hole Type CP
Location:		Level: 36.30	Scale 1:50
Client: Highways England		Dates: 02/11/2006 - 02/11/2006	Logged By RMS/OP

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	B				0.20	36.10		MADE GROUND. Light to medium brown slightly sandy, gravelly soft clay with occasional rootlets up to 20mm. Gravel is subrounded to rounded fine and medium of quartzite and angular to subangular fine and medium of limestone and mudstone. MG-EF
		0.45	B				0.40	35.90		
		0.60	B				0.60	35.70		
		1.20 - 1.65	U							MADE GROUND. Light brown very sandy gravel with frequent rootlets up to 100mm. Gravel is angular and subangular fine to coarse of sandstone, mudstone and limestone. MG-EF
		1.70	D							
		2.20 - 2.65	D							MADE GROUND. Light brown very gravelly, clayey fine and medium sand. Gravel is angular and subangular fine to coarse of sandstone. Possible MG-EF
		2.20 - 2.70	B							
		3.20 - 3.65	U							MADE GROUND. Firm to stiff red brown slightly gravelly clay. Gravel is subrounded and rounded fine to coarse of mudstone, sandstone and siltstone. Possible MG-EF
		3.70	D							*From 2.20m, slightly sandy.*
		4.20 - 4.65	D							*From 4.20m, slightly friable with some light green grey mottling*
		4.20 - 4.70	B							
		5.20 - 5.65	U							
		5.70	D							
		6.00	D				6.00	30.30		Stiff brown grey with black mottling, slightly sandy slightly gravelly CLAY. Gravel is subrounded and rounded, fine and medium of quartz with occasional gravel sized fragments of organic material. Possible FGA
		6.20 - 6.65	D							
		6.20 - 6.70	B							
		7.00 - 7.50	B				6.90	29.40		Very dense brown fine to coarse SAND and subrounded to rounded, fine to coarse GRAVEL of quartz, mudstone and sandstone. FGA-SG
		8.00 - 8.50	B							
		9.50 - 10.00	B							
										Continued on next sheet.

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.00m.;The borehole was advanced by chiselling methods from 14.30m to 14.60m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1109 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446966.00 - 332758.00	Hole Type CP
Location:		Level: 36.30	Scale 1:50
Client: Highways England		Dates: 02/11/2006 - 02/11/2006	Logged By RMS/OP

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										SAND and GRAVEL (as previous sheet)
		11.00 - 11.50	B							
		11.60	D				11.60	24.70		Stiff to very stiff red brown CLAY with pockets of fine to coarse sand. MM-Z3
		11.70 - 12.15	U							
		12.20	D							
		13.20 - 13.65	D							From 13.20m, mottled red brown and grey with some subangular to subrounded fine to coarse gravel sized fragments of siltstone. With white gypsum crystals
		13.20 - 13.70	B							
		14.30 - 14.50	B				14.30	22.00		Recovered as grey, clayey angular to subangular fine to coarse gravel sized fragments of SILTSTONE. MM-ST
							14.50	21.80		End of borehole at 14.50 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.00m.;The borehole was advanced by chiselling methods from 14.30m to 14.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. **HIS0015**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446981.00 - 332776.00	Hole Type CP
Location:		Level: 30.70	Scale 1:50
Client: Highways England		Dates: 15/06/1964 - 17/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.50		TOPSOIL TP
		0.46 - 0.91	U							Stiff brown silty CLAY FGA
		0.91	D							
	▼	1.37	D				1.50	29.20		
		1.68 - 2.13	B							Medium dense brown sandy fine to medium GRAVEL FGA-SG
		2.59 - 3.05	B							
		3.51 - 3.96	B							
		4.45 - 4.88	B							
		5.79 - 6.25	U				5.60	25.10		Stiff to very stiff friable red-brown and grey silty CLAY (Keuper Marl) MM-Z4
		6.25	D							
		6.86	D							
		7.47 - 7.92	U							
		7.92	D							
		8.38 - 8.69	B				8.40	22.30		Light grey SANDSTONE MM-SS
		8.69	W							
							9.15	21.55		End of borehole at 9.14 m

Remarks
Ground-water was first encountered at a depth of 1.5m but subsequently rose to 1.2m below ground level. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. **HIS0016**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447010.00 - 332758.00	Hole Type CP
Location:		Level: 30.80	Scale 1:50
Client: Highways England		Dates: 17/06/1964 - 19/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.60		TOPSOIL TP
		0.46 - 0.91	U							Stiff brown silty CLAY with traces of organic matter FGA
		0.91	D							
							1.50	29.30		
	▼	1.68 - 2.13 1.83	B W							Medium dense brown slightly sandy fine to medium GRAVEL with occasional coarse gravel; becoming sandy with depth FGA-SG
		2.59 - 3.05	B							
		3.51 - 3.96	B							
		4.42 - 4.88	B							
							5.60	25.20		
		5.94 - 6.40	U							Stiff friable red-brown and grey silty CLAY or clayey SILT (Keuper Marl) MM-Z4
		6.40	D							
		7.01	D							
		7.47 - 7.92	U							
		7.92	D							
		8.38 - 8.69	B				8.40	22.40		Grey SANDSTONE MM-SS
							8.70	22.10		End of borehole at 8.69 m

Remarks
Water was added to assist boring. On completion of boring the water stood at a depth of 1.8m below ground level and a sample was taken.

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Rotary Core Log

Borehole No. **HIS0017**
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446985.00 - 332782.00	Hole Type CP
Location:		Level: 30.80	Scale 1:50
Client: Highways England		Dates: 09/06/1964 - 15/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.60		TOPSOIL TP
		0.61 - 1.07	U							Firm brown sandy CLAY with gravel FGA
	▼	1.07	D				1.10	29.70		
		1.22 - 1.68	B							Medium dense brown sandy fine to medium GRAVEL with occasional coarse gravel and cobbles; becoming more sandy with depth FGA-SG
		2.13 - 2.59	B							
	▽	3.05 - 3.51	B							
		3.96 - 4.42	B							
		4.88 - 5.33	B							
							5.80	25.00		
		6.10 - 6.55	U							Stiff to very stiff friable red-brown and grey silty CLAY (Keuper Marl) MM-Z4
		6.55	D							
		6.86	D							
		7.62 - 8.08	U							
		8.08	D							
		8.69	D				8.70	22.10		Grey SANDSTONE MM-SS
		9.14	W							
		9.14	D							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level and rose overnight to 1.22m depth. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. **HIS0017**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446985.00 - 332782.00	Hole Type CP
Location:		Level: 30.80	Scale 1:50
Client: Highways England		Dates: 09/06/1964 - 15/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.52	20.28		End of borehole at 10.52 m

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level and rose overnight to 1.22m depth. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. **HIS0018**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447014.00 - 332763.00	Hole Type CP
Location:		Level: 30.80	Scale 1:50
Client: Highways England		Dates: 19/06/1964 - 20/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.60		TOPSOIL TP
										Firm brown silty CLAY with gravel FGA
		0.91 - 1.37	U							
	▼	1.22	W							
		1.37	D				1.40	29.40		
		1.52 - 1.98	B							Medium dense brown sandy fine to medium GRAVEL with occasional coarse gravel at depth FGA-SG
		2.44 - 2.90	B							
		3.35 - 3.81	B							
		4.27 - 4.72	B							
							5.50	25.30		Firm to stiff friable red-brown and grey silty CLAY or clayey SILT (Keuper Marl) MM-Z4
		5.79 - 6.25	U							
		6.25	D							
		6.71	D							
		7.47 - 7.92	U							
		7.92	D							
		8.53	D				8.50	22.30		
							8.70	22.10		Grey SANDSTONE MM-SS End of borehole at 8.69 m

Remarks
Ground-water was first encountered at a depth of 1.8m below ground level. Subsequently the water level rose to a depth of 1.22m and a sample was taken.

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Rotary Core Log

Borehole No. HIS0019
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446983.00 - 332779.00	Hole Type RC
Location:		Level: 30.70	Scale 1:50
Client: Highways England		Dates: 09/07/1964 - 11/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.50		TOPSOIL TP
										Brown silty CLAY FGA
							1.20	29.50		Sandy fine to medium GRAVEL FGA-SG
	▼									
							5.60	25.10		Stiff red-brown and grey silty CLAY (Keuper Marl) MM-Z4
							8.50	22.20		Grey medium SANDSTONE with veins of gypsum MM-SS
										Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level.

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Rotary Core Log

Borehole No. HIS0019
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446983.00 - 332779.00	Hole Type RC
Location:		Level: 30.70	Scale 1:50
Client: Highways England		Dates: 09/07/1964 - 11/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.20	20.50		Green-grey clayey sandy MUDSTONE MM-Z2
							11.00	19.70		Mottled red-brown and green-grey sandy MUDSTONE with fine sandstone and viens of gypsum MM-Z2
							14.03	16.67		End of borehole at 14.02 m

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level.

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Rotary Core Log

Borehole No. **NWHM67**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446978.66 - 332707.69	Hole Type CP
Location:		Level: 37.38	Scale 1:50
Client: Highways England		Dates: 01/09/1999 - 02/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	D				0.20	37.18		TOPSOIL. TP
							0.50	36.88		MADE GROUND: Very stiff desiccated marl fill. MG-EF
							0.70	36.68		MADE GROUND: Blue grey sandy fine to coarse angular gravel of limestone. (Hardcore) MG-EF
										MADE GROUND: Stiff red brown mottled/ dappled blue grey slightly sandy clay with a little, locally some fine to coarse subangular mudstone gravel (as lithorelicts). (Embankment Fill - Marl) MG-EF
		6.00	B							
							6.50	30.88		Very dense brown clayey medium and coarse SAND with much fine to coarse angular to rounded gravel of sandstone, limestone and quartz? (River Terrace Deposits?) FGA-SG
							6.80	30.58		at 6.80m possible obstruction/boulder. End of borehole at 6.80 m

Remarks
1. Hand excavated inspection pit to 1.20m. CAT scan at GL and 1.20m. 2. M67 commenced in 150mm - terminated at 6.80m - see M67A redrilled on sameposition with 200mm casing to start. 3. M67 backfilled with arisings tomake secure overnight. 4. Marker Post Ref 190/7 -50S.

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Rotary Core Log

Borehole No. SK43SE22

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446920.00 - 332730.00	Hole Type CP
Location:		Level: 31.50	Scale 1:50
Client: Highways England		Dates: 03/03/1962 - 06/03/1962	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	D				0.30	31.20		Topsoil TP
		0.46	D				0.61	30.89		Subsoil FGA
	▼	0.76	W							Mottled clay FGA
		0.91	D							
		1.98 - 2.44	U				1.83	29.67		Sandy clay FGA
	▽	2.29	D							
		2.44 - 2.90	U				2.44	29.06		Grey silt FGA
		3.05	D				3.05	28.45		Gravel & silt FGA-SG
		3.35	D							
							3.66	27.84		Gravel & sand FGA-SG
		4.11 - 4.57	SPTL							
		4.11 - 4.57	S							
			B							
		4.88	D							
		5.64 - 6.10	SPTL							
		5.64 - 6.10	S							
			B							
		6.40	D							
		7.32 - 7.77	SPTL							
		7.32 - 7.77	S							
		7.62	B							
			D				7.77	23.73		End of borehole at 7.77 m

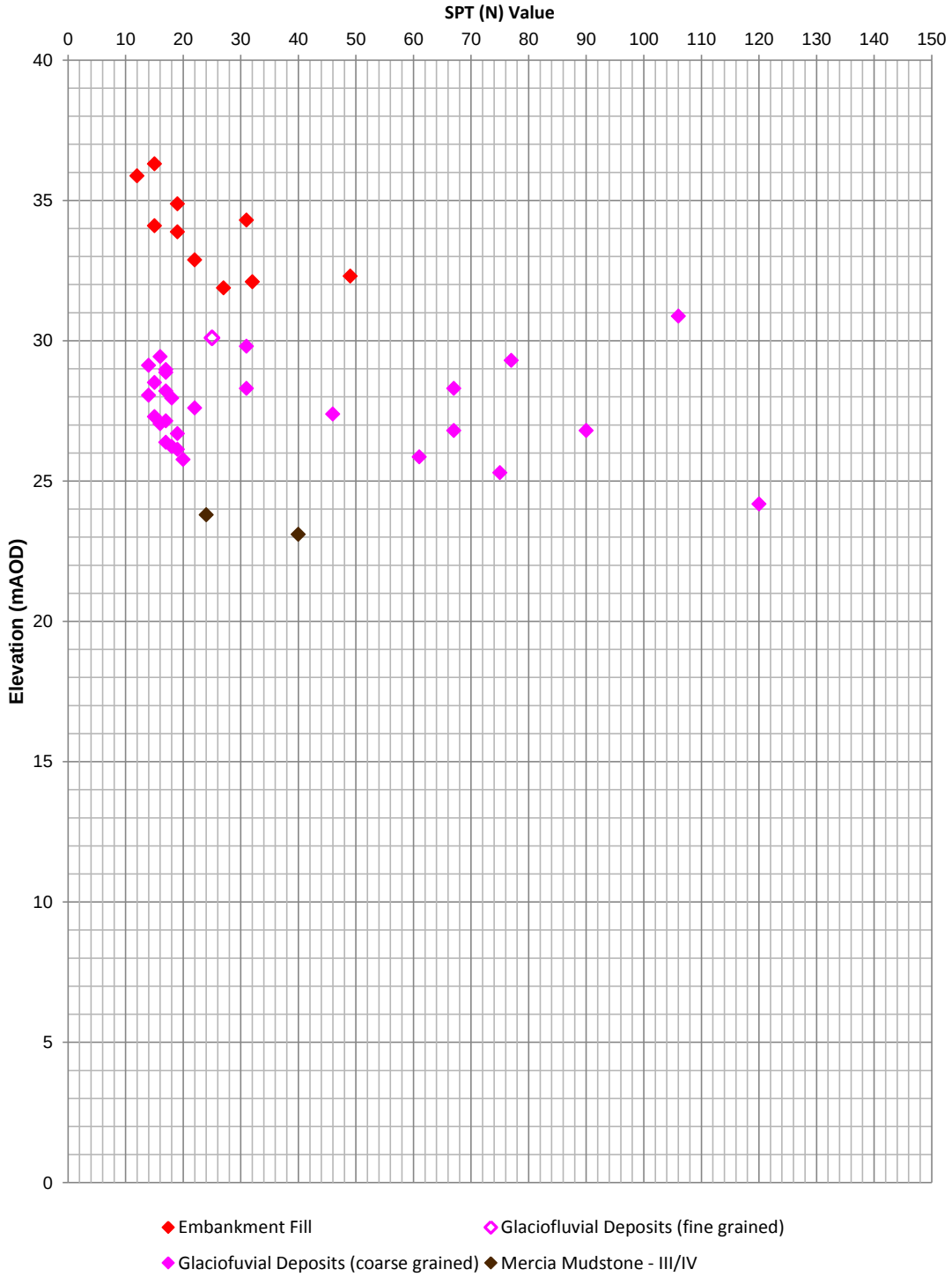
Remarks

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PLOTS

amey ARUP	SPT N Value vs Depth
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25** | Data Sheet: **190530-190550NB**
Client: **Highways England**	Borehole ID: **CP1108, CP1109, HIS0015-0019, NWHM67, SK43SE22**

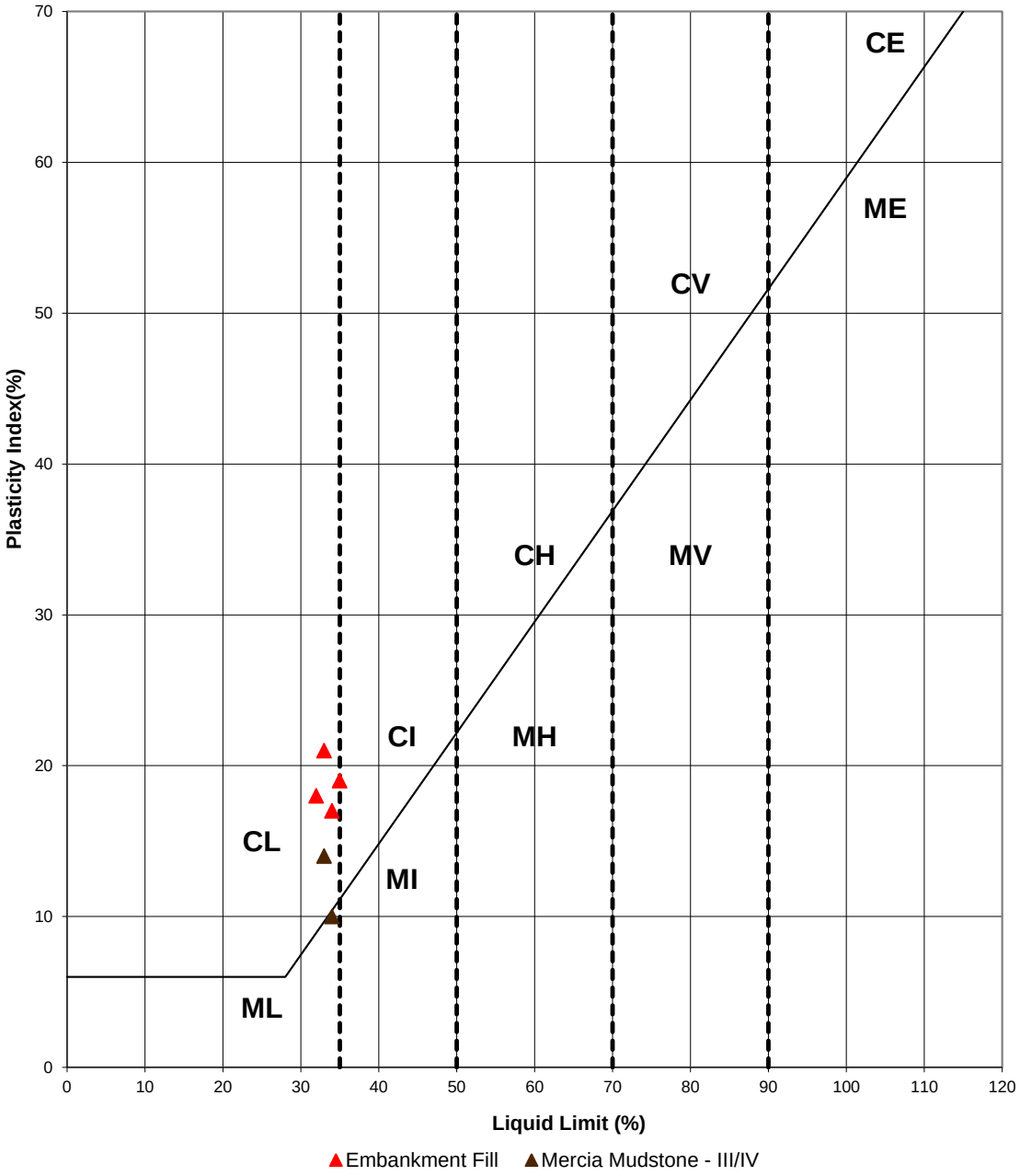


Rev: P01 Date: 09/03/2017 Ref: HA549342-AMAR-HGT-190530-190550NB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **190530-190560NB**
Client: **Highways England**	Borehole ID: **CP1108, CP1109**	



Key

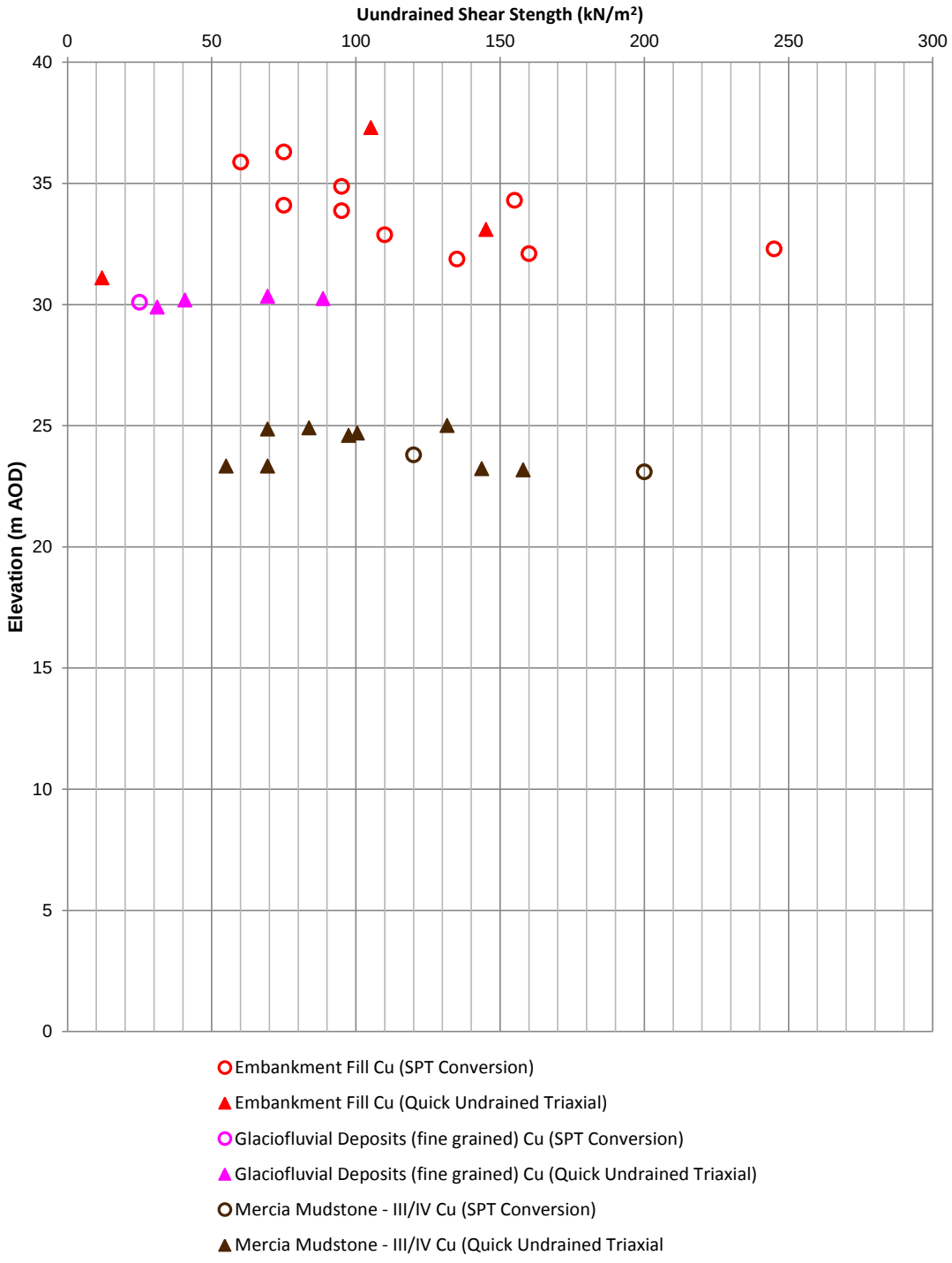
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 09/03/2017 Ref: HA549342-AMAR-HGT-190530-190560NB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **190530-190550NB**
Client: **Highways England**	Borehole ID: **CP1108, CP1109, NWHM67, HIS0015-HIS0018**	



Rev: P01 Date: 09/03/2017 Ref: HA549342-AMAR-HGT-190530-190550NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-190740-190930NB-GSS-000001		
Earthworks Widening Solution	Full Height Embankment Widening (1:2.0)		
Structure Number	GANTRY_313[1]; E3-A2[1]		
Structure Type	MS3 Cantilever; Emergency Refuge Area (ERA)		
Design Chainage	190740-190930NB		
Carriageway	Northbound		
Marker Post	190/7+40 – 190/9+30		
National Grid Reference	E 447021, N 332844 – E 447110, N 333010		
Existing Ground Level at Location	Carriageway	33.0-34.7mAOD	
	Toe of Embankment	29.5-30.6mAOD	
Earthwork Type	NB: Embankment	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: 7_M1_24498	SB: N/A	HAGDMS designation
Earthwork Height	NB: 2.8-4.9m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 17°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	27/04/2017	[redacted]
Checked	Roheel Masrat	11/03/2017	
Reviewed	Gary Summerfield	13/03/2017	
Approved	Tom Bulteel	06/06/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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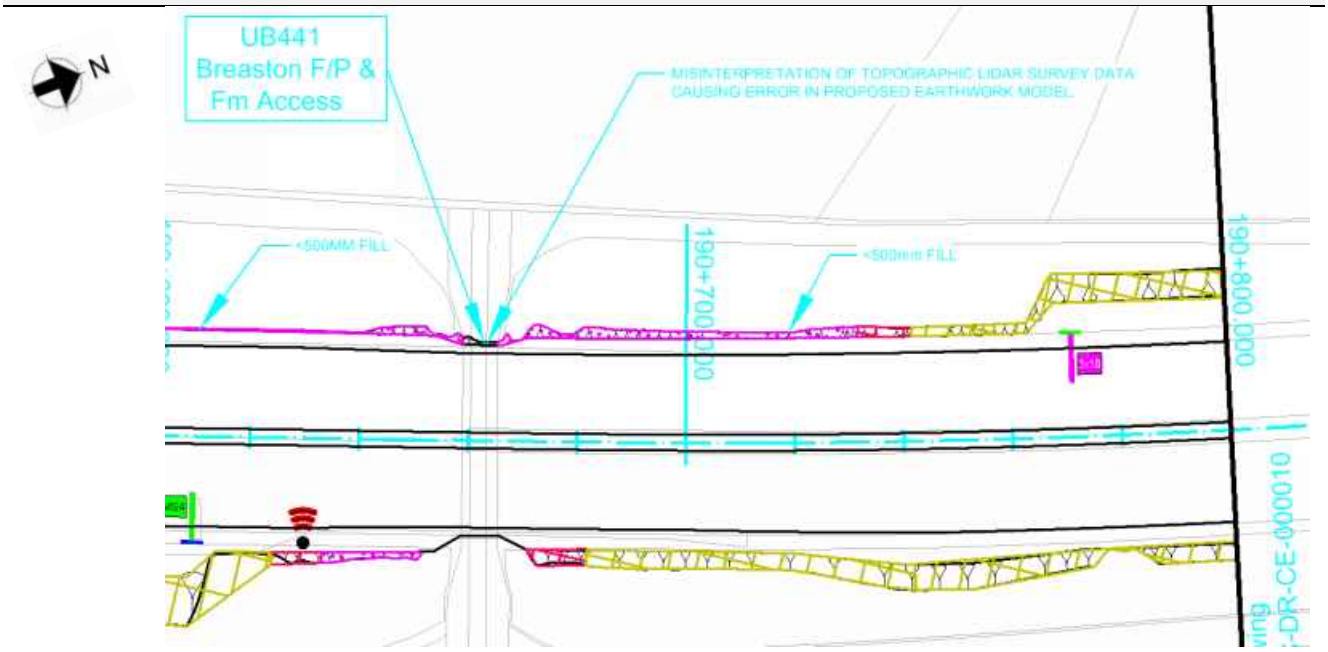


Figure 1.1: Location Plan 1 of 2

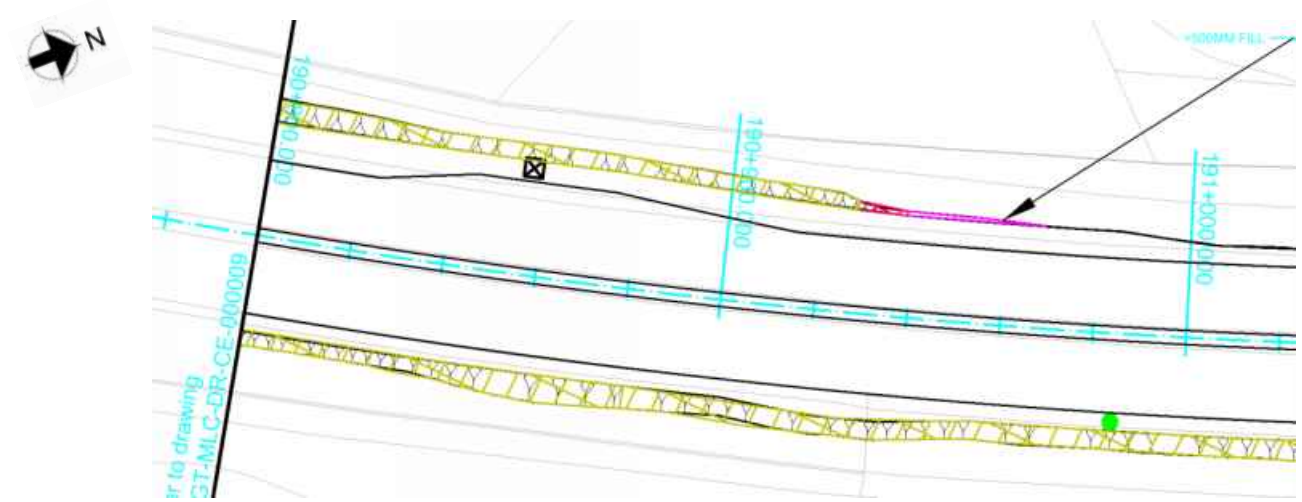


Figure 1.2: Location Plan 2 of 2

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, Full Height Embankment Widening (1:2.0) is to be constructed.

Proposed Major Structures:

A new MS3 Cantilever Gantry structure (GANTRY_313) is to be constructed at Ch190771.

Emergency Refuge Area (ERA) E3-A2 is to be constructed between Ch190800-190900.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is an embankment. The earthwork ranges in height approximately from 2.8m to 4.9m and has a typical slope angle of 17^{o}.

The critical cross section Ch190770 was chosen based on greatest earthwork height where there is significant buildout associated with the construction of GANTRY_313. The cross section shows a

Granular Wedge at Embankment Crest (1:2.0), however it was found after slope stability analyses that a Full Height Embankment Widening (1:2.0) is required to ensure sufficient stability of the slope.

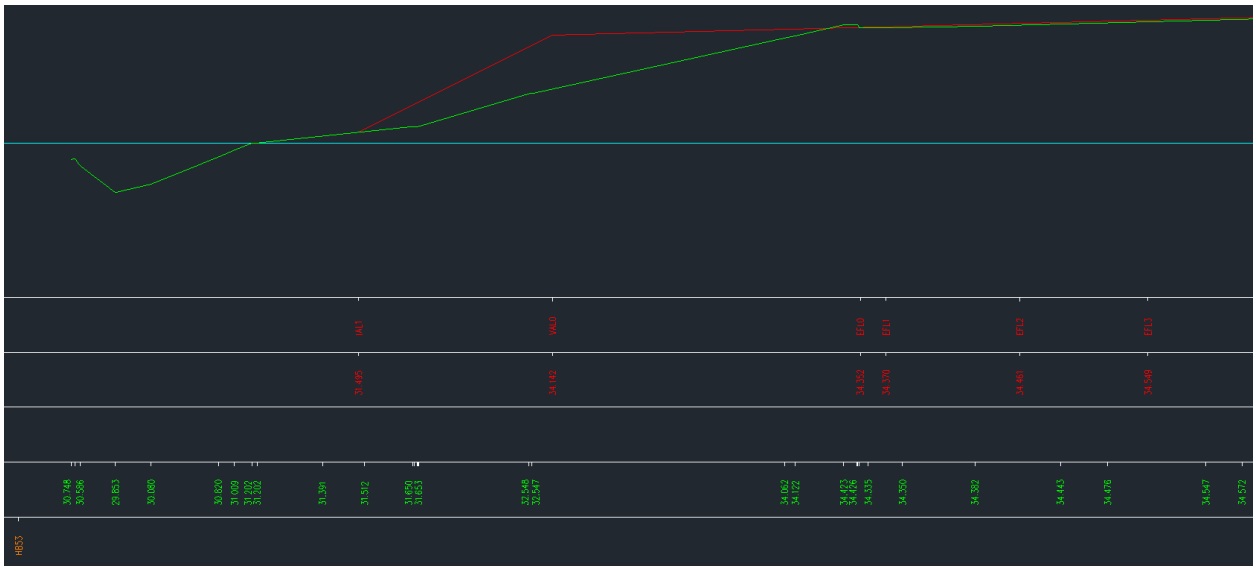


Figure 2: Topographic Critical Cross Section Ch190770

Utilities:

BT comms are present beneath the existing verge running parallel to the carriageway along the entirety of the chainage extents.

Western Power overhead mid voltage cable present around embankment crest running parallel to the carriageway approximately between Ch190830-190930 of the chainage extents.

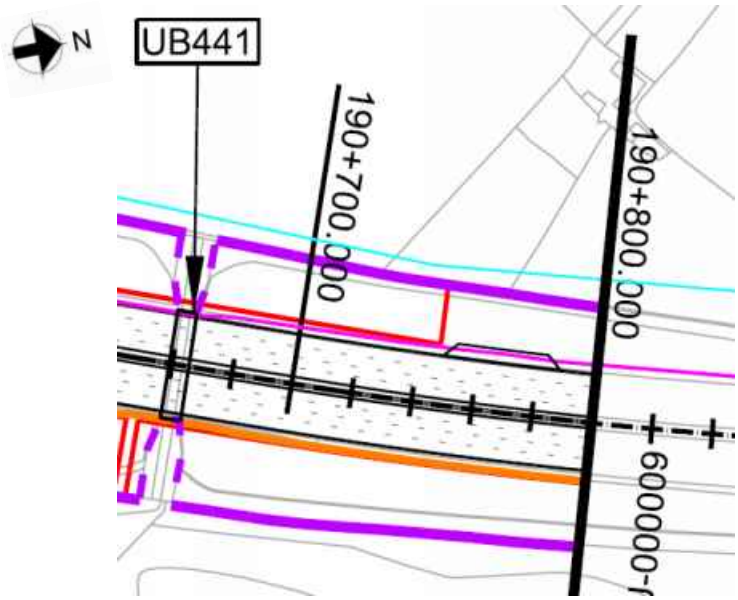


Figure 3.1: Utilities Plan 1 of 2

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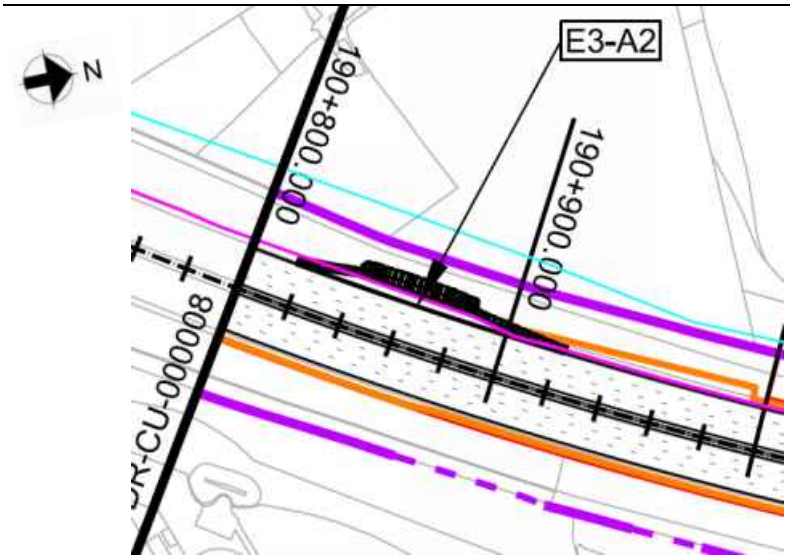


Figure 3.2: Utilities Plan 2 of 2

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Hemington Member (Glaciofluvial Deposits) Ch190740-190785 and Ch190865-190930; Alluvium Ch190785-190865;

Solid Deposits: Edwalton Member (Mercia Mudstone Group)

Ground Investigation:

There are no historical exploratory holes within the design chainage; however, 8 No. historical exploratory holes were considered relevant, those of which are shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000034, Rev P01 and HA549342-AMAR-HGT-SWI-DR-CE-000035, Rev P01.

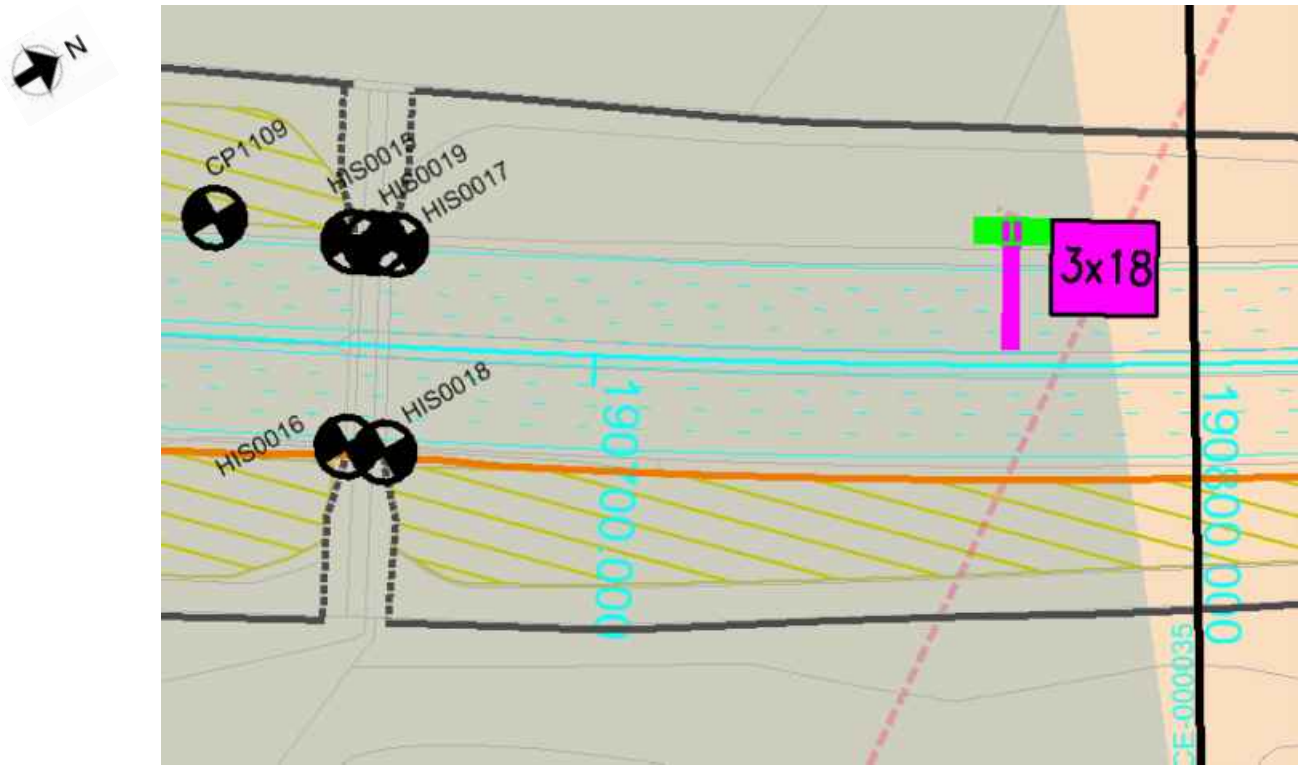


Figure 4.1: Borehole Location Plan 1 of 2

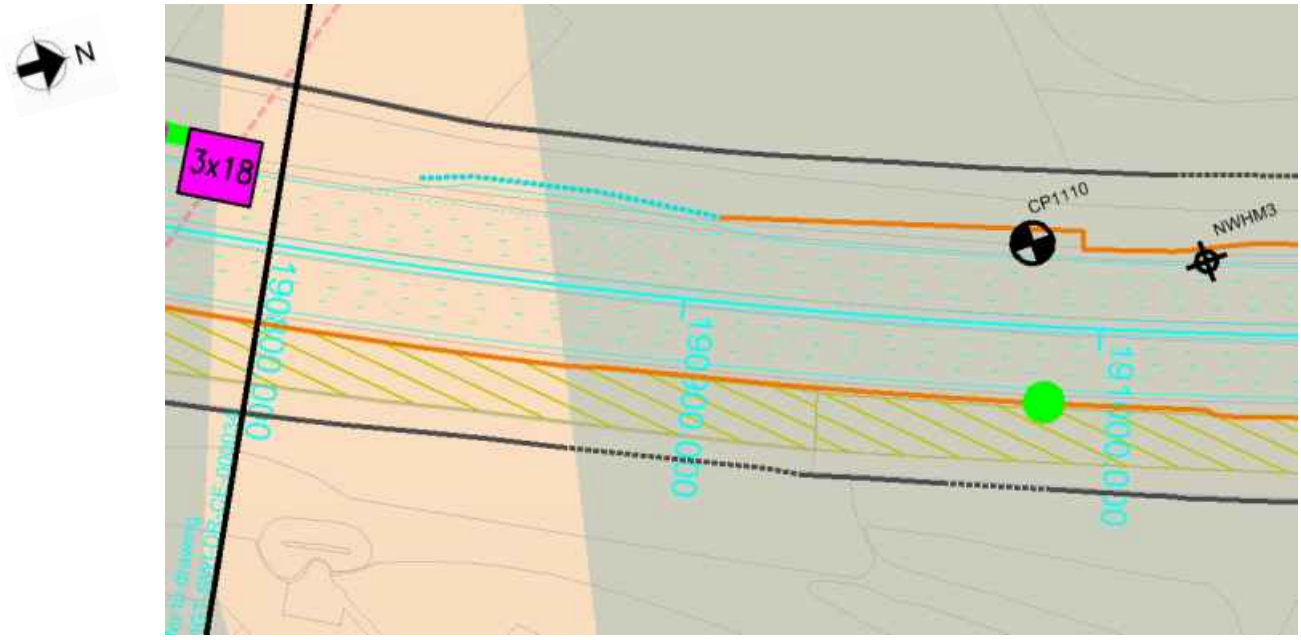


Figure 4.2: Borehole Location Plan 2 of 2

Flood Risk:

The design flood level for the chainage extents is 31.2mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR, Document Ref. HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	CP1110
Borehole Chainage	190980
Borehole Location	Northbound verge
National Grid Reference	E 447131, N 333059
Ground Level at Exploratory Hole	33.95mAOD (above Ordnance Datum)
RAG Analysis	Green
Date Drilled	03/11/2006 – 06/11/2006
Termination Depth	15.35m below ground level (mbgl)
Other suitable holes	CP1109, HIS0015-HIS0019, NWHM3

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey data:

Stratum	Depth to Base (m bgl)	Depth to Base (m AOD)	SPT (N) Value
Embankment Fill	4.2	29.9	15-103 (19)
Glaciofluvial Deposits (fine grained)	5.6	28.5	25
Glaciofluvial Deposits (coarse grained)	7.6	26.5	9-77 (17)
Mercia Mudstone – III/IV	Not proven	Not proven	19-150 (35)

(1) Ground level is assumed to be at carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in historical exploratory holes CP1109, CP1100, HIS0015-HIS0018 and NWHM3.

Groundwater:

The following groundwater strikes were recorded within the historical exploratory holes:

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Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		mbgl	mAOD	Time	mbgl	mAOD
HIS0015	Glaciofluvial Deposits (coarse grained), rising into Glaciofluvial Deposits (fine grained)	1.52	29.18	Unspecified	1.22	29.48
HIS0016	Glaciofluvial Deposits (coarse grained)	1.83	28.97	-	-	-
HIS0017	Glaciofluvial Deposits (coarse grained)	3.05	27.75	Unspecified	1.22	29.58
HIS0018	Glaciofluvial Deposits (coarse grained), rising into Glaciofluvial Deposits (fine grained)	1.83	28.97	Unspecified	1.22	29.58
HIS0019	Glaciofluvial Deposits (coarse grained)	3.05	27.75	-	-	-

(1) No groundwater information was available for historical exploratory hole NWHM3.

(2) The following note was included for historical exploratory holes CP1109 and CP1110: “Groundwater was not apparent during boring but may have been masked by the addition of water”.

Groundwater Design Level:

Design groundwater level of 31.2mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

7 No. Atterberg Limit Tests and 7 No. Moisture Content Tests were undertaken within historical exploratory holes with the following results for the strata noted in the ground model:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	2.2	15	36	17	19	CI
Embankment Fill	3.7	14	32	14	18	CL
Embankment Fill	5.7	17	34	17	17	CL
Glaciofluvial Deposits (fine grained)	4.0	37	65	33	32	CH
Mercia Mudstone – III/IV	9.6	23	34	17	17	CL
Mercia Mudstone – III/IV	12.2	22	33	19	14	CL
Mercia Mudstone – III/IV	14.0	21	27	16	11	CL

17 No. Quick Undrained Triaxial Tests were undertaken with the following results:

Stratum	Depth to Top of Test (m bgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	3.2	145
Embankment Fill	5.2	12
Glaciofluvial Deposits (fine grained)	3.5	84
Glaciofluvial Deposits (fine grained)	0.5	89
Glaciofluvial Deposits (fine grained)	0.5	69
Glaciofluvial Deposits (fine grained)	0.6	41
Glaciofluvial Deposits (fine grained)	0.9	31
Mercia Mudstone – III/IV	11.7	98
Mercia Mudstone – III/IV	13.5	279
Mercia Mudstone – III/IV	5.8	84
Mercia Mudstone – III/IV	7.5	144
Mercia Mudstone – III/IV	7.5	69
Mercia Mudstone – III/IV	5.9	69
Mercia Mudstone – III/IV	6.1	101
Mercia Mudstone – III/IV	7.6	158
Mercia Mudstone – III/IV	5.8	132
Mercia Mudstone – III/IV	7.5	55

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Lab Test Data – BRE Classification:

The following BRE Classification chemical testing data was available from the historical exploratory holes for the strata noted in the ground model:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	pH	Solid	1	8.8	-
Embankment Fill	pH	Solid (water extract)	1	8.6	-
Embankment Fill	Sulphate (Total) as SO4	Solid	1	0.05	%SO4
Embankment Fill	Water Soluble Sulphate as SO4	Solid (2:1 soil/water extract)	1	0.05	g/l SO4
Glaciofluvial Deposits (fine grained)	pH	Water	1	7.5	-
Glaciofluvial Deposits (fine grained)	pH	Solid (water extract)	4	6.7-7.1	-
Glaciofluvial Deposits (fine grained)	Sulphate (Total) as SO4	Solid	4	0.01-0.12	%SO4
Glaciofluvial Deposits (fine grained)	Water Soluble Sulphate as SO4	Water	1	0.4	g/l SO4
Glaciofluvial Deposits (coarse grained)	pH	Water	1	7.3	-
Glaciofluvial Deposits (coarse grained)	Water Soluble Sulphate as SO4	Water	1	0.61	g/l SO4
Mercia Mudstone – III/IV	pH	Solid (water extract)	10	7.2-7.5	-
Mercia Mudstone – III/IV	Sulphate (Total) as SO4	Solid	10	0.07-1.14	%SO4
Mercia Mudstone – Sandstone	pH	Water	2	7.5-7.5	-
Mercia Mudstone – Sandstone	Sulphate (Total) as SO4	Solid	2	1.06-1.64	g/l SO4

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Assumed Ground Model For Design:

Ground model based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-CE-000034, Rev P01 and HA549342-AMAR-HGT-SWI-DR-CE-000035, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01. The below table outlines the assumed anticipated ground model, to be confirmed by 'Just in Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment fill	0-4.2	34.1-29.9	4.2	21	27	0	95	6.3	5.0	-	0.50	0.20	-	2.1	0.46	-	6.2*	-	DS-1 AC-1
Glaciofluvial Deposits (fine grained)	4.2-5.6	29.9-28.5	1.4	21	26	0	70	9.3	7.4	-	0.50	0.20	-	3.1	0.52	-	9	-	DS-1 AC-1
Glaciofluvial Deposits (coarse grained)	5.6-7.6	28.5-26.5	2.0	21	32	-	-	-	27.6	-	-	0.25	-	11.0	-	1.0	-	50	DS-2 AC-2
Mercia Mudstone – III/IV	>7.6	<26.5	-	21	30	2	100	12.3	9.8	-	0.50	0.20	-	4.1	0.45	-	9	-	DS-3 AC-3

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.

(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.

(3) Given the limited amount of local PI data, the ϕ' of Embankment Fill, Glaciofluvial Deposits (fine grained) and Mercia Mudstone – III/IV were taken as the characteristic values given in the AMAR GIR.

(4) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a characteristic SPT 'N' value of 17, ϕ' was found to be 32^o.

(5) c_u of Embankment Fill and Mercia Mudstone – III/IV was determined based on recorded undrained triaxial tests and c_u derived using the Stroud correlation. Due to the limited amount of local PI data, a typical f1 value of 5.0

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was used. An undrained shear strength of 95kN.m^2, 70kN/m^2 and 100kN/m^2 was adopted for Embankment Fill. Glaciofluvial Deposits (Fine Grained) and Mercia Mudstone-III/IV respectively.

(6) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the characteristic SPT 'N' value of 19, Eu = 6.3MN/m^2. Therefore E' = 5.0MN/m^2.

(7) E' of Glaciofluvial Deposits (fine grained) was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the recorded SPT 'N' value of 25, Eu = 9.3MN/m^2. Therefore E' = 7.4MN/m^2.

(8) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a characteristic SPT 'N' value of 17, E' = 27.6MN/m^2.

(9) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the characteristic SPT 'N' value of 35, Eu = 12.3MN/m^2. Therefore E' = 9.8MN/m^2.

(10) Shear modulus is based on G = E/2(1+v).

(11) Adhesion Factor is based on BS8004 (equation 41) for Embankment Fill and Glaciofluvial Deposits (fine grained). Adhesion Factor for Mercia Mudstone – III/IV is based on Tomlinson and Woodward (2008).

(12) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl

(13) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).

(14) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1). For sandstone, Nq is derived based on a very dense siliceous cohesionless soil (Tomlinson Table 7.1).

(15) BRE Classification is determined using criteria set out in BRE Special Digest 1.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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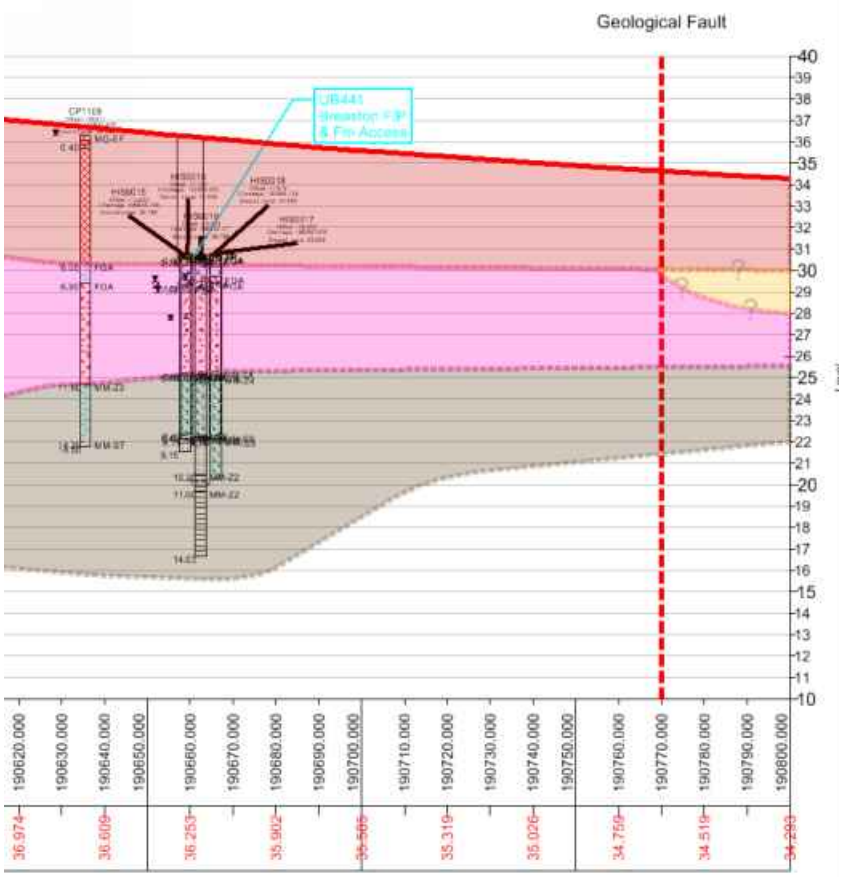


Figure 5.1: Geological Long Section 1 of 2

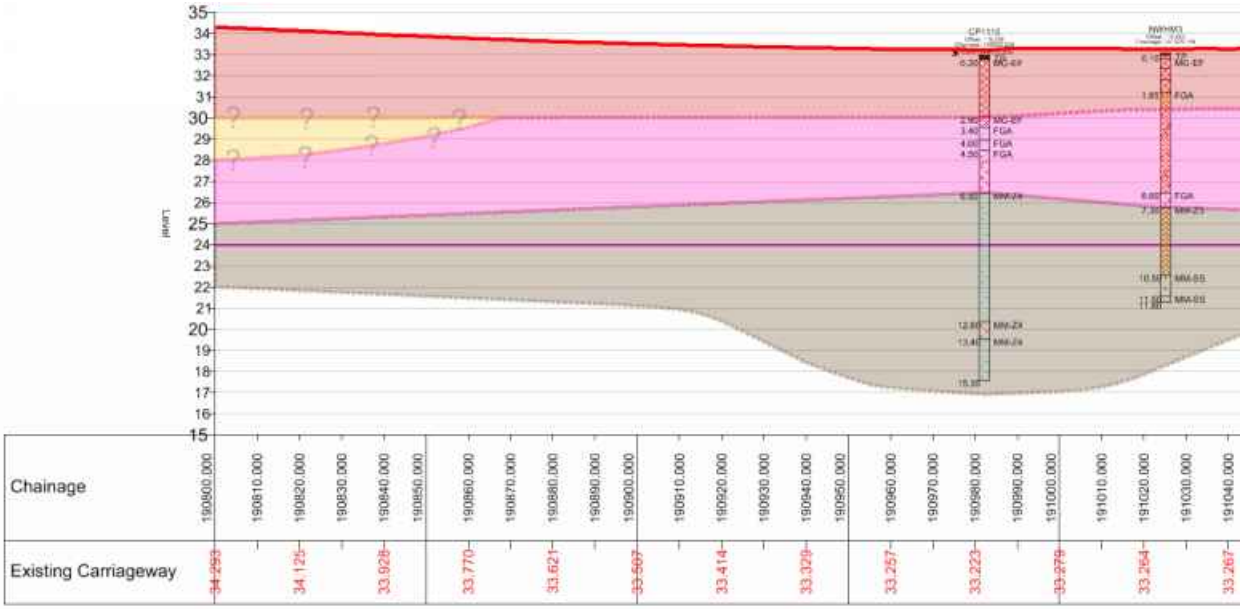


Figure 5.2: Geological Long Section 2 of 2

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solution is proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle
190740	190930	Full Height Embankment Widening (1:2.0)	5.0	1:2.5 22°

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Structure Ref.	Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
GANTRY _313	4 (2x2)	750	8	2.25	9	133	273

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FURTHER GROUND INVESTIGATION

'Just in Time' Validation Ground Investigation is required at this location to confirm ground conditions. The following has been proposed:

- BH – G313 at Ch190771, northbound, dynamic sample with rotary follow on to 13m bgl.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **CP1109** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446966.00 - 332758.00	Hole Type CP
Location:		Level: 36.30	Scale 1:50
Client: Highways England		Dates: 02/11/2006 - 02/11/2006	Logged By RMS/OP

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	B				0.20	36.10		MADE GROUND. Light to medium brown slightly sandy, gravelly soft clay with occasional rootlets up to 20mm. Gravel is subrounded to rounded fine and medium of quartzite and angular to subangular fine and medium of limestone and mudstone. MG-EF
		0.45	B				0.40	35.90		
		0.60	B				0.60	35.70		
		1.20 - 1.65	U							MADE GROUND. Light brown very sandy gravel with frequent rootlets up to 100mm. Gravel is angular and subangular fine to coarse of sandstone, mudstone and limestone. MG-EF
		1.70	D							
		2.20 - 2.65	D							MADE GROUND. Light brown very gravelly, clayey fine and medium sand. Gravel is angular and subangular fine to coarse of sandstone. Possible MG-EF
		2.20 - 2.70	B							
		3.20 - 3.65	U							MADE GROUND. Firm to stiff red brown slightly gravelly clay. Gravel is subrounded and rounded fine to coarse of mudstone, sandstone and siltstone. Possible MG-EF
		3.70	D							*From 2.20m, slightly sandy*
		4.20 - 4.65	D							*From 4.20m, slightly friable with some light green grey mottling*
		4.20 - 4.70	B							
		5.20 - 5.65	U							
		5.70	D							
		6.00	D				6.00	30.30		Stiff brown grey with black mottling, slightly sandy slightly gravelly CLAY. Gravel is subrounded and rounded, fine and medium of quartz with occasional gravel sized fragments of organic material. Possible FGA
		6.20 - 6.65	D							
		6.20 - 6.70	B							
		7.00 - 7.50	B				6.90	29.40		Very dense brown fine to coarse SAND and subrounded to rounded, fine to coarse GRAVEL of quartz, mudstone and sandstone. FGA-SG
		8.00 - 8.50	B							
		9.50 - 10.00	B							
										Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.00m.;The borehole was advanced by chiselling methods from 14.30m to 14.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1109 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446966.00 - 332758.00	Hole Type CP
Location:		Level: 36.30	Scale 1:50
Client: Highways England		Dates: 02/11/2006 - 02/11/2006	Logged By RMS/OP

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										SAND and GRAVEL (as previous sheet)
		11.00 - 11.50	B							
		11.60	D				11.60	24.70		Stiff to very stiff red brown CLAY with pockets of fine to coarse sand. MM-Z3
		11.70 - 12.15	U							
		12.20	D							
		13.20 - 13.65	D							From 13.20m, mottled red brown and grey with some subangular to subrounded fine to coarse gravel sized fragments of siltstone. With white gypsum crystals
		13.20 - 13.70	B							
		14.30 - 14.50	B				14.30	22.00		Recovered as grey, clayey angular to subangular fine to coarse gravel sized fragments of SILTSTONE. MM-ST
							14.50	21.80		End of borehole at 14.50 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.00m.;The borehole was advanced by chiselling methods from 14.30m to 14.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. **CP1110** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447131.00 - 333059.00	Hole Type CP
Location:		Level: 32.95	Scale 1:50
Client: Highways England		Dates: 03/11/2006 - 06/11/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	B				0.20	32.75		TOPSOIL. TP
		0.60	B							MADE GROUND. Firm, friable, red brown with some grey mottling, slightly gravelly clay. Gravel is subangular to subrounded, fine to coarse of siltstone and mudstone. MG-EF
		1.20 - 1.65	U							
		1.70	D							
		2.20 - 2.65	D							
		2.20 - 2.70	B							
		2.90 - 3.30	B				2.90	30.05		MADE GROUND. Very dense brown and grey rounded fine to coarse gravel of quartz. MG-EF
		3.40	D				3.40	29.55		Stiff dark green grey slightly gravelly CLAY. Gravel is subangular and subrounded, fine and medium of mudstone with pockets of brown sand. Sand is fine to coarse. FGA
		3.50 - 3.95	U							
		4.00	D				4.00	28.95		Firm light brown with light grey mottling slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded, fine and medium of quartz, with occasional gravel sized pockets of black organic matter. FGA
		4.50 - 5.00	B				4.50	28.45		Dense to very dense brown fine to coarse SAND, and subrounded and rounded fine to coarse GRAVEL of quartz, mudstone and sandstone. FGA-SG
		5.50 - 6.00	B							*Below 5.50m, sandy gravel*
		6.50	D				6.50	26.45		Firm red brown with some grey mottling, sandy slightly gravelly CLAY. Gravel is subangular to rounded, fine to coarse of quartz, mudstone and siltstone. MM-Z4
		6.60 - 7.05	U							
		7.10	D							
		7.60 - 8.05	D							
		7.60 - 8.10	B							
		8.30	W							
		9.10 - 9.55	U							
		9.60	D							*From 9.60m, friable.*
		9.60 - 10.05	D							
		9.60 - 10.10	B							

Continued on next sheet.

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.50m.;The borehole was advanced by chiselling methods from 14.90m to 15.20m (1 hour).;No visual or olfactory indication of contamination was observed.;The borehole was backfilled on completion with grout.;

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Rotary Core Log

Borehole No. CP1110 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447131.00 - 333059.00	Hole Type CP
Location:		Level: 32.95	Scale 1:50
Client: Highways England		Dates: 03/11/2006 - 06/11/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										CLAY (as previous sheet)
		11.10 - 11.55	U							
		11.55	D							
		12.60 - 13.05	D				12.60	20.35		Dense light grey fine and medium SAND, with pockets of firm green grey sandy clay and silt. MM-Z4
		12.60 - 13.10	B							
		13.50 - 13.95	U				13.40	19.55		Very stiff red brown CLAY with angular and subangular fine to coarse gravel sized weathered mudstone lithorelics. MM-Z4
		14.00	D							
		14.80 - 15.00	D							From 14.80m, sandy
		14.80 - 15.20	B							
		15.20 - 15.34	D				15.35	17.60		At 15.20m, recovered as red brown angular and subangular fine to coarse gravel sized fragments of mudstone and gypsum
										End of borehole at 15.35 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.50m.;The borehole was advanced by chiselling methods from 14.90m to 15.20m (1 hour).;No visual or olfactory indication of contamination was observed.;The borehole was backfilled on completion with grout.;

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Rotary Core Log

Borehole No. **HIS0015**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446981.00 - 332776.00	Hole Type CP
Location:		Level: 30.70	Scale 1:50
Client: Highways England		Dates: 15/06/1964 - 17/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.50		TOPSOIL TP
		0.46 - 0.91	U							Stiff brown silty CLAY FGA
		0.91	D							
	▼	1.37	D				1.50	29.20		
		1.68 - 2.13	B							Medium dense brown sandy fine to medium GRAVEL FGA-SG
		2.59 - 3.05	B							
		3.51 - 3.96	B							
		4.45 - 4.88	B							
							5.60	25.10		
		5.79 - 6.25	U							Stiff to very stiff friable red-brown and grey silty CLAY (Keuper Marl) MM-Z4
		6.25	D							
		6.86	D							
		7.47 - 7.92	U							
		7.92	D							
		8.38 - 8.69	B				8.40	22.30		
		8.69	W							Light grey SANDSTONE MM-SS
							9.15	21.55		End of borehole at 9.14 m

Remarks
Ground-water was first encountered at a depth of 1.5m but subsequently rose to 1.2m below ground level. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. **HIS0016**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447010.00 - 332758.00	Hole Type CP
Location:		Level: 30.80	Scale 1:50
Client: Highways England		Dates: 17/06/1964 - 19/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.60		TOPSOIL TP
		0.46 - 0.91	U							Stiff brown silty CLAY with traces of organic matter FGA
		0.91	D							
							1.50	29.30		
	▼	1.68 - 2.13 1.83	B W							Medium dense brown slightly sandy fine to medium GRAVEL with occasional coarse gravel; becoming sandy with depth FGA-SG
		2.59 - 3.05	B							
		3.51 - 3.96	B							
		4.42 - 4.88	B							
							5.60	25.20		
		5.94 - 6.40	U							Stiff friable red-brown and grey silty CLAY or clayey SILT (Keuper Marl) MM-Z4
		6.40	D							
		7.01	D							
		7.47 - 7.92	U							
		7.92	D							
		8.38 - 8.69	B				8.40	22.40		Grey SANDSTONE MM-SS
							8.70	22.10		End of borehole at 8.69 m

Remarks
Water was added to assist boring. On completion of boring the water stood at a depth of 1.8m below ground level and a sample was taken.

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Rotary Core Log

Borehole No. **HIS0017** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446985.00 - 332782.00	Hole Type CP
Location:		Level: 30.80	Scale 1:50
Client: Highways England		Dates: 09/06/1964 - 15/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.60		TOPSOIL TP
		0.61 - 1.07	U							Firm brown sandy CLAY with gravel FGA
	▼	1.07	D				1.10	29.70		
		1.22 - 1.68	B							Medium dense brown sandy fine to medium GRAVEL with occasional coarse gravel and cobbles; becoming more sandy with depth FGA-SG
		2.13 - 2.59	B							
	▽	3.05 - 3.51	B							
		3.96 - 4.42	B							
		4.88 - 5.33	B							
							5.80	25.00		
		6.10 - 6.55	U							Stiff to very stiff friable red-brown and grey silty CLAY (Keuper Marl) MM-Z4
		6.55	D							
		6.86	D							
		7.62 - 8.08	U							
		8.08	D							
		8.69	D				8.70	22.10		Grey SANDSTONE MM-SS
		9.14	W							
		9.14	D							

Continued on next sheet

Remarks

Ground-water was first encountered at a depth of 3.05m below ground level and rose overnight to 1.22m depth. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No.
HIS0017
Sheet 2 of 2

Project Name:	SMP - M1 J23A TO J25	Project No.	COCDFL1SMP01	Co-ords:	446985.00 - 332782.00
Location:				Level:	30.80
Client:	Highways England			Dates:	09/06/1964 - 15/06/1964

Hole Type: CP
Scale: 1:50
Logged By:

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.52	20.28		End of borehole at 10.52 m

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level and rose overnight to 1.22m depth. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. **HIS0018**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447014.00 - 332763.00	Hole Type CP
Location:		Level: 30.80	Scale 1:50
Client: Highways England		Dates: 19/06/1964 - 20/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.60		TOPSOIL TP
										Firm brown silty CLAY with gravel FGA
		0.91 - 1.37	U							
	▼	1.22	W							
		1.37	D				1.40	29.40		
		1.52 - 1.98	B							Medium dense brown sandy fine to medium GRAVEL with occasional coarse gravel at depth FGA-SG
		2.44 - 2.90	B							
		3.35 - 3.81	B							
		4.27 - 4.72	B							
							5.50	25.30		Firm to stiff friable red-brown and grey silty CLAY or clayey SILT (Keuper Marl) MM-Z4
		5.79 - 6.25	U							
		6.25	D							
		6.71	D							
		7.47 - 7.92	U							
		7.92	D							
		8.53	D				8.50	22.30		
							8.70	22.10		Grey SANDSTONE MM-SS End of borehole at 8.69 m

Remarks
Ground-water was first encountered at a depth of 1.8m below ground level. Subsequently the water level rose to a depth of 1.22m and a sample was taken.

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Rotary Core Log

Borehole No. HIS0019
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446983.00 - 332779.00	Hole Type RC
Location:		Level: 30.70	Scale 1:50
Client: Highways England		Dates: 09/07/1964 - 11/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.50		TOPSOIL TP
										Brown silty CLAY FGA
							1.20	29.50		Sandy fine to medium GRAVEL FGA-SG
	▼									
							5.60	25.10		Stiff red-brown and grey silty CLAY (Keuper Marl) MM-Z4
							8.50	22.20		Grey medium SANDSTONE with veins of gypsum MM-SS
										Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level.

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Rotary Core Log

Borehole No. HIS0019
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446983.00 - 332779.00	Hole Type RC
Location:		Level: 30.70	Scale 1:50
Client: Highways England		Dates: 09/07/1964 - 11/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.20	20.50		Green-grey clayey sandy MUDSTONE MM-Z2
							11.00	19.70		Mottled red-brown and green-grey sandy MUDSTONE with fine sandstone and viens of gypsum MM-Z2
							14.03	16.67		End of borehole at 14.02 m

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level.

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Rotary Core Log

Borehole No. NWHM3
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447149.38 - 333096.71	Hole Type CP+RC
Location:		Level: 33.07	Scale 1:50
Client: Highways England		Dates: 20/09/1999 - 23/09/1999	Logged By NBR/BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.30	D				0.10	32.97		TOPSOIL.
		0.00 - 0.30	D							TP
		0.30 - 0.70	D				0.30	32.77		MADE GROUND: Brown sandy clay with much fine to coarse angular gravel sized fragments of limestone, sandstone and mudstone. MG-EF
		0.30 - 0.70	D							
		0.70	D				0.70	32.37		
		0.70 - 0.80	D							MADE GROUND: Light grey medium and coarse angular gravel sized fragments of limestone. MG-EF
		1.00 - 1.30	B							
		1.00 - 1.30	B	56	0	0	1.25	31.82		
		1.60 - 2.05	D							MADE GROUND: Brown very clayey sandy fine to coarse angular to subrounded gravel sized fragments of quartz, sandstone and limestone. MG-EF
		1.60 - 2.05	D				1.85	31.22		
		2.00 - 2.50	D							MADE GROUND: Reddish brown very silty clay with some fine and medium subangular gravel sized fragments of mudstone. (Reworked Mercia Mudstone) MG-EF
		2.00 - 2.50	D							
		2.05 - 2.60	98	91	0	0				
		3.00 - 3.50	B							Medium dense brown clayey sandy medium and coarse subrounded and rounded GRAVEL of quartz, sandstone and siltstone. (River Terrace Deposits) FGA-SG
		3.00 - 3.50	B							
		3.05 - 3.60	98	0	0	0				
		4.00 - 4.50	B							
		4.00 - 4.50	B							
		4.05 - 4.60	98	0	0	0				
										from 4.60m to 5.05m loose
		5.05 - 5.50	98	0	0	0				
		5.50	D							
		5.50	D							
		5.50 - 6.00	B							
		5.50 - 6.00	B							
		6.05 - 6.50	98	0	0	0				
		6.50 - 7.00	B							
		6.50 - 7.00	B				6.60	26.47		Medium dense brown SAND and GRAVEL: Gravel content fine to coarse subangular to rounded of sandstone, limestone and quartz. (River Terrace Deposits) FGA-SG
		7.30	D				7.30	25.77		
		7.30	D							Firm to stiff red brown (friable) sandy CLAY with some fine and medium subangular mudstone lithorelicts. (Mercia Mudstone - Zone III?) MM-Z3
		7.50 - 7.95	D							
		7.50 - 7.95	D							
		8.50	D							
		8.50	D							
		9.00 - 9.45	D							
		9.00 - 9.45	D							
		9.50 - 10.00	B							
		9.50 - 10.00	B							
										Continued on next sheet

Remarks
1. Inspection pit excavated to 0.80m. 2. Rotary coring complete at 6.60m due to collapse. 3. Borehole completed by cablepercussive methods. 4. Borehole complete at 11.80m. 5. Boreholebackfilled with bentonite grout. 6. Marker post ref 191/0+30N.

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Rotary Core Log

Borehole No. NWHM3
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447149.38 - 333096.71	Hole Type CP+RC
Location:		Level: 33.07	Scale 1:50
Client: Highways England		Dates: 20/09/1999 - 23/09/1999	Logged By NBR/BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 - 10.95	D				10.50	22.57		
		10.50 - 10.95	D							Dense blue grey slightly clayey medium SAND with a little medium and coarse subangular gravel sized lithorelicts of sandstone. MM-SS
		11.50	D				11.50	21.57		
		11.50 - 11.52	D							Blue grey fine and medium grained slightly weathered SANDSTONE, moderately strong to strong. MM-SS.
		11.50 - 11.52	D				11.80	21.27		
										End of borehole at 11.80 m

Remarks
1. Inspection pit excavated to 0.80m. 2. Rotary coring complete at 6.60m due to collapse. 3. Borehole completed by cablepercussive methods. 4. Borehole complete at 11.80m. 5. Boreholebackfilled with bentonite grout. 6. Marker post ref 191/0+30N.

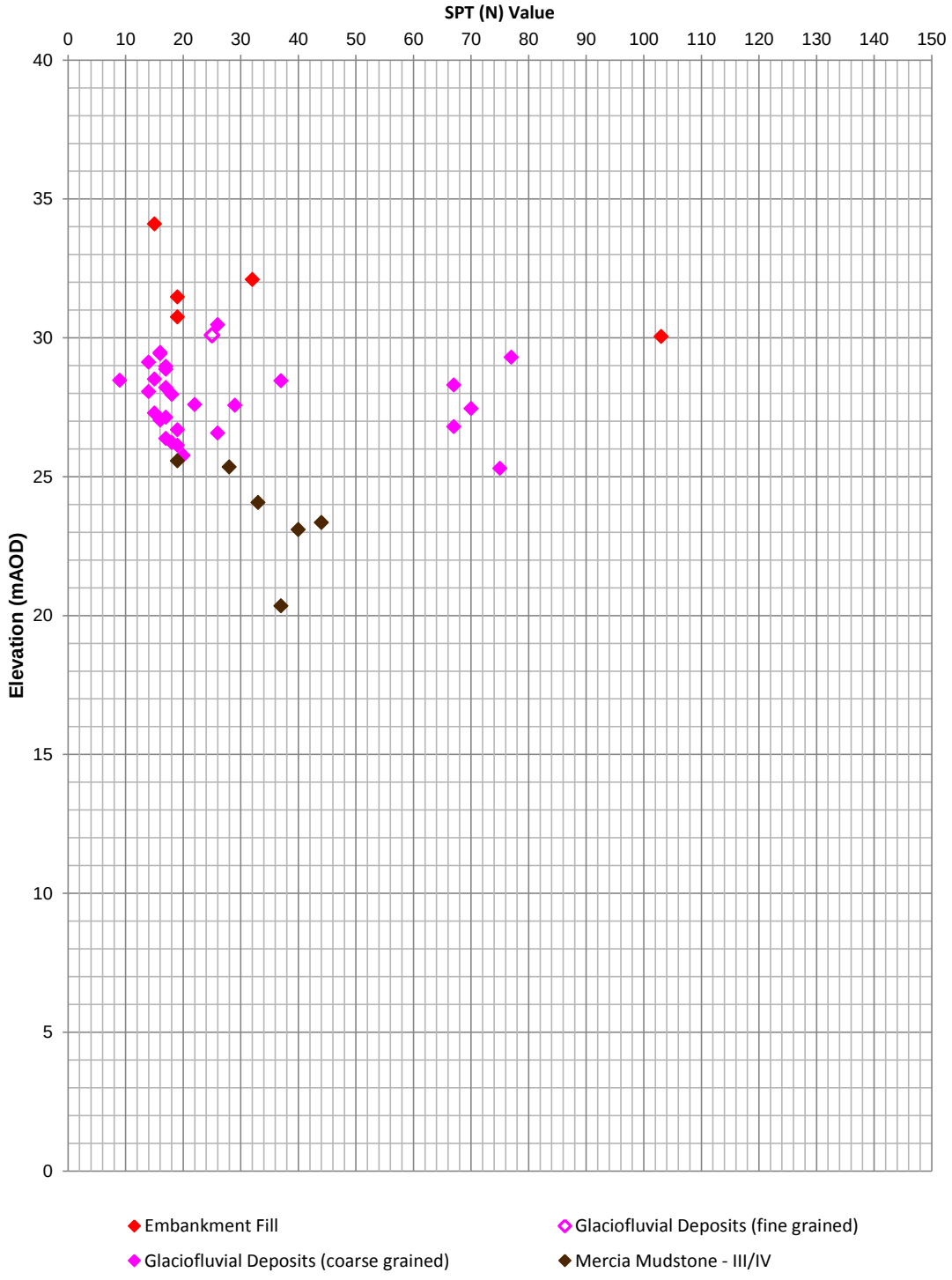
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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **190740-190930NB**
Client: **Highways England**	Borehole ID: **CP1109, CP1100, HIS0015-HIS0018, NWHM3**	



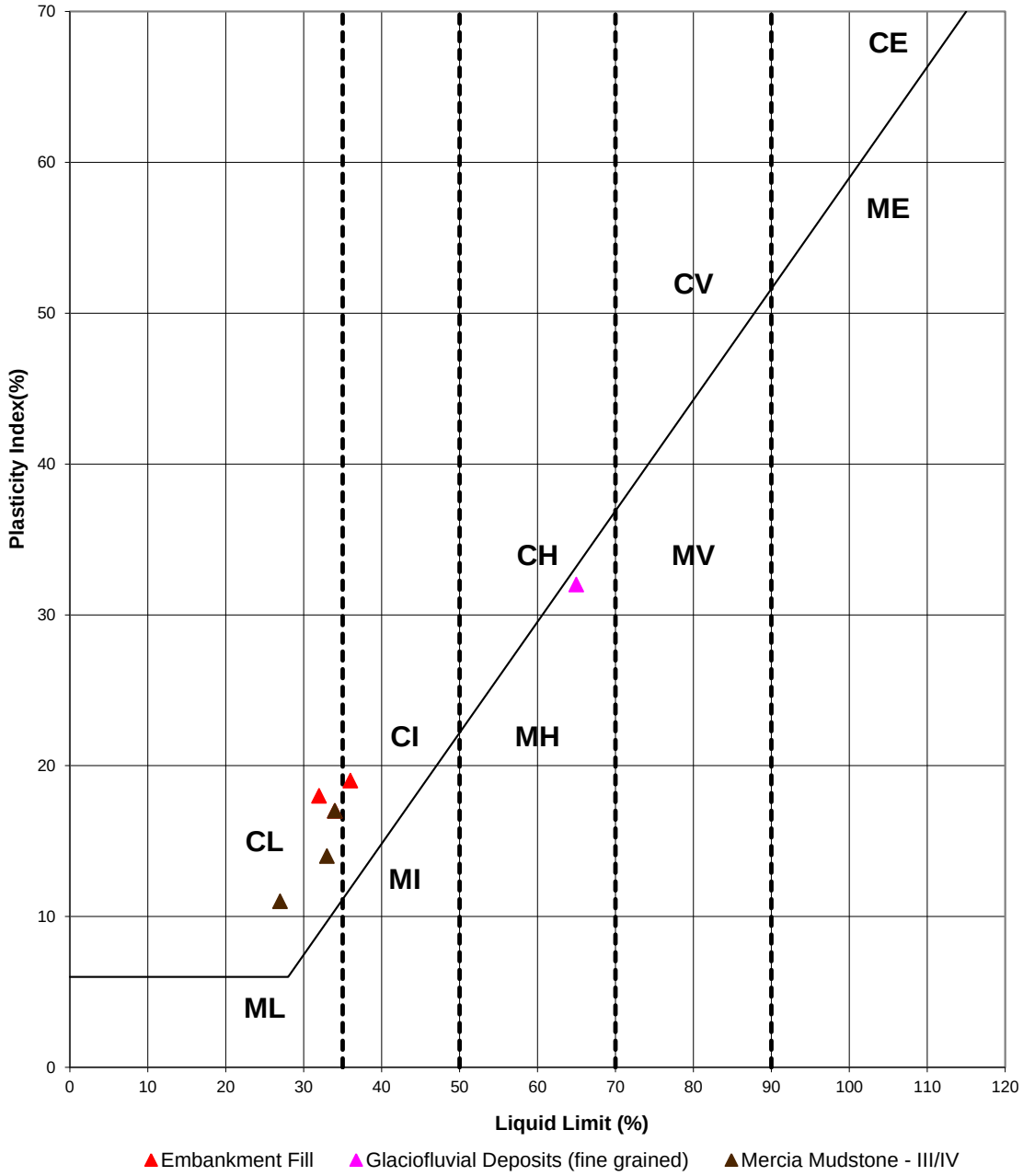
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 08/03/2017 Ref: HA549342-AMAR-HGT-190740-190930NB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **190740-190930NB**
Client: **Highways England**	Borehole ID: **CP1109, CP1110**	



Key

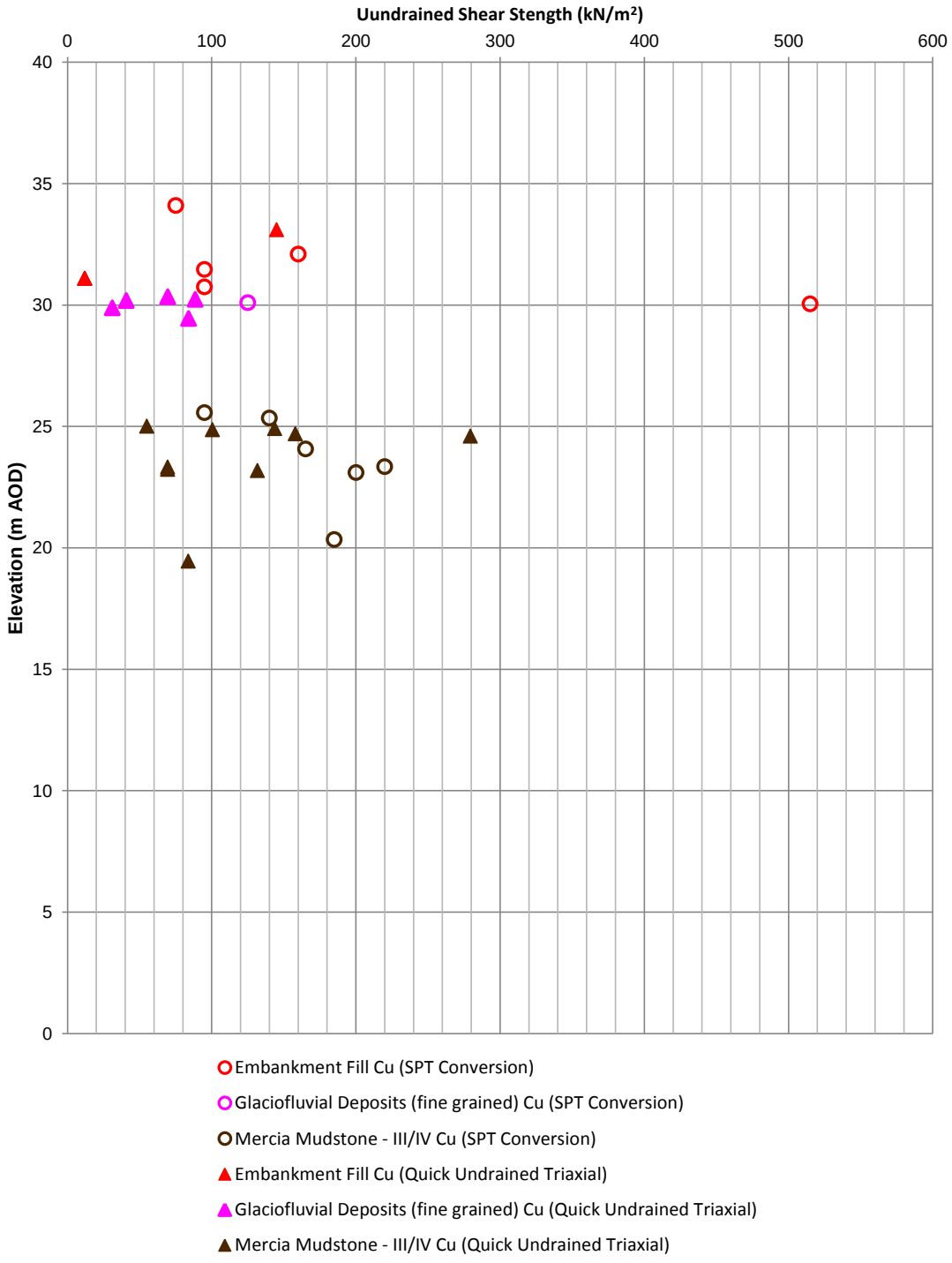
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 08/03/2017 Ref: HA549342-AMAR-HGT-190740-190930NB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **190740-190930NB**
Client: **Highways England**	Borehole ID: **CP1109, CP1110, HIS0015-HIS0015, NWHM3**	



Rev: P01 Date: 08/03/2017 Ref: HA549342-AMAR-HGT-190740-190930NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-191090-191310NB-GSS-000001		
Earthworks Widening Solution	Full Height Embankment Widening (1:2.0); <500mm Fill; No Solution Required		
Structure Number	GANTRY_314[1]; GANTRY_315[1]		
Structure Type	MS4 Cantilever (Gantry 314); ADS Cantilever (Gantry 315)		
Design Chainage	191090-191310NB		
Carriageway	Northbound		
Marker Post	191/0+90 – 191/3+10		
National Grid Reference	E 447167, N 333148 – E 447232, N 333376		
Existing Ground Level at Location	Carriageway	32.7-32.8mAOD	
	Toe of Embankment	29.7-31.7mAOD	
Earthwork Type	NB: Embankment	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: 7_M1_24498	SB: N/A	HAGDMS designation
Earthwork Height	NB: 1.5-3.1m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 10°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	27/04/2017	[redacted]
Checked	Roheel Masrat	27/04/2017	
Reviewed	Gary Summerfield	08/05/2017	
Approved	Thomas Bulteel	06/06/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch191090-191200 (110m), Full Height Embankment Widening (1:2.0);
- Ch191200-192200 (20m), No Solution Required;
- Ch192200-192280 (80m), <500mm Fill;
- Ch192280-191320 (40m), Full Height Embankment Widening (1:2.0).

Proposed Major Structures:

Within the chainage extents, the following structures are to be constructed:

- Gantry, G314, MS4 Cantilever at chainage 191096;
- Gantry, G315, ADS Cantilever at chainage 191296.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is an embankment. The earthwork ranges in height approximately from 1.5m to 3.1m and has a typical slope angle of 10^{o}.

The critical cross section Ch191300 was chosen based on greatest earthwork height where Full Height Embankment Widening (1:2.0) is required.

Although the embankment is up to 3.1m high, the embankment is only a maximum of 2.5m high in locations of Full Height Embankment Widening (1:2.0). Therefore, the ground model includes Embankment Fill that is 2.5m thickness.

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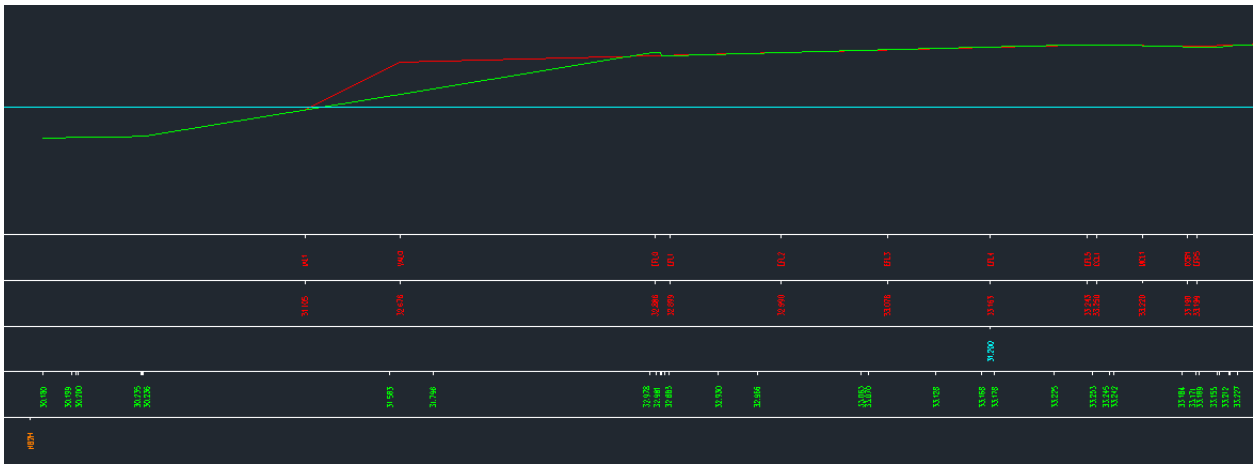


Figure 2: Topographic Critical Cross Section Ch191300

Utilities:

BT comms are present at beneath the existing verge running parallel to the carriageway along the entirety of the chainage extents.

Western Power overhead mid voltage powerline present around embankment crest running parallel to the carriageway along the entirety of the chainage extents. Refer to drawing No. HA549342-AMAR-VUT-MLC-DR-CU-000009 for more details.



Figure 3: Utilities Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Hemington Member (Glaciofluvial Deposits);

Solid Deposits: Edwalton Member (Mercia Mudstone Group)

Ground Investigation:

There are no historical exploratory holes within the design chainage; however, there are 4 No. historical exploratory holes considered relevant, of which are shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000035, Rev P01.

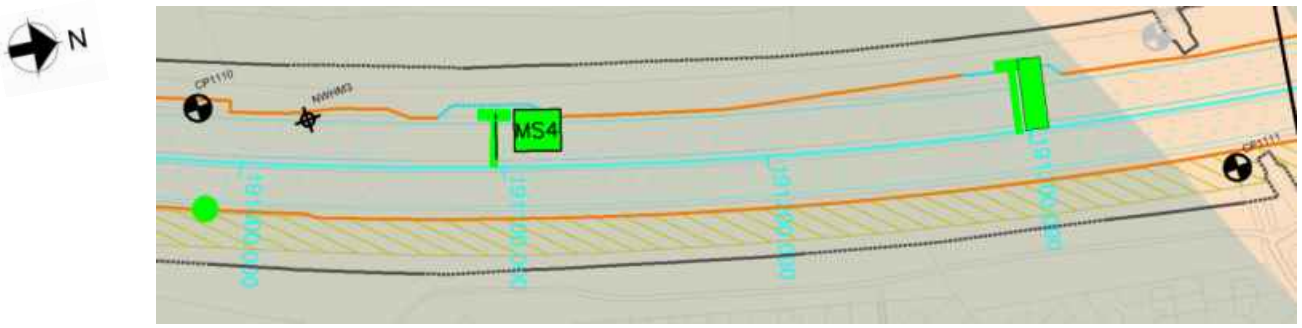


Figure 4: Borehole Location Plan

Flood Risk:

The design flood level is 31.2mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR, Document Ref. HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	NWHM3
Borehole Chainage	191025
Borehole Location	Northbound verge
National Grid Reference	E 447149, N 333097
Ground Level at Exploratory Hole	33.07mAOD (above Ordnance Datum)
RAG Analysis	Green
Date Drilled	20/09/1999 – 23/09/1999
Termination Depth	11.80m below ground level (mbgl)
Other suitable holes	CP1100, CP1111 and SK43SE552

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey data:

Stratum	Depth to Base (m bgl)	Depth to Base (m AOD)	SPT (N) Value
Embankment Fill	2.5	30.2	5-103 (19)
Glaciofluvial Deposits (coarse grained)	8.9	25.8	9-70 (30)
Mercia Mudstone – III/IV	Not proven	Not proven	19-150 (40)

(1) Ground level is assumed to be at carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in historical exploratory holes CP1110, CP1111 and NWHM3.

Groundwater:

The following groundwater data was included in the historical exploratory holes:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		mbgl	mAOD	Time	mbgl	mAOD
CP1111	Glaciofluvial Deposits (coarse grained) rising into Embankment Fill	4.60	27.45	20mins	3.10	28.95

The following was noted in historical exploratory hole CP1110: "Groundwater was not apparent during drilling but may have been masked by the addition of water".

No groundwater data was provided in historical exploratory hole NWHM6 or SK43SE552.

Groundwater Design Level:

Design groundwater level of 31.2mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

4 No. Atterberg Limit Tests and 5 No. Moisture Content Tests were undertaken within historical exploratory holes with the following results for the strata noted in the ground model:

Stratum	Depth to Top of Test (m bgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	0.50	101	36	16	20	CI
Embankment Fill	2.20	15	36	17	19	CI
Glaciofluvial Deposits (coarse grained)	6.45	14	-	-	-	-
Mercia Mudstone – III/IV	9.60	23	34	17	17	CL
Mercia Mudstone – III/IV	140	21	27	16	11	CL

(1) 1 No. Atterberg Limit Test was undertaken within fine grained elements of the Glaciofluvial Deposits (coarse grained). This test has not been used because it is not representative of a stratum that is predominantly coarse grained.

(2) 1 No. Atterberg Limit Test was undertaken within Glaciofluvial Deposits (fine grained); this test has not been used because only Glaciofluvial Deposits (coarse grained) are included in the ground model.

2 No. Quick Undrained Triaxial Tests were undertaken with the following results:

Stratum	Depth to Top of Test (m bgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	2.00	85
Mercia Mudstone – III/IV	13.50	279

(1) 1 No. Quick Undrained Triaxial Test was undertaken within Glaciofluvial Deposits (fine grained); this test has not been used because only Glaciofluvial Deposits (coarse grained) are included in the ground model.

Lab Test Data – BRE Classification:

The following BRE Classification chemical testing data was available from the historical exploratory holes for the strata noted in the ground model:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	pH	Solid (water extract)	2	7.9-8.8	-
Mercia Mudstone – I/II	pH	Solid	1	8.5	-
Embankment Fill	Sulphate (Total) as SO4	Solid	1	0.05	%SO4
Embankment Fill	Water Soluble Sulphate as SO4	Solid (2:1 soil/water extract)	1	0.05	g/l SO4
Mercia Mudstone – I/II	Sulphate (Total) as SO4	Solid	1	0.02	%SO4
Mercia Mudstone – I/II	Water Soluble Sulphate as SO4	Solid (2:1 soil/water extract)	1	0.01	g/l SO4

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Assumed Ground Model For Design:

Ground model based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-CE-000035, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01. The below table outlines the assumed anticipated ground model, to be confirmed by 'Just in Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment fill	0-2.5	32.7-30.2	2.5	21	27	0	100	7.5	6.0	-	0.50	0.20	-	2.5	0.45	-	6.2*	-	DS-1 AC-1
Glaciofluvial Deposits (coarse grained)	2.5-8.9	30.2-25.8	6.4	21	36	-	-	-	43.2	-	-	0.25	-	17.3	-	1.0	-	50	DS-3 AC-3z
Mercia Mudstone – III/IV	>8.9	<25.8	-	21	30	2	200	13.8	11.0	-	0.50	0.20	-	4.6	0.45	-	9.0	-	DS-1 AC-1

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Given the limited amount of local PI data, the ϕ' of Embankment Fill and Mercia Mudstone – III/IV was taken as the characteristic value given in the AMAR GIR.
(4) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a characteristic SPT 'N' value of 30, ϕ' was found to be 36°.
(5) c_u of Embankment Fill and Mercia Mudstone – III/IV was determined based on recorded undrained triaxial tests and c_u derived using the Stroud correlation. Due to the limited amount of local PI data, a typical f1 value of 5.0 was used.
(6) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the characteristic SPT 'N' value of 19, Eu = 6.3MN/m^2. Therefore E' = 5.0MN/m^2.
(7) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a characteristic SPT 'N' value of 30, E' = 43.2MN/m^2.
(8) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the characteristic SPT 'N' value of 40, Eu = 13.8MN/m^2. Therefore E' = 11.0MN/m^2.
(9) Shear modulus is based on G = E/2(1+v).

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(10) Adhesion Factor is based on BS8004 (equation 41) for Embankment Fill. Adhesion Factor for Mercia Mudstone – III/IV is based on Tomlinson and Woodward (2008).
(11) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl
(12) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Glaciofluvial Deposits (coarse grained), the classification used for the strata in the AMAR GIR was adopted.
(13) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1).
(14) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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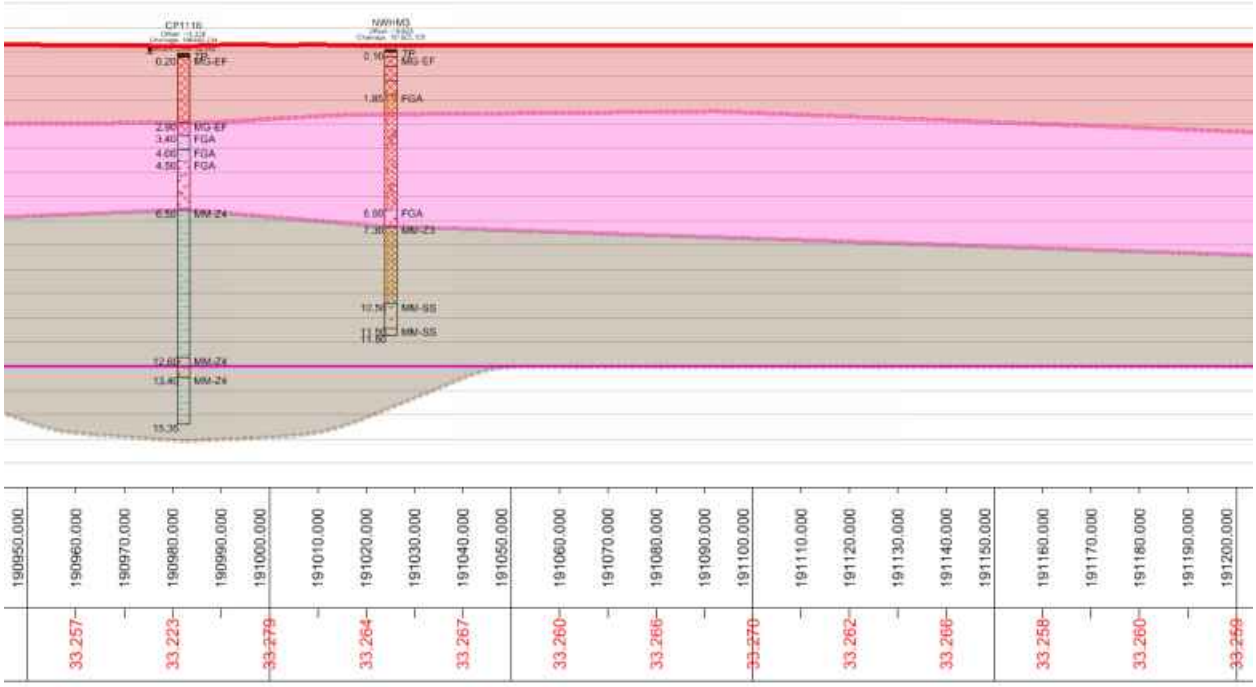


Figure 5.1: Geological Long Section 1 of 2

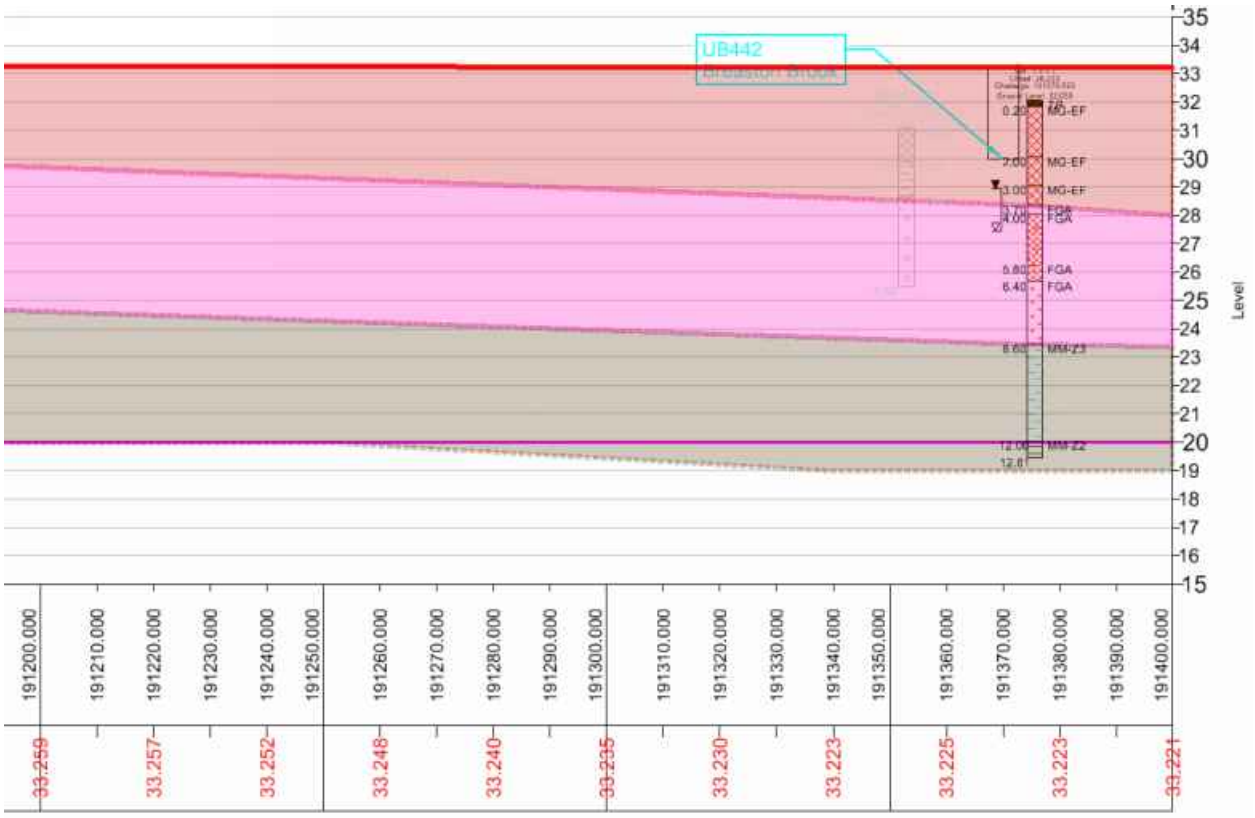


Figure 5.2: Geological Long Section 2 of 2

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (°)
191090	191190	Full Height Embankment Widening (1:2.0)	2.4	11°* 1(V):5(H)
191280	191310	Full Height Embankment Widening (1:2.0)	2.4	11°* 1(V):5(H)

*Note: batter angle is shallow due to the existing angle of the slope.

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Structure Ref.	Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
GANTRY _314	4 (2x2)	750	11	2.25	10	182	638
GANTRY _315	4 (2x2)	900	26	2.70	13	371	1222

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FURTHER GROUND INVESTIGATION

'Just in Time' Validation Ground Investigation is required at this location to confirm ground conditions. The following has been proposed:

- BH – G314 at Ch191096, northbound, dynamic sample with rotary follow on to 16m bgl;
- BH – G315 at Ch191296, northbound, dynamic sample with rotary follow on to 30m bgl.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **CP1110** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447131.00 - 333059.00	Hole Type CP
Location:		Level: 32.95	Scale 1:50
Client: Highways England		Dates: 03/11/2006 - 06/11/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	B				0.20	32.75		TOPSOIL. TP
		0.60	B							MADE GROUND. Firm, friable, red brown with some grey mottling, slightly gravelly clay. Gravel is subangular to subrounded, fine to coarse of siltstone and mudstone. MG-EF
		1.20 - 1.65	U							
		1.70	D							
		2.20 - 2.65	D							
		2.20 - 2.70	B							
		2.90 - 3.30	B				2.90	30.05		MADE GROUND. Very dense brown and grey rounded fine to coarse gravel of quartz. MG-EF
		3.40	D				3.40	29.55		Stiff dark green grey slightly gravelly CLAY. Gravel is subangular and subrounded, fine and medium of mudstone with pockets of brown sand. Sand is fine to coarse. FGA
		3.50 - 3.95	U							
		4.00	D				4.00	28.95		Firm light brown with light grey mottling slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded, fine and medium of quartz, with occasional gravel sized pockets of black organic matter. FGA
		4.50 - 5.00	B				4.50	28.45		Dense to very dense brown fine to coarse SAND, and subrounded and rounded fine to coarse GRAVEL of quartz, mudstone and sandstone. FGA-SG
		5.50 - 6.00	B							*Below 5.50m, sandy gravel*
		6.50	D				6.50	26.45		Firm red brown with some grey mottling, sandy slightly gravelly CLAY. Gravel is subangular to rounded, fine to coarse of quartz, mudstone and siltstone. MM-Z4
		6.60 - 7.05	U							
		7.10	D							
		7.60 - 8.05	D							
		7.60 - 8.10	B							
		8.30	W							
		9.10 - 9.55	U							
		9.60	D							*From 9.60m, friable*
		9.60 - 10.05	D							
		9.60 - 10.10	B							
										Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.50m.;The borehole was advanced by chiselling methods from 14.90m to 15.20m (1 hour).;No visual or olfactory indication of contamination was observed.;The borehole was backfilled on completion with grout.;

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Rotary Core Log

Borehole No. CP1110 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447131.00 - 333059.00	Hole Type CP
Location:		Level: 32.95	Scale 1:50
Client: Highways England		Dates: 03/11/2006 - 06/11/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										CLAY (as previous sheet)
		11.10 - 11.55	U							
		11.55	D							
		12.60 - 13.05	D				12.60	20.35		Dense light grey fine and medium SAND, with pockets of firm green grey sandy clay and silt. MM-Z4
		12.60 - 13.10	B							
		13.50 - 13.95	U				13.40	19.55		Very stiff red brown CLAY with angular and subangular fine to coarse gravel sized weathered mudstone lithorelics. MM-Z4
		14.00	D							
		14.80 - 15.00	D							From 14.80m, sandy.
		14.80 - 15.20	B							
		15.20 - 15.34	D				15.35	17.60		At 15.20m, recovered as red brown angular and subangular fine to coarse gravel sized fragments of mudstone and gypsum.
										End of borehole at 15.35 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.50m.;The borehole was advanced by chiselling methods from 14.90m to 15.20m (1 hour).;No visual or olfactory indication of contamination was observed.;The borehole was backfilled on completion with grout.;

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Rotary Core Log

Borehole No. CP1111 Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447287.00 - 333422.00	Hole Type CP
Location:		Level: 32.05	Scale 1:50
Client: Highways England		Dates: 29/08/2006 - 30/08/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	31.85		TOPSOIL. TP
		0.50	D							MADE GROUND. Firm to stiff red brown sandy gravelly clay. Gravel is coarse angular to subrounded of dolerite, quartz, mudstone and sandstone with frequent cobbles of the same. MG-EF
		0.50 - 1.00	B							
		1.20 - 1.70	U#B							To 1.20m, with many rootlets. From 1.20m, red brown mottled grey slightly sandy clay.
		1.70 - 2.00	B							
		2.00 - 2.40	U				2.00	30.05		MADE GROUND. Stiff dark grey/brown gravelly clay with some organic matter. Gravel is angular fine to coarse of red brick. MG-EF
		2.40	D							
		3.00 - 3.45	D				3.00	29.05		MADE GROUND. Soft brown mottled grey slightly sandy clay with occasional gravel of quartz, brick and sandstone. With gravel size pockets of coal dust and occasional organic matter (grass). MG-EF
		3.00 - 3.50	B							
		3.10	W							
		3.70	D				3.70	28.35		(Soft) grey black organic CLAY with occasional plant matter. Possible FGA
		4.00 - 4.45	U				4.00	28.05		Dense brown grey slightly clayey sandy GRAVEL/gravelly SAND. Gravel is angular to rounded fine to coarse of sandstone, mudstone, dolerite, flint and quartz. FGA-SG
		4.45	D							
		5.00 - 5.45	D							
		5.00 - 5.50	B							
		5.80	D				5.80	26.25		Soft blue grey sandy CLAY with occasional fine subrounded gravel of quartz and flint. FGA
		6.00 - 6.45	U							
		6.45	D				6.40	25.65		Very dense light grey/white fine to medium SAND with occasional angular to subrounded fine gravel of grey sandstone. Becoming gravelly with depth. FGA-SG
		7.00 - 7.45	D							
		7.00 - 7.50	B							
		8.00 - 8.45	D							
		8.00 - 8.50	B							
		8.60	D				8.60	23.45		Firm to stiff red brown mottled grey gravelly CLAY. Gravel is angular fine to coarse of friable mudstone. MM-Z3
		9.00 - 9.45	D							At 8.60m, becoming sandy silt/clay.
		9.00 - 9.50	B							
		10.00	D							Continued on next sheet.

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. A hand held Photo-ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm. The borehole was advanced by chiselling methods from 1.70m to 2.00 (1.5hr) and 12.00m to 12.50m (1hr).

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Rotary Core Log

Borehole No.	CP1111	Sheet 2 of 2	
Project Name:	SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447287.00 - 333422.00
Hole Type	CP		
Location:			Level: 32.05
Scale	1:50		
Client:	Highways England		Dates: 29/08/2006 - 30/08/2006
Logged By	RMS		

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.00 - 10.50	B							CLAY (as previous sheet)
		11.00	D							
		11.00 - 11.50	B							
		12.00	D				12.00	20.05		MUDSTONE. Recovered as red brown clayey angular fine to coarse gravel sized fragments with pockets of blue grey slightly sandy fissile clay. MM-Z2
		12.00 - 12.50	B							
		12.50	D				12.61	19.44		End of borehole at 12.61 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;A hand held Photo-ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm .;The borehole was advanced by chiselling methods from 1.70m to 2.00 (1.5hr) and 12.00m to 12.50m (1hr).;

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Rotary Core Log

Borehole No. **NWHM3** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447149.38 - 333096.71	Hole Type CP+RC
Location:		Level: 33.07	Scale 1:50
Client: Highways England		Dates: 20/09/1999 - 23/09/1999	Logged By NBR/BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.30	D				0.10	32.97		TOPSOIL.
		0.00 - 0.30	D				0.30	32.77		TP
		0.30 - 0.70	D							MADE GROUND: Brown sandy clay with much fine to coarse angular gravel sized fragments of limestone, sandstone and mudstone.
		0.30 - 0.70	D							MG-EF
		0.70	D				0.70	32.37		MADE GROUND: Light grey medium and coarse angular gravel sized fragments of limestone.
		0.70 - 0.80	D							MG-EF
		1.00 - 1.30	B							MADE GROUND: Brown very clayey sandy fine to coarse angular to subrounded gravel sized fragments of quartz, sandstone and limestone.
		1.00 - 1.80	98	56	0	0	1.25	31.82		MG-EF
		1.60 - 2.05	D							MADE GROUND: Reddish brown very silty clay with some fine and medium subangular gravel sized fragments of mudstone. (Reworked Mercia Mudstone)
		1.60 - 2.05	D				1.85	31.22		MG-EF
		2.00 - 2.50	D							Medium dense brown clayey sandy medium and coarse subrounded and rounded GRAVEL of quartz, sandstone and siltstone. (River Terrace Deposits)
		2.00 - 2.50	D							FGA-SG
		2.05 - 2.60	98	91	0	0				
		3.00 - 3.50	B							
		3.00 - 3.50	B							
		3.05 - 3.60	98	0	0	0				
		4.00 - 4.50	B							
		4.00 - 4.50	B							
		4.05 - 4.60	98	0	0	0				
										—from 4.60m to 5.05m loose
		5.05 - 5.50	98	0	0	0				
		5.50	D							
		5.50	D							
		5.50 - 6.00	B							
		5.50 - 6.00	B							
		6.05 - 6.50	98	0	0	0				
		6.50 - 7.00	B							
		6.50 - 7.00	B				6.60	26.47		Medium dense brown SAND and GRAVEL: Gravel content fine to coarse subangular to rounded of sandstone, limestone and quartz. (River Terrace Deposits)
										FGA-SG
		7.30	D				7.30	25.77		Firm to stiff red brown (friable) sandy CLAY with some fine and medium subangular mudstone lithorelicts. (Mercia Mudstone - Zone III?)
		7.30	D							MM-Z3
		7.50 - 7.95	D							
		7.50 - 7.95	D							
		8.50	D							
		8.50	D							
		9.00 - 9.45	D							
		9.00 - 9.45	D							
		9.50 - 10.00	B							
		9.50 - 10.00	B							
										Continued on next sheet

Remarks
1. Inspection pit excavated to 0.80m. 2. Rotary coring complete at 6.60m due to collapse. 3. Borehole completed by cablepercussive methods. 4. Borehole complete at 11.80m. 5. Boreholebackfilled with bentonite grout. 6. Marker post ref 191/0+30N.

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Rotary Core Log

Borehole No. **NWHM3** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447149.38 - 333096.71	Hole Type CP+RC
Location:		Level: 33.07	Scale 1:50
Client: Highways England		Dates: 20/09/1999 - 23/09/1999	Logged By NBR/BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 - 10.95	D				10.50	22.57		
		10.50 - 10.95	D							Dense blue grey slightly clayey medium SAND with a little medium and coarse subangular gravel sized lithorelicts of sandstone. MM-SS
		11.50	D				11.50	21.57		
		11.50 - 11.52	D							Blue grey fine and medium grained slightly weathered SANDSTONE, moderately strong to strong. MM-SS
		11.50 - 11.52	D				11.80	21.27		
										End of borehole at 11.80 m

Remarks
1. Inspection pit excavated to 0.80m. 2. Rotary coring complete at 6.60m due to collapse. 3. Borehole completed by cablepercussive methods. 4. Borehole complete at 11.80m. 5. Boreholebackfilled with bentonite grout. 6. Marker post ref 191/0+30N.

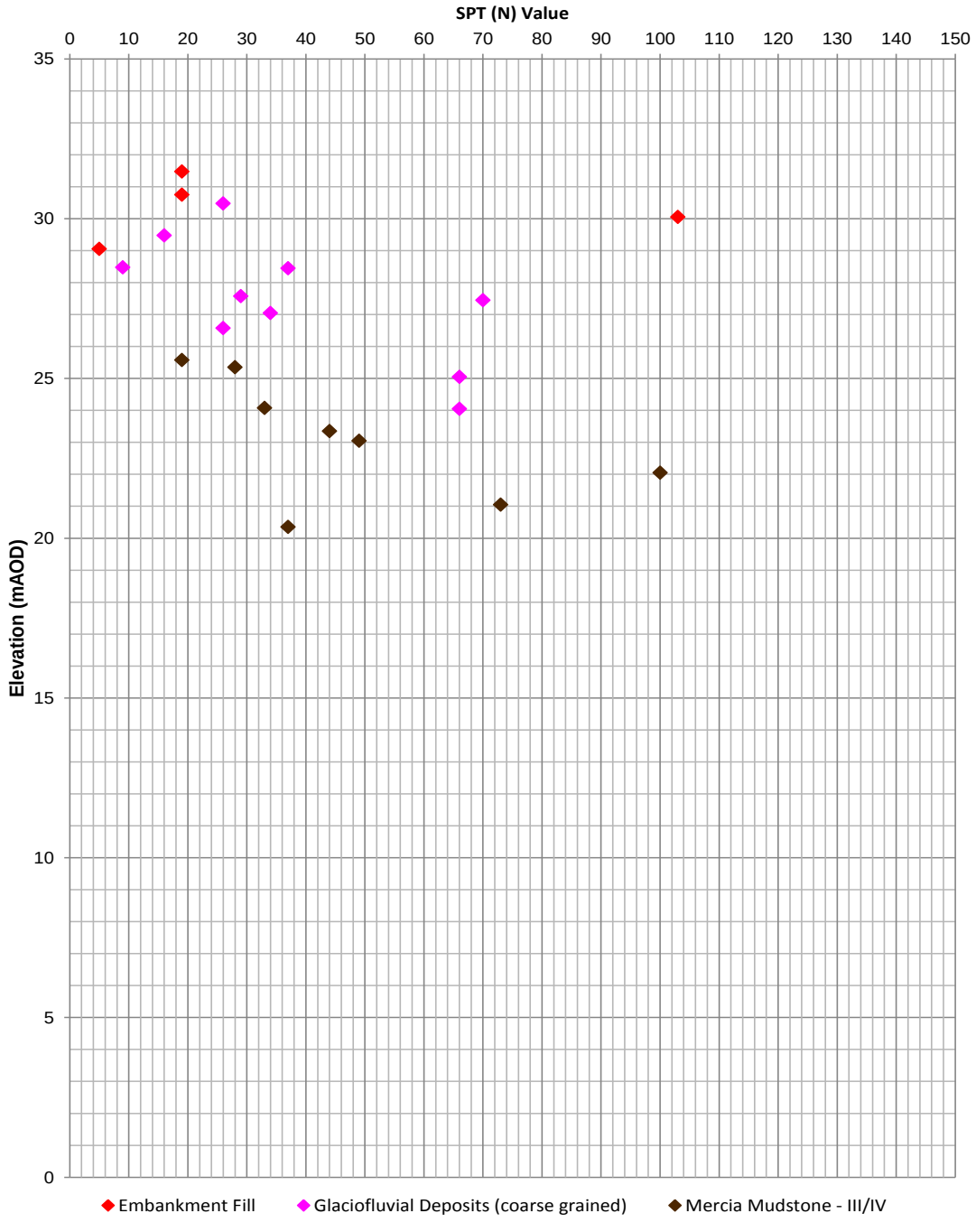
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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **191090-191310NB**
Client: **Highways England**	Borehole ID: **CP1110, CP1111, NWHM3**	



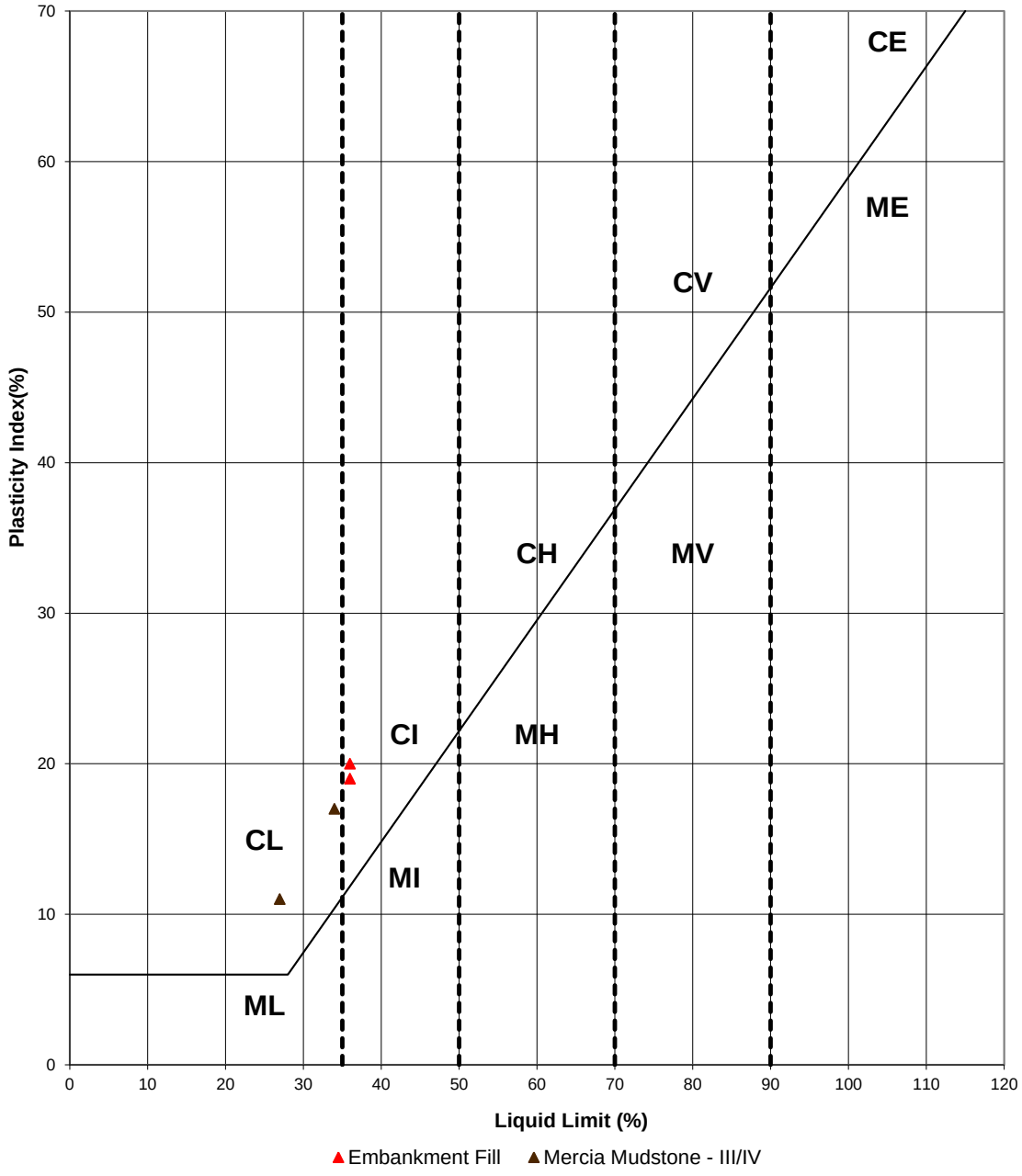
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 06/03/2017 Ref: HA549342-AMAR-HGT-191090-191310NB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **191090-191310NB**
Client: **Highways England**	Borehole ID: **CP1110, CP1111**	



Key

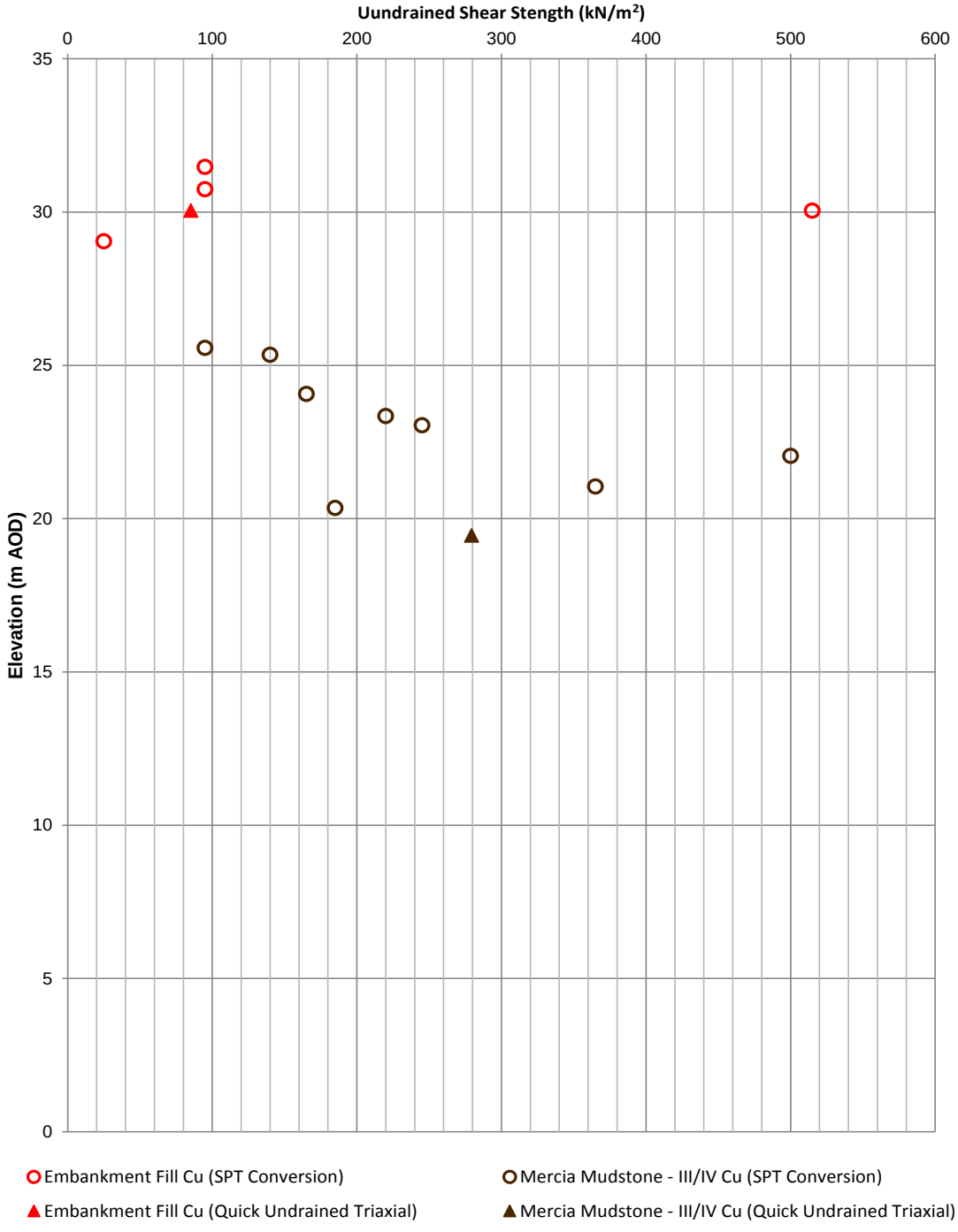
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **191090-191310NB**
Client: **Highways England**	Borehole ID: **CP1110, CP1111, NWHM6**	



Rev: P01 Date: 06/03/2017 Ref: HA549342-AMAR-HGT-191090-191310NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-191460-191480NB-GSS-000001		
Earthworks Widening Solution	Full Height Regrade (1:3.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	191460-191480		
Carriageway	Northbound		
Marker Post	191/4+60 – 191/4+80		
National Grid Reference	E 447258, N 333512 – E 447259, N 333533		
Existing Ground Level at Location	Carriageway	32.8mAOD	
	Crest of Bund	35.4mAOD	
Earthwork Type	NB: Bund	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_24568; 7_M1_24440	SB: N/A	HAGDMS designation
Maximum Earthwork Height	NB: 2.6m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Typical Earthwork Angle	NB: 10°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	27/04/2017	[redacted]
Checked	Roheel Masrat	11/03/2017	
Reviewed	Gary Summerfield	12/03/2017	
Approved	Thomas Bulteel	06/06/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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DESK STUDY

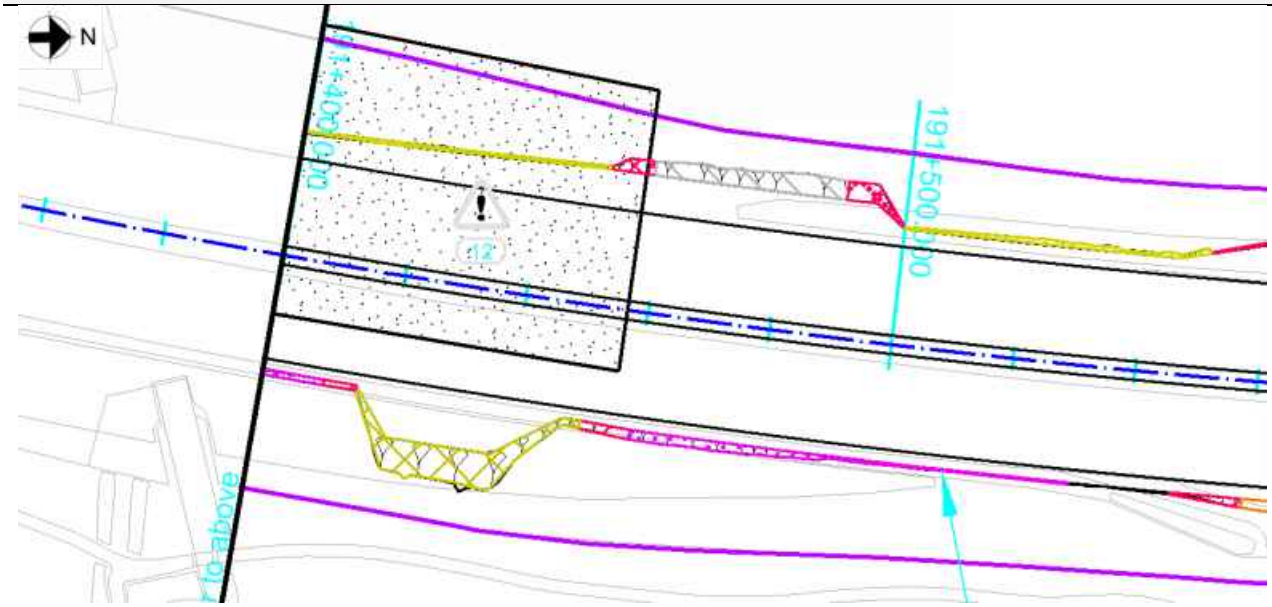


Figure 1: Location Plan

Proposed Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- 191460-191480 – Full Height Regrade (1:3.0)

Proposed Major Structures:

- No major Structures are proposed within the design chainage.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is classified as a bund. The bund is approximately 2.0m high in the south increasing to 2.6m in the north of the chainage extents, with a typical slope angle of 10^{o}.

The critical cross section Ch191470 was chosen based on the greatest bund height and the greatest vertical regrade height required.

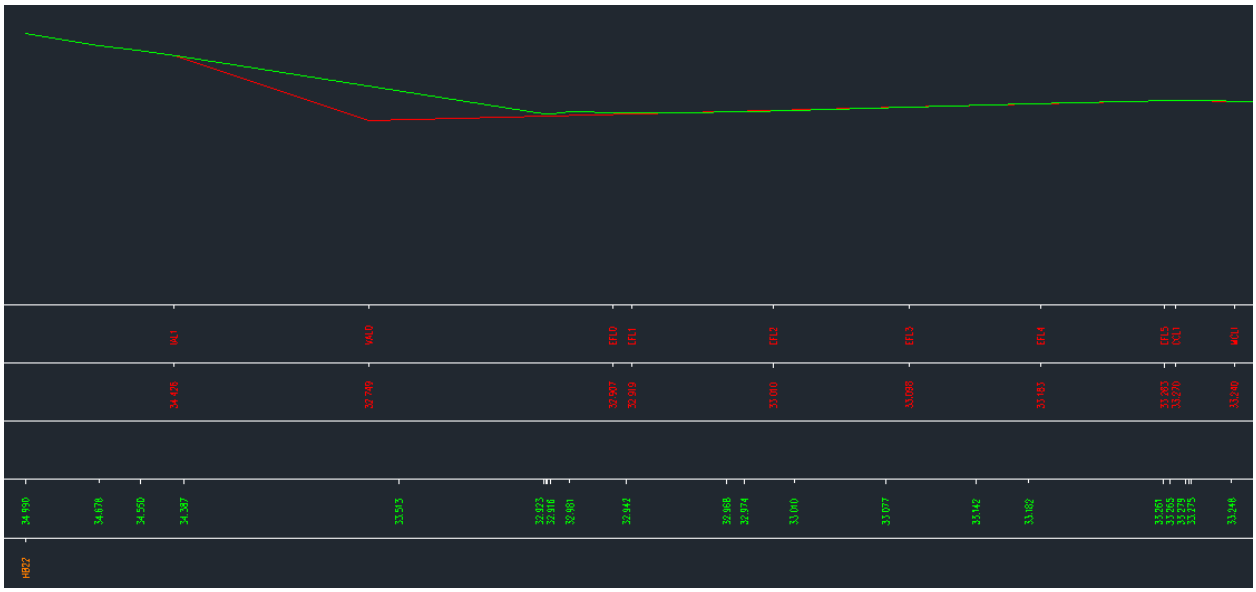


Figure 2: Topographic Critical Cross Section Ch191470

Utilities:

There are BT Comms at the existing verge and a buried Weston Power high voltage cable at the bund crest, both running parallel to the motorway.

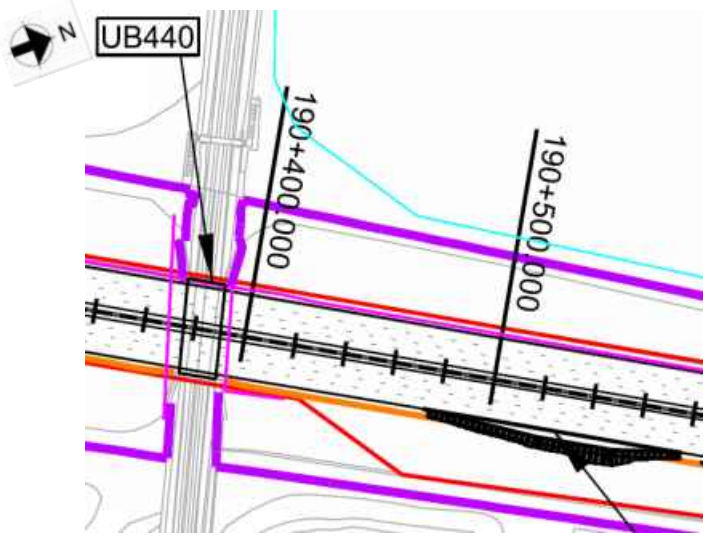


Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Beeston Sand and Gravel Member (Glaciofluvial Deposits);

Solid Deposits: Cotgrave Sandstone Member (Mercia Mudstone)

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however 2 No. relevant exploratory holes were considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000028, Rev P01.



Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	CP1111
Borehole Chainage	191375
Borehole Location	Southbound earthwork
National Grid Reference	E 447287, N 333422
Ground Level at Exploratory Hole	32.05m Above Ordnance Datum (mAOD)
RAG Analysis	Green
Date Drilled	29/08/2006 – 30/08/2006
Termination Depth	12.61m below ground level (mbgl)
Other suitable holes	SK43SE552

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey data.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT (N) Value
Embankment Fill	2.6	32.8	5
Glaciofluvial Deposits (coarse grained)	11.9	23.5	34-66 (34)
Mercia Mudstone – III/IV	Not proven	Not proven	49-100 (49)

(1) Ground level is assumed to be at the crest of the bund, of which is assumed to comprise Embankment Fill.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in historical exploratory hole CP1111.

Groundwater:

In CP1111 a groundwater strike was recorded at 4.60mbgl (27.45mAOD), rising to 3.10mbgl (28.95mAOD) after 20minutes. No groundwater data was provided in SK43SE552.

Groundwater Design Level:

No local groundwater level is available and therefore a design groundwater level of 1.0m below ground level throughout bund has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

2 No. Atterberg Limit Tests and 3 No. Moisture Content Tests were undertaken with the following results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	0.50	11	36	16	20	CI
Glaciofluvial Deposits (coarse grained)	4.00	39	31	23	8	MI*
Glaciofluvial Deposits (coarse grained)	6.45	14	-	-	-	-

*Test was undertaken within fine grained element of a predominantly coarse grained material; therefore has not been considered for derivation of geotechnical parameters.

1 No. Triaxial Test was undertaken within the Embankment Fill with the following result:

Stratum	Depth to Top of Test (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	2.00	85

Lab Test Data - BRE Classification:

The following chemical testing data was available from the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result	Unit
Embankment Fill	pH	Solid (water extract)	1	7.9	-
Embankment Fill	Total Sulphate	Solid	1	0.02	%
Embankment Fill	Water Soluble Sulphate	Solid (2:1 soil/water extract)	1	0.05	%
Mercia Mudstone – I/II	pH	Solid (water extract)	1	8.5	-
Mercia Mudstone – I/II	Total Sulphate	Solid	1	0.01	%
Mercia Mudstone – I/II	Water Soluble Sulphate	Solid (2:1 soil/water extract)	1	0.05	%

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Assumed Ground Model For Design:

Ground model based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-CE-000036 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01. The below table outlines the assumed anticipated ground model, to be confirmed by 'Just in Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γ_b (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)		Poisson's Ratio		Shear Modulus (MN/m^2)	BRE Classification
								E_u	E'	v_u	v'		
Embankment Fill	35.4-32.8	0-2.6	2.6	21	27	0	100	7.8	6.2	0.50	0.20	0.45	DS-1 AC-1
Glaciofluvial Deposits (coarse grained)	32.8-23.5	2.6-9.3	6.7	21	37	-	-	-	48.0	-	0.25	-	DS-3 AC-3
Mercia Mudstone – III/IV	<23.5	>9.3	-	21	30	2	245	16.5	13.2	0.50	0.20	0.45	DS-1 AC-1

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Given the limited amount of local PI data, the ϕ' of Embankment Fill and Mercia Mudstone – III/IV was taken as the characteristic value given in the AMAR GIR.
(4) Given the lack of GI data for Embankment Fill, the characteristic c_u and E values given in the AMAR GIR were adopted.
(5) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a characteristic SPT 'N' value of 34, ϕ' was found to be 37^o.
(6) c_u of Mercia Mudstone – III/IV was determined using recorded SPT 'N' values and the Stroud correlation. Due to the limited amount of local PI data, a typical f1 value of 5.0 was used along with the typical SPT 'N' value of 49.
(7) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a characteristic SPT 'N' value of 34, E' = 31.2MN/m^2.
(8) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the characteristic SPT 'N' value of 49, Eu = 16.5MN/m^2. Therefore E' = 13.2MN/m^2.
(9) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Glaciofluvial Deposits (coarse grained), the classification used for the strata in the AMAR GIR was adopted.

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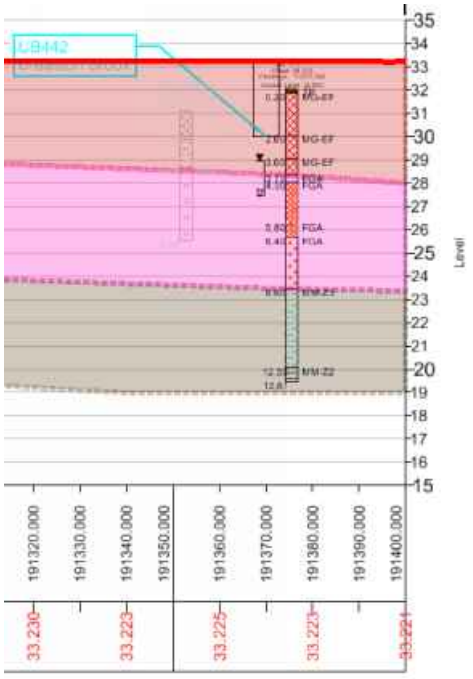


Figure 4.1: Geological Long Section



Figure 4.2: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
191460	191480	Full Height Regrade (1:3.0)

Proposed Structural Solution:

N/A.

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FURTHER GROUND INVESTIGATION

No ‘Just In Time’ GI is required at this location.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **SK43SE552**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447230.00 - 333410.00	Hole Type CP
Location:		Level: 31.09	Scale 1:50
Client: Highways England		Dates: 09/01/1966 - 09/01/1966	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		1.22	U				1.22	29.87		MADE GROUND - red marl MG-CL
		2.10	U							Firm mottled brown & grey CLAY FGA
		2.44	U				2.44	28.65		Compact grey sandy c.m.f GRAVEL FGA-SG
		4.57	U							
							5.60	25.49		End of borehole at 5.60 m

Remarks

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Rotary Core Log

Borehole No. CP1111 Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447287.00 - 333422.00	Hole Type CP
Location:		Level: 32.05	Scale 1:50
Client: Highways England		Dates: 29/08/2006 - 30/08/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	31.85		TOPSOIL. TP
		0.50	D							MADE GROUND. Firm to stiff red brown sandy gravelly clay. Gravel is coarse angular to subrounded of dolerite, quartz, mudstone and sandstone with frequent cobbles of the same. MG-EF
		0.50 - 1.00	B							
		1.20 - 1.70	U#8							To 1.20m, with many rootlets. From 1.20m, red brown mottled grey slightly sandy clay.
		1.70 - 2.00	B							
		2.00 - 2.40	U				2.00	30.05		MADE GROUND. Stiff dark grey/brown gravelly clay with some organic matter. Gravel is angular fine to coarse of red brick. MG-EF
		2.40	D							
		3.00 - 3.45	D				3.00	29.05		MADE GROUND. Soft brown mottled grey slightly sandy clay with occasional gravel of quartz, brick and sandstone. With gravel size pockets of coal dust and occasional organic matter (grass). MG-EF
		3.00 - 3.50	B							
		3.10	W							
		3.70	D				3.70	28.35		(Soft) grey black organic CLAY with occasional plant matter. Possible FGA
		4.00 - 4.45	U				4.00	28.05		Dense brown grey slightly clayey sandy GRAVEL/gravelly SAND. Gravel is angular to rounded fine to coarse of sandstone, mudstone, dolerite, flint and quartz. FGA-SG
		4.45	D							
		5.00 - 5.45	D							
		5.00 - 5.50	B							
		5.80	D				5.80	26.25		Soft blue grey sandy CLAY with occasional fine subrounded gravel of quartz and flint. FGA
		6.00 - 6.45	U							
		6.45	D				6.40	25.65		Very dense light grey/white fine to medium SAND with occasional angular to subrounded fine gravel of grey sandstone. Becoming gravelly with depth. FGA-SG
		7.00 - 7.45	D							
		7.00 - 7.50	B							
		8.00 - 8.45	D							
		8.00 - 8.50	B							
		8.60	D				8.60	23.45		Firm to stiff red brown mottled grey gravelly CLAY. Gravel is angular fine to coarse of friable mudstone. MM-Z3
		9.00 - 9.45	D							At 8.60m, becoming sandy with clay.
		9.00 - 9.50	B							
		10.00	D							Continued on next sheet.

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. A hand held Photo-Ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm. The borehole was advanced by chiselling methods from 1.70m to 2.00 (1.5hr) and 12.00m to 12.50m (1hr).

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Rotary Core Log

Borehole No. CP1111 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447287.00 - 333422.00	Hole Type CP
Location:		Level: 32.05	Scale 1:50
Client: Highways England		Dates: 29/08/2006 - 30/08/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.00 - 10.50	B							CLAY (as previous sheet)
		11.00	D							
		11.00 - 11.50	B							
		12.00	D				12.00	20.05		MUDSTONE. Recovered as red brown clayey angular fine to coarse gravel sized fragments with pockets of blue grey slightly sandy fissile clay. MM-Z2
		12.00 - 12.50	B							
		12.50	D				12.61	19.44		End of borehole at 12.61 m

Remarks

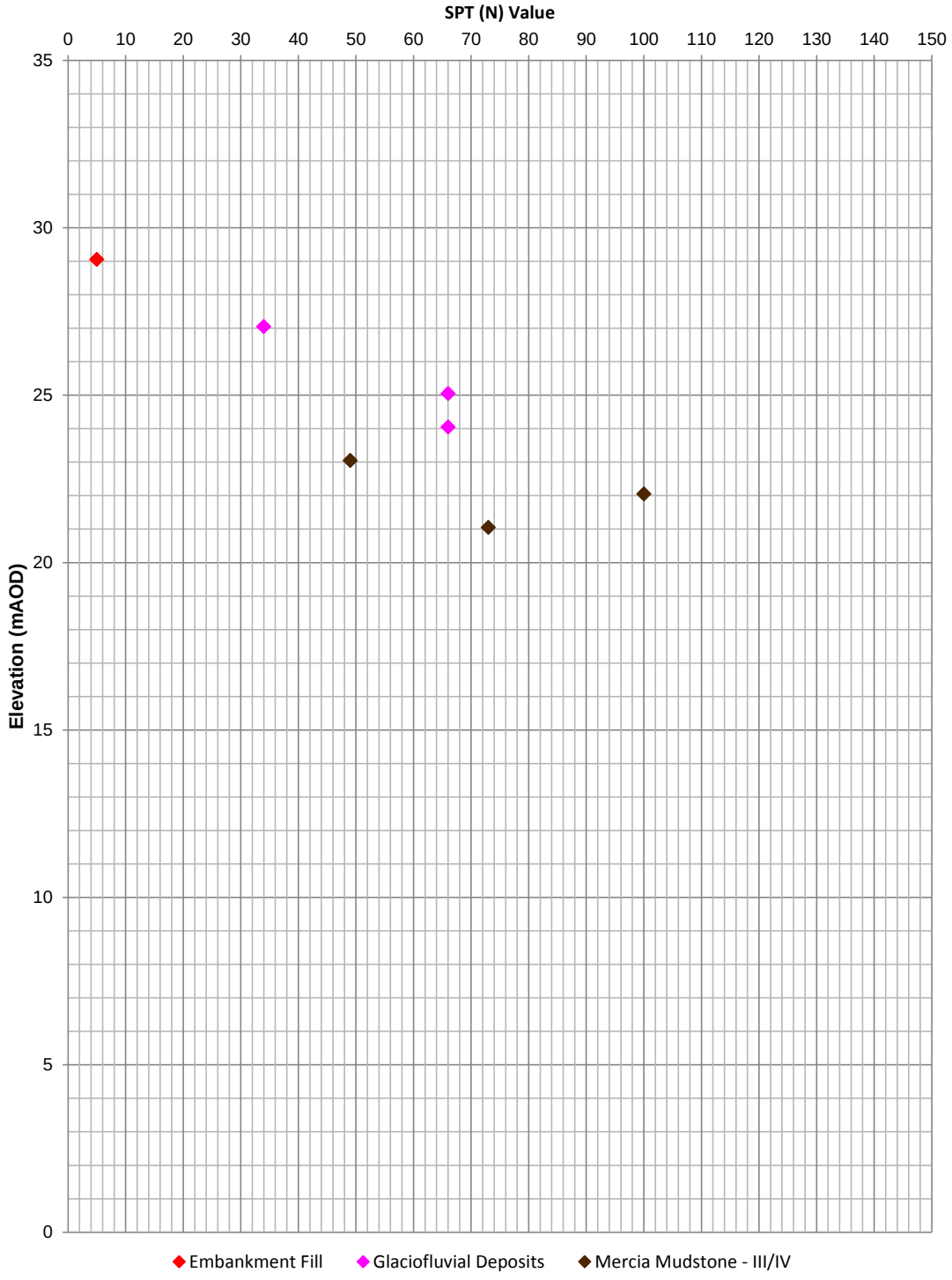
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. .A hand held Photo-ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm .The borehole was advanced by chiselling methods from 1.70m to 2.00 (1.5hr) and 12.00m to 12.50m (thr).

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PLOTS

amey ARUP	SPT N Value vs Depth
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25** | Data Sheet: **191460-191490NB**
Client: **Highways England**	Borehole ID: **CP1111**



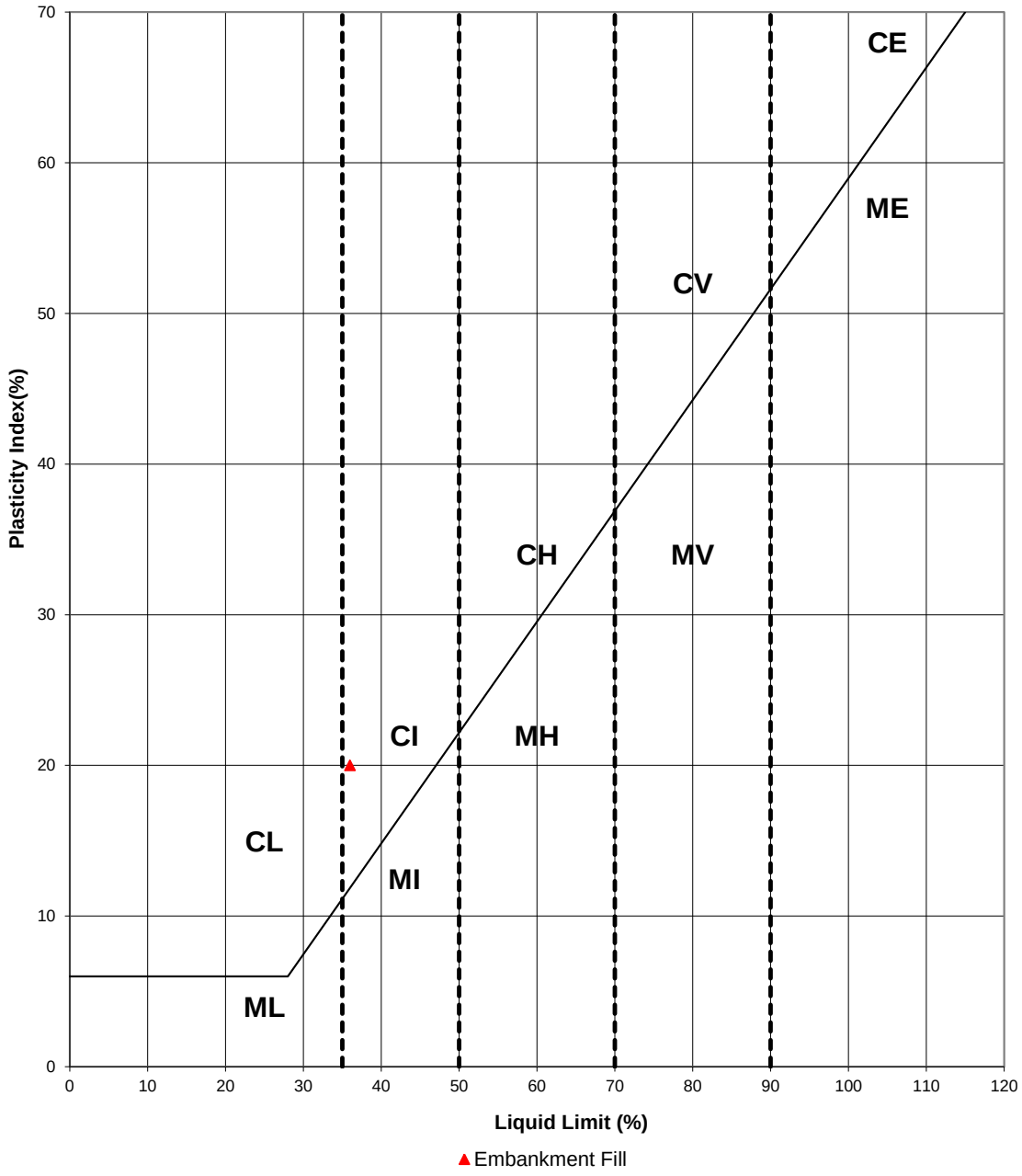
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 03/03/2017 Ref: HA549342-AMAR-HGT-191460-191490NB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **191460-191490NB**
Client: **Highways England**	Borehole ID: **CP1111**	



Key

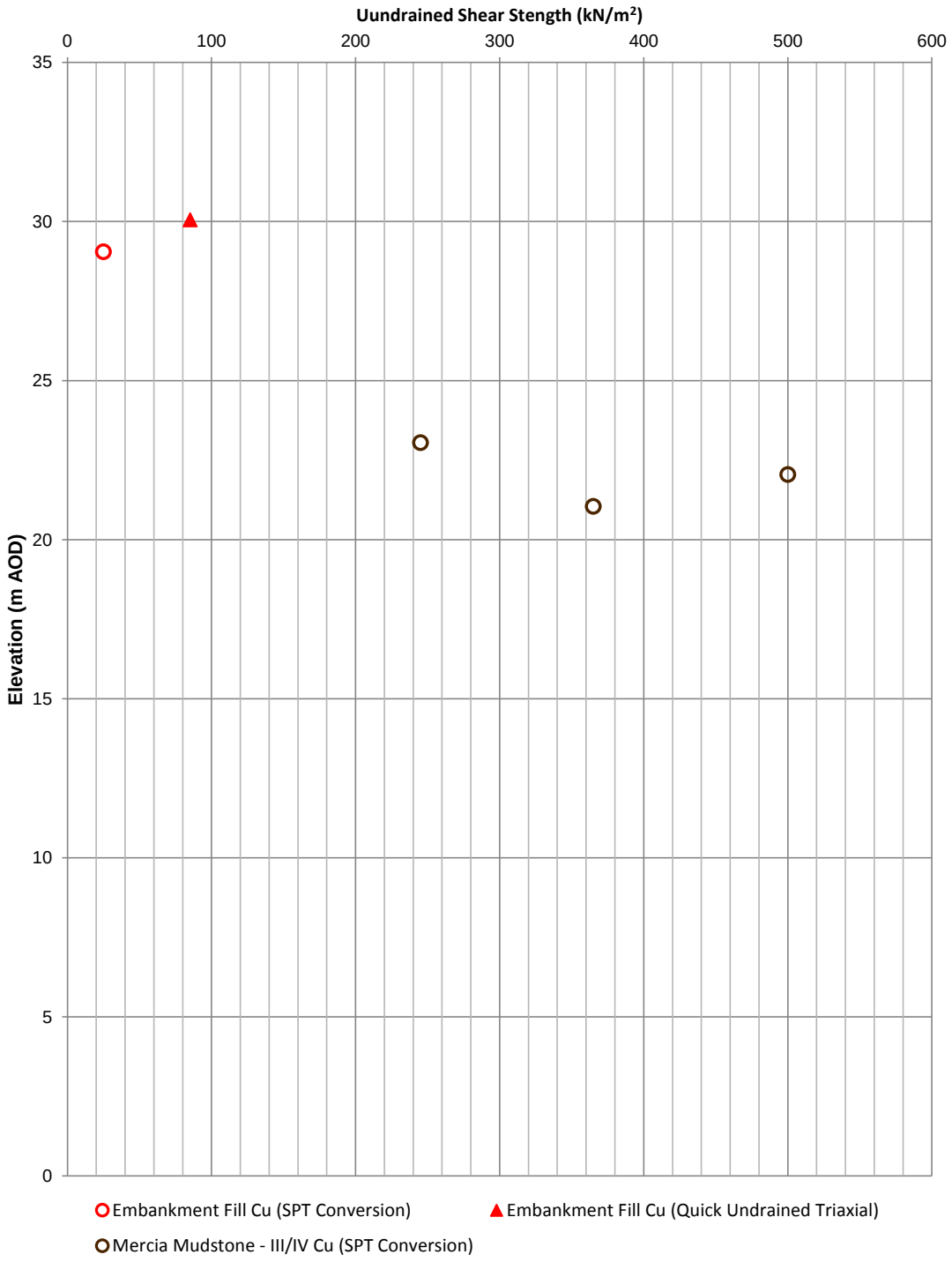
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 03/03/2017 Ref: HA549342-AMAR-HGT-191460-191490NB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **191460-191490NB**
Client: **Highways England**	Borehole ID: **CP1111**	



Rev: P01 Date: 03/03/2017 Ref: HA549342-AMAR-HGT-191460-191490NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-191560-191580NB-GSS-000001		
Structure Number	N/A		
Structure Type	King Sheet Pile Retaining Wall		
Design Chainage	191560-191580		
Carriageway	Northbound		
Marker Post	191/5+60A – 191/5+80A		
National Grid Reference	E 447268, N 333611 – E 447269, N 333631		
Existing Ground Level at Location	Crest	35.7mAOD	
	Carriageway	33.1mAOD	
Earthwork Type	NB: Cutting	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_24568	SB: N/A	HAGDMS designation
Earthwork Height	NB: 2.6m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 18°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Roheel Masrat	23/01/2017	[redacted]
Checked	Scott Bishton	26/04/2017	
Reviewed	Gary Summerfield	27/04/2017	
Approved	Thomas Bulteel	04/05/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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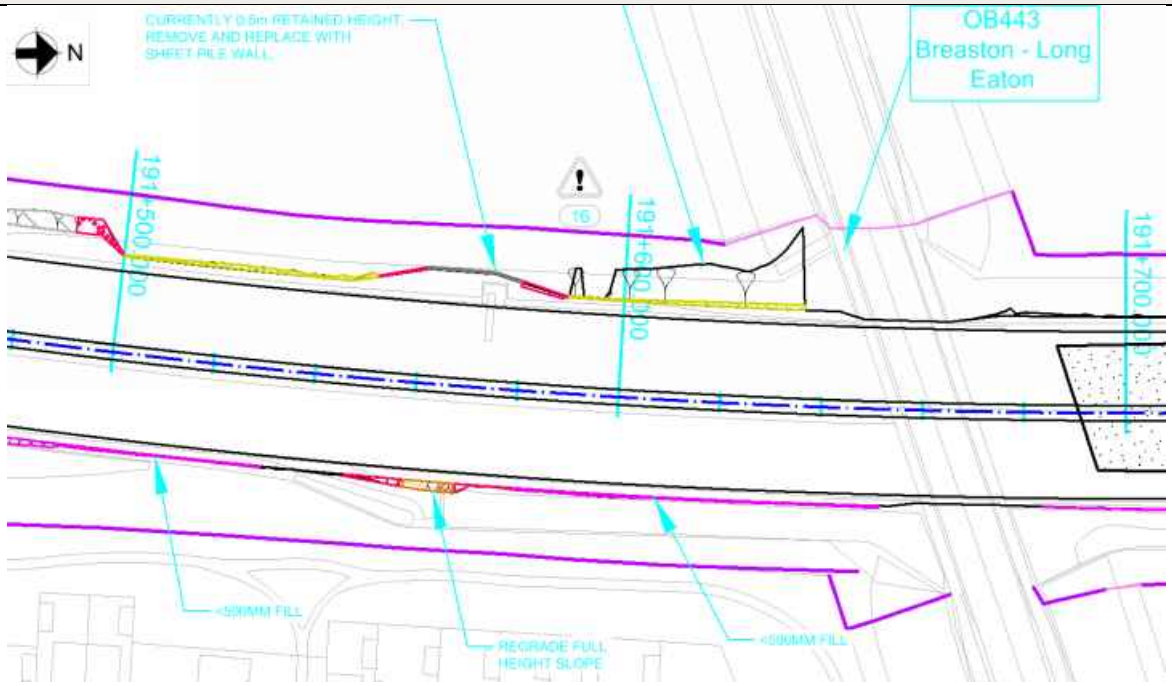


Figure 1: Location Plan

Proposed Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch191560-191580, King Sheet Pile Retaining Wall

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as cutting at approximately 2.6m height and an approximate slope angle of 18°.

The critical cross sections used is Ch191570.

Proposed Major Structures:

N/A.



Figure 2: Topographic Critical Cross Section Ch191570

Utilities:

Western Power Overhead Mid Voltage cable at cutting crest running parallel to the carriageway.



Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough, indicates that the site is underlain by:

Superficial Deposits: Beeston Sand and Gravel Member (Glaciofluvial Deposits)

Solid Deposits: Gunthorpe Member (Mercia Mudstone)

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however there are considered to be 5 No. additional relevant exploratory holes, as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000028, Rev P01.

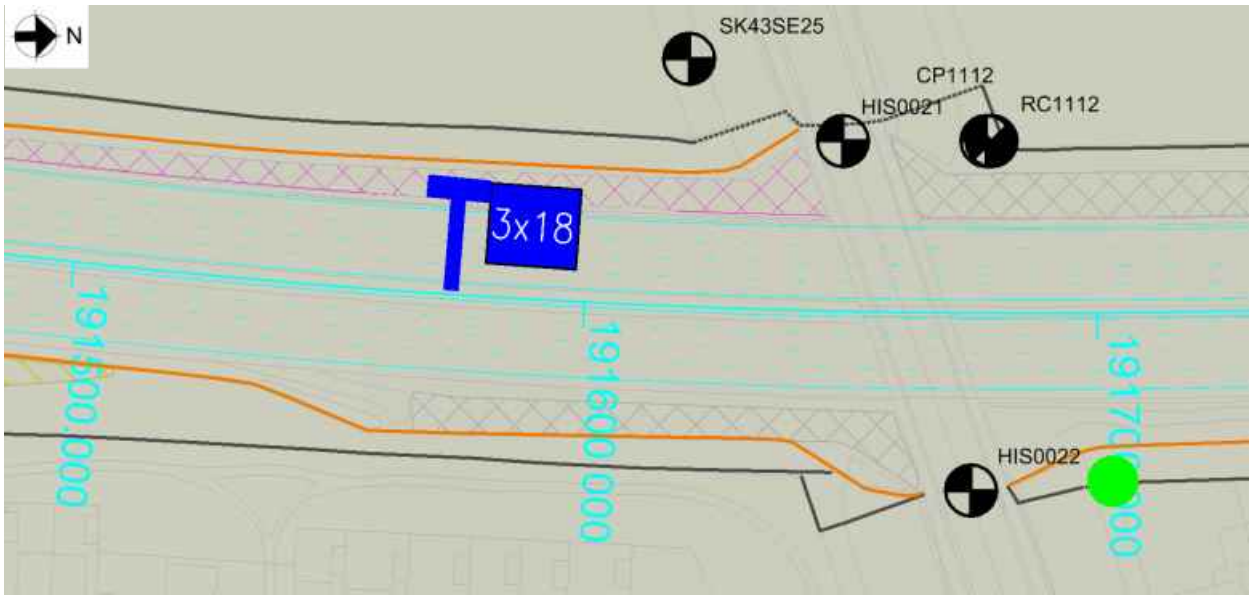


Figure 3: Borehole Location Plan

Flood Risk:

Location is not in a flood risk area.

Historical Boreholes:

Relevant Borehole Number	SK43SE25	CP1112	HIS0021	RC1112
Borehole Chainage	191620	191678	191650	191678
Borehole Location	Outside of HE boundary on west side of carriageway (prior to motorway construction)	Outside of HE boundary on west side of carriageway	Outside of HE boundary on west side of carriageway (prior to motorway construction)	Outside of HE boundary on west side of carriageway
National Grid Reference	E 447240, N 333670	E 447256, N 333728	E 447256 N333700	E 447256, N 333729
Ground Level at Exploratory Hole	35.40mAOD	33.35mAOD	35.70mAOD	35.50mAOD
RAG Analysis	Amber	Green	Green	Green
Date Drilled	28/02/1962 – 01/03/1962	16/10/2006	17/06/1964 – 29/06/1964	18/10/2006
Termination Depth	7.62 metres below ground level (mbgl)	7.55mbgl (25.8mAOD)	24.99mbgl (10.71mAOD)	19.75mbgl (15.75mAOD)

	(27.78mAOD)			
Other suitable holes	HIS0022			

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT (N) Values
Head Deposits (fine grained)	0.8	34.9	None recorded
Glaciofluvial Deposits (coarse grained)	5.2	30.5	15-150 (20)
Mercia Mudstone – III/IV	Not proven	Not proven	40-43 (40)

1. Ground level is assumed to be at the crest of the cutting
2. SPT capped at 150. Characteristic 'N' Values are given in brackets.
3. Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.
4. Given the lack of local GI data post-dating motorway construction for the location, it is assumed that Head Deposits are fine grained as a conservative measure.
5. Historical exploratory hole SK43SE25 records River Terrace Deposits; however, it is considered that at this location Glaciofluvial Deposits are present, as interpreted within the geological long section Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000036. Therefore, the River Terrace Deposits of SK43SE25 are considered as Glaciofluvial Deposits here.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in all historical exploratory holes (SK43SE25, HIS0021, HIS0022, CP1112 and RC1112).

Groundwater:

The following groundwater strikes were recorded in the historical exploratory holes (groundwater was not apparent during boring but may have been masked by the addition of water for CP1112 and RC1112):

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		mbgl	mAOD	Time	mbgl	mAOD
HIS0021	Glaciofluvial Deposits (coarse grained)	1.52	34.18	-	-	-
HIS0022	Glaciofluvial Deposits (coarse grained)	0.91	34.79	-	-	-
SK43SE25	Glaciofluvial Deposits (coarse grained)	2.74	32.66	-	-	-

Groundwater Design Level:

A groundwater level of 1.0m below carriageway level was assumed for the WALLAP king sheet pile retaining wall analysis. For the global stability check using SLOPE/W, Ru values of 0.2 were adopted for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

15 No. undrained triaxial tests were undertaken with the following results:

Stratum	Depth to Top of Test (mbgl)	Undrained Shear Strength (kN/m^2)
Mercia Mudstone – III/IV	12.19	110
Mercia Mudstone – III/IV	13.72	110
Mercia Mudstone – III/IV	10.67	144
Mercia Mudstone – III/IV	7.62	91
Mercia Mudstone – III/IV	16.76	96
Mercia Mudstone – III/IV	9.14	165
Mercia Mudstone – III/IV	6.71	55
Mercia Mudstone – III/IV	14.48	249
Mercia Mudstone – III/IV	8.38	132
Mercia Mudstone – III/IV	6.86	117
Mercia Mudstone – III/IV	12.95	220
Mercia Mudstone – III/IV	11.43	194
Mercia Mudstone – III/IV	16.00	110
Mercia Mudstone – III/IV	5.33	110
Mercia Mudstone – III/IV	9.91	144

Lab Test Data - Chemical:

The following chemical testing data was available from the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result	Unit
Glaciofluvial Deposits (coarse grained)	pH	Water	4	6.0-8.4	-
Glaciofluvial Deposits (coarse grained)	Sulphate (Total) as SO_4	Water	6	0.02-0.41	g/l
Mercia Mudstone – III/IV	pH	Solid	10	7.2-7.5	-
Mercia Mudstone – III/IV	Sulphate (Total) as SO4	Solid	10	0.04-0.12	%

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000036 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outlines the assumed anticipated ground model:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)		Poisson's Ratio		BRE Classification
								E_u	E'	v_u	v'	
Head Deposits	0.0 – 0.8	35.7 – 34.9	0.8	21	27	0	100	7.8	6.2	0.5	0.2	DS-1 AC-1
Glaciofluvial Deposits (coarse grained)	0.8 – 5.2	34.9 – 30.5	4.4	21	33	-	-	-	31.2	-	0.25	DS-2 AC-2
Mercia Mudstone – III/IV	>5.2	<30.5	-	21	30	2	200	13.8	11.0	0.5	0.20	DS-1 AC-1

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Due to limited localised GI data for Head Deposits, the geotechnical parameters derived in the AMAR GIR have been adopted for design.
(4) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a characteristic SPT 'N' value of 20, ϕ' was found to be 33°.
(5) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a characteristic SPT 'N' value of 20, E' = 31.2MN/m^2.
(6) Due to limited localised GI data for Mercia Mudstone – III/IV, the characteristic ϕ' derived in the AMAR GIR was adopted for design.
(7) c_u of Mercia Mudstone – III/IV was derived using the Stroud correlation. In the absence of local PI data, an f1 value of 5.0 was adopted (after guidance in CIRIA C570), with a characteristic SPT of 40, c_u= 200kN/m^2.
(8) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the characteristic SPT 'N' value of 40, Eu = 13.8MN/m^2. Therefore E' = 11.0MN/m^2.
(9) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Head Deposits, the classification used for the strata in the AMAR GIR was adopted.

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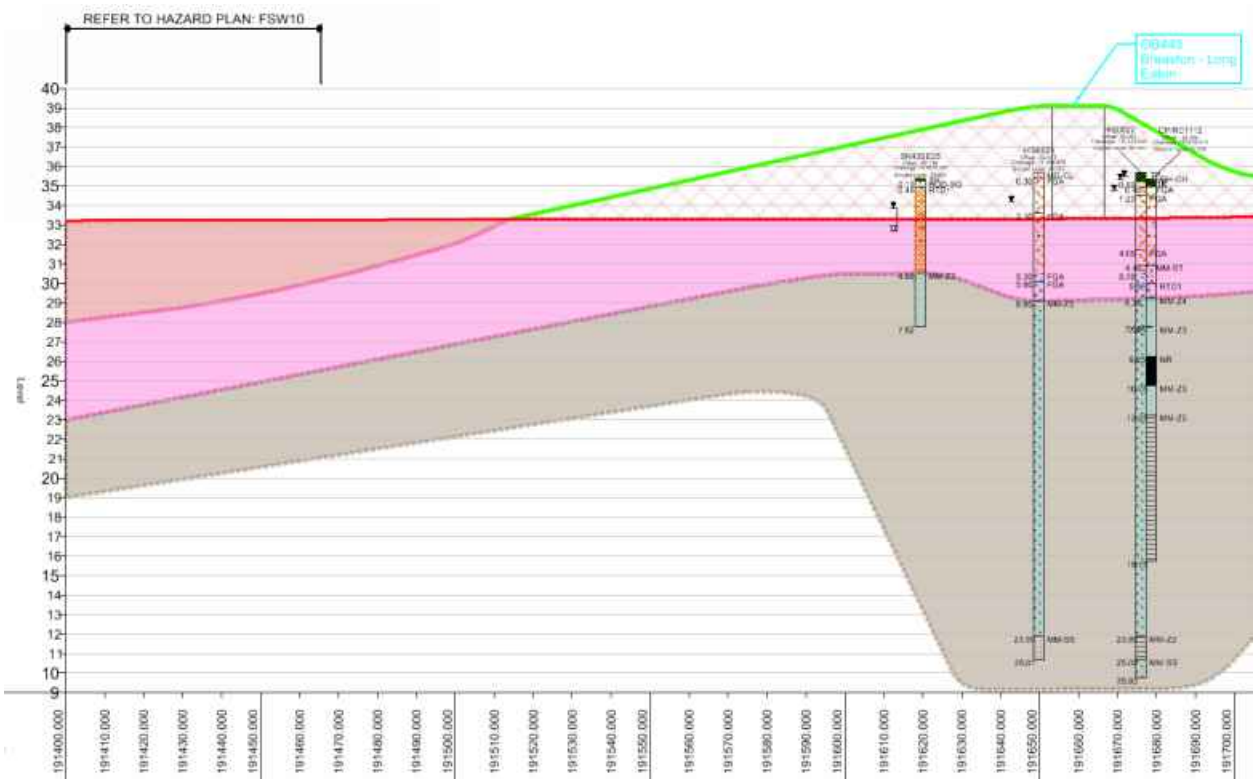


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to slope profile impeding the HE boundary and environmental barrier, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	King Section Type	Retained Height (m)	Embedded Depth (m)	King Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
191557	191582	AZ-12 S 390 GP	0.9	3.8	4.7	85	30	5.0	21.0

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

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FURTHER GROUND INVESTIGATION

No additional GI will be undertaken specifically for this location.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **CP1112** Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447256.00 - 333728.00	Hole Type CP
Location:		Level: 35.35	Scale 1:50
Client: Highways England		Dates: 16/10/2006 - 16/10/2006	Logged By MW

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.40	B							Brown slightly sandy, occasional gravelly to gravelly clayey TOPSOIL. Gravel is subangular to subrounded fine to coarse, of sandstone, quartz and rare coke. TP
		0.40 - 1.20	B				0.40	34.95		Medium dense grey brown becoming brown clayey SAND and GRAVEL. Sand is medium to coarse. Gravel is angular to subrounded fine to coarse of sandstone and quartz. FGA-SG
		1.20 - 1.65	B							
		2.20 - 2.65	B							*Below 2.20m, sandy gravel*
		3.20 - 3.65	B							
		4.20 - 4.65	B				4.40	30.95		Very stiff purple brown, locally grey green, SILT. Locally a silt/clay with some siltstone lithorelics. MM-ST
		5.20 - 5.65	D							
		5.20 - 5.70	B							
		6.20	D				6.20	29.15		(Very weak) orange brown laminated, locally sandy SILTSTONE recovered as friable slightly sandy to sandy silt with some lithorelics. MM-ST
		6.20 - 6.70	B							
		7.20	D							
		7.50	D				7.55	27.80		*At 7.50m, purple brown and grey green siltstone with some bands of very sandy siltstone to a sandstone* End of borehole at 7.55 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 3.40m to 3.70m (1 hour) and 7.30m to 7.50m (1 hour).;No visual or olfactory indication of contamination was observed.;The borehole was backfilled on completion with grout.;

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Rotary Core Log

Borehole No. HIS0021
Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447256.00 - 333700.00	Hole Type CP
Location:		Level: 35.70	Scale 1:50
Client: Highways England		Dates: 17/06/1964 - 29/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	35.40		FILL MG-CL
		0.91 - 1.22	B							Medium dense brown slightly sandy fine to coarse GRAVEL FGA-SG
	▼	1.52	W							
		1.83 - 2.13	B							
							2.10	33.60		Medium dense brown sandy medium to coarse GRAVEL FGA-SG
		2.74 - 3.05	B							
		3.66 - 3.96	B							
		5.18	D				5.20	30.50		
		5.33 - 5.64	U							Stiff brown silty CLAY FGA
							5.60	30.10		
		5.79 - 6.10	B							Medium dense brown fine to coarse GRAVEL FGA-SG
		6.55	D				6.60	29.10		
		6.71 - 7.16	U							Firm to stiff, becoming very stiff to hard, friable red-brown and grey silty CLAY with mudstone fragments; SANDSTONE from 14.3m to 14.5m and from 18m to 18.3m. (keuper Marl) MM-Z3
		7.16	D							
		7.62 - 8.08	U							
		8.08	D							
		9.14 - 9.60	U							
		9.60	D							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 1.5m below ground level and a sample was taken.

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Rotary Core Log

Borehole No. HIS0021
Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447256.00 - 333700.00	Hole Type CP
Location:		Level: 35.70	Scale 1:50
Client: Highways England		Dates: 17/06/1964 - 29/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.06	D							
		10.67 - 11.13	U							
		11.13	D							
		11.58	D							
		12.19 - 12.65	U							
		12.65	D							
		13.11	D							
		13.72 - 14.17	U							
		14.17	D							
		14.48	D							
		15.24 - 15.73	U							
		15.70	D							
		16.00	D							
		16.76 - 17.22	U							
		17.22	D							
		17.98	D							
		18.03	U							
		19.51	B							
		19.51 - 19.58	U							
		19.81 - 20.73	B							

11 12 13 14 15 16 17 18 19 20

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 1.5m below ground level and a sample was taken.

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Rotary Core Log

Borehole No. HIS0021
Sheet 3 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447256.00 - 333700.00	Hole Type CP
Location:		Level: 35.70	Scale 1:50
Client: Highways England		Dates: 17/06/1964 - 29/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		21.95	D							
		22.86	D							
							23.80	11.90		Grey SANDSTONE MM-SS
		24.99	D				25.01	10.69		End of borehole at 24.99 m

21 22 23 24 25 26 27 28 29 30

Remarks
Ground-water was first encountered at a depth of 1.5m below ground level and a sample was taken.

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Rotary Core Log

Borehole No. HIS0022 Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447324.00 - 333725.00	Hole Type CP
Location:		Level: 35.70	Scale 1:50
Client: Highways England		Dates: 30/06/1964 - 08/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.30	B							TOPSOIL TP
		0.61 - 1.07	B				0.50	35.20		Very dense weakly cemented brown fine to medium SAND with occasional gravel FGA-SG
	▼						1.20	34.50		Medium dense brown very sandy fine to coarse GRAVEL FGA-SG
		1.83 - 2.13	B							
		2.74 - 3.05	B							
		3.66 - 3.96	B							
							4.00	31.70		Medium dense brown coarse GRAVEL and COBBLES FGA-SG
		4.57 - 4.88	B							
		5.18	D				5.20	30.50		Stiff to very stiff, becoming hard, friable red-brown, occasionally grey silty CLAY with mudstone and fibrous gypsum bands at depth (Keuper Marl) MM-Z3
		5.33 - 5.79	U							
		5.79	D							
		6.40	D							
		6.86 - 7.32	U							
		7.32	D							
		7.92	D							
		8.38 - 8.84	U							
		8.84	D							
		9.45	D							
		9.91 - 10.36	U							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 0.91m below ground level. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. HIS0022 Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447324.00 - 333725.00	Hole Type CP
Location:		Level: 35.70	Scale 1:50
Client: Highways England		Dates: 30/06/1964 - 08/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.36	D							
		10.97	D							
		11.43 - 11.89	U							
		11.89	D							
		12.50	D							
		12.95 - 13.41	U							
		13.41	D							
		14.02	D							
		14.48 - 14.94	U							
		14.94	D							
		15.54	D							
		16.00 - 16.46	U							
		16.46	D							
		17.07	D							
		17.53 - 17.58	U							
		17.98	D							
		18.29	D							
		18.59 - 18.90	U							
		18.90	D							
		19.81	D							

11 12 13 14 15 16 17 18 19 20

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 0.91m below ground level. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. HIS0022
Sheet 3 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447324.00 - 333725.00	Hole Type CP
Location:		Level: 35.70	Scale 1:50
Client: Highways England		Dates: 30/06/1964 - 08/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		20.73	D							
		21.34	D							
		22.56	D							
		23.77	D				23.80	11.90		Grey MUDSTONE MM-Z2
		24.99	D				25.00	10.70		Grey SANDSTONE MM-SS
		25.91	D				25.93	9.77		End of borehole at 25.91 m

Remarks
Ground-water was first encountered at a depth of 0.91m below ground level. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. **RC1112** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447256.00 - 333729.00	Hole Type RC
Location:		Level: 35.50	Scale 1:50
Client: Highways England		Dates: 18/10/2006 - 18/10/2006	Logged By SM

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 5.50								OPEN HOLE. Refer to borehole CP1112 for likely material description OH-OH
		3.35	W							
		3.65	W							
		5.50 - 6.25		33	0	0	5.50	30.00		Poor recovery. Recovered as light and dark grey subrounded to rounded coarse GRAVEL and COBBLES of siltstone and sandstone. RTD1
		6.25 - 7.75		70	0	0	6.25	29.25		Very stiff red brown sandy friable CLAY with rare rounded fine and medium gravel sized lithorelics of very weak mudstone. MM-Z4
		7.75 - 9.25		37	0	0	7.75	27.75		*Gradational boundary* Poor recovery. Recovered as very stiff red brown sandy friable CLAY with very weak rounded fine and medium gravel sized lithorelics of mudstone. With occasional pockets/bands up to 25mm of light grey green slightly sandy clay. Sand is fine. MM-Z3
							9.25	26.25		NO RECOVERY NR
										Continued on next sheet

Remarks
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. RC1112 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447256.00 - 333729.00	Hole Type RC
Location:		Level: 35.50	Scale 1:50
Client: Highways England		Dates: 18/10/2006 - 18/10/2006	Logged By SM

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.25 - 10.75		0	0	0				NO RECOVERY (as previous sheet)
		10.75 - 12.25		30	0	0	10.75	24.75		Poor recovery. Recovered as very stiff red brown sandy friable CLAY with very weak rounded fine and medium gravel sized lithorelics of mudstone. MM-Z3
		12.25 - 13.75		73	47	0	12.25	23.25		Very weak laminated to very thinly bedded red brown MUDSTONE with occasional bands and pockets of siltstone. Fractures are subhorizontal very closely to closely spaced, generally tight, planar and smooth. MM-Z2
		13.75 - 15.25		67	50	0				At 12.60m, 30mm band of moderately strong light grey green siltstone. Between 12.65m and 13.25m, fractures are randomly orientated and extremely closely spaced. Between 13.25m and 14.30m, assumed zone of core loss. Below 14.30m, becoming weak and locally moderately weak.
		15.25 - 16.75		40	40	13				Between 15.25m and 16.75m, poor recovery.
		16.75 - 18.25		63	53	7				Between approximately 17.30m and 17.60m, becoming very weak with very closely spaced thin to thick laminae of firm red brown clay. Between approximately 17.60m and 17.70m, becoming light grey green.
		18.25 - 19.75	PL	57	57	32				Below approximately 18.55m, with occasional very closely to closely spaced thin to thick laminae of quartz. Fractures becoming closely spaced.
							19.75	15.75		End of borehole at 19.75 m

Remarks
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. **SK43SE25** Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447240.00 - 333670.00	Hole Type CP
Location:		Level: 35.40	Scale 1:50
Client: Highways England		Dates: 28/02/1962 - 01/03/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	D				0.15	35.25		Topsoil
		0.30	D							TP
							0.46	34.94		Subsoil
										HDD-SG
										Gravel & sand
										RTD1
		1.52	D							
		2.13 - 2.59	B							
		2.13 - 2.59	SPTL S							
		2.74	W							
		3.05	D							
		3.66 - 4.11	SPTL S							
		3.66 - 4.11	B							
		4.57	D							
							4.88	30.52		Red marl & decomposed grey sandstone
										MM-Z3
		5.18	D							
		5.33 - 5.64	U							
		5.64	D							
		6.40	D							
		7.32 - 7.62	U							
		7.62	D				7.62	27.78		End of borehole at 7.62 m

Remarks

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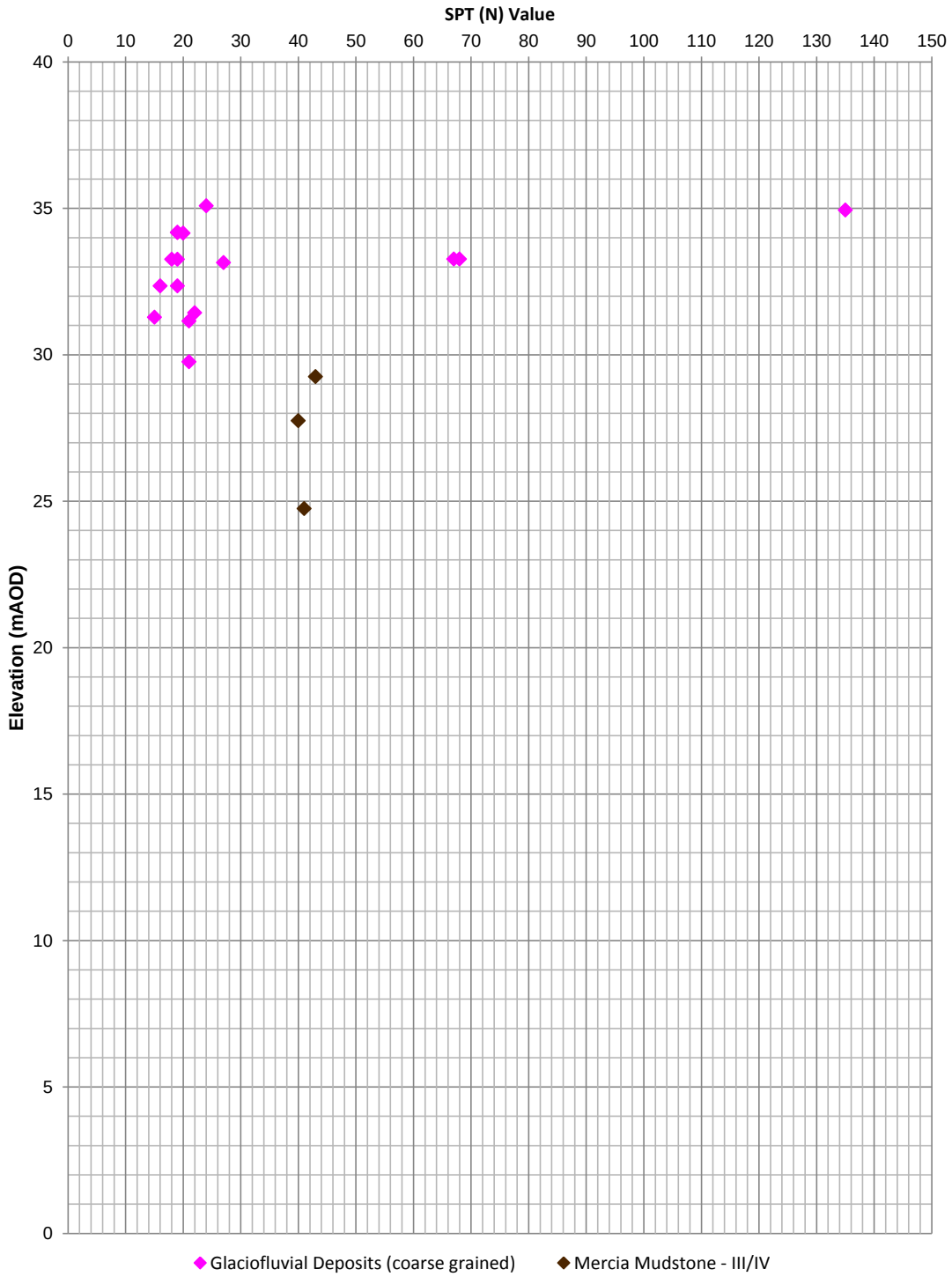
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PLOTS

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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **191560-191580SB**
Client: **Highways England**	Borehole ID: **SK43SE25, HIS0021, HIS0022, CP1112, RC1112**	



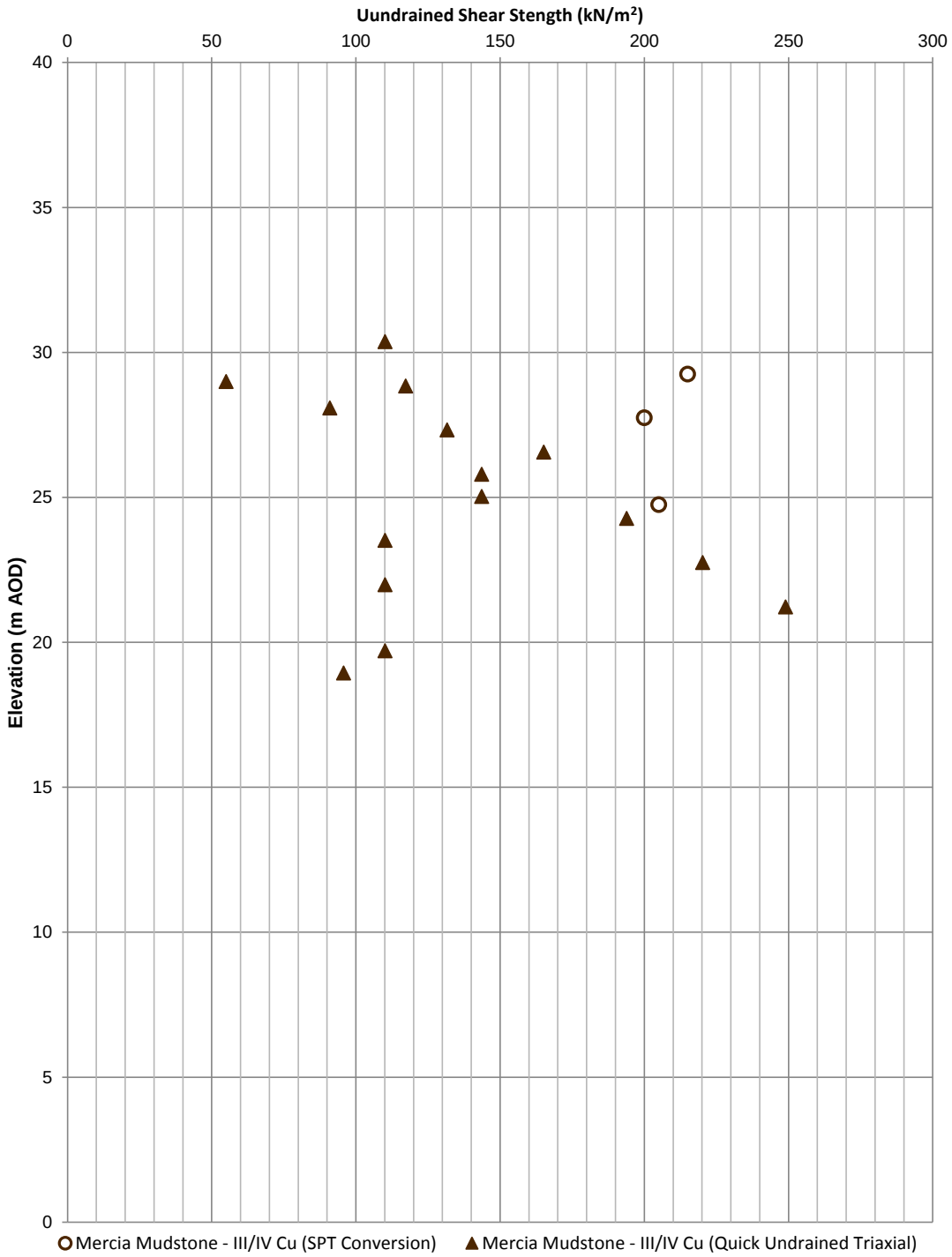
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 23/01/2017 Ref: HA549342-AMAR-HGT-191560-191580SB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **191560-191580NB**
Client: **Highways England**	Borehole ID: **RC1112, HIS0021, HIS0022**	



Rev: P01 Date: 23/01/2017 Ref: HA549342-AMAR-HGT-191560-191580NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-191760-191820NB-GSS-000001		
Earthworks Widening Solution	Full Height Regrade (1:3.0)		
Structure Number	GANTRY_318[1]		
Structure Type	MS4 Cantilever Gantry		
Design Chainage	191760-191820		
Carriageway	Northbound		
Marker Post	191/7+80 – 191/8+20		
National Grid Reference	E 447270, N 333810 – E 447266, N 333868		
Existing Ground Level at Location	Carriageway	33.7mAOD	
	Crest of Bund	35.7mAOD	
Earthwork Type	NB: Bund	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_22235	SB: N/A	HAGDMS designation
Maximum Earthwork Height	NB: 2.0m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Typical Earthwork Angle	NB: 20°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	26/04/2017	[redacted]
Checked	Roheel Masrat	13/03/2017	
Reviewed	Gary Summerfield	13/03/2017	
Approved	Thomas Bulteel	06/06/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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DESK STUDY

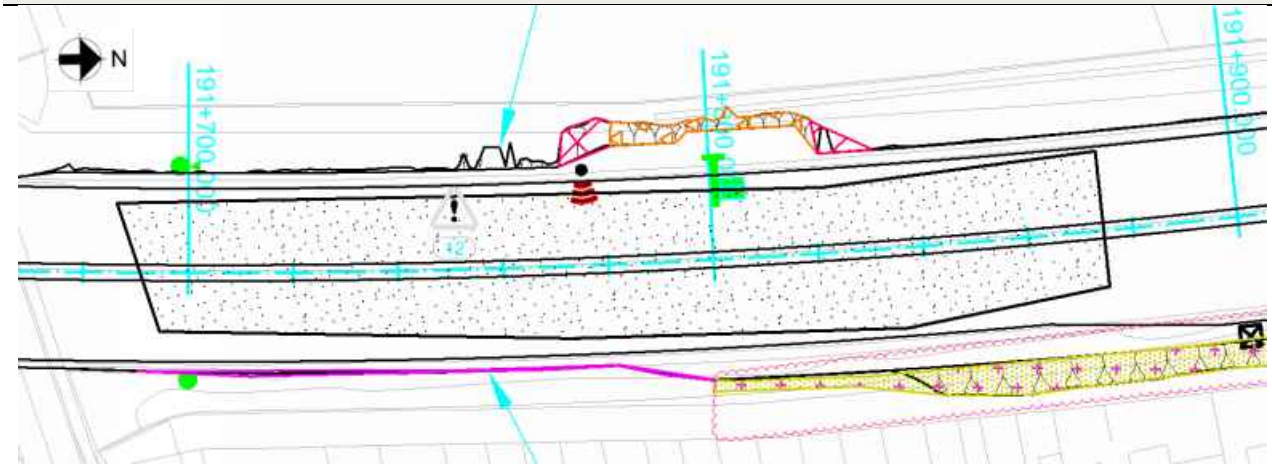


Figure 1: Location Plan

Proposed Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- 191760-191820 - Full Height Regrade (1:3.0).

Proposed Major Structures:

Within the chainage extents, Gantry 318 is to be constructed at Ch191801.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is classified as a bund. The bund is approximately 2.0m high with a typical slope angle of 20^{o}.

The critical cross section Ch191760 was chosen based on the greatest vertical regrade height required.

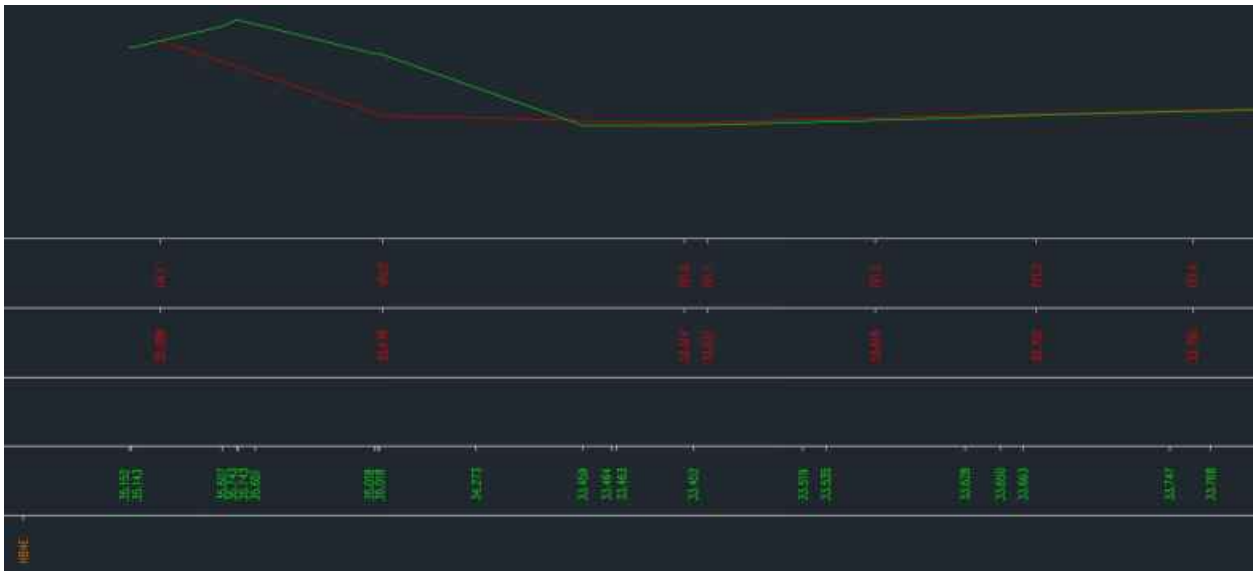


Figure 2: Topographic Critical Cross Section Ch191780

Utilities:

There are BT Comms at the bund crest running parallel to the motorway and a buried Western Power high voltage cable is in the adjacent field running parallel to the road.



Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Beeston Sand and Gravel Member (Glaciofluvial Deposits);

Solid Deposits: Gunthorpe Member (Mercia Mudstone)

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however 3 No. relevant exploratory holes were considered outside the design chainage; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000028, Rev P01.

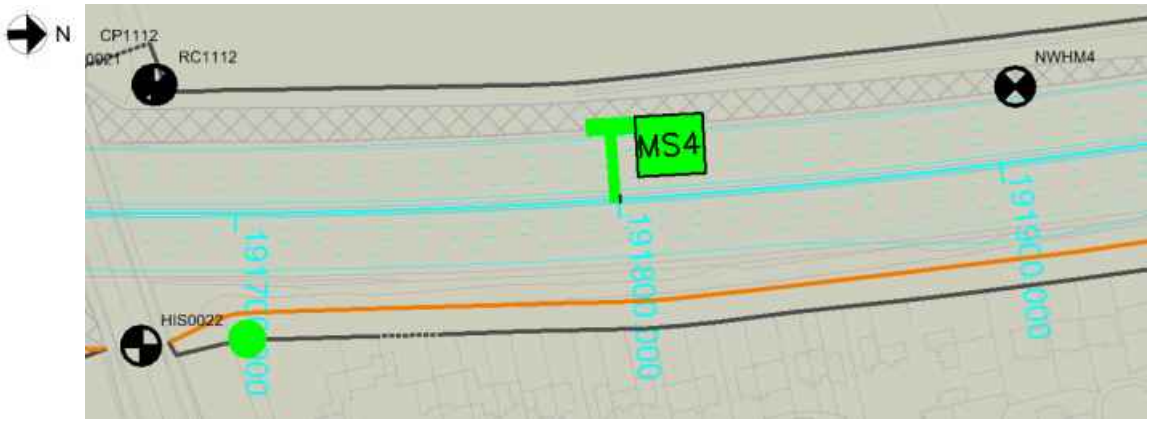


Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Closest Borehole Number	NWHM4
Borehole Chainage	191907
Borehole Location	Northbound verge
National Grid Reference	E 447257, N 333953
Ground Level at Exploratory Hole	34.91m AOD (Above Ordnance Datum)
RAG Analysis	Green
Date Drilled	04/09/1999 – 06/09/1999
Termination Depth	12.35 metres below ground level (mbgl)
Other suitable holes	CP1113, RC1113

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey data. The ground conditions are assessed from the top (35.7m AOD) of the adjacent bund which is assumed to be constructed from Embankment Fill, carriageway level at this location is approximately 33.7m AOD.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT (N) Value
Embankment Fill	2.0	33.7	None recorded
Glaciofluvial Deposits (coarse grained)	4.6	31.1	20-150 (20)
Mercia Mudstone – III/IV	Not proven	Not proven	40-43 (40)

(1) Ground level is assumed to be at the crest of the bund (of which is anticipated to comprise Embankment Fill).
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in historical exploratory holes CP1112, NWHM66 and RC1112.

Groundwater:

Groundwater was not apparent during drilling in CP1112 or RC1112.

Groundwater seepage was recorded at 2.10mbgl (33.4mAOD) in Glaciofluvial Deposits

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(coarse grained) in NWHM4.

Groundwater Design Level:

Given the lack of local groundwater level available, a design groundwater level of 1.0m below ground level throughout the bund has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

2 No. Moisture Content Tests were undertaken within historical exploratory holes with the following results for the strata noted in the ground model:

Historical Exploratory Hole	Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)
NWHM4	Glaciofluvial Deposits (coarse grained)	0.10	3.7
NWHM4	Glaciofluvial Deposits (coarse grained)	0.75	2.4

Lab Test Data – BRE Classification:

The following chemical testing data was available from the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result	Unit
Glaciofluvial Deposits (coarse grained)	pH	Solid (water extract)	1	8.30	-
Glaciofluvial Deposits (coarse grained)	pH	Water	2	8.09-8.42	-
Glaciofluvial Deposits (coarse grained)	Sulphate (Total) as SO4	Solid (2:1 soil/water extract)	1	0.020	g/l
Glaciofluvial Deposits (coarse grained)	Sulphate (Total) as SO4	Water	2	0.076-0.410	g/l

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Assumed Ground Model For Design:

Ground model based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-CE-000036 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01. The below table outlines the assumed anticipated ground model, to be confirmed by 'Just in Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)		Poisson's Ratio		Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	v_u	v'						
Embankment fill	0-2.0	35.7-33.7	2.0	21	27	0	100	7.8	6.2	0.50	0.20	2.60	0.45	-	6.2*	-	DS-2 AC-2
Glaciofluvial Deposits (Coarse Grained)	2.0-4.6	33.7-31.1	2.6	21	33	-	-	-	31.2	-	0.25	12.50	-	1.0	-	50	DS-1 AC-1
Mercia Mudstone III/IV	>4.6	<31.1	-	21	30	2	200	13.8	11.0	0.50	0.20	3.60	0.45	-	9	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Given the limited amount of local PI data, the ϕ' of Embankment Fill and Mercia Mudstone – III/IV was taken as the characteristic value given in the AMAR GIR.
(4) Given the lack of GI data for Embankment Fill, the characteristic c_u and E values given in the AMAR GIR were adopted.
(5) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a characteristic SPT 'N' value of 20, ϕ' was found to be 33°.
(6) c_u of Mercia Mudstone – III/IV was determined using recorded SPT 'N' values and the Stroud correlation. Due to the limited amount of local PI data, a typical f1 value of 5.0 was used along with the typical SPT 'N' value of 40.
(7) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a characteristic SPT 'N' value of 20, E' = 31.2MN/m^2.
(8) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the characteristic SPT 'N' value of 40, Eu = 13.8MN/m^2. Therefore E' = 11.0MN/m^2.
(9) Shear modulus is based on G = E/2(1+v).

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(10) Adhesion factor for Embankment fill is based on BS8004 (equation 41). Adhesion factor for Mercia Mudstone is based on Table 4.17 in Tomlinson and Woodward.
(11) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl
(12) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).
(13) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1). For sandstone, Nq is derived based on a very dense siliceous cohesionless soil (Tomlinson Table 7.1).
(14) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Embankment Fill and Mercia Mudstone, the classification used for the strata in the AMAR GIR was adopted.

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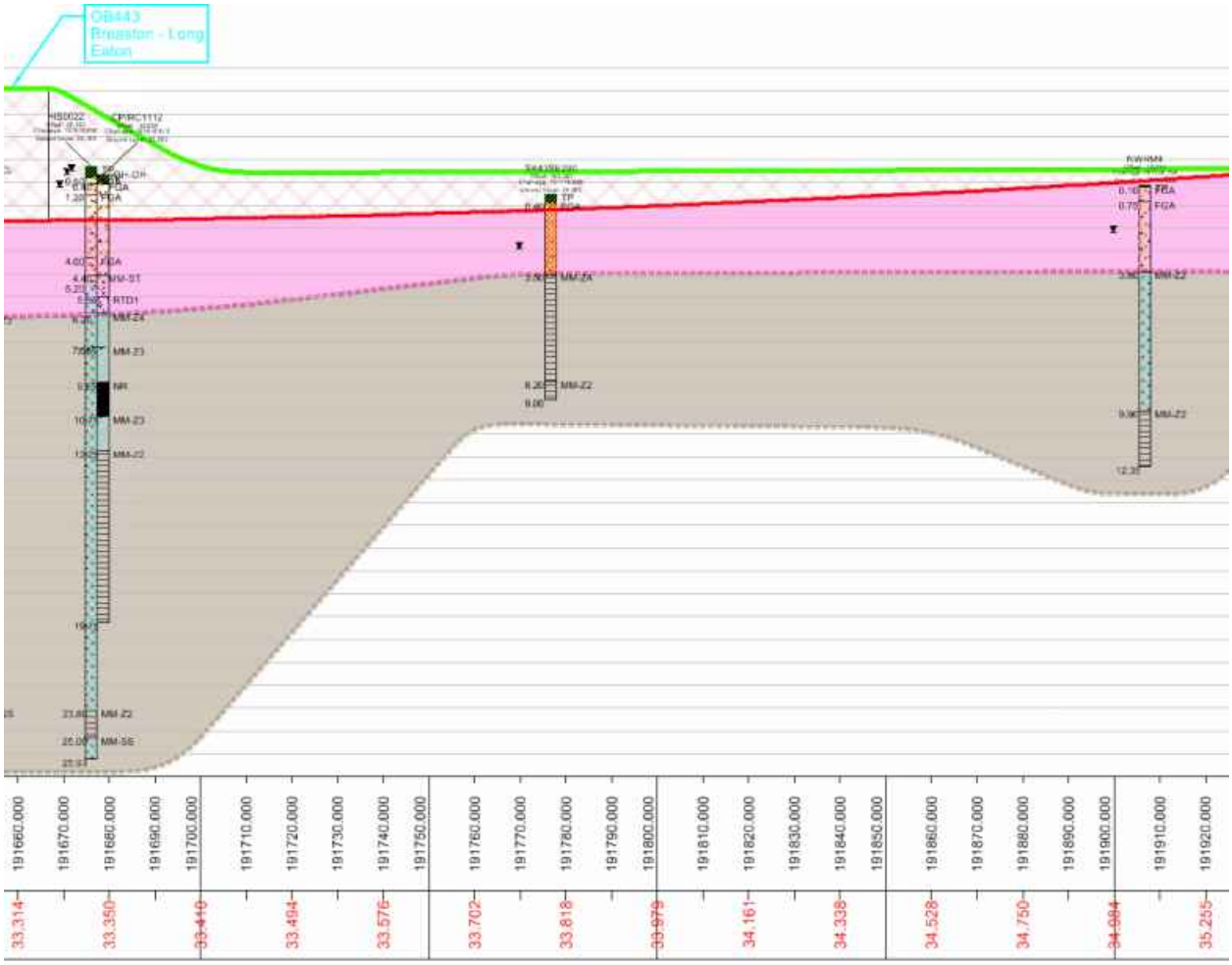


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
191760	191820	Full Height Regrade (1:3.0)	N/A	N/A

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	750	13	2.25	11	209	454

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH – G318, Ch191801, Northbound, 18m dynamic sample with rotary follow on.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **CP1112** Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447256.00 - 333728.00	Hole Type CP
Location:		Level: 35.35	Scale 1:50
Client: Highways England		Dates: 16/10/2006 - 16/10/2006	Logged By MW

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.40	B							Brown slightly sandy, occasional gravelly to gravelly clayey TOPSOIL. Gravel is subangular to subrounded fine to coarse, of sandstone, quartz and rare coke. TP
		0.40 - 1.20	B				0.40	34.95		Medium dense grey brown becoming brown clayey SAND and GRAVEL. Sand is medium to coarse. Gravel is angular to subrounded fine to coarse of sandstone and quartz. FGA-SG
		1.20 - 1.65	B							
		2.20 - 2.65	B							*Below 2.20m, sandy gravel*
		3.20 - 3.65	B							
		4.20 - 4.65	B							
							4.40	30.95		Very stiff purple brown, locally grey green, SILT. Locally a silt/clay with some siltstone lithorelics. MM-ST
		5.20 - 5.65	D							
		5.20 - 5.70	B							
		6.20	D				6.20	29.15		(Very weak) orange brown laminated, locally sandy SILTSTONE recovered as friable slightly sandy to sandy silt with some lithorelics. MM-ST
		6.20 - 6.70	B							
		7.20	D							
		7.50	D				7.55	27.80		*At 7.50m, purple brown and grey green siltstone with some bands of very sandy siltstone to a sandstone* End of borehole at 7.55 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 3.40m to 3.70m (1 hour) and 7.30m to 7.50m (1 hour).;No visual or olfactory indication of contamination was observed.;The borehole was backfilled on completion with grout.;

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Rotary Core Log

Borehole No. **NWHM4** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447256.51 - 333952.93	Hole Type RC
Location:		Level: 34.91	Scale 1:50
Client: Highways England		Dates: 04/09/1999 - 06/09/1999	Logged By NBR

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.10	D				0.10	34.81		TOPSOIL. TP
		0.10 - 0.75	D							Reddish brown very clayey fine and medium SAND and fine to coarse angular to subrounded GRAVEL of mudstone, sandstone and quartz. FGA-SG
		0.75	C				0.75	34.16		
		0.75	D							Dense brown fine and medium SAND and fine to coarse angular to rounded GRAVEL of sandstone, mudstone and quartz. (River Terrace Deposits) FGA-SG
		0.75 - 1.10	D							
		1.10 - 2.10	98	0	0	0				
	▼									
		2.55 - 3.10	98	0	0	0				
		3.55 - 4.10	98	0	0	0	3.80	31.11		
		4.50	C							Firm to stiff reddish brown slightly mottled greenish grey very silty CLAY with much fine and medium angular and subangular gravel sized lithorelicts (upto 17mm). (Mercia Mudstone - Zone IIIa) MM-Z2
		4.56 - 5.10	98	100	0	0				
										—from 5.10m becomes stiff
		5.55 - 6.10	98	100	0	0				
		6.55 - 7.10	98	0	0	0				—from 7.10m becomes very stiff
		7.55 - 8.10	98	58	0	0				
		8.47 - 9.60	98	65	0	0				
							9.90	25.01		
										Continued on next sheet.

Remarks
1. Inspection pit excavated to 1.10m. 2. 06/09/99 water artesian 0.15m AGL. 3. Borehole complete at 12.35m. 4. Borehole backfilled with grout.5. Marker Post Ref 191/9 +60N.

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Rotary Core Log

Borehole No. NWHM4
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447256.51 - 333952.93	Hole Type RC
Location:		Level: 34.91	Scale 1:50
Client: Highways England		Dates: 04/09/1999 - 06/09/1999	Logged By NBR

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.97 - 11.10	14 99 5	100	51	9				Reddish brown very thinly and thinly bedded subhorizontal slightly weathered very silty MUDSTONE, weak to moderately weak with medium spaced thin laminae of greenish grey siltstone, weak with very closely and closely spaced subhorizontal fractures open rough undulose. (Mercia Mudstone Zone 11) MM-Z2
		11.10 - 12.35	99 4 99	0	0	0				—from 10.60m to 10.63m fibrous gypsum —from 11.10m to 11.25m non intact —from 11.60m to 11.70m non intact —from 11.81m to 11.90m non intact —from 11.92m to 11.98m fibrous gypsum —from 12.00m to 12.25m non intact
			99				12.35	22.56		End of borehole at 12.35 m

Remarks
1. Inspection pit excavated to 1.10m. 2. 06/09/99 water artesian 0.15m AGL. 3. Borehole complete at 12.35m. 4. Borehole backfilled with grout.5. Marker Post Ref 191/9 +60N.

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Rotary Core Log

Borehole No. **RC1112** Sheet 1 of 2

Project Name:	SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords:	447256.00 - 333729.00	Hole Type RC
Location:			Level:	35.50	Scale 1:50
Client:	Highways England		Dates:	18/10/2006 - 18/10/2006	Logged By SM

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 5.50								OPEN HOLE. Refer to borehole CP1112 for likely material description OH-OH
		3.35	W							
		3.65	W							
		5.50 - 6.25		33	0	0	5.50	30.00		Poor recovery. Recovered as light and dark grey subrounded to rounded coarse GRAVEL and COBBLES of siltstone and sandstone. RTD1
		6.25 - 7.75		70	0	0	6.25	29.25		Very stiff red brown sandy friable CLAY with rare rounded fine and medium gravel sized lithorelics of very weak mudstone. MM-Z4
		7.75 - 9.25		37	0	0	7.75	27.75		*Gradational boundary* Poor recovery. Recovered as very stiff red brown sandy friable CLAY with very weak rounded fine and medium gravel sized lithorelics of mudstone. With occasional pockets/bands up to 25mm of light grey green slightly sandy clay. Sand is fine. MM-Z3
							9.25	26.25		NO RECOVERY NR
										Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. RC1112 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447256.00 - 333729.00	Hole Type RC
Location:		Level: 35.50	Scale 1:50
Client: Highways England		Dates: 18/10/2006 - 18/10/2006	Logged By SM

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.25 - 10.75		0	0	0				NO RECOVERY (as previous sheet)
		10.75 - 12.25		30	0	0	10.75	24.75		Poor recovery. Recovered as very stiff red brown sandy friable CLAY with very weak rounded fine and medium gravel sized lithorelics of mudstone. MM-Z3
		12.25 - 13.75		73	47	0	12.25	23.25		Very weak laminated to very thinly bedded red brown MUDSTONE with occasional bands and pockets of siltstone. Fractures are subhorizontal very closely to closely spaced, generally tight, planar and smooth. MM-Z2
		13.75 - 15.25		67	50	0				At 12.60m, 30mm band of moderately strong light grey green siltstone. Between 12.65m and 13.25m, fractures are randomly orientated and extremely closely spaced. Between 13.25m and 14.30m, assumed zone of core loss. Below 14.30m, becoming weak and locally moderately weak.
		15.25 - 16.75		40	40	13				Between 15.25m and 16.75m, poor recovery.
		16.75 - 18.25		63	53	7				Between approximately 17.30m and 17.60m, becoming very weak with very closely spaced thin to thick laminae of firm red brown clay. Between approximately 17.60m and 17.70m, becoming light grey green.
		18.25 - 19.75	PL	57	57	32				Below approximately 18.55m, with occasional very closely to closely spaced thin to thick laminae of quartz. Fractures becoming closely spaced.
							19.75	15.75		End of borehole at 19.75 m

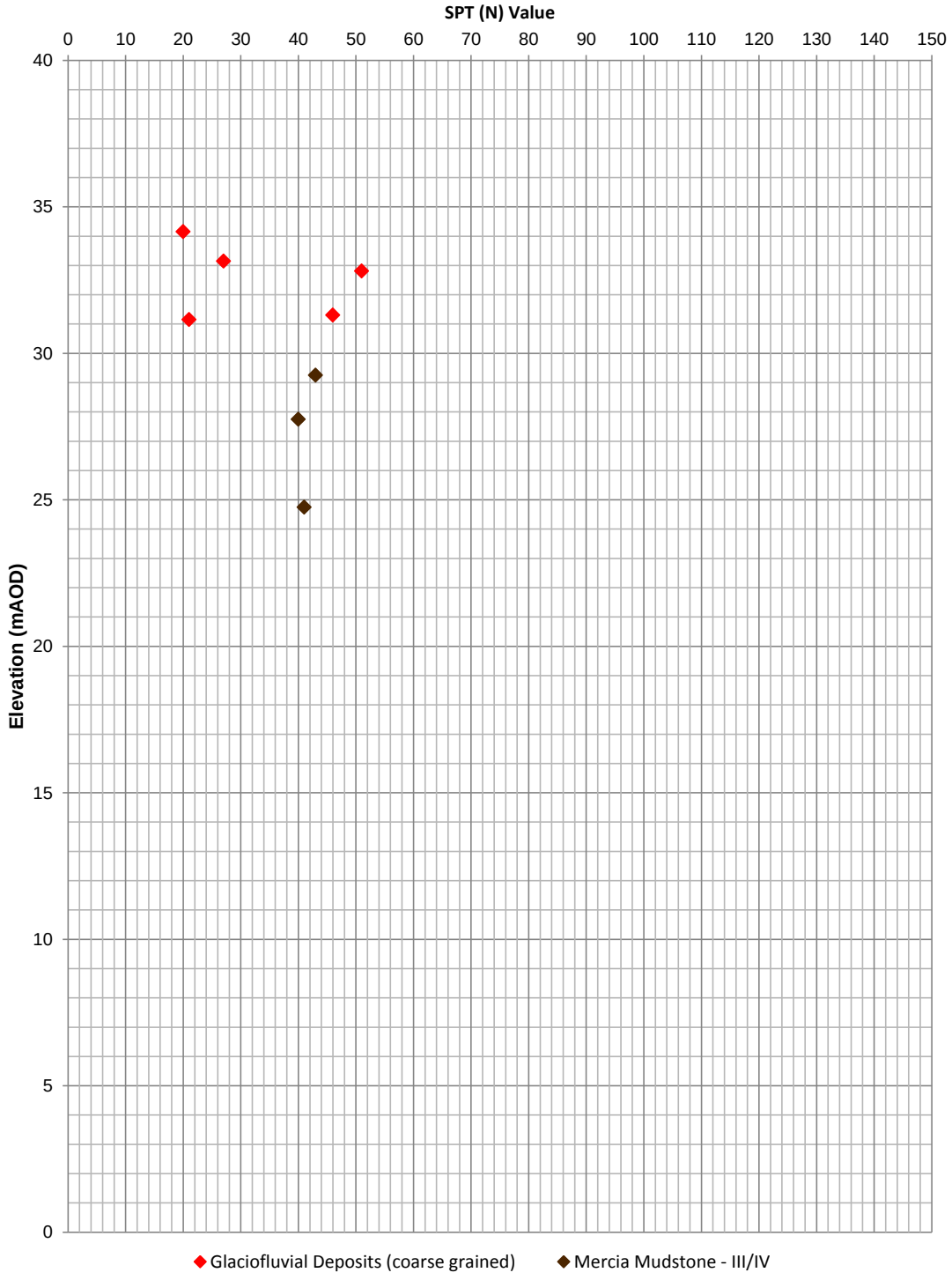
Remarks
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;No visual or olfactory indication of contamination was observed.;

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PLOTS

amey ARUP	**SPT N Value vs Depth**
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25** | Data Sheet: **191780-191820NB**
Client: **Highways England**	Borehole ID: **CP1112, RC1112, NWHM4**



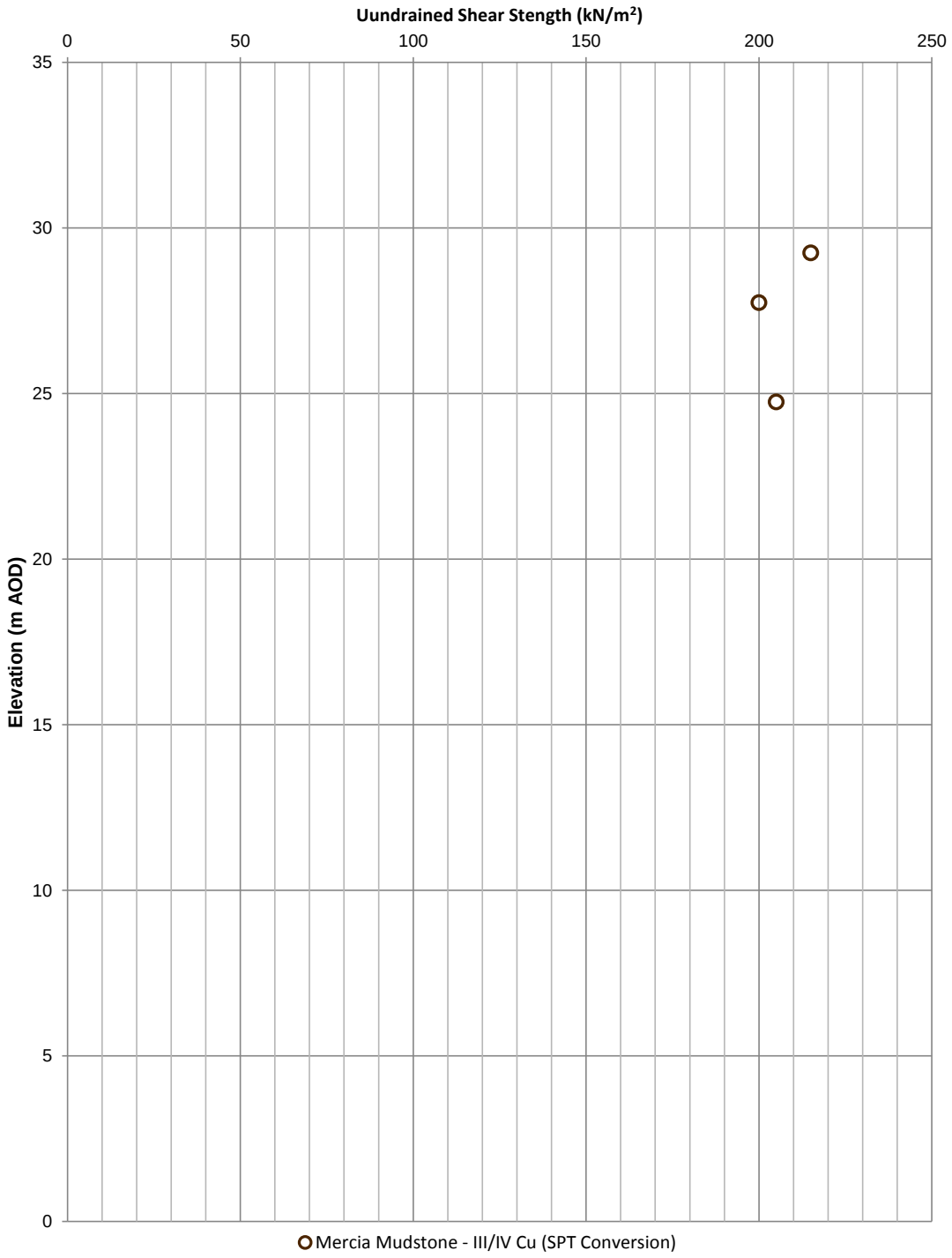
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 02/03/2017 Ref: HA549342-AMAR-HGT-191780-191820NB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **191780-191820NB**
Client: **Highways England**	Borehole ID: **RC1112**	



Rev: P01 Date: 02/03/2017 Ref: HA549342-AMAR-HGT-191780-191820NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-192100-192140NB-GSS-000001		
Earthworks Widening Solution	Full Height Embankment Widening (1:2.0), <500mm Fill, Granular Wedge at Embankment Crest (1:2.0)		
Structure Number	GANTRY_319 [1]		
Structure Type	ADS Cantilever Gantry		
Design Chainage	192100-192140		
Carriageway	Northbound		
Marker Post	192/1A+00-192/1A+40		
National Grid Reference	E 447223, N 334141- E 447217, N 334162		
Existing Ground Level at Structure Location	Carriageway	37.9mAOD	
	Toe of Embankment	35.0mAOD	
Earthwork Type	NB: Embankment	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: 7_M1_22045	SB:N/A	HAGDMS designation
Earthwork Height	NB: 2.9m	SB:N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 17°	SB:N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Oliver Youle Simon Arinze Scott Bishton	26/04/2017	[redacted]
Checked	Roheel Masrat	13/03/2017	
Reviewed	Gary Summerfield	13/03/2017	
Approved	Tom Bulteel	06/06/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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DESK STUDY

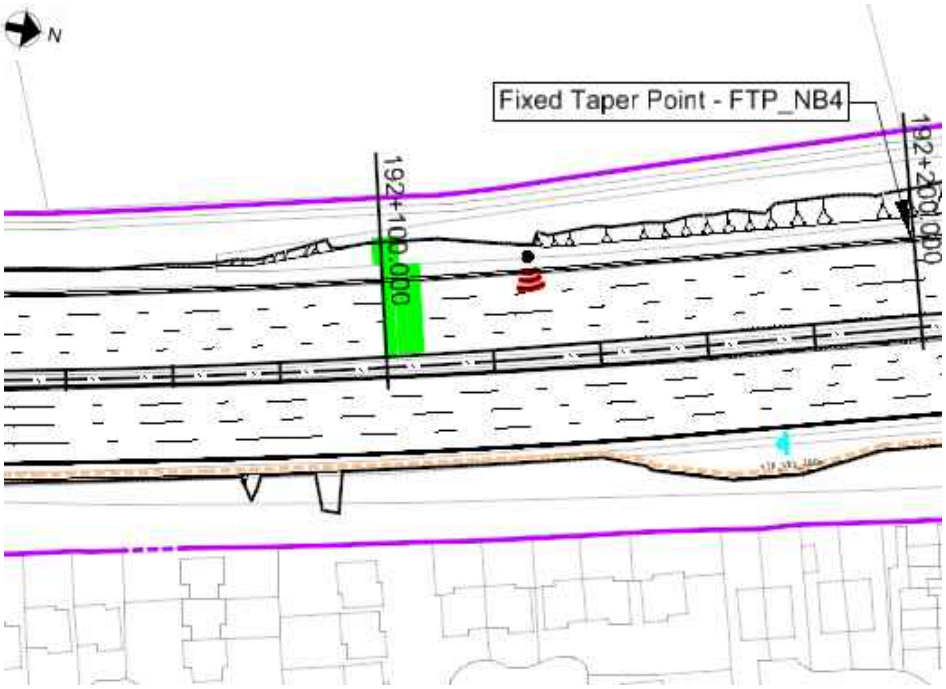


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch192100-192120 – Full Height Embankment Widening (1:2.0);
- Ch192120-192130 – <500mm Fill;
- Ch192130-192140 - Granular Wedge at Embankment Crest (1:2.0);

Proposed Major Structures:

ADS cantilever gantry structure, situated on the northbound carriageway at Ch192101.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is to be located on an embankment of approximately 3.1m height and a slope of 17°.

The critical cross section (the cross section with the greatest earthwork height) used is Ch192110 for Full Height Embankment Widening (1:2.0) and Ch192130 for Granular Wedge at Embankment Crest (1:2.0).

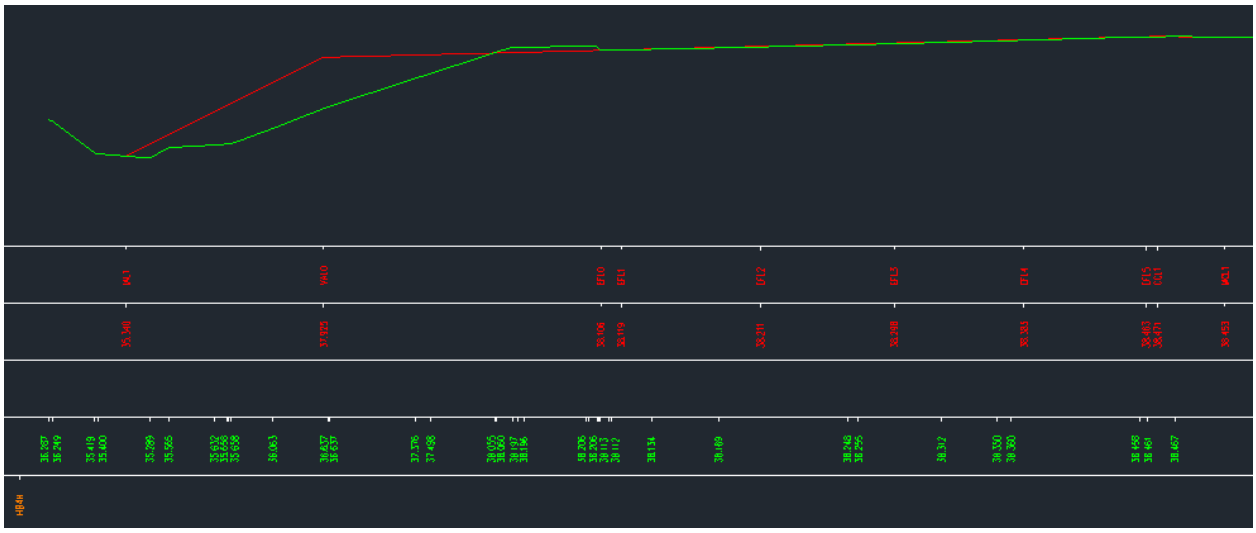


Figure 2.1: Topographic Cross Section Ch192110

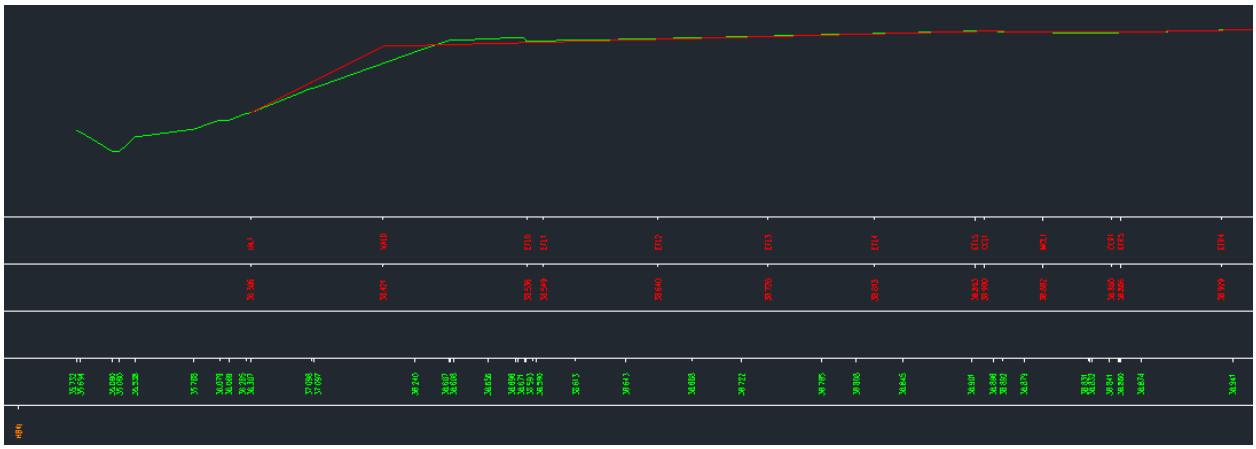


Figure 2.2: Topographic Cross Section Ch192130

Utilities:

A BT Comms Cable runs parallel to carriageway around 1m from VRS.

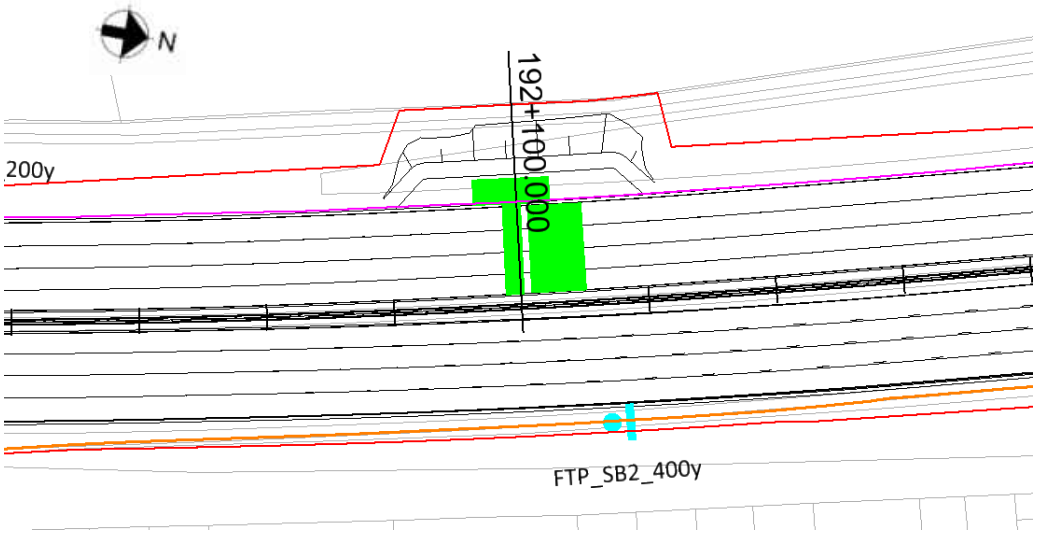


Figure 3: Utilities Plan

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Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Beeston Sand and Gravel Member (Glaciofluvial Deposits)

Solid Deposits: Gunthorpe Member (Mudstone – Mercia Mudstone Group)

Ground Investigation:

There is 1 No. historical exploratory holes recorded within the design chainage on the southbound, with additional 2 No. relevant exploratory holes considered outside as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000037, Rev P01

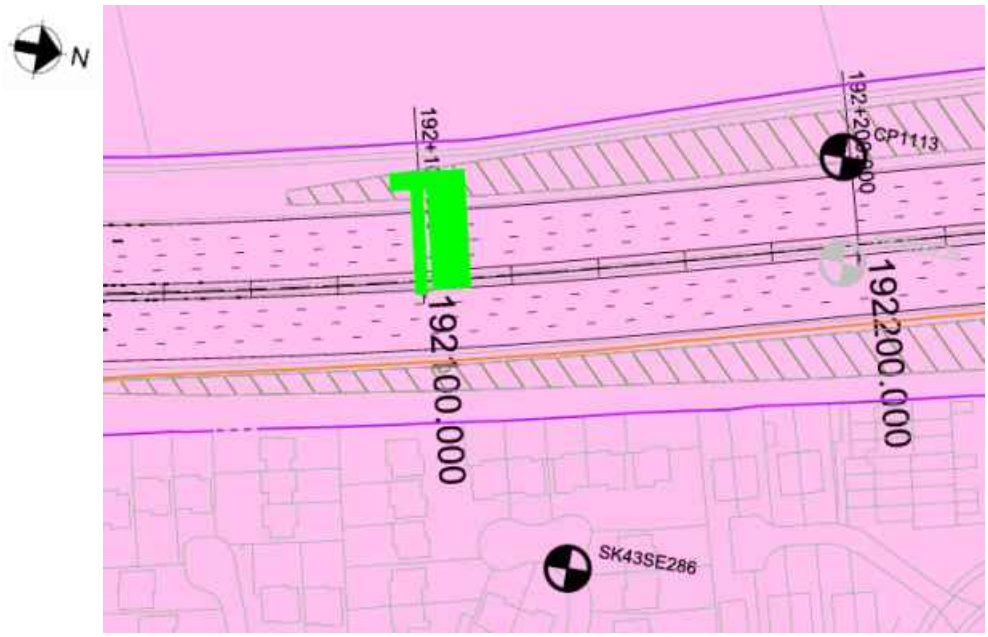


Figure 4: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	CP1113
Borehole Chainage	192200
Borehole Location	Northbound - verge
National Grid Reference	E 447196, N 334236
Ground Level at Exploratory Hole	40.05 metres above Ordnance Datum (mAOD)
RAG Analysis	Green

Date Drilled	03/11/2006
Termination Depth	14.60 metres below ground level (mbgl)
Other suitable holes	SK43SE286 & SK43SE26

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR Survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Embankment Fill	2.90	35.00	15 (15)
Glaciofluvial Deposits (coarse grained)	5.00	32.85	16-107 (20)
Mercia Mudstone – III/IV	6.90	25.95	21-67 (21)
Mercia Mudstone – I/II	>6.90	<25.45	>150 (150)

(1) Ground level is assumed to be at carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Mercia Mudstone - I/II was encountered in the borehole. Given the uncertainties on ground conditions, this has been modelled as Mercia Mudstone – III/IV in the ground model for a conservative design.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes SK43SE286, CP113 and SK43SE26.

Groundwater:

The following groundwater strikes were recorded in the historical exploratory holes (no groundwater data was recorded in CP1113):

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		mbgl	mAOD	Time	mbgl	mAOD
SK43SE26	Glaciofluvial Deposits (coarse grained)	1.83	33.17	20minutes	1.37	33.63
SK43SE286	Glaciofluvial Deposits (coarse grained)	2.50	33.77	-	-	-

Groundwater Design Level:

Limited local groundwater level is available and therefore a design groundwater level of 1.0m below toe of embankment has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

3 No. Atterberg Limit Tests and 3 No. Moisture Content Tests were undertaken within historical exploratory holes with the following results for the strata noted in the ground model:

Historical Exploratory Hole	Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
CP1113	Embankment Fill	4.00	11.76	36	14	22	CI
CP1113	Glaciofluvial Deposits (fine grained)	4.50	16.19	39	19	20	CI
CP1113	Mercia Mudstone – III/IV	13.50	16.99	40	17	23	CI

1 No. undrained triaxial test was undertaken with the following result:

Historical Exploratory Hole	Stratum	Depth to Top of Test (mbgl)	Depth to Top of Test (mAOD)	Undrained Shear Strength (kN/m^2)
CP1113	Embankment Fill	3.50	36.55	139

Lab Test Data – BRE Classification:

The following chemical lab testing data was available from the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result	Unit
Embankment Fill	pH	Solid (water extract)	1	7.8	-
Embankment Fill	Water-soluble sulphate	Solid (2:1 solid/water extract)	1	1.7	g/l
Embankment Fill	Sulphate (Total) as SO4	Solid	1	0.44	%

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Assumed Ground Model For Design:

Ground model based on geological long section HA549342-AMAR-HGT-SWI-DR-CE-000037 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. Should be made specific to each proposed new location. The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)		Poisson's Ratio		Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	v_u	v'						
Embankment Fill	0-2.90	37.89-34.99	2.90	21	26	0	75	6.3	5.0	0.50	0.20	2.1	0.51	-	6.2	-	DS-3 AC-3
Glaciofluvial Deposits (coarse grained)	2.90-5.040	34.99-32.85	2.14	21	33	-	-	-	31.2	-	0.25	12.5	-	1.0	-	45	DS-3 AC-3
Mercia Mudstone – III/IV	5.04->6.9	31.50-<24.20	>3.00	21	26	2	105	8.1	6.5	0.50	0.20	2.7	0.44	-	9	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical borehole SK42NE10.
(3) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) c_u of Embankment Fill can be derived using the Stroud correlation. The recorded PI of 22% gives an f_1 value of 5kN/m^2, combined with a recorded SPT N value of 15, this gives a typical c_u of 75kN/m^2.
(5) ϕ' of Embankment Fill can be determined using Table 2 in BS8002:2015 using the recorded PI of 22% gives 26°.
(6) E' of Embankment Fill is based relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the recorded SPT N value of 15, Eu = 6.3MN/m^2. Therefore E' = 5.0MN/m^2.
(7) ϕ' of Glaciofluvial Deposits (coarse grained) can be determined using correlation with SPT (Peck 1974) N values. Using a typical N value of 20 gives an angle of 33°.
(8) E' of Glaciofluvial Deposits (coarse grained) can be determined using Bowles correlation E' = 1200 (N + 6) which (using typical N value of 20) gives a value of 31.2MN/m^2.
(9) c_u of Mercia Mudstone – III/IV can be derived using the Stroud correlation. A recorded PI of 23% gives an f_1 value of 5kN/m^2 for Mercia Mudstone – III/IV; combined with a conservative SPT N value of 21, this gives a c_u of 105kN/m^2.
(10) The ϕ' for Mercia Mudstone – III/IV is derived using plasticity index lab data (based on Table 2 in BS 8002:2015). The ϕ' obtained has a value of 26°.

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(11) E_u for Mercia Mudstone – III/IV can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 21 gives Eu = 8.1MN/m^2. E' of Mercia Mudstone – III/IV is based relationship by Wroth (1972) where E' = 2/3 (1+v)Eu.
(12) Shear modulus is based on G = E/2(1+v).
(13) Adhesion factor is based on BS8004 (equation 41).
(14) Nc is based on CIRIA C570. Embankment Fill is assumed to comprise reworked Mercia Mudstone.
(15) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).
(16) Nq is based on relationship with density as shown in Tomlinson (Table 7.1).
(17) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of local BRE test data for Glaciofluvial Deposits or Mercia Mudstone, the classification used in the AMAR GIR were adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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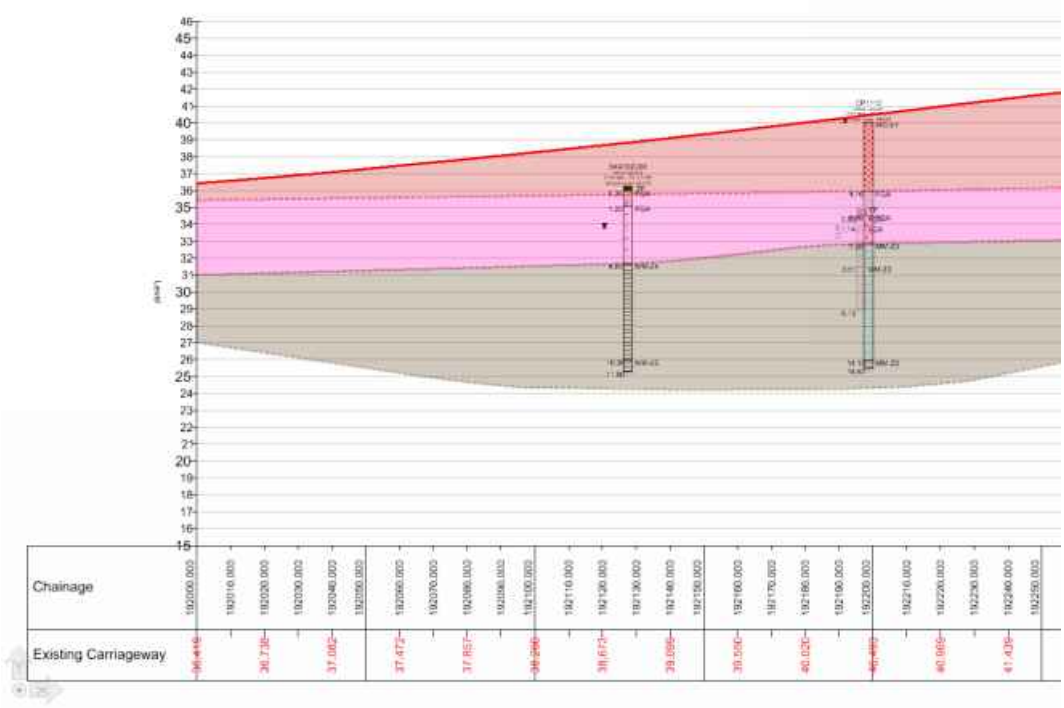


Figure 5: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (°)
192100	192120	Full Height Embankment Widening (1:2.0)	2.4	26.6 1V:2H
192120	192130	<500mm Fill	-	-
192130	192140	Granular Wedge at Embankment Crest (1:2.0)	3.5	45 1V:1H

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	900	25	2.70	13	467	1133

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FURTHER GROUND INVESTIGATON

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-G319, CH192101, Northbound – 30.0m Dynamic Sample with Rotary Core follow on.

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HISTORICAL EXPLORATORY HOLES

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Rotary Core Log

Borehole No. **CP1113** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447196.00 - 334236.00	Hole Type CP
Location:		Level: 40.05	Scale 1:50
Client: Highways England		Dates: 03/11/2006 - 06/11/2006	Logged By SM

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.50	B							MADE GROUND. Stiff red brown slightly sandy slightly gravelly clay with occasional pockets of light grey silt. Sand is fine. Gravel is subangular and subrounded fine to coarse of sandstone, mudstone and coal. MG-EF
		1.50 - 1.95	U							
		2.00	D							
		2.50	D							
		2.50 - 3.00	B							
		3.50 - 3.95	U							
		4.00	D							
		4.10	D				4.10	35.95		
		4.50	D							Stiff dark grey brown sandy slightly gravelly CLAY with occasional rootlets. Sand is fine to coarse. Gravel is subangular to rounded fine to coarse flint and sandstone. FGA
		4.50 - 5.00	B							
		5.50 - 6.00	U#B				5.50	34.55		Dense brown sandy GRAVEL. Gravel is subangular to rounded fine to coarse of sandstone, siltstone and flint. Sand is fine to coarse. FGA-SG
		6.50	B							
							7.20	32.85		Red brown CLAY with subangular and subrounded fine and medium gravel sized lithorelics of mudstone. With occasional pockets of light grey green silt/siltstone. MM-Z3
		7.50	D							
		7.50 - 8.00	U#B							
		9.00	D							
		9.00 - 9.50	B							

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.50m.;The borehole was advanced by chiselling methods from 14.10m to 14.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447196.00 - 334236.00	Borehole No. CP1113 Sheet 2 of 2
Location:		Level: 40.05	Hole Type CP
Client: Highways England		Dates: 03/11/2006 - 06/11/2006	Scale 1:50
			Logged By SM

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 - 11.00	U#B							CLAY (as previous sheet)
		12.00	D							
		12.00 - 12.50	B							
		13.50	D							
		13.50 - 14.00	B							
		14.10	D				14.10	25.95		
		14.10 - 14.50	B							Weak red brown MUDSTONE recovered as red brown clay with fine to coarse gravel sized fragments. MM-Z2
		14.50	D				14.60	25.45		End of borehole at 14.60 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.50m.;The borehole was advanced by chiselling methods from 14.10m to 14.60m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. **SK43SE26**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447220.00 - 334240.00	Hole Type CP
Location:		Level: 35.00	Scale 1:50
Client: Highways England		Dates: 24/02/1962 - 26/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.53	D				0.53	34.47		Topsoil TP
		1.07	D				1.14	33.86		Brown sandy clay & stones FGA-SG
	▼	1.37	W							Sand & gravel with boulders FGA-SG
		1.52 - 1.98	SPTL S							
		1.83	D							
		1.83 - 3.51	B							
		3.05 - 3.51	SPTL S							
		3.35	D							
		3.96 - 4.42	U				3.51	31.49		Redish marl MM-Z3
		4.50	D							
		5.56 - 6.02	U							
		6.10	D				6.10	28.90		End of borehole at 6.10 m

Remarks
Very little water encountered

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Rotary Core Log

Borehole No. SK43SE286

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447300.00 - 334190.00	Hole Type CP
Location:		Level: 36.27	Scale 1:50
Client: Highways England		Dates: 18/11/1975 - 18/11/1975	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	35.97		TOPSOIL TP
										Grey brown very stony sandy CLAY FGA
							1.20	35.07		Medium compact medium grained SAND and GRAVEL. FGA-SG
	▼									
							4.60	31.67		Highly weathered red/brown silty MARL with occasional bands of green marl MM-Z4
		5.00	U							
		6.50	U							
		8.00	U							
		9.50	U							

Continued on next sheet

Remarks
Water struck at 2.50m. Water standing level 2.50m.

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Rotary Core Log

Borehole No.
SK43SE286
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447300.00 - 334190.00	Hole Type CP
Location:		Level: 36.27	Scale 1:50
Client: Highways England		Dates: 18/11/1975 - 18/11/1975	Logged By

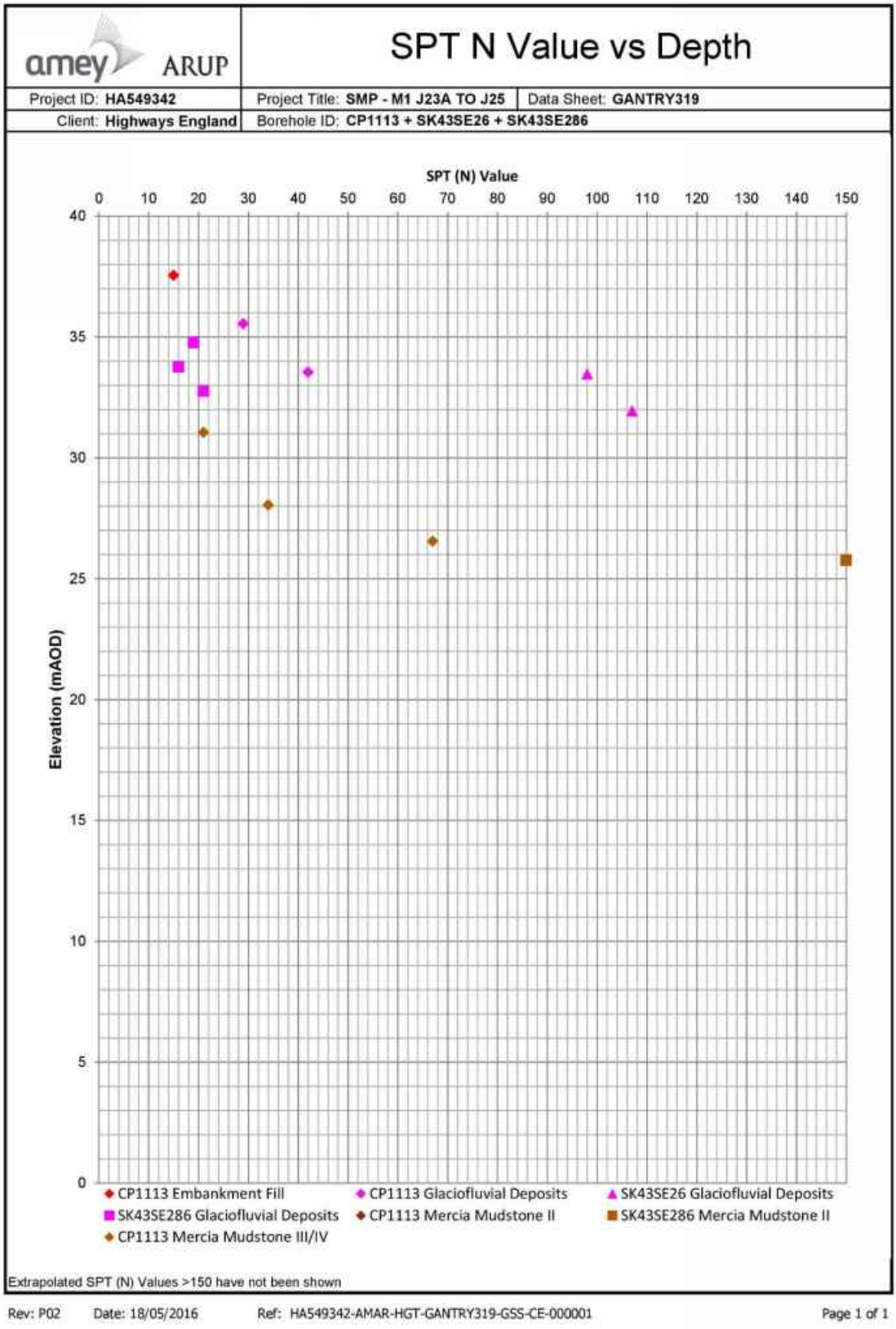
Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.30	25.97		Moderately weathered hard MARL MM-Z2
							11.00	25.27		End of borehole at 11.00 m

Remarks
Water struck at 2.50m. Water standing level 2.50m.

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PLOTS

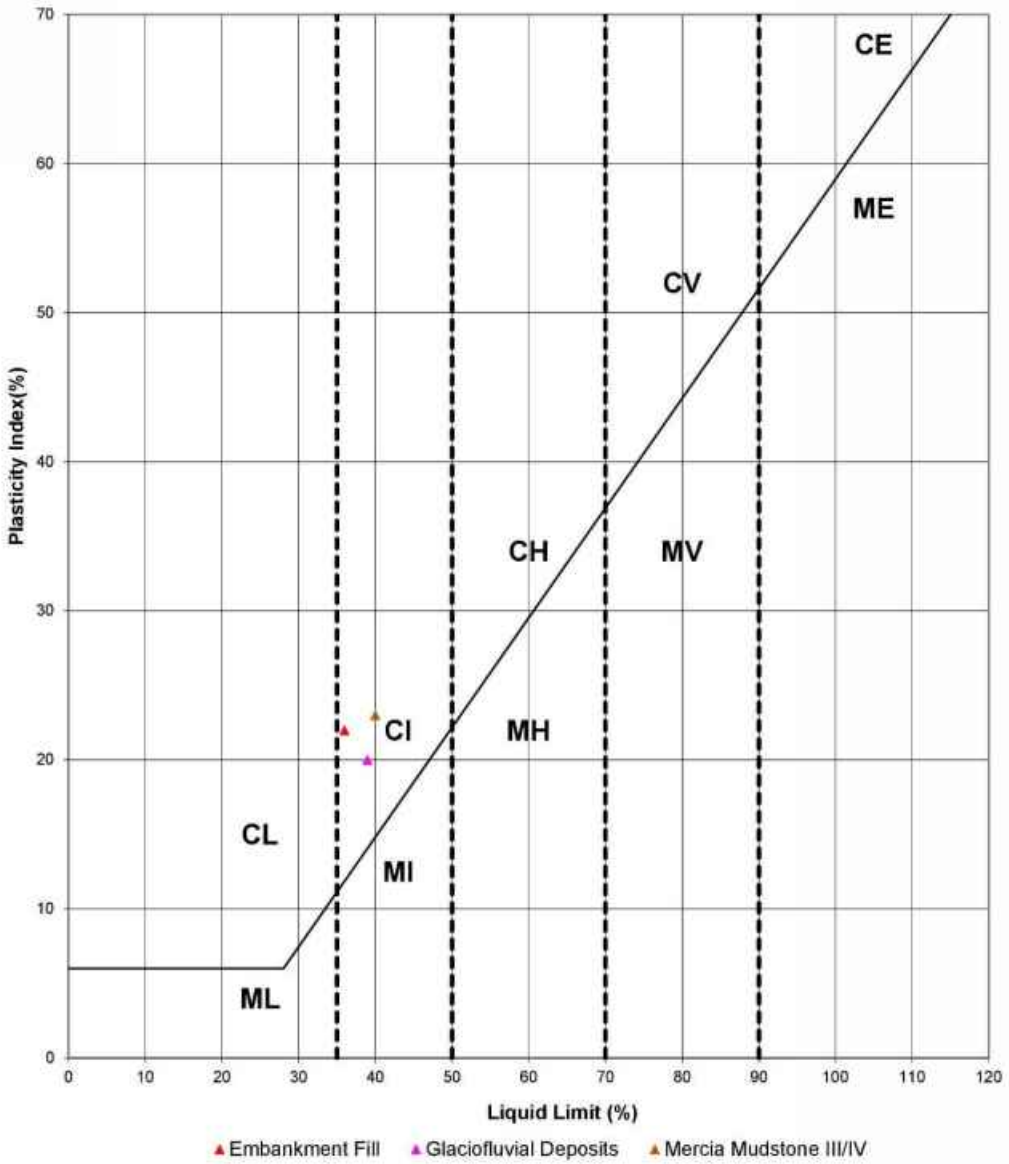


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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **GANTRY319**
Client: **Highways England**	Borehole ID: **CP1113**	



Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

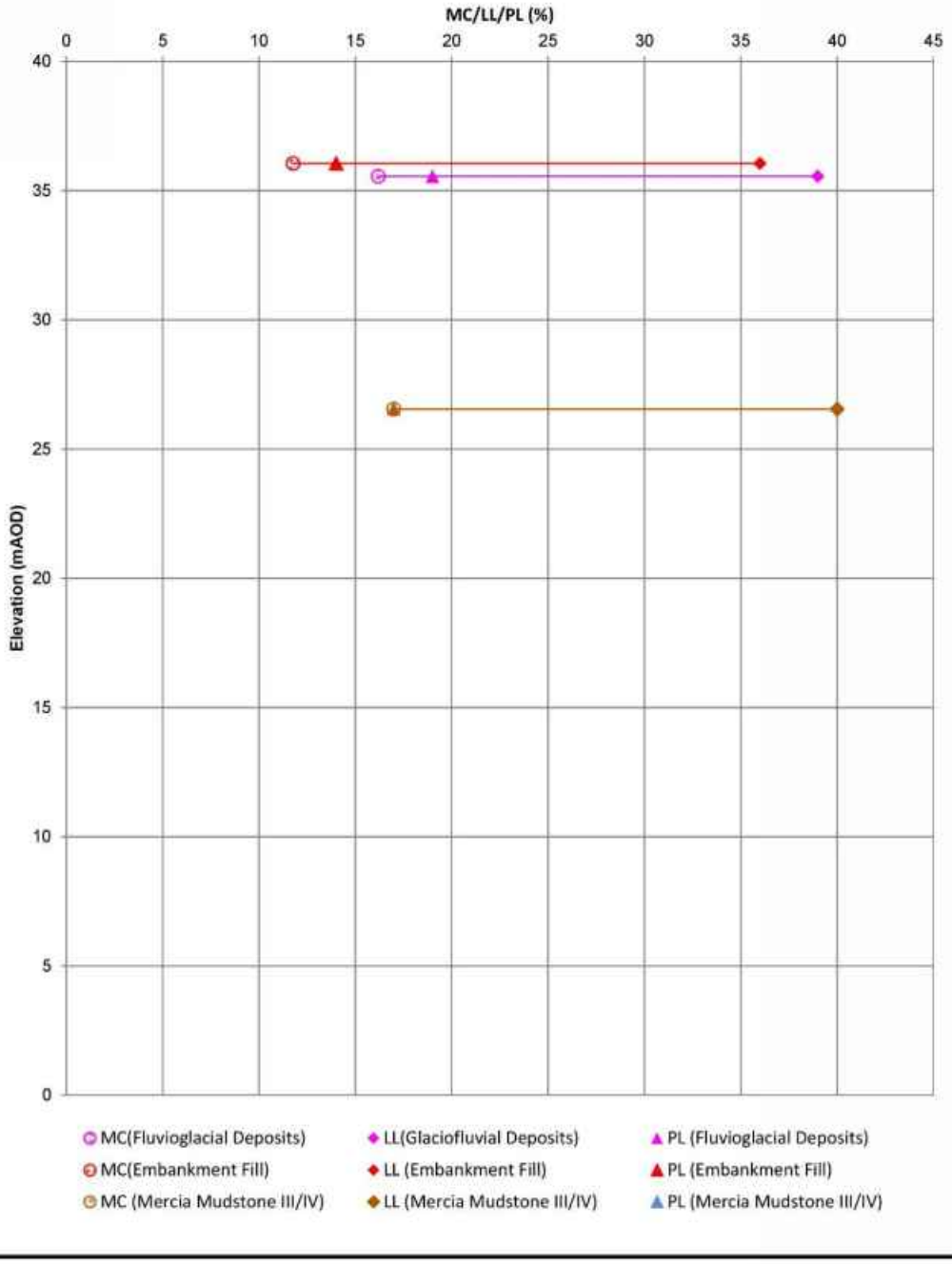
Rev: P01 Date: 23/02/2016 Ref: HA549342-AMAR-HGT-GANTRY319-GSS-CE-000001 Page 1 of 1

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **GANTRY319**
Client: **Highways England**	Borehole ID: **CP1113**	



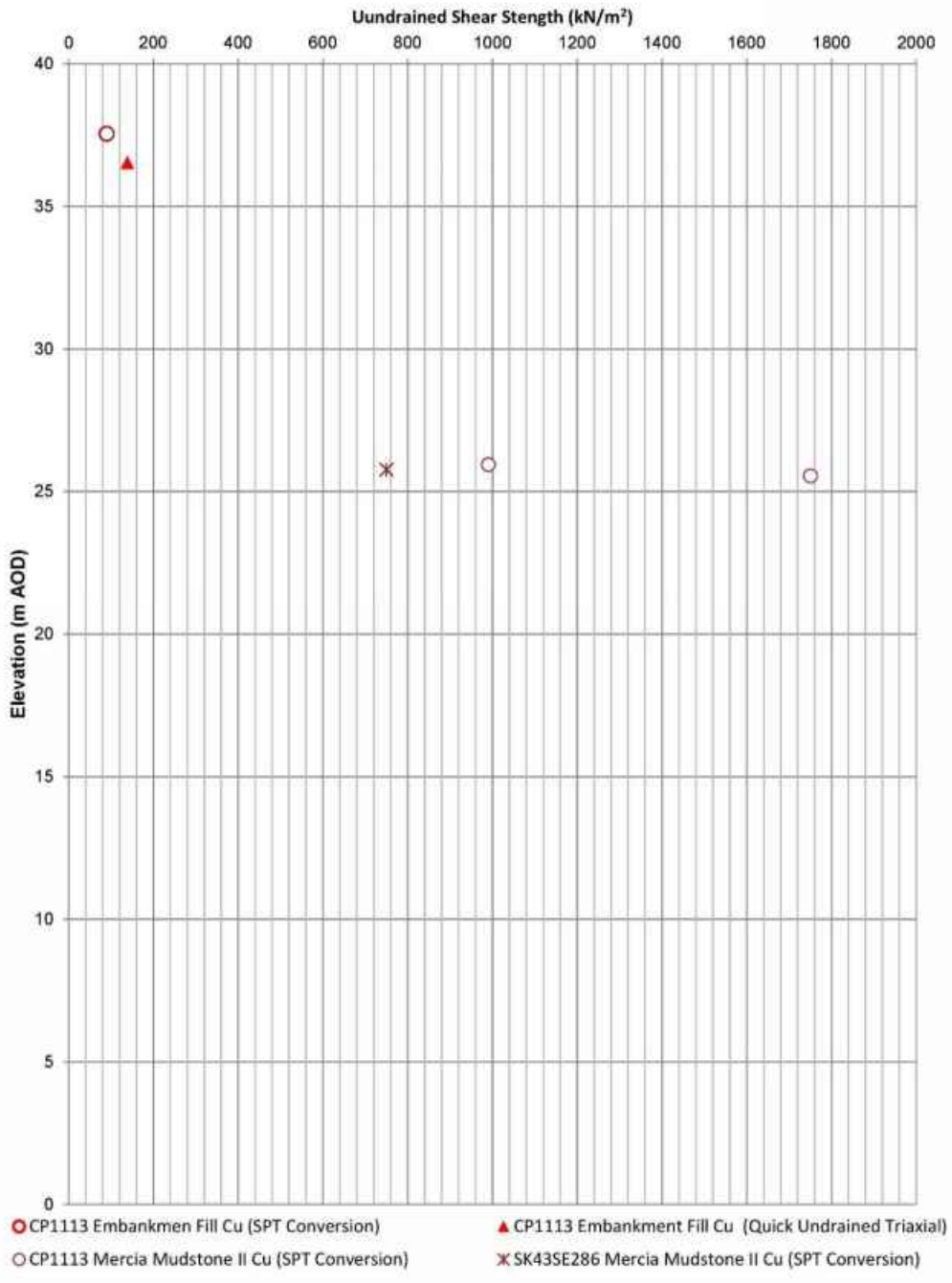
Rev: P02 Date: 16/06/2016 Ref: HA549342-AMAR-HGT-GANTRY319-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **GANTRY319**
Client: **Highways England**	Borehole ID: **CP1113 + SK43SE26 + SK43SE286**	



Rev: P01 Date: 23/02/2016 Ref: HA549342-AMAR-HGT-GANTRY319-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-192210-192400NB-GSS-000001		
Earthwork Widening Solution	Granular Wedge at Embankment Crest 1:2		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	192210-192400		
Carriageway	Northbound		
Marker Post	192/2+10 – 192/4+00		
National Grid Reference	E 447194, N 334248 – E 447144, N 334433		
Existing Ground Level at Location	Carriageway	43.9mAOD	
	Toe of Embankment	36.4mAOD	
Earthwork Type	NB: Embankment	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_22045	SB: N/A	HAGDMS designation
Maximum Earthwork Height	NB: 7.5m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Typical Earthwork Angle	NB: 27°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	26/04/2017	[redacted]
Checked	Roheel Masrat	13/03/2017	
Reviewed	Gary Summerfield	14/03/2017	
Approved	Tom Bulteel	06/06/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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DESK STUDY



Figure 1: Location Plan

Proposed Widening:

The following widening is proposed for the chainage extents:

- Ch192210-192400, Granular Wedge at Embankment Crest (1:2.0);

Proposed Major Structures:

N/A.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is classified as an embankment. The embankment increases in height from 4.2m in the south to 7.9m in the north of the extents with a typical slope angle of 27^{o}.

The critical cross section Ch192350 was chosen based on the greatest embankment height.



Figure 2: Topographic Critical Cross Section Ch192350

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Utilities:

BT comms are present at the embankment crest running parallel to the carriageway along the entirety of the chainage extents.



Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Beeston Sand and Gravel Member (Glaciofluvial Deposits);

Solid Deposits: Gunthorpe Member (Mercia Mudstone)

Ground Investigation:

There are 3 No. historical exploratory holes recorded within the design chainage, with additional 1 No. relevant exploratory hole considered; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000028, Rev P01.



Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	CP1113
Borehole Chainage	192200
Borehole Location	Northbound verge
National Grid Reference	E 447196, N 334236
Ground Level at Exploratory Hole	40.05mAOD (above Ordnance Datum)
Date Drilled	03/11/2006 – 06/11/2006
Termination Depth	14.60m below ground level (mbgl)
Hole Category	Green
Other suitable holes	SK43SE26, SK43SE286, NWHM66

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT (N) Value
Embankment Fill	7.5	36.4	15-150 (15)
Glaciofluvial Deposits (fine grained)	9.3	34.6	29
Glaciofluvial Deposits (coarse grained)	11.0	32.9	16-107 (20)
Mercia Mudstone – III/IV	Not proven	Not proven	21-150 (35)

(1) Ground level is assumed to be at carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) Characteristic SPT 'N' values are given in brackets. Extrapolated SPT 'N' values have been capped at 150.
(4) Mercia Mudstone – I/II was recorded at depth beneath Mercia Mudstone – III/IV, but for a conservative design only Mercia Mudstone – III/IV has been included. Any in situ or laboratory tests undertaken within Mercia Mudstone – I/II have not been used to derive geotechnical properties of Mercia Mudstone – III/IV.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in historical exploratory holes CP1113, SK43SE26, SK43SE286 and NWHM66.

Groundwater:

The following groundwater strikes were recorded in the historical exploratory holes (no

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groundwater data was recorded in CP1113):

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		mbgl	mAOD	Time	mbgl	mAOD
SK43SE26	Glaciofluvial Deposits (coarse grained)	1.83	33.17	20minutes	1.37	33.63
SK43SE286	Glaciofluvial Deposits (coarse grained)	2.50	33.77	-	-	-
NWHM66	Mercia Mudstone – III/IV	14.80	27.82	-	-	-

Groundwater Design Level:

Limited local groundwater level is available and therefore a design groundwater level of 1.0m below toe of embankment (35.4mAOD) has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

4 No. Atterberg Limit Tests and 4 No. Moisture Content Tests were undertaken within historical exploratory holes with the following results for the strata noted in the ground model:

Historical Exploratory Hole	Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
CP1113	Embankment Fill	4.00	11.76	36	14	22	CI
CP1113	Glaciofluvial Deposits (fine grained)	4.50	16.19	39	19	20	CI
NWHM66	Mercia Mudstone – III/IV	12.50	27.00	36	19	17	CI
CP1113	Mercia Mudstone – III/IV	13.50	16.99	40	17	23	CI

1 No. undrained triaxial test was undertaken with the following result:

Historical Exploratory Hole	Stratum	Depth to Top of Test (mbgl)	Depth to Top of Test (mAOD)	Undrained Shear Strength (kN/m^2)
CP1113	Embankment Fill	3.50	36.55	139

Lab Test Data – BRE Classification:

The following chemical lab testing data was available from the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result	Unit
Embankment Fill	pH	Solid (water extract)	1	7.8	-
Embankment Fill	pH	Solid	1	8.6	-
Embankment Fill	Water-soluble sulphate	Solid (2:1 solid/water extract)	1	1.7	g/l
Embankment Fill	Sulphate (Total) as SO4	Solid	1	0.08	%

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Assumed Ground Model For Design:

Ground model based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-CE-000037 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01. The below table outlines the assumed anticipated ground model, to be confirmed by 'Just in Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)		Poisson's Ratio		BRE Classification
								E_u	E'	v_u	v'	
Embankment Fill	0-7.5	43.9-36.4	7.5	21	27	0	75	6.3	5.0	0.50	0.20	DS-3 AC-3
Glaciofluvial Deposits (fine grained)	7.5-9.3	36.4-34.6	1.8	21	26	0	100	10.0	8.0	0.50	0.20	DS-3 AC-3
Glaciofluvial Deposits (coarse grained)	9.3-11.0	34.6-32.9	1.7	21	33	-	-	-	31.2	-	0.25	DS-3 AC-3
Mercia Mudstone – III/IV	>11.0	<32.9	-	21	30	2	175	10.8	8.6	0.50	0.20	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Given the limited amount of local PI data, the ϕ' of Embankment Fill, Glaciofluvial Deposits and Mercia Mudstone – III/IV was taken as the characteristic value given in the AMAR GIR.
(4) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a characteristic SPT 'N' value of 20, ϕ' was found to be 33°.
(5) c_u of Embankment Fill and Mercia Mudstone – III/IV was determined based on recorded undrained triaxial tests and c_u derived using the Stroud correlation. Due to the limited amount of local PI data, a typical f1 value of 5.0 was used.

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(6) Given the lack of GI data for Glaciofluvial Deposits (fine grained), the characteristic c_u and E values given in the AMAR GIR were adopted.
(7) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the characteristic SPT 'N' value of 15, Eu = 6.3MN/m^2. Therefore E' = 5.0MN/m^2.
(8) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a characteristic SPT 'N' value of 20, E' = 31.2MN/m^2.
(9) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the characteristic SPT 'N' value of 30, Eu = 10.8MN/m^2. Therefore E' = 8.6MN/m^2.
(10) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of local BRE test data for Glaciofluvial Deposits or Mercia Mudstone, the classification used in the AMAR GIR were adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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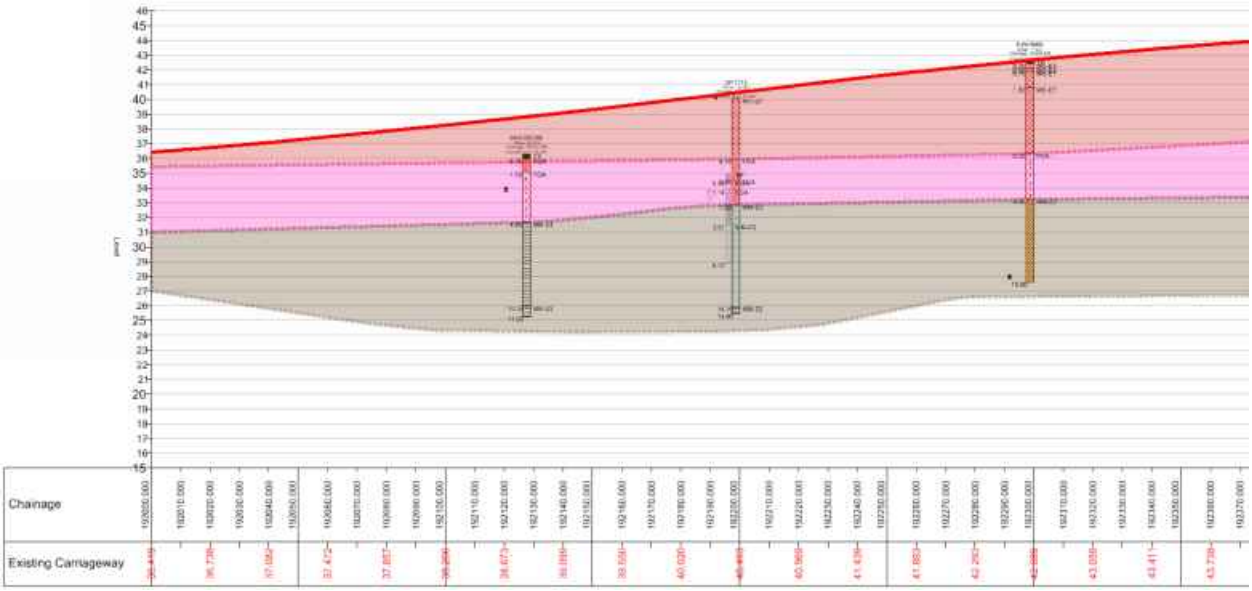


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solution is proposed:

Start Chainage	End Chainage	Widening Solution	Benching Detail	
			Base Width (m)	Batter Angle (°)
192210	192400	Granular Wedge at Embankment Crest (1:2.0)	6.8	1:1

Proposed Structural Solution:

N/A.

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- CPT-11, Ch192344, Northbound, 5m deep CPT exploratory hole.

HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **CP1113** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447196.00 - 334236.00	Hole Type CP
Location:		Level: 40.05	Scale 1:50
Client: Highways England		Dates: 03/11/2006 - 06/11/2006	Logged By SM

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.50	B							MADE GROUND. Stiff red brown slightly sandy slightly gravelly clay with occasional pockets of light grey silt. Sand is fine. Gravel is subangular and subrounded fine to coarse of sandstone, mudstone and coal. MG-EF
		1.50 - 1.95	U							
		2.00	D							
		2.50	D							
		2.50 - 3.00	B							
		3.50 - 3.95	U							
		4.00	D							
		4.10	D				4.10	35.95		Stiff dark grey brown sandy slightly gravelly CLAY with occasional rootlets. Sand is fine to coarse. Gravel is subangular to rounded fine to coarse flint and sandstone. FGA
		4.50	D							
		4.50 - 5.00	B							
		5.50 - 6.00	U#B				5.50	34.55		Dense brown sandy GRAVEL. Gravel is subangular to rounded fine to coarse of sandstone, siltstone and flint. Sand is fine to coarse. FGA-SG
		6.50	B							
		7.50	D				7.20	32.85		Red brown CLAY with subangular and subrounded fine and medium gravel sized lithorelics of mudstone. With occasional pockets of light grey green silt/siltstone. MM-Z3
		7.50 - 8.00	U#B							
		9.00	D							
		9.00 - 9.50	B							

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.50m.;The borehole was advanced by chiselling methods from 14.10m to 14.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1113
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447196.00 - 334236.00	Hole Type CP
Location:		Level: 40.05	Scale 1:50
Client: Highways England		Dates: 03/11/2006 - 06/11/2006	Logged By SM

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 - 11.00	U#B							CLAY (as previous sheet)
		12.00	D							
		12.00 - 12.50	B							
		13.50	D							
		13.50 - 14.00	B							
		14.10	D				14.10	25.95		
		14.10 - 14.50	B							Weak red brown MUDSTONE recovered as red brown clay with fine to coarse gravel sized fragments. MM-Z2
		14.50	D				14.60	25.45		End of borehole at 14.60 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.50m.;The borehole was advanced by chiselling methods from 14.10m to 14.60m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. **NWHM66** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447206.93 - 334342.18	Hole Type CP
Location:		Level: 42.62	Scale 1:50
Client: Highways England		Dates: 04/09/1999 - 04/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00	D							TOPSOIL.
		0.00	D				0.20	42.42		TP
		0.20	D							MADE GROUND: Hardcore of limestone.
		0.20	D				0.50	42.12		MG-EF
		0.50	D				0.70	41.92		MADE GROUND: Concrete. (Backfill)
		0.50	D							MG-EF
		0.70	D							MADE GROUND: Dark grey fine to coarse angular gravel of limestone. Occasional cobble. (Hardcore)
		0.70	D							MG-EF
		1.00	D							
		1.00	D							
		1.80	D				1.80	40.82		MADE GROUND: Firm to stiff occasionally stiff red brown dappled blue grey sandy clay with some fine to coarse subangular gravel of mudstone and very occasionally sandstone. (Backfill Embankment of Mercia Mudstone)
		1.80	D							MG-EF
		2.00 - 2.50	B							
		2.00 - 2.50	B							
		3.00 - 3.50	B							
		3.00 - 3.50	B							
		4.00 - 4.50	B							
		4.00 - 4.50	B							
		5.00 - 5.50	B							
		5.00 - 5.50	B							
		6.00 - 6.50	B							
		6.00 - 6.50	B							
		6.30	D				6.30	36.32		Dense brown slightly silty medium and coarse SAND and GRAVEL:- gravel content fine to coarse subangular to rounded of sandstone, limestone and quartz. (River Terrace Deposits?) - Driller notes sand and gravel to be bound in clay matrix.
		6.30	D							FGA-SG
		6.50	B							
		6.50 - 7.00	B							
		7.50 - 8.00	B							
		7.50 - 8.00	B							
		8.00	B							
		8.00 - 8.50	B							
		9.00 - 9.80	B							
		9.00 - 9.80	B							
		9.40	D				9.40	33.22		Stiff red brown mottled/dappled blue grey slightly sandy CLAY with some fine to coarse subangular gravel sized lithorelicts of mudstone
		9.40	D							

Continued on next sheet

Remarks
1. Hand dug pit GL-1.20m. 2. End of drilling borehole grouted up to 0.50m topsoil replaced. 3. Marker Post Ref 192/4 -50S.

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Rotary Core Log

Borehole No. **NWHM66** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447206.93 - 334342.18	Hole Type CP
Location:		Level: 42.62	Scale 1:50
Client: Highways England		Dates: 04/09/1999 - 04/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										(up to 40mm). (Mercia Mudstone - Zone III/IVa?) MM-Z3
		10.50 - 11.00	B							
		10.50 - 11.00	B							
		11.50	D							—from 11.50m to 12.00m locally grading to grade III/II with thin interbeds of siltstone/mudstone (note slow boring/ chiselling)
		11.50	D							
		12.40 - 13.50	B							
		12.40 - 13.50	B							
		12.50	B							
		14.00 - 15.00	B							
		14.00 - 15.00	B							
	▼						15.00	27.62		End of borehole at 15.00 m

11 12 13 14 15 16 17 18 19 20

Remarks
1. Hand dug pit GL-1.20m. 2. End of drilling borehole grouted up to 0.50m topsoil replaced. 3. Marker Post Ref 192/4 -50S.

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Rotary Core Log

Borehole No. **SK43SE26**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447220.00 - 334240.00	Hole Type CP
Location:		Level: 35.00	Scale 1:50
Client: Highways England		Dates: 24/02/1962 - 26/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.53	D				0.53	34.47		Topsoil TP
		1.07	D				1.14	33.86		Brown sandy clay & stones FGA-SG
	▼	1.37	W							Sand & gravel with boulders FGA-SG
		1.52 - 1.98	SPTL S							
		1.83	D							
		1.83 - 3.51	B							
		3.05 - 3.51	SPTL S							
		3.35	D							
		3.96 - 4.42	U				3.51	31.49		Redish marl MM-Z3
		4.50	D							
		5.56 - 6.02	U							
		6.10	D				6.10	28.90		End of borehole at 6.10 m

Remarks
Very little water encountered

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Rotary Core Log

Borehole No. SK43SE286

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447300.00 - 334190.00	Hole Type CP
Location:		Level: 36.27	Scale 1:50
Client: Highways England		Dates: 18/11/1975 - 18/11/1975	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	35.97		TOPSOIL TP
										Grey brown very stony sandy CLAY FGA
							1.20	35.07		Medium compact medium grained SAND and GRAVEL. FGA-SG
	▼									
							4.60	31.67		Highly weathered red/brown silty MARL with occasional bands of green marl MM-Z4
		5.00	U							
		6.50	U							
		8.00	U							
		9.50	U							

Continued on next sheet

Remarks
Water struck at 2.50m. Water standing level 2.50m.

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Rotary Core Log

Borehole No.
SK43SE286
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447300.00 - 334190.00	Hole Type CP
Location:		Level: 36.27	Scale 1:50
Client: Highways England		Dates: 18/11/1975 - 18/11/1975	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.30	25.97		Moderately weathered hard MARL MM-Z2
							11.00	25.27		End of borehole at 11.00 m

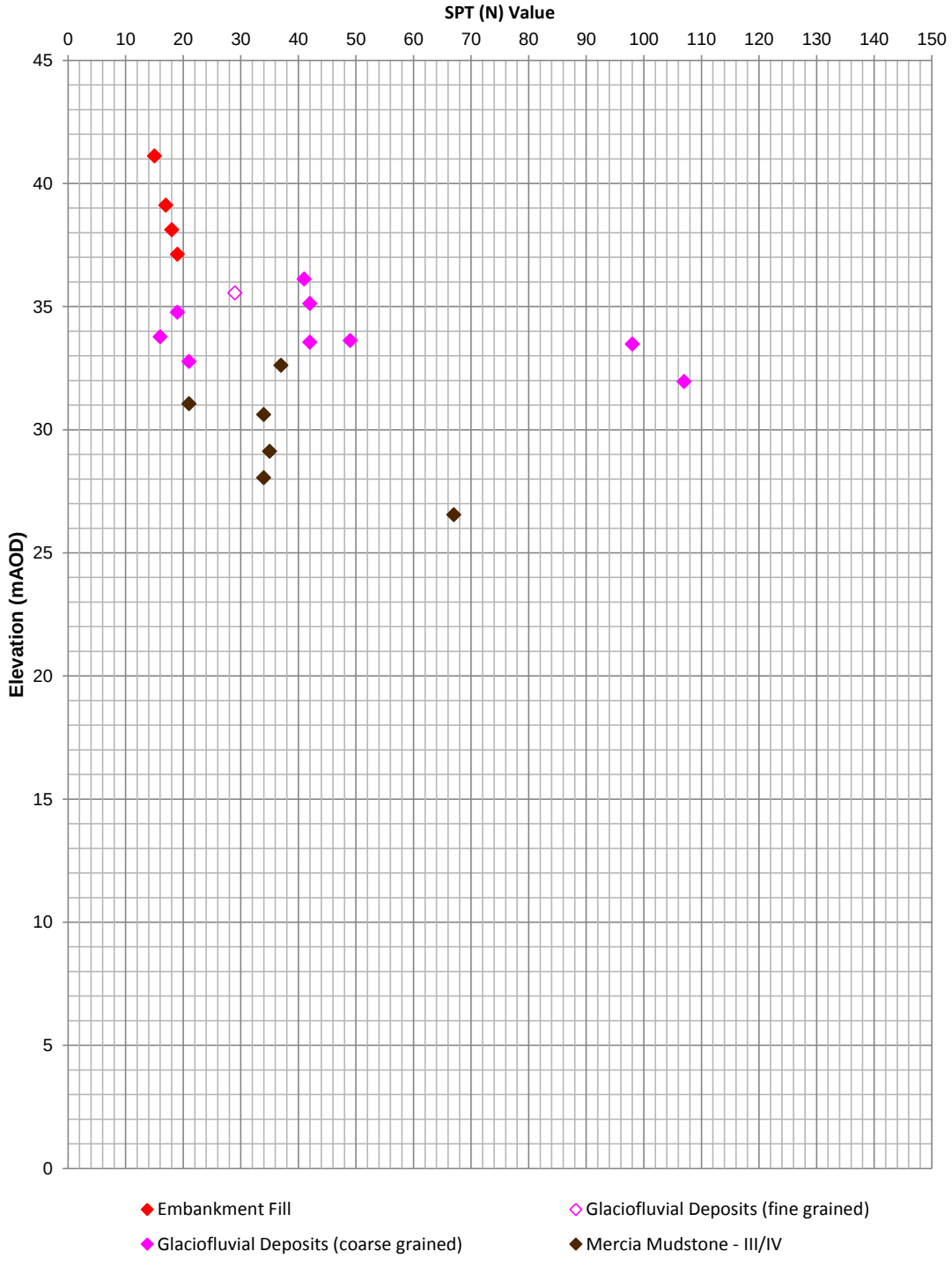
Remarks
Water struck at 2.50m. Water standing level 2.50m.

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PLOTS

amey ARUP	**SPT N Value vs Depth**
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25** | Data Sheet: **192170-192370NB**
Client: **Highways England**	Borehole ID: **CP1113, SK43SE286, SK43SE26, NWHM66**



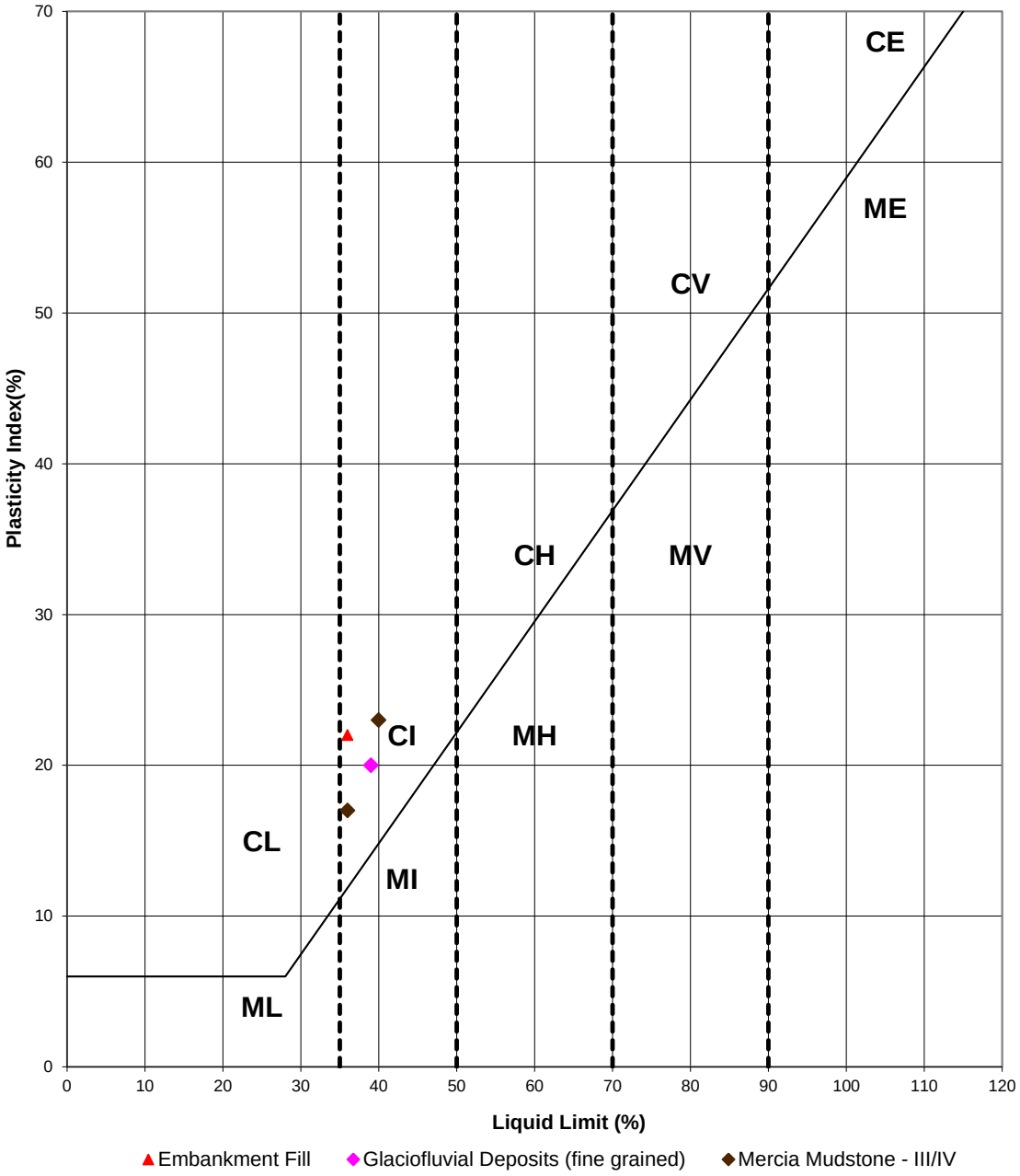
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 01/03/2017 Ref: HA549342-AMAR-HGT-192170-192370NB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **192170-192370NB**
Client: **Highways England**	Borehole ID: **CP1113, NWHM66**	



Key

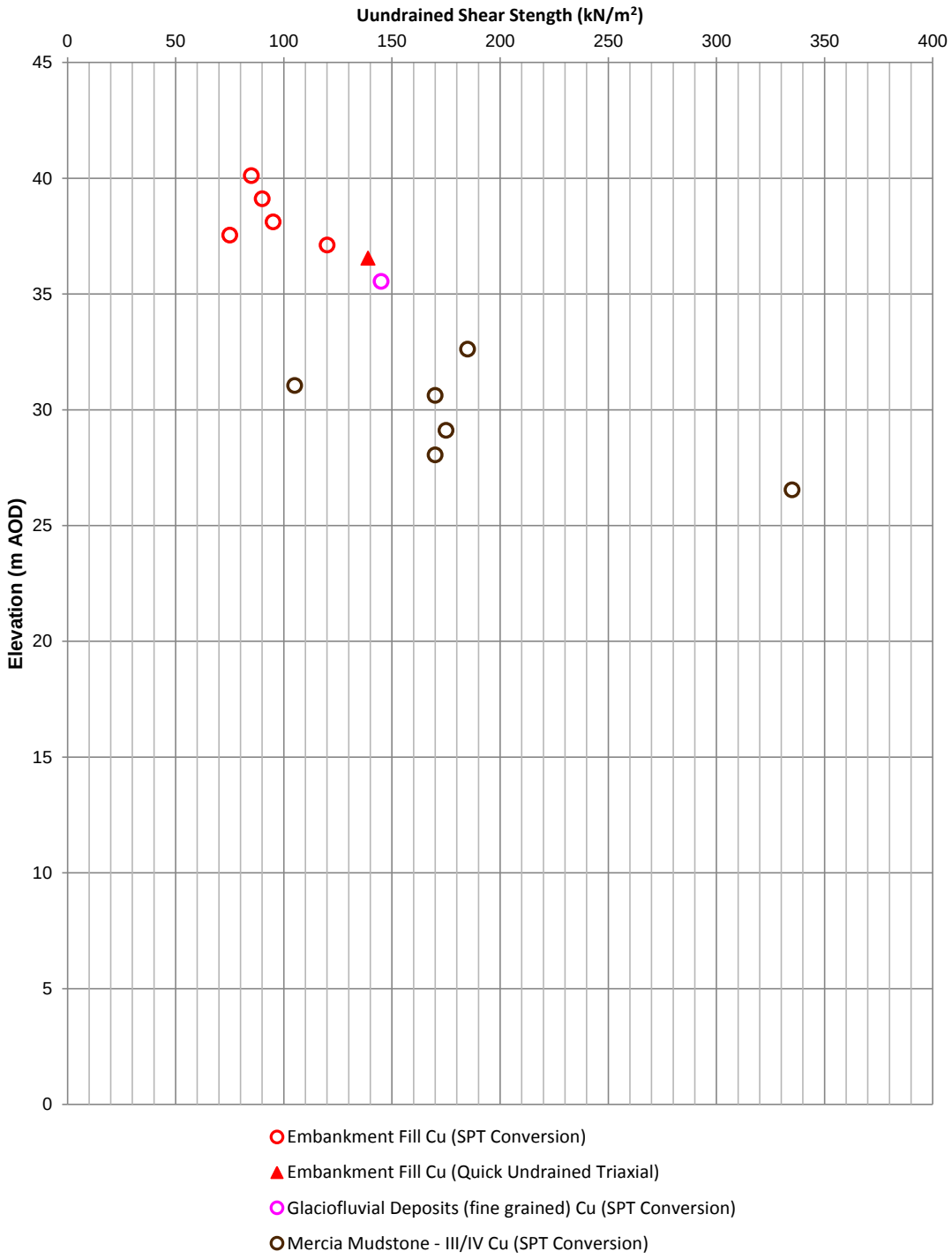
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **192170-192370NB**
Client: **Highways England**	Borehole ID: **CP1113, NWHM66**	



Rev: P01 Date: 01/03/2017 Ref: HA549342-AMAR-HGT-192170-192370NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-192470-192500NB-GSS-000001		
Earthworks Widening Solution	Full Height Embankment Widening (1:2.0)		
Structure Number	GANRTRY_321		
Structure Type	MS4 Cantilever		
Design Chainage	192470-192500		
Carriageway	Northbound		
Marker Post	192/4+70 – 192/5+00		
National Grid Reference	E 447139, N 334506 – E 447136, N 334534		
Existing Ground Level at Location	Carriageway	45.4mAOD	
	Toe of embankment	38.5mAOD	
Earthwork Type	NB: Embankment	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_22045	SB: N/A	HAGDMS designation
Maximum Earthwork Height	NB: 6.9m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Typical Earthwork Angle	NB: 27°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	28/02/2017	[redacted]
Checked	Roheel Masrat	13/03/2017	
Reviewed	Gary Summerfield	14/03/2017	
Approved	Thomas Bulteel	21/03/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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DESK STUDY



Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location a Full Height Embankment Widening (1:2.0) has been proposed.

Proposed Major Structures:

A new MS4 Cantilever Gantry (GANTRY_321) at Ch192476.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is classified as an embankment. The embankment has a height of approximately 6.9m with an existing slope gradient of approximately 21° and a proposed slope gradient of 1V:2H.

The critical cross sections (i.e. the cross section with the greatest earthwork height) used is at Ch192470.

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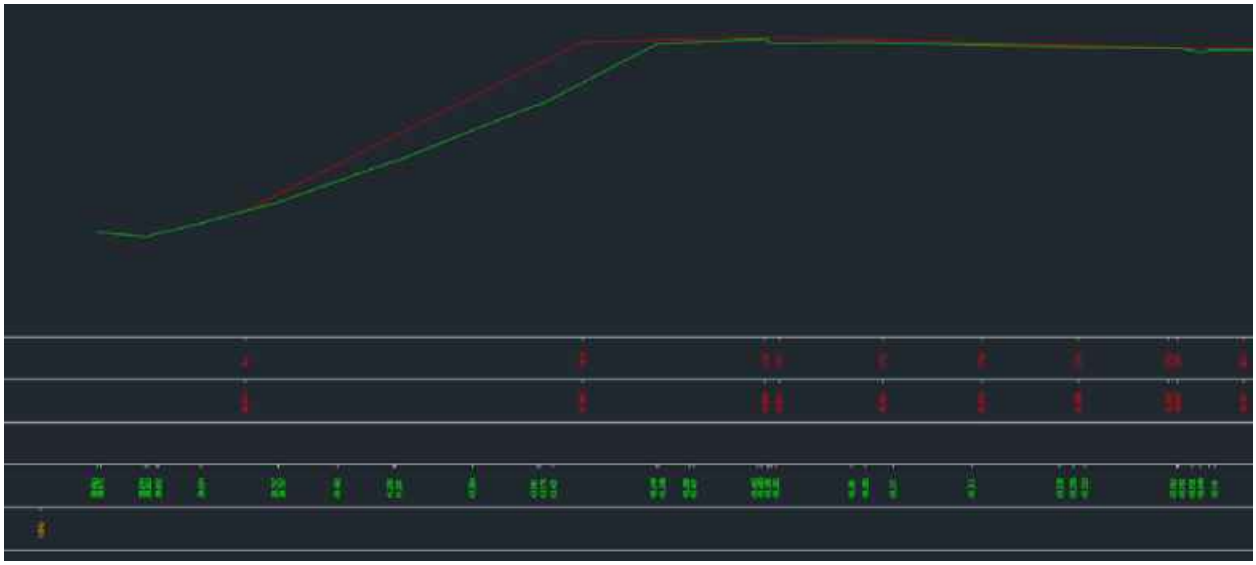


Figure 2: Topographic Critical Cross Section Ch192470

Utilities:

A BT comms cable is located at the edge of the carriageway.

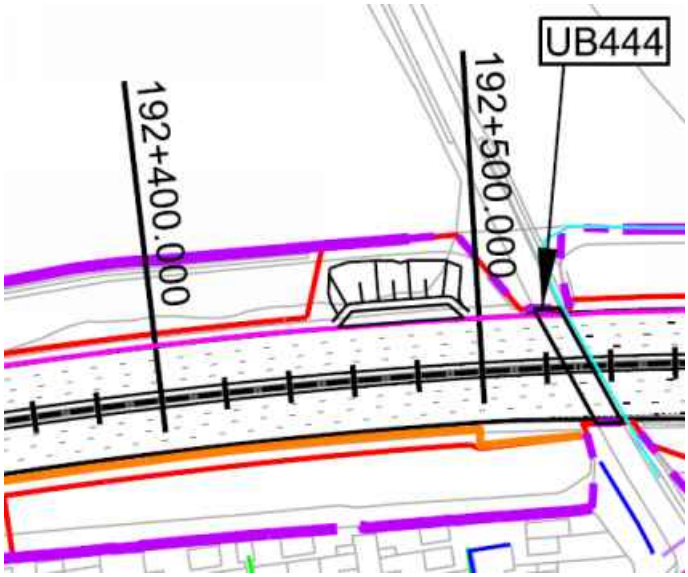


Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Head (Clay, Silt, Sand and Gravel)

Solid Deposits: Gunthorpe Member (Mudstone – Mercia Mudstone Group)

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however 4 No. additional relevant exploratory holes outside design chainage were considered as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000037, Rev P01.



Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	HIS0023
Borehole Chainage	192514
Borehole Location	Northbound (0.5m from VRS)
National Grid Reference	E 447137, N 334548
Ground Level at Exploratory Hole	39.20mAOD
RAG Analysis	Green
Date Drilled	23/06/1964 – 29/06/1964
Termination Depth	18.61 metres below ground level (mbgl) 20.59 metres above Ordnance Datum (mAOD)
Other suitable holes	CP1115 & HIS0025 & HIS0026

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT (N) Value
Embankment Fill	6.9	38.5	19-28 (19)
Head Deposits (fine grained)	8.9	36.5	10-23 (10)
Glaciofluvial Deposits (fine grained)	10.5	34.9	None recorded
Mercia Mudstone – III/IV	Not proven	Not proven	25-28 (25)

(1) Ground level is assumed to be at carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) Characteristic 'N' Values are given in brackets. Given the limited amount of local GI data, these values were taken as the lower bound of the recorded range.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.
(5) Depth of Embankment Fill is based on driven LiDAR survey data at the critical cross section location Ch192470.
(6) Depths of natural strata are based on the closest historical exploratory hole to the critical cross section (HIS0023).
(7) 2 No. SPTs were undertaken within Mercia Mudstone – Siltstone and experienced refusal; these have not been considered further.
(8) 4 No. SPTs were undertaken within Glaciofluvial Deposits (coarse grained), of which is not included in the above ground model; therefore these have not been considered further.
(9) Mercia Mudstone – Siltstone and Mercia Mudstone – I/II were recorded in CP1115, both at depth beneath Mercia Mudstone – III/IV. Given that the closest historical exploratory hole HIS0023 does not contain these strata, they have been excluded from the ground model.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in historical exploratory holes HIS0023, HIS0025, HIS0026 and CP1115.

Groundwater:

The following groundwater strikes were recorded in the historical exploratory holes (no groundwater was apparent during boring of CP1115 but may have been masked by the addition of water):

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		mbgl	mAOD	Time	mbgl	mAOD
HIS0023	Head Deposits	1.98	37.22	Unrecorded	1.52	37.68
HIS0025	Glaciofluvial Deposits	3.05	35.55	Unrecorded	2.13	36.47
HIS0026	Head Deposits	1.52	36.68	Unrecorded	1.22	36.98

Groundwater Design Level:

A groundwater level of 1.0m below toe of embankment (37.5mAOD) has been assumed for a conservative design.

GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

5 No. Atterberg Limit Test and 5 No. Natural Moisture Content tests were undertaken with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	2.7	19.17	33	16	17	CL
Embankment Fill	4.7	15.52	31	13	18	CL
Head Deposits (fine grained)	6.7	11.93	26	14	12	CL
Head Deposits (fine grained)	8.7	20.34	46	17	29	CI
Glaciofluvial Deposits (fine grained)	11.8	18.74	34	17	17	CL

2 No. Triaxial Tests were undertaken with the following results:

Stratum	Depth to Top of Test (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	2.2	116
Embankment Fill	6.2	138

Lab Test Data – BRE Classification:

The following chemical testing data was available from the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	pH	Solid (water extract)	1	8.5	-
Head Deposits	pH	Solid (water extract)	5	7.2-8.5	-
Head Deposits	Sulphate (Total) as SO_4	Solid	4	0.04	%
Glaciofluvial Deposits (fine grained)	Sulphate (Total) as SO_4	Solid	3	0.01-0.37	%
Glaciofluvial Deposits (coarse grained)	pH	Solid (water extract)	3	7.0-7.2	-
Glaciofluvial Deposits (coarse grained)	Sulphate (Total) as SO_4	Water	1	0.05	g/l
Mercia Mudstone – III/IV	pH	Solid (water extract)	20	4.6-8.4	-
Mercia Mudstone – III/IV	Sulphate (Total) as SO_4	Solid	14	0.07-0.25	%
Mercia Mudstone – III/IV	Sulphate (Total) as SO_4	Water	3	0.18-0.55	g/l

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Assumed Ground Model For Design:

Ground model based on geological long section HA549342-AMAR-HGT-SWI-DR-CE-000037 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01. The below table outlines the assumed anticipated ground model, to be confirmed by 'Just in Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)		Poisson's Ratio		Shear Modulus (MN/m^2)	Adhesion Factor α	Nc	BRE Classification
								E_u	E'	v_u	v'				
Embankment Fill	0-6.9	45.4-38.5	6.9	21	27	0	116	7.5	3.8	0.50	0.20	2.5	0.42	6.2*	DS-2 AC-2
Head Deposits (fine grained)	6.9-8.9	38.5-36.5	2.0	20	27	0	95	4.8	6.0	0.50	0.20	1.6	0.46	9	DS-1 AC-1
Glaciofluvial Deposits (fine grained)	8.9-10.5	36.5-34.9	1.6	21	26	0	100	10.0	8.0	0.50	0.20	3.3	0.45	9	DS-3 AC-3
Mercia Mudstone – III/IV	>10.5	<34.9	-	21	30	2	125	9.3	7.4	0.50	0.20	3.1	0.45	9	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Given the limited amount of local PI data, the ϕ' of Embankment Fill, Head Deposits, Glaciofluvial Deposits (fine grained) and Mercia Mudstone – III/IV was taken as the characteristic value given in the AMAR GIR.
(4) Given the limited amount of local data for Glaciofluvial Deposits (fine grained), the characteristic parameters given in the AMAR GIR were adopted.
(5) c_u of Embankment Fill, Head Deposits and Mercia Mudstone – III/IV was determined based on recorded undrained triaxial tests and c_u derived using the Stroud correlation. Due to the limited amount of local PI data, a typical f1 value of 5.0 was used.
(6) Eu of Embankment Fill can be determined using Bowles relationship Eu = 300 (N + 6); using a N value of 19 (Taken from exploratory hole CP1115) gives Eu = 7.5MN/m^2. Using Wroth (1972) E' can then be calculated using

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E' = 2/3 (1 + v) Eu = 6.0MN/m^2.

(7) Eu for Head deposits can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 10 (Taken from exploratory whole CP1115) gives Eu = 4.8MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 3.8MN/m^2.

(8) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the conservative SPT 'N' value of 25, Eu = 9.3MN/m^2. Therefore E' = 7.4MN/m^2.

(9) Adhesion factor for Embankment fill is based on BS8004 (equation 41). Adhesion Factor for Mercia Mudstone is based on Table 4.16 in Tomlinson and Woodward.

(10) Shear modulus is based on G = E/2(1+v).

(11) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl

(12) K_o/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).

(13) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1). For sandstone, Nq is derived based on a very dense siliceous cohesionless soil (Tomlinson Table 7.1).

(14) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of sufficient local BRE test data for Embankment Fill, Head Deposits (fine grained) or Glaciofluvial Deposits (fine grained), the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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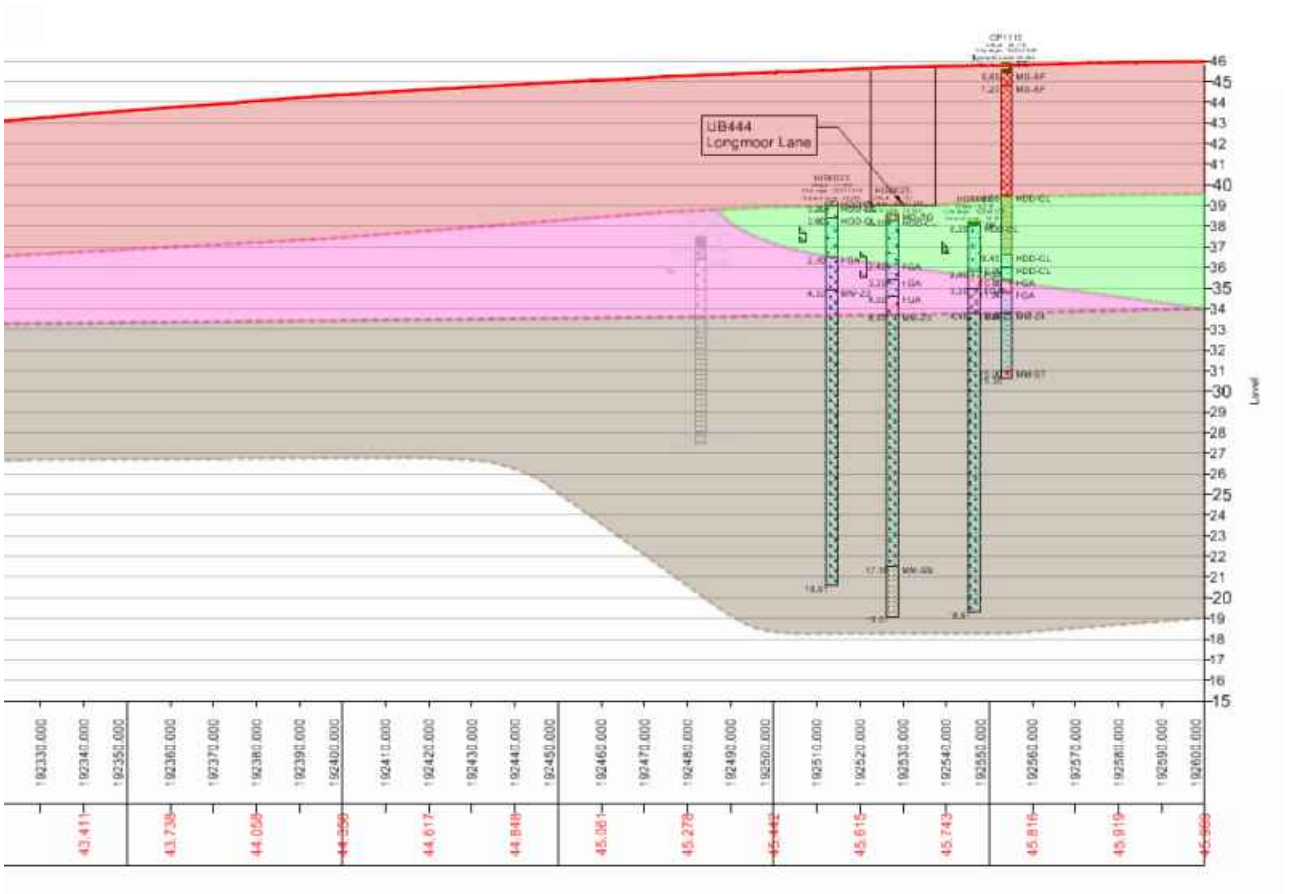


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Benching Detail	
			Base Width (m)	Batter Angle (°)
192470	192500	Full Height Embankment Widening 1:2	3.9	1:2

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Structure Reference	Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
Gantry 321	4	750	15	2.25	11	181	510

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-G321, Ch192476, Northbound, dynamic sample with rotary core follow to 20mbgl.

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HISTORICAL EXPLORATORY HOLES

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Borehole Log

Borehole No. **CP1115** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447130.00 - 334588.00	Hole Type CP
Location:		Level: 46.00mbgl	Scale 1:50
Client: Highways England		Dates: 13/11/2006 - 14/11/2006	Logged By OP

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.50	101B			0.60	45.40		TOPSOIL TP
		1.00	102B						MADE GROUND. Dark brown sandy gravelly clay. Sand is predominantly fine and medium. Gravel is subangular fine to coarse of siltstone. MG-EF
		1.20	SPT (C)	N=28 (11,14/8,7,7,6)	Water=DRY	1.20	44.80		MADE GROUND. Stiff red brown with occasional grey mottling slightly gravelly clay with occasional pockets of silt. Gravel is subangular to rounded fine to coarse of claystone, siltstone and quartzite. Possible MG-EF
		1.20 - 1.70	2B						
		2.20 - 2.65	3U	57blows	Dia.=100mm				
		2.70	4D						
		3.20	SPT (S)	N=28 (3,5/5,7,8,8)	Casing=3.20m Water=DRY				
		3.20 - 3.65	5D						
		3.20 - 3.70	6B						
		4.20 - 4.65	7U	53blows	Dia.=100mm				
		4.70	8D						
		5.20	9D						
		5.20	SPT (S)	N=19 (2,4/4,5,5,5)	Casing=5.20m Water=DRY				
		5.20 - 5.70	10B						
		6.20 - 6.65	11U	50blows	Dia.=100mm				
		6.70	12D			6.50	39.50		Stiff friable red brown sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to rounded fine to coarse of quartzite. Possible HDD-CL
		7.20	SPT (S)	N=23 (2,3/5,5,6,7)	Casing=7.20m Water=DRY				Between 7.20m and 7.70m, orange brown with occasional light grey and red brown mottling.
		7.20 - 7.65	13D						
		7.20 - 7.70	14B						
		8.20 - 8.65	15U	39blows	Dia.=100mm				
		8.34	201 W						
		8.70	16D						At 8.70m, slightly sandy.
		9.40	17D			9.40	36.60		Stiff red brown slightly sandy CLAY. Sand is fine and medium. Possible HDD-CL
		9.70	SPT (S)	N=19 (2,3/3,4,5,7)	Casing=9.70m Water=DRY				
		9.70 - 10.15	18D			10.00	36.00		Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. An amount of water was added to facilitate boring from 10.60m.:The borehole was advanced by chiselling methods from 15.00m to 15.30m (1 hour).:No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **CP1115** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447130.00 - 334588.00	Hole Type CP
Location:		Level: 46.00mbgl	Scale 1:50
Client: Highways England		Dates: 13/11/2006 - 14/11/2006	Logged By OP

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		9.70 - 10.20	19B						Dark grey slightly organic slightly sandy CLAY. Sand is fine. HDD-CL
		10.60	SPT (C)	N=32 (2,4/6,7,9,10)	Casing=10.60m Water=ADDED	10.60	35.40		
		10.60 - 11.10	20B						Dense brown, white and grey SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to rounded of quartzite, sandstone and siltstone. FGA-SG
		11.20	21D			11.20	34.80		
		11.30 - 11.75	22U	50blows	Dia.=100mm				Firm and stiff brown and orange brown slightly sandy slightly gravelly CLAY with occasional partings of silt. Sand is fine. Gravel is subangular and subrounded fine of mudstone. Possible FGA
		11.80	23D						
		12.20	SPT (S)	N=25 (3,3/5,6,7,7)	Casing=12.20m Water=ADDED	12.20	33.80		
		12.20 - 12.65	24D						Stiff red brown slightly sandy CLAY. Sand is fine. MM-Z4
		12.20 - 12.70	25B						
		13.70	SPT (S)	N=28 (3,4/4,7,8,9)	Casing=13.70m Water=ADDED				
		13.70 - 14.15	26D						
		13.70 - 14.20	27B						
		15.00	SPT (S)	50 (25 for 50mm/50 for 20mm)	Casing=15.00m Water=ADDED	15.00	31.00		
		15.00 - 15.07	28D			15.35	30.65		Weak light grey SILTSTONE recovered as light grey subangular fine to coarse gravel and cobble sized fragments. MM-ST
		15.00 - 15.30	29B						End of borehole at 15.35 m
		15.30	SPT (C)	50 (25 for 30mm/50 for 20mm)	Casing=15.30m Water=ADDED				

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. :An amount of water was added to facilitate boring from 10.60m.:The borehole was advanced by chiselling methods from 15.00m to 15.30m (1 hour).:No visual or olfactory indication of contamination was observed.:

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Borehole Log

Borehole No. **HIS0023** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447137.00 - 334548.00	Hole Type CP
Location:		Level: 39.20mbgl	Scale 1:50
Client: Highways England		Dates: 23/06/1964 - 29/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.00 - 0.61	1B			0.20	39.00		Brown CLAY HDD-CL
		0.30	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				Medium dense brown clayey coarse GRAVEL HDD-CL
						0.80	38.40		Firm red-brown silty CLAY with occasional gravel HDD-CL
		1.22 - 1.68	2U		Dia.=100mm				
		1.68	3D						
		2.29	4B						
		2.74 - 3.20	5U		Dia.=100mm	2.70	36.50		Firm grey-blue silty CLAY FGA
		3.20	6D						
		3.66	7D						
		4.27 - 4.72	8U		Dia.=100mm	4.30	34.90		Stiff to very stiff, becoming hard, friable mottled red-brown and grey silty CLAY, with bands of mudstone and sandstone (Keuper Marl) MM-Z3
		4.72	9D						
		5.33	10D						
		5.79 - 6.25	11U		Dia.=100mm				
		6.25	12D						
		6.86	13D						
		7.32 - 7.77	14U		Dia.=100mm				
		7.77	15D						
		8.38	16D						
		8.84 - 9.30	17U		Dia.=100mm				
		9.30	18D						
		9.75	19B						

Continued on next sheet

Remarks

Ground-water was first observed at a depth of 1.98m below ground level on the morning of 24.06.64 but had risen to 1.52m below ground level on the morning of 27.06.64. Water samples were taken.

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Borehole Log

Borehole No. **HIS0023** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords:	447137.00 - 334548.00	Hole Type CP
Location:		Level:	39.20mbgl	Scale 1:50
Client: Highways England		Dates:	23/06/1964 - 29/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		10.36 - 10.82	20U		Dia.=100mm				
		10.82	21D						
		11.43	22D						
		11.89 - 12.34	23U		Dia.=100mm				
		12.34	24D						
		12.95	25D						
		13.41 - 13.87	26U		Dia.=100mm				
		13.87	27D						
		14.48	28D						
		14.94	29D						
		16.46	30B						
		17.37	31D						
		18.29 - 18.59	32B						
		18.59	33W			18.61	20.59		End of borehole at 18.59 m

Remarks

Ground-water was first observed at a depth of 1.98m below ground level on the morning of 24.06.64 but had risen to 1.52m below ground level on the morning of 27.06.64. Water samples were taken.

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Borehole Log

Borehole No. **HIS0025**
HISTORIC
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447135.00 - 334562.00	Hole Type CP
Location:		Level: 38.60mbgl	Scale 1:50
Client: Highways England		Dates: 09/07/1964 - 13/07/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.30	38.30		FILL (Brick rubble and gravel) MG-SG
		0.61	1D						Stiff mottled blue and brown silty CLAY with occasional fine to medium gravel HDD-CL
		0.91 - 1.37	2U		Dia.=100mm				
		1.37	3D						
	▼	1.98	4D						
		2.44 - 2.90	5U		Dia.=100mm	2.40	36.20		Firm brown sandy CLAY FGA
	▽	2.90	6D						
		3.51	7D			3.20	35.40		Firm grey silty CLAY FGA
		4.11 - 4.57	8B			4.00	34.60		Medium dense brown fine to medium GRAVEL FGA-SG
		4.27	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.03 - 5.49	9U		Dia.=100mm	4.90	33.70		Stiff to very stiff friable red-brown and grey silty CLAY and clayey SILT with occasional mudstone fragments; thin bands of sandstone below 8.2m (Keuper Marl) MM-Z3
		5.49	10D						
		5.94	11D						
		6.25 - 6.71	12U		Dia.=100mm				
		6.71	13D						
		7.16	14D						
		7.77 - 8.23	15U		Dia.=100mm				
		8.23	16D						
		8.69	17D						
		9.30 - 9.75	18U		Dia.=100mm				
		9.75	19D						

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level but had risen to 2.13m below ground level on the morning of 13.07.64. Sample of ground-water taken.

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Borehole Log

Borehole No.
HIS0025
HISTORIC
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447135.00 - 334562.00	Hole Type CP
Location:		Level: 38.60mbgl	Scale 1:50
Client: Highways England		Dates: 09/07/1964 - 13/07/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		10.21	20D						
		10.82 - 11.28	21U		Dia.=100mm				
		11.28	22D						
		11.73	23D						
		12.34 - 12.80	24U		Dia.=100mm				
		12.80	25D						
		13.26	26D						
		13.87 - 14.33	27U		Dia.=100mm				
		14.33	28D						
		14.78	29D						
		15.39 - 15.85	30U		Dia.=100mm				
		15.85	31W						
						17.10	21.50		Grey SANDSTONE MM-SS
						19.51	19.09		End of borehole at 19.51 m

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level but had risen to 2.13m below ground level on the morning of 13.07.64. Sample of ground-water taken.

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Borehole Log

Borehole No. **HIS0026** HISTORIC Sheet 1 of 2

Project Name:	SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords:	447168.00 - 334584.00
Location:			Level:	38.20mbgl
Client:	Highways England		Dates:	06/07/1964 - 08/07/1964

Hole Type CP | Scale 1:50 | Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.20	38.00		TOPSOIL TP
		0.46 - 0.91	1U		Dia.=100mm				Stiff friable brown silty sandy CLAY with roots. HDD-CL
		0.91	2D						
	▼	1.52	3D						
		2.44 - 2.90 2.59	4B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	2.40	35.80		Medium dense brown sandy fine to medium GRAVEL FGA-SG
		3.51 - 3.96 3.66	5B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	3.20	35.00		Medium dense brown clayey fine to medium GRAVEL FGA-SG
		4.57 - 5.03	6U		Dia.=100mm	4.40	33.80		Stiff to very stiff friable mottled red-brown and grey clayey SILTY or silty CLAY; thin bands of sandstone and mudstone below 4.7m. MM-Z3
		5.03	7D						
		5.64	8D						
		6.10 - 6.55	9U		Dia.=100mm				
		6.55	10D						
		7.16	11D						
		7.62 - 8.08	12U		Dia.=100mm				
		8.08	13D						
		8.69	14D						
		9.14 - 9.60	15U		Dia.=100mm				
		9.60	16D						

Continued on next sheet

Remarks

Ground-water was first encountered at a depth of 1.53m below ground level on the morning of 7.07.64 but had risen to 1.22m below ground level by the following morning. Sample of ground-water taken.

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Borehole Log

Borehole No.
HIS0026
HISTORIC
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447168.00 - 334584.00	Hole Type CP
Location:		Level: 38.20mbgl	Scale 1:50
Client: Highways England		Dates: 06/07/1964 - 08/07/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		10.21	17D						
		10.67 - 11.13	18U		Dia.=100mm				
		11.13	19D						
		11.73	20D						
		12.19 - 12.65	21U		Dia.=100mm				
		12.65	22D						
		13.26	23D						
		13.72 - 14.17	24U		Dia.=100mm				
		14.17	25D						
		14.78	26D						
		15.54 - 16.00	27U		Dia.=100mm				
		16.00	28D						
		16.46	29D						
		17.07 - 17.53	30U		Dia.=100mm				
		17.53	31D						
		17.98	32D						
		18.29 - 18.75	33U		Dia.=100mm				
		18.75	34D						
		18.75	35W			18.91	19.29		End of borehole at 18.91 m

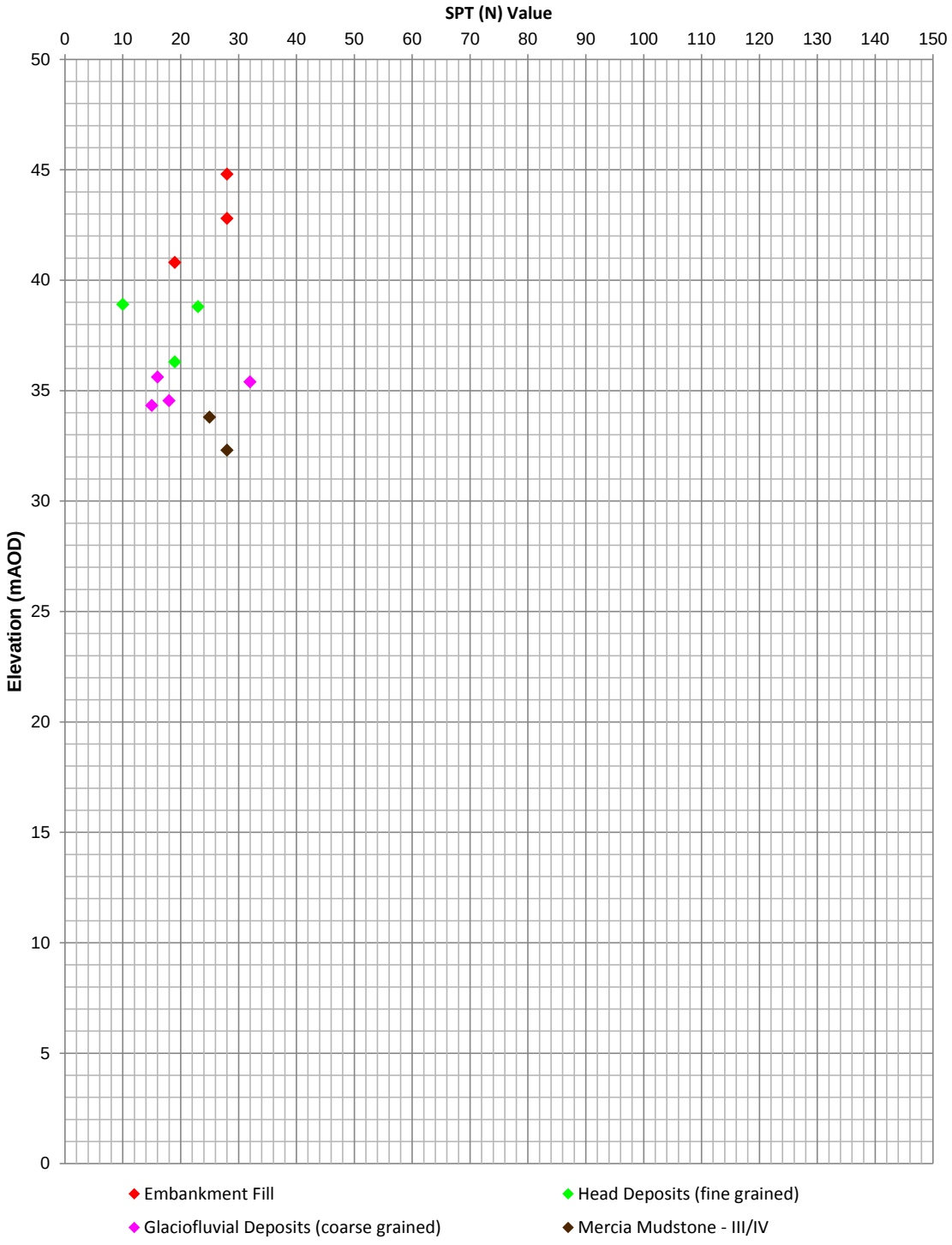
Remarks
Ground-water was first encountered at a depth of 1.53m below ground level on the morning of 7.07.64 but had risen to 1.22m below ground level by the following morning. Sample of ground-water taken.

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PLOTS

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Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25** | Data Sheet: **192470-192500NB**
Client: **Highways England**	Borehole ID: **CP1115 + HIS0023 + HIS0025 + HIS0026**



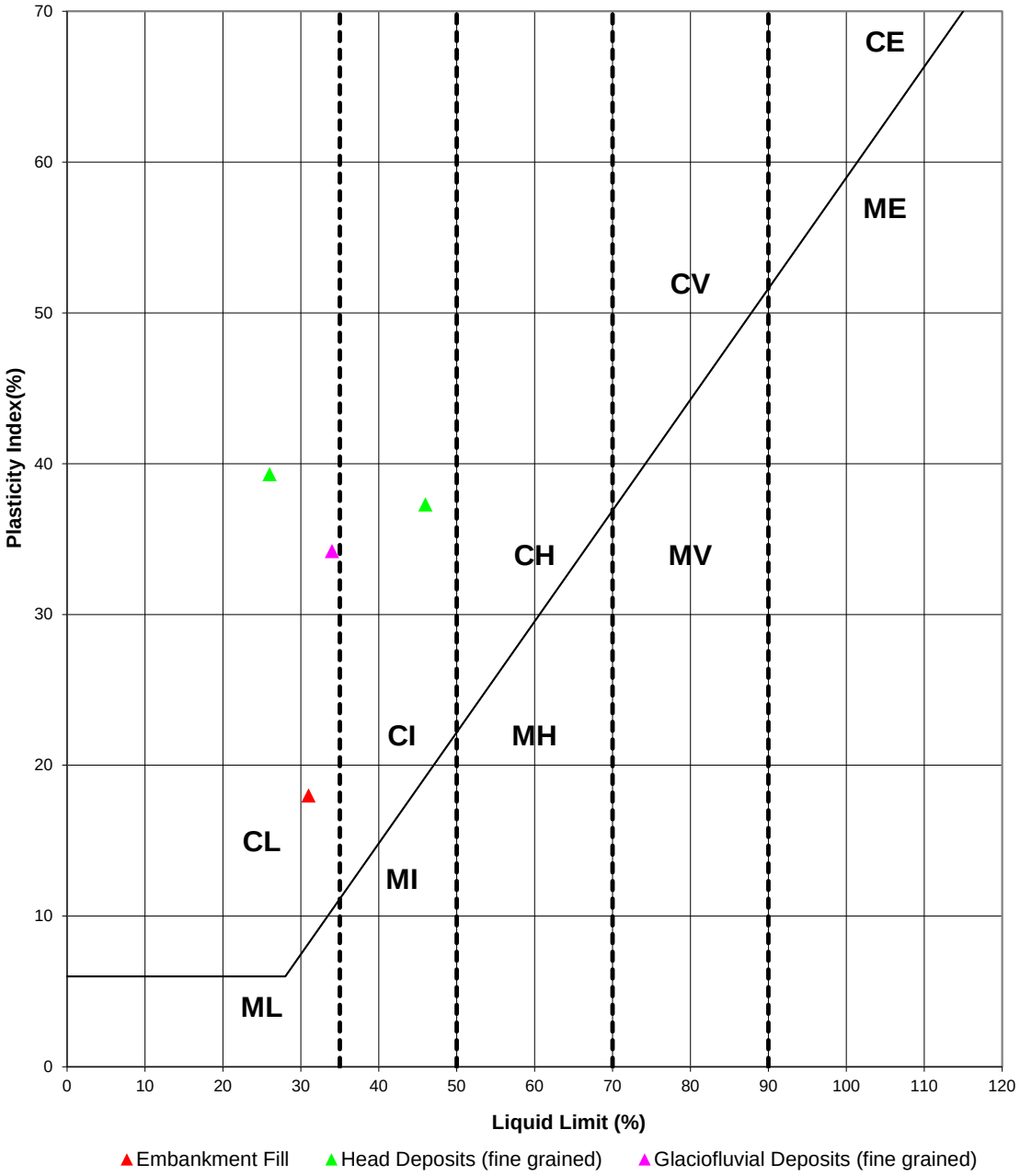
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 28/02/2017 Ref: HA549342-AMAR-HGT-192470-192500NB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **192470-192500NB**
Client: **Highways England**	Borehole ID: **CP1115**	



Key

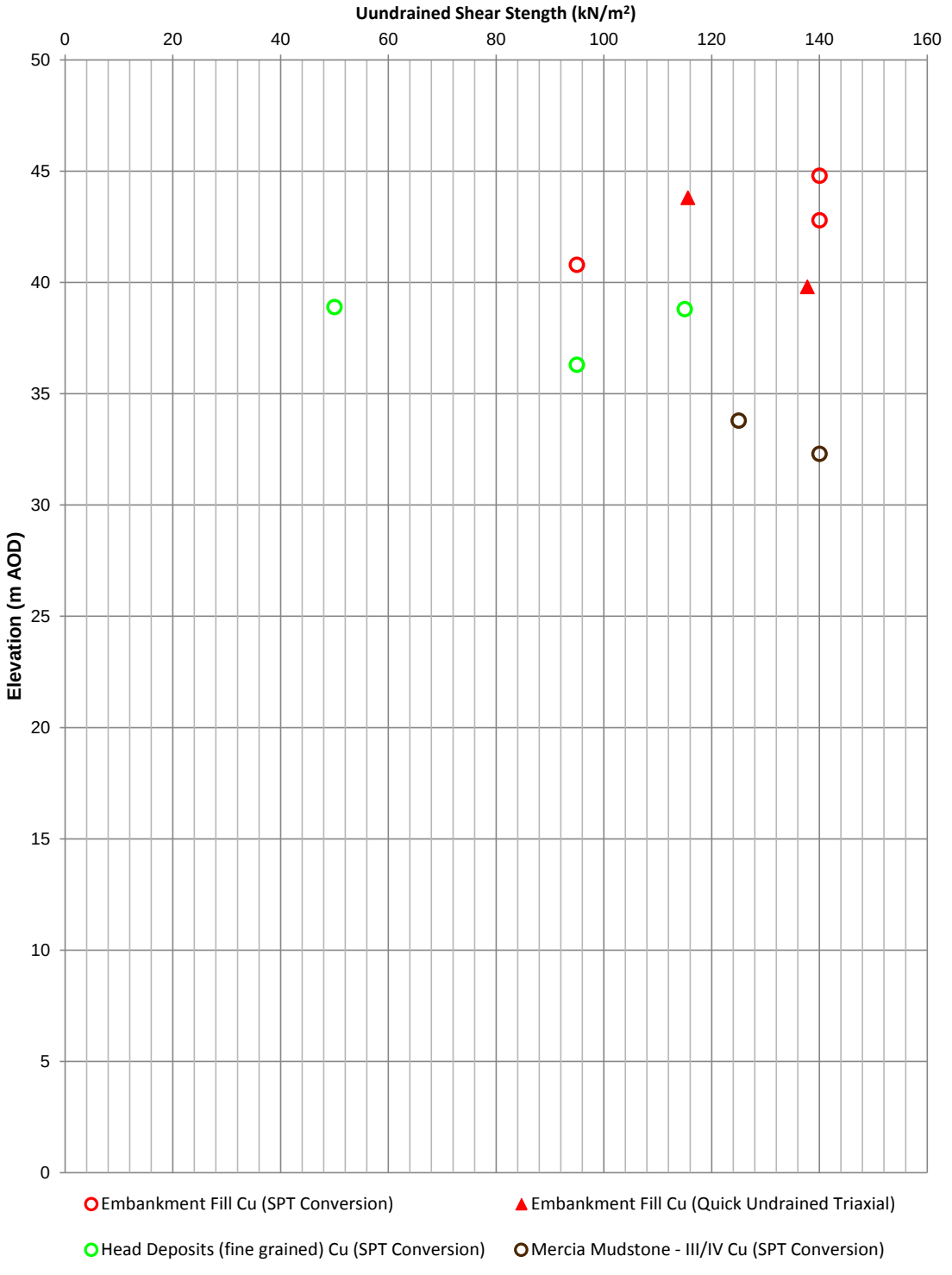
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **192470-192500NB**
Client: **Highways England**	Borehole ID: **CP1115 + HIS0023**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-192980-193020NB-GSS-000001		
Structure Number	N/A		
Structure Type	Gabion Wall		
Design Chainage	192980-193020		
Carriageway	Northbound		
Marker Post	192/9+80 – 193/0+20		
National Grid Reference	E 447145, N 335017 – E 447148, N 335057		
Existing Ground Level at Location	Crest	52.5mAOD	
	Carriageway	45.0mAOD	
Earthwork Type	NB: Cutting	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_22261	SB: N/A	HAGDMS designation
Earthwork Height	NB: 6.5-8.0m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 16°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Roheel Masrat	17/01/2017	[redacted]
Checked	Alice Bazen	12/04/2017	
Reviewed	Gary Summerfield	12/04/2017	
Approved	Tom Bulteel	06/06/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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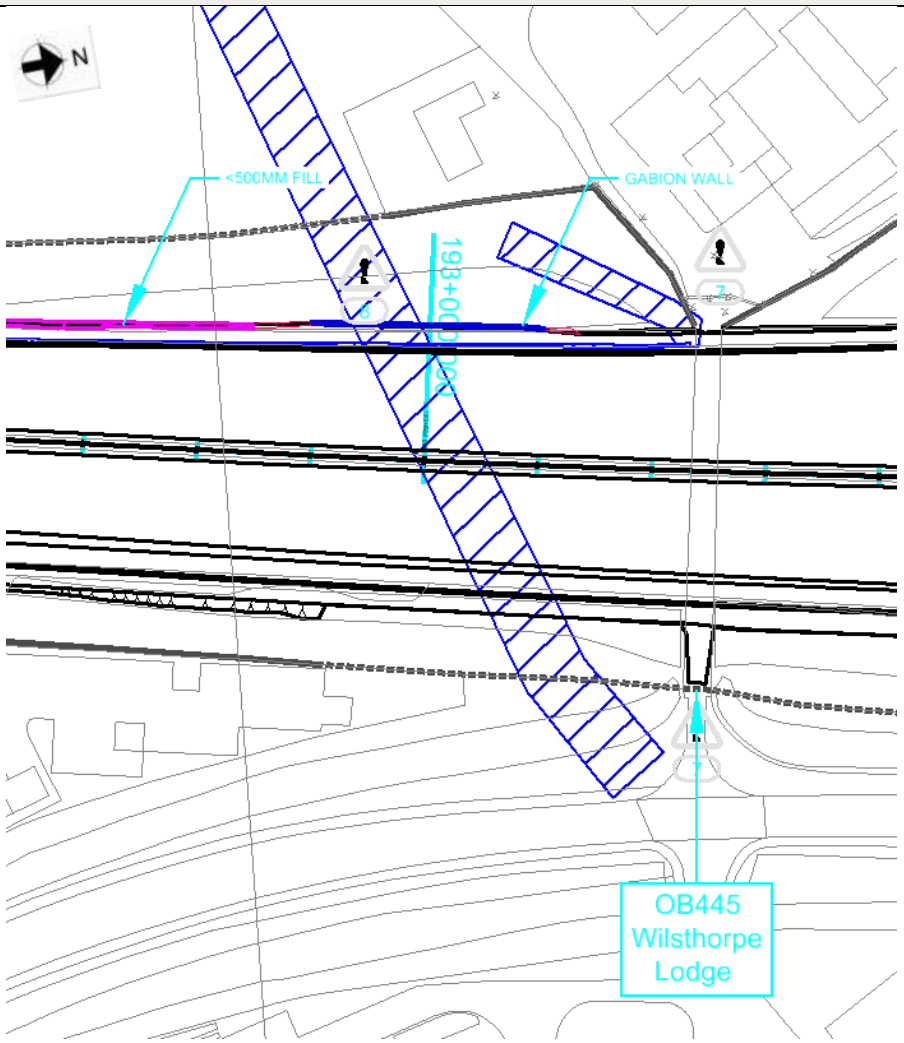


Figure 1: Location Plan

Proposed Widening:

Gabion wall has been proposed as the widening solution at this location.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at this location is classified as a cutting of 6.5-8.0m height and a typical slope angle of 16°.

The critical cross section (i.e. the section with greatest retained height, 1.6m) chosen for design has a height of 7.5m and a typical slope angle of 16°.



Figure 2: Topographic Critical Cross Section Ch193010

Utilities:

Western Power Low Voltage Meter Connection running northbound to southbound at approximately ch.192990.

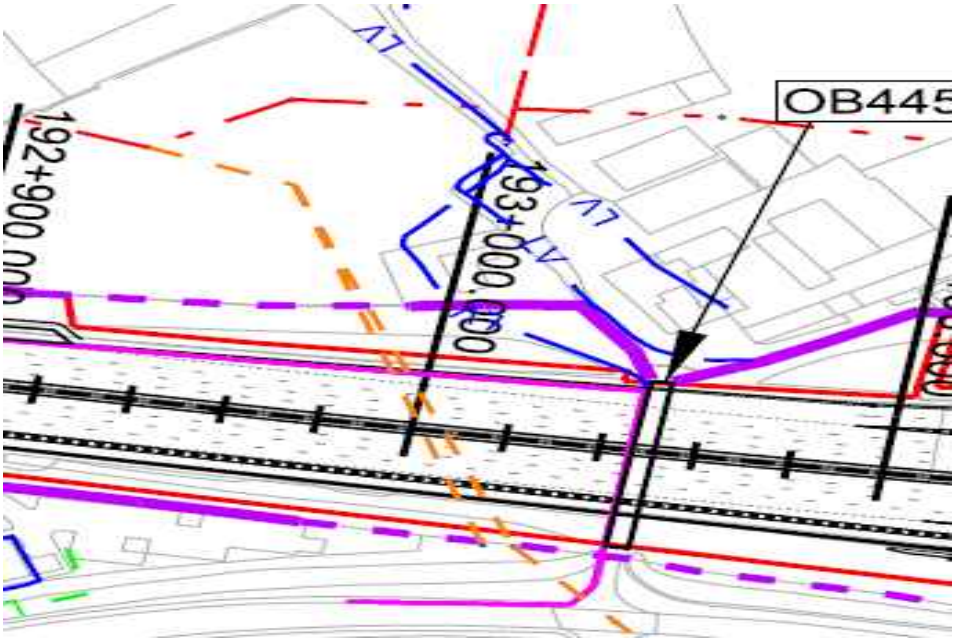


Figure 2: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: None recorded

Solid Deposits: Gunthorpe Member - Mudstone

Ground Investigation:

1 No. historical exploratory hole is located between Ch192980-193050 and 1 No. additional relevant historical exploratory hole is located outside the widening location.

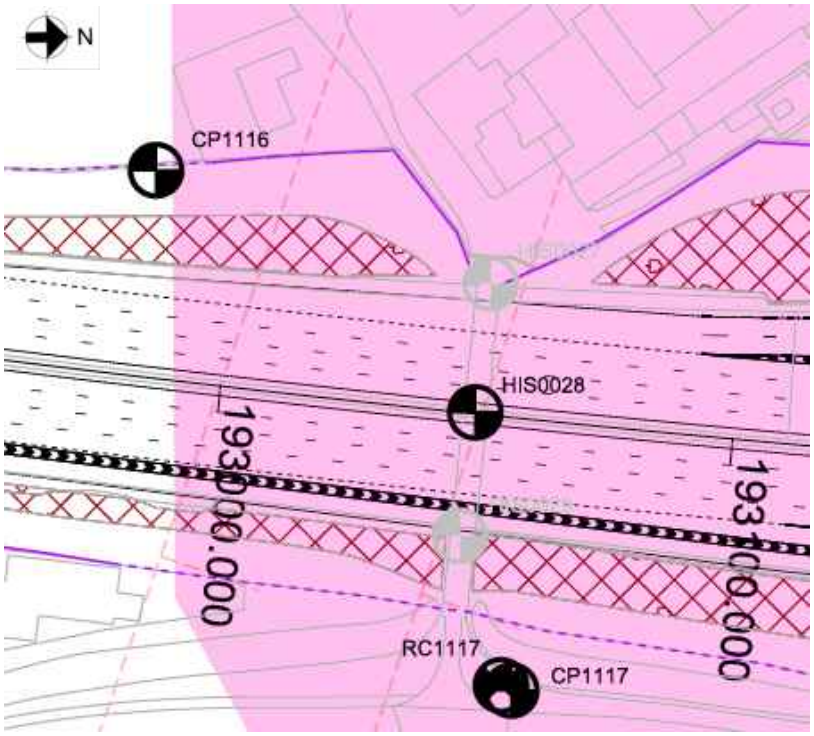


Figure 3: Borehole Location Plan

Flood Risk:

Location is not in a flood risk area.

Historical Boreholes:

Relevant Borehole Number	CP1116
Borehole Chainage	192983
Borehole Location	Northbound (beyond HE earthwork)
National Grid Reference	E 447124, N 335022
Ground Level at Exploratory Hole	48.95mAOD
RAG Analysis	Green
Date Drilled	05/10/2006 – 06/10/2006
Termination Depth	8.50 metres below ground level (mbgl) (40.45mAOD)

Other suitable holes	HIS0028

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LIDAR Survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT (N)
Embankment Fill (Made Ground)	5.58	45.20	6-7 (7)
Mercia Mudstone III/IV	Not proven	Not proven	67-150 (67)

(1) Ground level is assumed to be at the crest of the cutting
(2) Earthwork height will vary per location analysed, therefore the above elevation/depth of Embankment Fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.
(5) Cutting slope is made of Made Ground due to the slip road.
(6) Mercia Mudstone – III/IV is divided at 10mbgl based on an increase in strength.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in borehole CP1116 only.

Groundwater:

Groundwater was encountered at a depth of 2.70mbgl (42.50mAOD) in the borehole HIS0028. No groundwater was recorded in borehole CP1116.

Groundwater Design Level:

A design groundwater level of 1.0m below ground level throughout the cutting was assumed for design. For the purpose of slope W analysis, an Ru value of 0.2 has been adopted.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

4 No. Atterberg Limit Tests and 4 No. Moisture Content Tests were completed in the historical exploratory holes:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill (Made Ground)	47.30	22	49	23	26	CI
Embankment Fill (Made Ground)	45.50	21	36	19	17	CI
Mercia Mudstone – III/IV	43.50	9	31	14	17	CL
Mercia Mudstone – III/IV	41.95	11	34	16	18	CL

Lab Test Data - Chemical:

2 No. Sulphate and 1 No. pH Tests were completed in in the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Mercia Mudstone – III/IV	Sulphate (Total) as SO4	Solid	1	0.06	%SO4
Mercia Mudstone – III/IV	Water Soluble Sulphate as SO4	Water	1	0.16	g/l SO4
Mercia Mudstone – III/IV	pH	Solid	1	7.1	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)		Poisson's Ratio		BRE Classification
								E_u	E'	v_u	v'	
Embankment Fill (Made Ground)	0.00 – 5.58	50.65 – 45.20	5.58	21	25	0	32	3.9	3.1	0.50	0.20	DS-2 AC-2
Mercia Mudstone III/IV	>5.58	<45.20	Not proven	21	30	2	389	21.9	17.5	0.50	0.20	DS-1 AC-1

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) ϕ' of Embankment Fill is determined using Table 2 in BS8002:2015 using the recorded PI of 26% gives 25°.
(4) c_u of Embankment Fill is derived using the Stroud correlation. The recorded PI of 26% gives an f1 value of 4.6, using a recorded SPT of 7, Cu=32kN/m^2.
(5) E' of Embankment Fill is based relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the intermediate SPT N value of 7, Eu = 3.9MN/m^2. Therefore E' = 3.1MN/m^2.
(6) c_u of Mercia Mudstone – III/IV can be derived using the Stroud correlation. A recorded PI of 17% gives an f1 value of 5.8, with an SPT of 67, Cu=389kN/m^2.
(7) E' of Mercia Mudstone is based relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the intermediate SPT N value of 67, Eu = 21.9MN/m^2. Therefore E' = 17.5MN/m^2.
(8) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Embankment Fill, the classification used for the strata in the AMAR GIR was adopted.

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Imported Granular Fill (Class 6N) has been proposed to allow design of the alternative gabion wall solution. The gabion box itself was modelled as a 'High Strength' material in SLOPE/W. The granular material has been assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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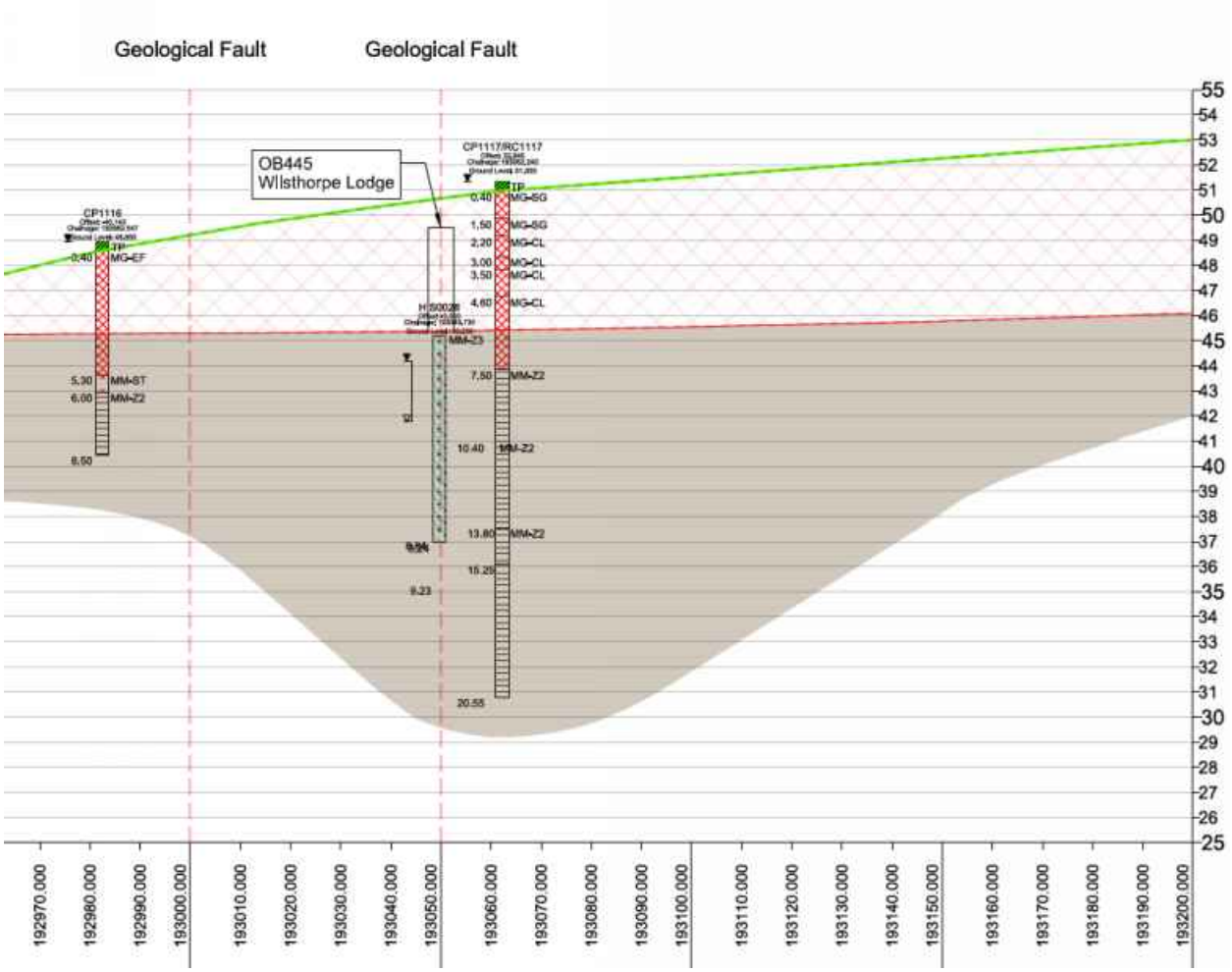


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to proximity of slip road, this solution was not viable and therefore a gabion wall was chosen:

Start Chainage	End Chainage	Solution	Layers	Gabion Wall Dimensions			
				Width (m)	Length (m)	Height (m)	Benching Gradient
192980	193020	Gabion Wall	Lower	1.0	1.0	1.0	45°
			Upper	1.0	1.0	1.0	
193250	193320	Gabion Wall	Lower	1.0	1.0	1.0	45°
			Upper	1.0	1.0	1.0	

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FURTHER GROUND INVESTIGATION

No further ground investigation has been proposed between Ch192980-Ch193020 during the JIT ground investigation.

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HISTORICAL EXPLORATORY HOLES

Borehole Log

Borehole No. **CP1116** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447124.00 - 335022.00	Hole Type CP
Location:		Level: 48.95mbgl	Scale 1:50
Client: Highways England		Dates: 05/10/2006 - 06/10/2006	Logged By RMS

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.40	1D			0.40	48.55		Sandy TOPSOIL. TP
		0.50 - 1.00	2B						MADE GROUND. Soft red brown friable slightly gravelly to gravelly clay with occasional rootlets. Gravel is subangular to subrounded fine to coarse siltstone, mudstone, coal, quartz, sandstone. With pockets of dark brown gravelly clay. MG-EF
		1.20 - 1.65	3U	68blows					*At 1.20m; firm.*
		1.65	4D						
		2.00	SPT (S)	N=6 (1,1/1,1,2,2)	Casing=1.60m Water=DRY				*From 2.00m to 3.45m; slightly gravelly.*
		2.00 - 2.45	5D						
		2.00 - 2.50	6B						
		3.00 - 3.45	7U	29blows					
		3.45	8D						
		4.00	SPT (S)	N=7 (1,1/1,2,2,2)	Casing=3.00m Water=DRY d				*From 4.00m; with pockets of gravelly clay and organic matter.*
		4.00 - 4.45	9D						
		4.00 - 4.50	10B						
		5.00 - 5.45	11U	31blows					
		5.45	12D			5.30	43.65		Recovered as grey green subangular to subrounded fine to coarse gravel size fragments of SILTSTONE with grey laminations. (Possible siltstone band). MM-ST
		6.00	SPT (S)	50 (4,10/50 for 225mm)	Casing=5.80m Water=DRY	6.00	42.95		MUDSTONE recovered as red brown mottled grey locally light yellow brown and light green grey silt/clay with angular to subrounded fine to coarse gravel sized fragments of mudstone and friable siltstone. MM-Z2
		6.00 - 6.45	13D						
		6.00 - 6.50	14B						
		7.00	15D						
		7.00	SPT (S)	50 (10,14/50 for 150mm)	Casing=6.10m Water=DRY				
		7.00 - 7.50	16B						
		8.00	SPT (S)	13 (62 for 130mm/13 for 10mm)	Casing=6.10m Water=DRY				
		8.00 - 8.50	17B			8.50	40.45		End of borehole at 8.50m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 8.00m to 8.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

AGS

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Borehole Log

Borehole No. **HIS0028** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447171.00 - 335084.00	Hole Type CP
Location:		Level: 45.20mbgl	Scale 1:50
Client: Highways England		Dates: 05/08/1964 - 05/08/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.46 - 0.91	1U		Dia.=100mm				Stiff to very stiff friable mottled red-brown and grey silty CLAY with mudstone fragments and bands of sandstone (Keuper Marl). MM-Z3
		1.98 - 2.44	2U		Dia.=100mm				
	▼	2.44	3D						
		3.51 - 3.96	4U		Dia.=100mm				
		3.96	5D						
		5.03 - 5.49	6U		Dia.=100mm				
		5.49	7D						
		6.10	8D						
		6.55 - 7.01	9U		Dia.=100mm				
		7.01	10D						
		7.77 - 8.23	11U		Dia.=100mm				
		8.23	12D			8.24	36.96		End of borehole at 8.23 m
		8.23	13W						

Remarks
Ground-water was first encountered at a depth of 2.7m below ground level. Sample of ground-water taken.

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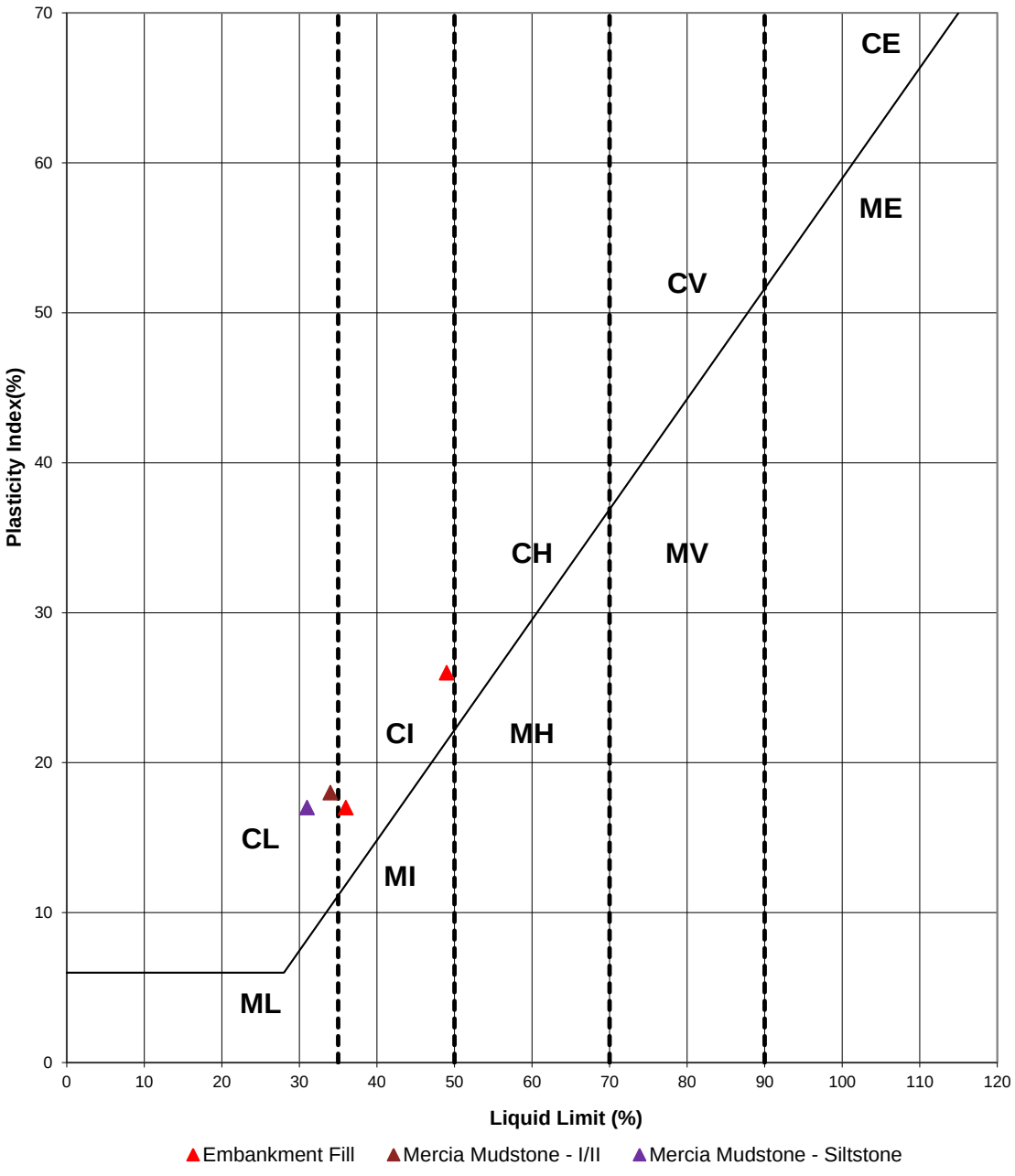
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PLOTS

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **192980-193020NB**
Client: **Highways England**	Borehole ID: **CP1116**	



Key

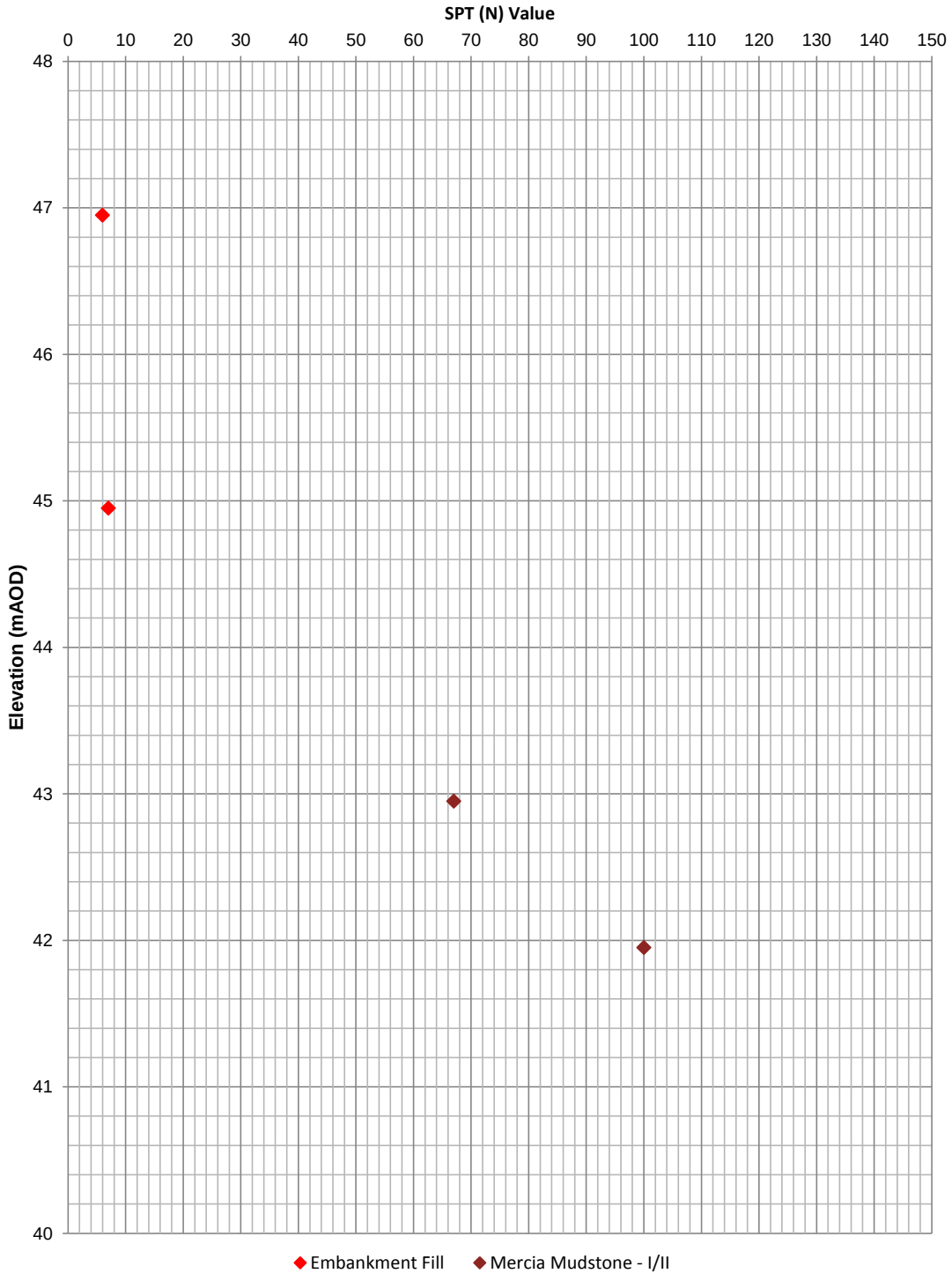
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 25/04/2017 Ref: HA549342-AMAR-HGT-192980-193020NB-GSS-CE-000001 Page 1 of 1

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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **192980-193020NB**
Client: **Highways England**	Borehole ID: **CP1116**	



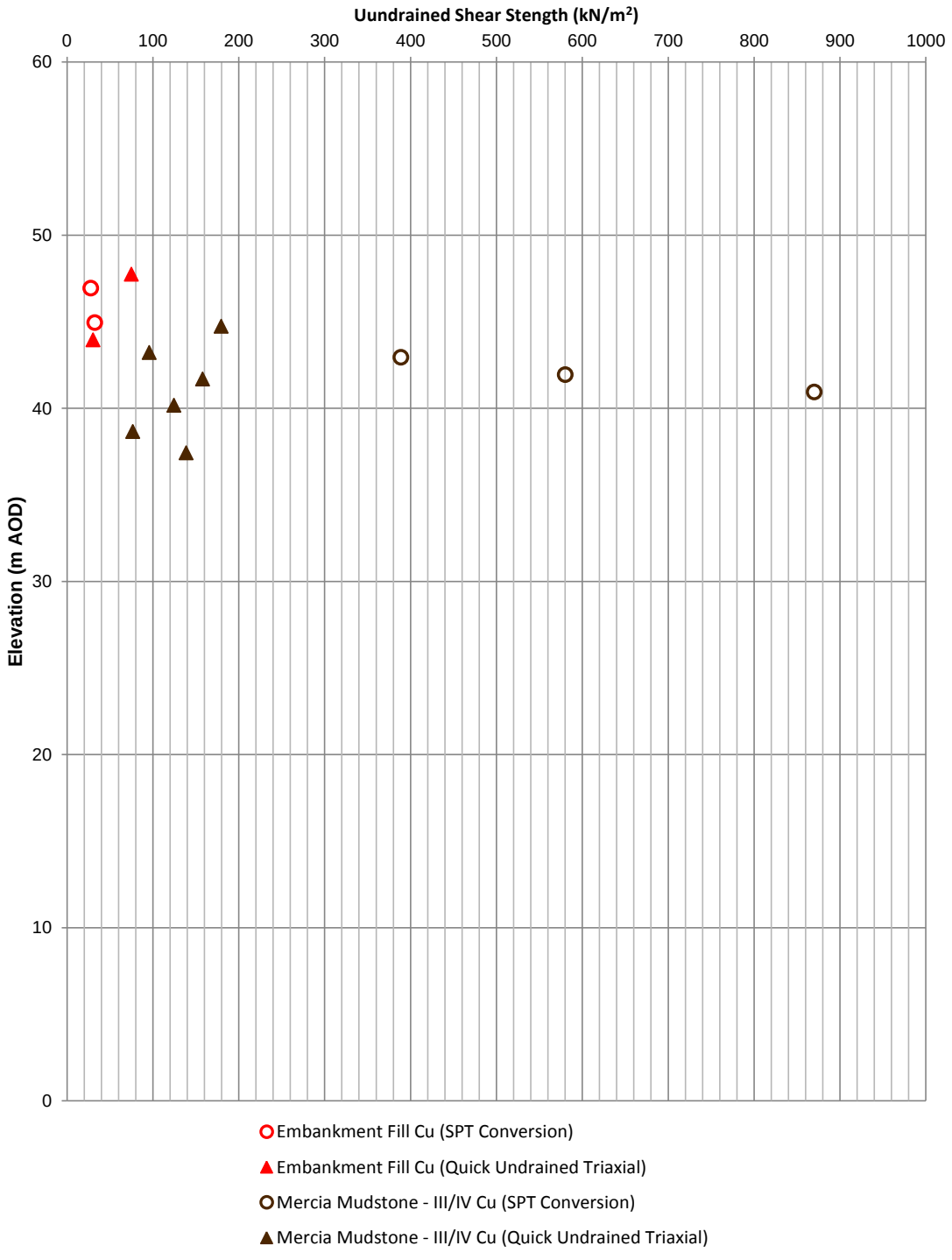
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 25/04/2017 Ref: HA549342-AMAR-HGT-192980-193020NB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **192980-193020NB**
Client: **Highways England**	Borehole ID: **CP1116 & HIS0028**	



Rev: P01 Date: 25/04/2017 Ref: HA549342-AMAR-HGT-192980-193020NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-193200-193420NB-GSS-000001		
Earthworks Retaining Solution	King Sheet Pile Retaining Wall; Gabion Wall		
Structure Number	GANTRY_324 [1]		
Structure Type	MS4 Cantilever		
Design Chainage	193200-193420		
Carriageway	Northbound		
Marker Post	193/2+00 – 193/4+20		
National Grid Reference	E 447166, N 335236 – E 447175, N 335454		
Existing Ground Level at Location	Carriageway	47.1-47.9mAOD	
	Crest of cutting	51.4-54.2mAOD	
Earthwork Type	NB: Cutting	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_22190	SB: N/A	HAGDMS designation
Earthwork Height	NB: 5.3m-6.4m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 25°-27°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	15/02/2017	
Checked	Roheel Masrat	14/03/2017	[redacted]
Reviewed	Gary Summerfield	14/03/2017	
Approved	Tom Bulteel	21/03/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

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Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

DESK STUDY

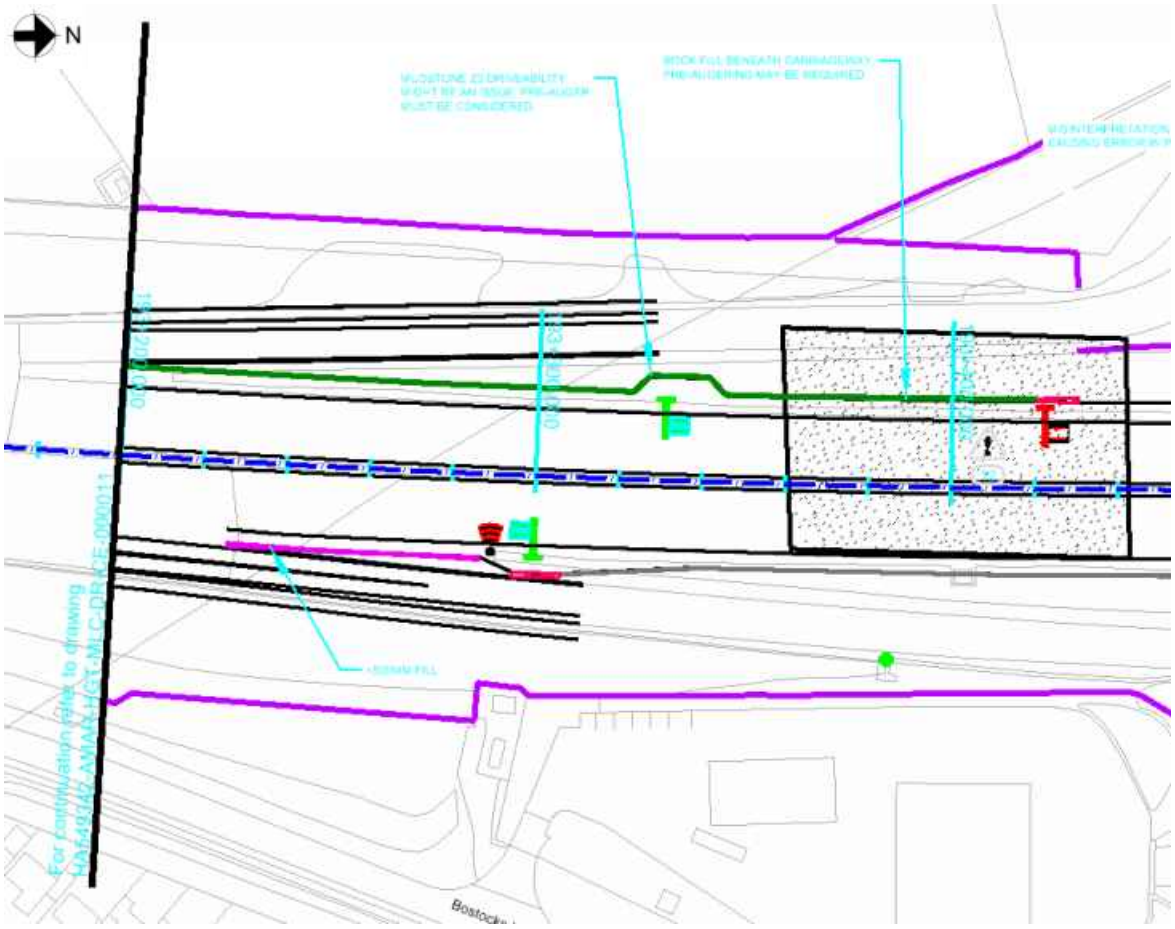


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch193250-193320 – gabion wall (up to 0.5m retained height);
- Ch193320-193350 – king sheet pile wall (up to 2.3m retained height);
- Ch193350-193420 – gabion wall (up to 1.0m retained height).

Proposed Major Structures:

A new MS4 cantilever Gantry structure (GANTRY_324) at Ch193331.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a cutting.

At the proposed king sheet pile wall locations and at GANTRY_324 the cutting is approximately 4.3m-4.6m high (increasing from south to north) and has a typical slope gradient of approximately 24°.

At the proposed gabion wall locations the cutting is approximately 1.7m-6.4m high (increasing from south to north) and has a typical slope gradient of approximately 24°.

The critical cross section was at Ch193340 for sheet pile walls and at Ch193410 for gabion walls; design for the above retained heights has been undertaken using the slope geometry within these cross sections.

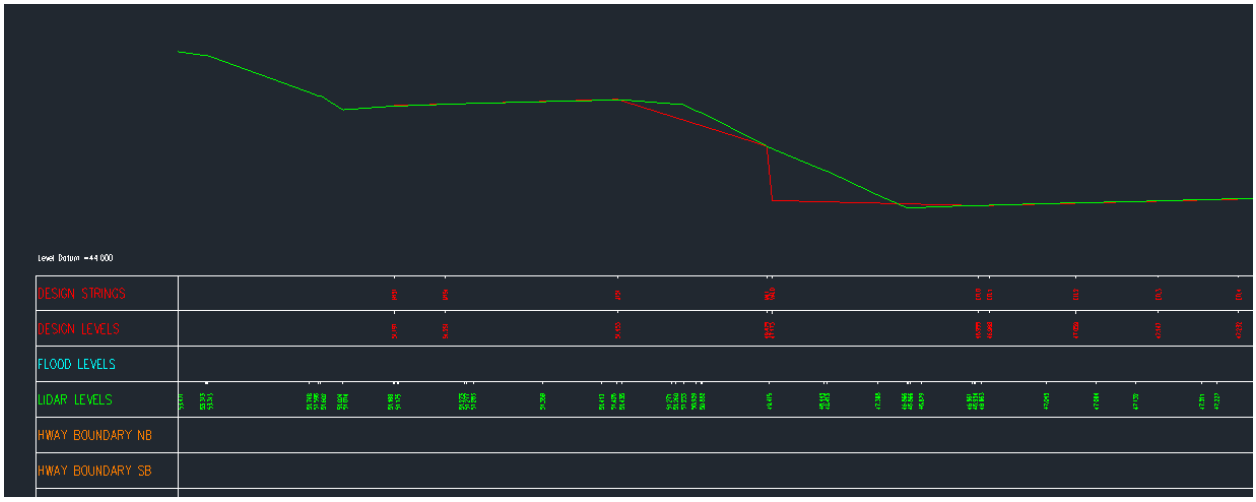


Figure 2.1: Topographic Critical Cross Section Ch193340 (for sheet pile walls and GANTRY_324)

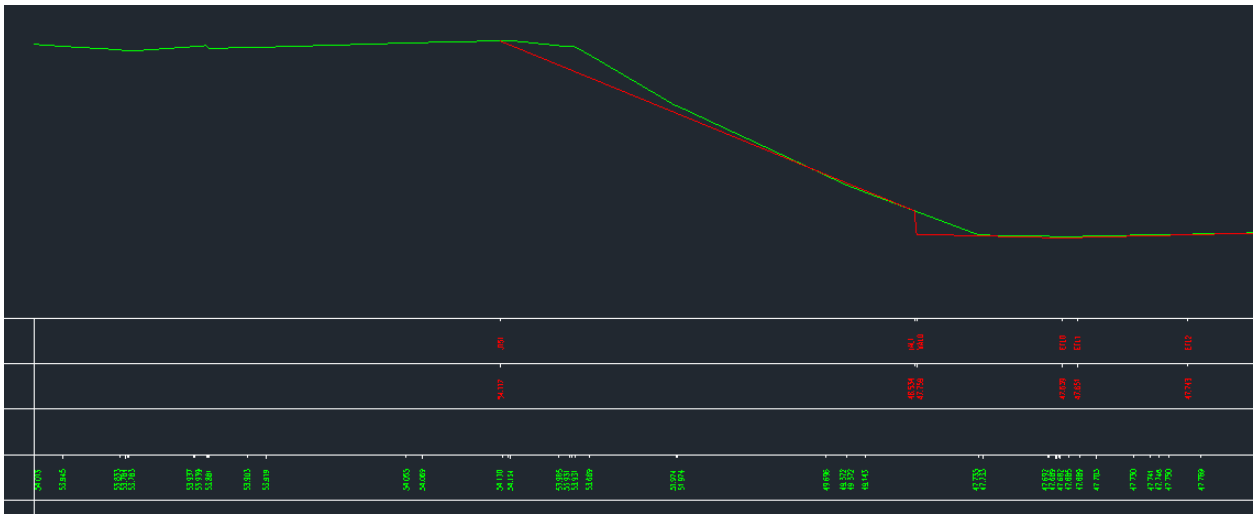


Figure 2.2: Topographic Critical Cross Section Ch193410 (for gabion walls)

Utilities:

There are no known utilities in close proximity to the proposed earthworks.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 125, Derby and Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: N/A

Solid Deposits: Gunthorpe Member (Mercia Mudstone Group)

Ground Investigation:

There are 2 No. historical exploratory holes recorded within the design chainage, with additional 1

No. relevant exploratory holes considered; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000039, Rev P01.

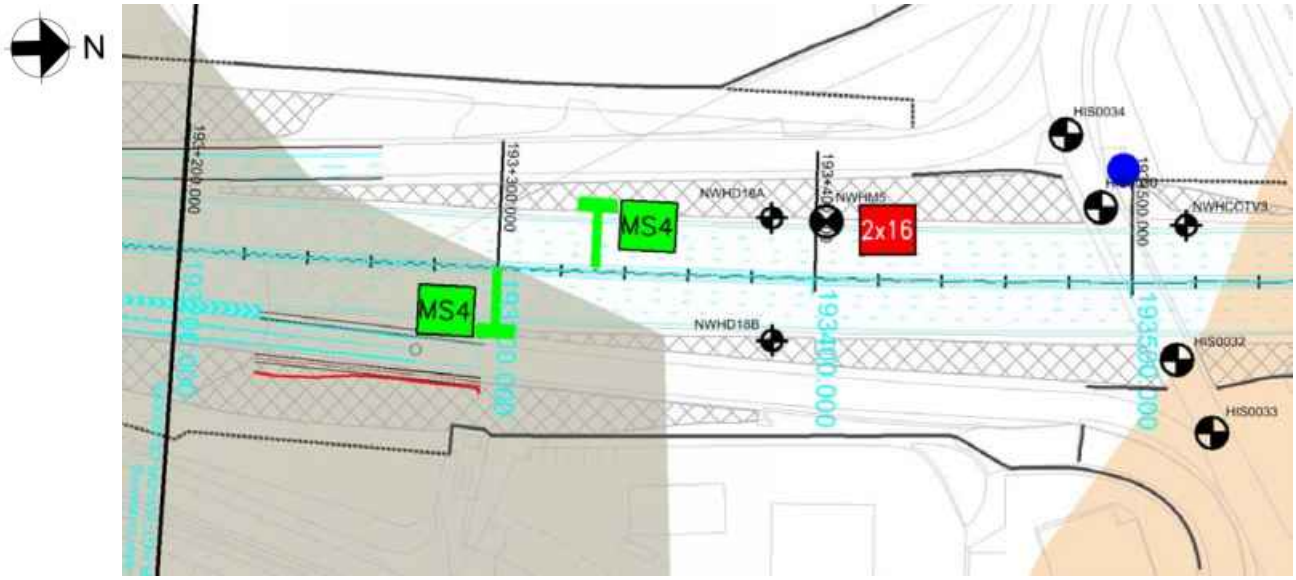


Figure 3: Borehole Location Plan

Flood Risk:

This location is not in an area at risk from flooding.

Historical Boreholes:

Relevant Borehole Number	NWHD18A	NWHM5	NWHD18B
Borehole Chainage	193386	193403	193388
Borehole Location	Northbound (in existing verge)	Northbound (in existing verge)	Southbound (in existing verge)
National Grid Reference	E 447174, N 335420	E 447175, N 335438	E 447213, N 335420
Ground Level at Exploratory Hole	47.60mAOD	47.67mAOD	48.50mAOD
RAG Analysis	Amber	Green	Amber
Date Drilled	07/09/1999	03/09/1999 – 04/09/1999	09/09/1999
Termination Depth	1.5 metres below ground level (mbgl)	12.00 mbgl	2.20mbgl
Other suitable holes	None		

Existing Ground Conditions (Ch193340 for sheet pile walls and GANTRY_324):

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Mercia Mudstone – III/IV	5.3	46.1	None recorded
Mercia Mudstone – I/II	>5.3	<46.1	>150

(1) Ground level is assumed to be at the crest of the cutting.
(2) SPT capped at 150.

Existing Ground Conditions (Ch193420 for gabion walls):

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Mercia Mudstone – III/IV	8.0	46.2	None recorded
Mercia Mudstone – I/II	>8.0	<46.2	>150

(1) Ground level is assumed to be at the crest of the cutting.
(2) SPT capped at 150.

Groundwater:

No groundwater data was available for the historical exploratory holes.

Groundwater Design Level:

No local groundwater level is available and therefore a design groundwater level of 1.0m below ground level throughout cutting has been assumed. For the global stability check using SLOPE/W, Ru values of 0.2 were adopted for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

1 No Atterberg Limit Test and 4 No Moisture Content Tests were undertaken within Mercia Mudstone – I/II in historical exploratory hole NWHM5 with the following results:

Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
3.70	12.0	-	-	-	-
4.40	10.0	-	-	-	-
4.60	8.8	-	-	-	-
6.65	9.5	28	16	12	CL

Lab Test Data – BRE Classification:

The following test data was available from the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Made Ground	pH	Solid	2	7.8-8.7	-
Made Ground	Sulphate (Total) as SO_4	Solid	2	0.02-0.06	%
Made Ground	Cl	Solid	2	0.01-0.04	%

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Assumed Ground Model For Design (Ch193340 for sheet pile walls and GANTRY_324):

Ground model based on geological long section HA549342-AMAR-HGT-SWI-DR-CE-000039 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outlines the assumed anticipated ground model at cutting crest for sheet pile walls and GANTRY_324 (Ch193340) to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)		Poisson's Ratio		Shear Modulus (MN/m^2)	Adhesion Factor α	Nc	BRE Classification
								E_u	E'	v_u	v'				
Mercia Mudstone – III/IV	0.0-5.3	51.4-46.1	5.3	21	30	2	100	10.8	8.6	0.50	0.20	3.6	0.45	6.2*	DS-2 AC-2
Mercia Mudstone – I/II	>5.3	<46.1	-	22	30	2	750	46.8	37.4	0.50	0.20	15.6	0.51	9	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths were derived from data recorded in historical boreholes NWHM5, NWHD18A and NWHD18B.
(3) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) In the absence of local data, typical friction angle, undrained shear strength and Young's Modulus for Mercia Mudstone – III/IV, as specified in the AMAR GIR, were adopted.
(5) A conservative SPT N value of 150 has been used for the Mercia Mudstone – I/II, combined with a typical f_1 value of 5 for Mercia Mudstone (CIRIA C570) to derive c_u.
(6) Eu for Mercia Mudstone – I/II can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 150 gives Eu = 46.8MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 37.4MN/m^2.
(7) Shear modulus is based on G = E/2(1+v).
(8) Adhesion Factor for Mercia Mudstone is based on BS8004 (equation 41).
(9) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl
(10) In the absence of BRE test data for Mercia Mudstone, the classification used for the strata in the AMAR GIR was adopted.

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Made Ground of 0.5m thickness is anticipated beneath the motorway footprint; typical parameters for Made Ground were not included in the AMAR GIR, so have been derived using published literature for coarse grained soils for Made Ground (coarse grained):

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio ν'	BRE Classification
Made Ground (coarse grained)	20	36	16	0.20	DS-1 AC-1

(1) Bulk density and friction angle for Made Ground (coarse grained) was derived using guidance in BS8002:2015. E' and v' of Made Ground (coarse grained) is derived using guidance in CIRIA 103.

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Assumed Ground Model For Design (Ch193340 for gabion walls):

Ground model based on geological long section HA549342-AMAR-HGT-SWI-DR-CE-000039 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outlines the assumed anticipated ground model at cutting crest for gabion walls (Ch193410) to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)		Poisson's Ratio		Shear Modulus (MN/m^2)	Adhesion Factor α	Nc	BRE Classification
								E_u	E'	v_u	v'				
Mercia Mudstone – III/IV	0.0-8.0	54.2-46.2	8.0	21	30	2	100	10.8	8.6	0.50	0.20	3.6	0.45	6.2*	DS-2 AC-2
Mercia Mudstone – I/II	>8.0	<46.2	-	22	30	2	140	46.8	37.4	0.50	0.20	15.6	0.38	9	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths were derived from data recorded in historical boreholes NWHM5, NWHD18A and NWHD18B.
(3) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) In the absence of local data, typical friction angle, undrained shear strength and Young's Modulus for Mercia Mudstone – III/IV, as specified in the AMAR GIR, were adopted.
(5) Based on a recorded PI of 12%, using guidance in BS8002:2015, the Mercia Mudstone – I/II has a friction angle of 30°.
(6) Based on recorded undrained triaxial tests for Mercia Mudstone – I/II, a typical c_u of 140kN/m^2 was adopted.
(7) Eu for Mercia Mudstone – I/II can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 150 gives Eu = 46.8MN/m2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 37.4MN/m2.
(8) Shear modulus is based on G = E/2(1+v).
(9) Adhesion Factor for Mercia Mudstone is based on BS8004 (equation 41).
(10) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl
(11) In the absence of BRE test data for Mercia Mudstone, the classification used for the strata in the AMAR GIR was adopted.

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Made Ground of 1.6m thickness is anticipated beneath the motorway footprint; typical parameters for Made Ground were not included in the AMAR GIR, so have been derived using published literature for coarse grained soils for Made Ground (coarse grained):

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio ν'	BRE Classification
Made Ground (coarse grained)	20	36	16	0.20	DS-1 AC-1

(1) Bulk density and friction angle for Made Ground (coarse grained) was derived using guidance in BS8002:2015. E' and v' of Made Ground (coarse grained) is derived using guidance in CIRIA 103.

Imported Granular Fill (Class 6N) has been proposed to allow design of the alternative gabion wall solution. The gabion box itself was modelled as a 'High Strength' material in SLOPE/W. The granular material has been assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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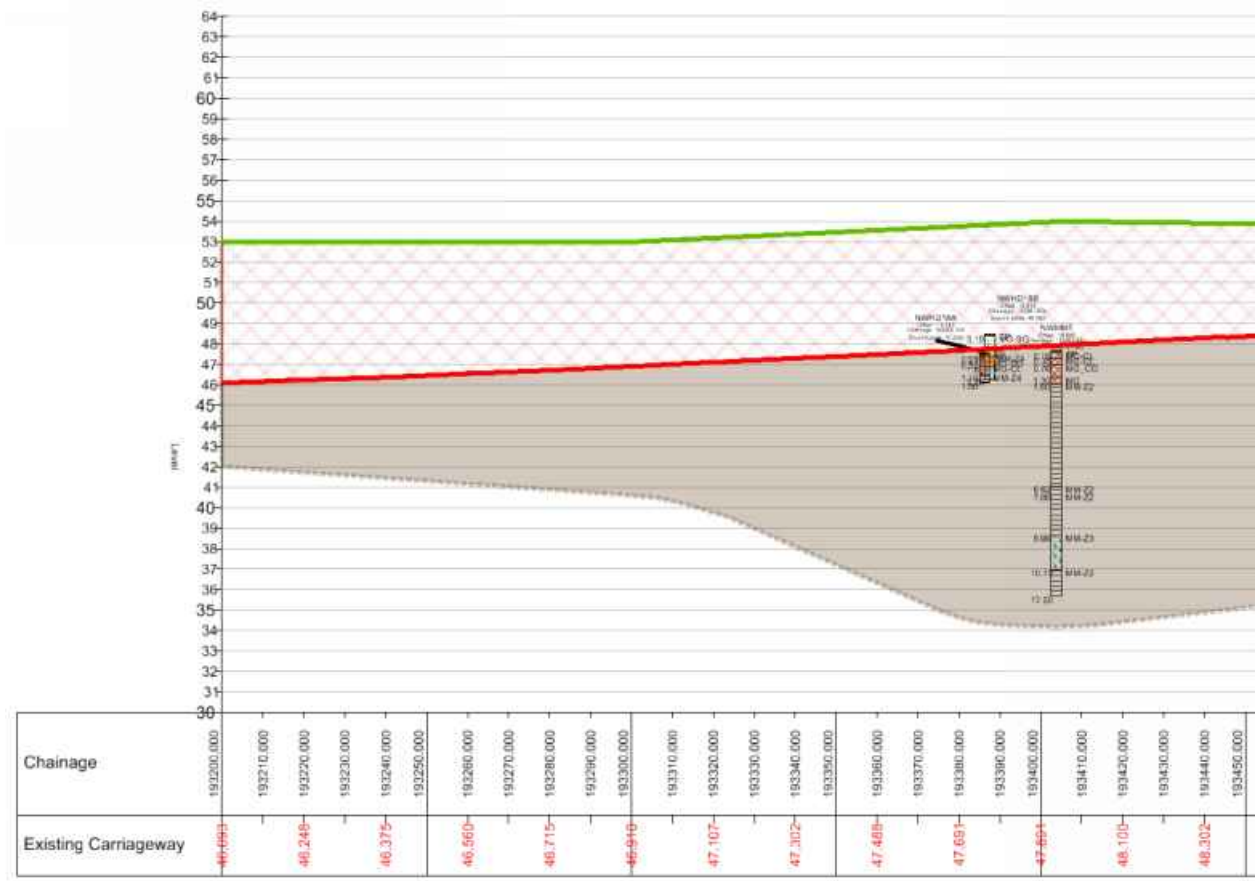


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to proximity of slip road, this solution was not viable and therefore a gabion wall was chosen:

Start Chainage	End Chainage	Solution	Layers	Gabion Wall Dimensions			
				Width (m)	Length (m)	Height (m)	Benching Gradient
193200	193320	Gabion Wall	Lower	1.0	1.0	1.0	45°
			Upper	0.5	0.5	0.5	
193350	193420	Gabion Wall	Lower	1.0	1.0	1.0	45°
			Upper	0.5	0.5	0.5	

Where it was not possible to construct a gabion wall (due to spatial constraints) a king sheet pile retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	King Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
193320	193350	AZ-36 700 S390 GP	2.3	7.7	10.0	84	35	25	207

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.

Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	750	7.0	2.25	10	177	434

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FURTHER GROUND INVESTIGATION

'Just in Time' GI is required at this location to confirm the ground conditions, the following GI has been proposed:

- BH-G324 at Ch193331, northbound, dynamic sample with rotary follow to 12.0mbgl.

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HISTORICAL EXPLORATORY HOLES

amey

Borehole Log

Borehole No. **NWHD18A** Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447174.27 - 335420.31	Hole Type WS
Location:		Level: 47.60	Scale 1:50
Client: Highways England		Dates: 07/09/1999 - 07/09/1999	Logged By NBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20	47.40		TOPSOIL. TP
		0.60	D	Ublow=0	0.50	47.10		MADE GROUND: Yellow brown medium and coarse gravel of limestone. (Hardcore) MG-SG
		0.60	D	Ublow=0				MADE GROUND: Red brown sandy clay with some medium and coarse gravel of mudstone. MG-CL
		1.10 - 1.50	D	Ublow=0	1.10	46.50		Red brown mottled blue grey highly locally completely weathered MUDSTONE, weak and very weak. (Mercia Mudstone - Grade IVa?) MM-Z4
		1.10 - 1.50	D	Ublow=0	1.50	46.10		End of borehole at 1.50 m

Remarks
1. Hand excavated inspection pit to 1.00m (0.50m x 0.50m). 2. Hole dry. 3. Marker Post Ref 193/3 +80. 4. Hole backfilled with grout.

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Borehole Log

Borehole No. **NWHD18B**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447212.87 - 335420.34	Hole Type WS
Location:		Level: 48.50	Scale 1:50
Client: Highways England		Dates: 09/09/1999 - 09/09/1999	Logged By NBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.10 - 1.10	D	Ublow=0	0.10	48.40		TOPSOIL. TP. Red fine grained, moderately weathered SANDSTONE, weak. (Possible Made Ground) MG-SG
		0.10 - 1.10	D	Ublow=0				
		1.10 - 2.20	D	Ublow=0	1.10	47.40		Soft to firm red slightly sandy CLAY with a little fine to coarse gravel sized mudstone lithorelicts. MM-Z4
		1.10 - 2.20	D	Ublow=0				
					1.60	46.90		Firm red mottled greenish grey CLAY. MM-Z4
					2.20	46.30		End of borehole at 2.20 m

Remarks
1. Hand excavated to 0.70m (0.50m x 0.50m). 2. Hole terminated at 2.20m due to no penetration. 3. Hole dry. 4. Marker Post Ref 193/3+80. 5. Hole backfilled with grout.

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Rotary Core Log

Borehole No. **NWHM5** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447175.38 - 335437.53	Hole Type RC
Location:		Level: 47.67	Scale 1:50
Client: Highways England		Dates: 03/09/1999 - 04/09/1999	Logged By NBR

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.35	D				0.10	47.56		TOPSOIL. TP
		0.00 - 0.35	D				0.35	47.32		MADE GROUND: Brownish grey slightly clayey medium and coarse angular gravel sized fragments of limestone. MG-CL
		0.35	D							
		0.35 - 0.70	D				0.70	46.96		MADE GROUND: Reddish brown very silty clay with some fine and medium subangular gravel sized fragments of mudstone and siltstone. MG-CL
		0.70 - 1.30		0	0	0	1.30	46.36		MADE GROUND: Ballast fill. (Driller's description) Openholed from 0.70m to 1.30m. MG_CO
			98				1.60	46.06		MADE GROUND: Grey concrete. MG
			99							Reddish brown moderately weathered very silty MUDSTONE weak and very weak with extremely closely spaced random fractures tight smooth irregular. (Mercia Mudstone - Zone IIIa/II) MM-Z2
		1.70 - 2.70	25	40	0	0				
		2.70 - 3.00	25	50	0	0				
		3.00 - 3.70	97	0	0	0				
		3.70	D							
		3.92 - 4.40	25	42	0	0				
		4.40	D							
		4.60	C							
		4.62 - 5.40	97	0	0	0				
		5.62 - 6.40	97	0	0	0				
		6.65	C				6.62	41.04		Reddish brown very thinly bedded subhorizontal slightly to moderately weathered very silty MUDSTONE, weak with very closely spaced subhorizontal open rough planar. (Mercia Mudstone - Zone II) MM-Z2
		6.62 - 7.40	9	100	38	0	7.00	40.66		Reddish brown moderately weathered very silty MUDSTONE weak and very weak with extremely closely spaced random fractures tight smooth irregular. (Mercia Mudstone - Zone IIIa/II) MM-Z2
			25							
		7.62 - 8.00	97	0	0	0				
		8.00 - 9.00	25	33	0	0				
							9.00	38.66		Firm reddish brown very silty CLAY with much fine subangular lithorelicts up to 20mm. (Mercia Mudstone - Zone IIIa) MM-Z3
		9.22 - 10.00	98	25	0	0				

Continued on next sheet

Remarks
1. Inspection pit excavated to 0.70m. 2. Borehole openholed to 1.30m. 3. Borehole complete at 12.00m. 4. Borehole backfilled with grout. 5. Marker Post Ref 193/4N.

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Rotary Core Log

Borehole No. **NWHM5**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447175.38 - 335437.53	Hole Type RC
Location:		Level: 47.67	Scale 1:50
Client: Highways England		Dates: 03/09/1999 - 04/09/1999	Logged By NBR

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.00 - 10.70	98	28	0	0				
							10.70	36.97		Reddish brown very thinly and thinly bedded subhorizontal slightly weathered very silty MUDSTONE, moderately weak and weak with very closely and closely spaced subhorizontal fractures open smooth and rough planar. (Mercia Mudstone Zone II) MM-Z2
		10.92 - 12.00	10	100	76	9				—from 11.65m vertical fracture open smooth planar
							12.00	35.66		End of borehole at 12.00 m

Remarks
1. Inspection pit excavated to 0.70m. 2. Borehole openholed to 1.30m. 3. Borehole complete at 12.00m. 4. Borehole backfilled with grout. 5. Marker Post Ref 193/4N.

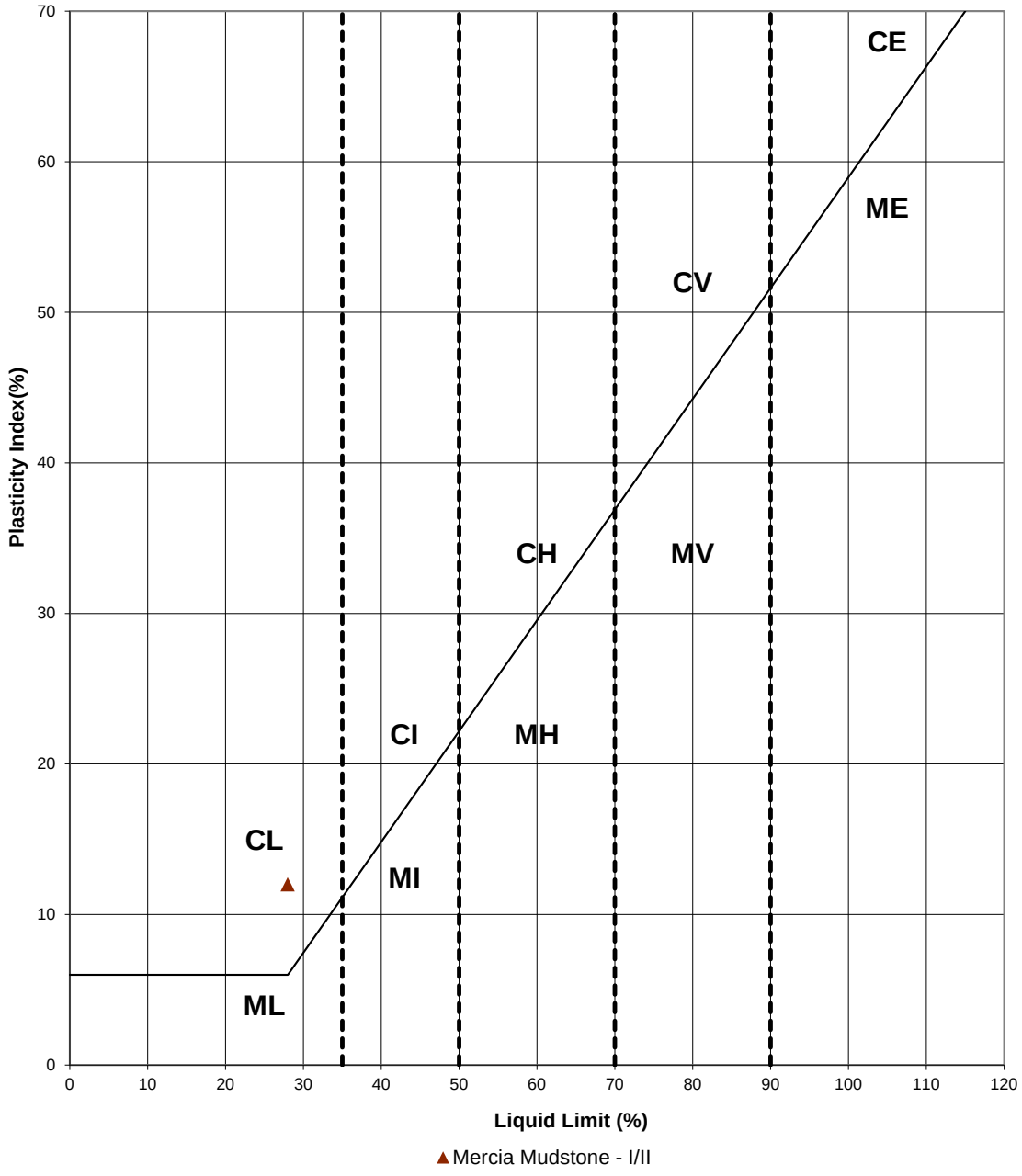
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PLOTS

A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **193200-193420**
Client: **Highways England**	Borehole ID: **NWHM5**	



Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 07/12/2016 Ref: HA549342-AMAR-HGT-193200-193420-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-193430-193480NB-GSS-000001		
Earthworks Widening Solution	Gabion Wall		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	193430-193480		
Carriageway	Northbound		
Marker Post	193/4+30 – 193/4+80		
National Grid Reference	E 447175, N 335467 – E 447175, N 335513		
Existing Ground Level	Carriageway	47.9mAOD	
	Crest of Cutting	54.8mAOD	
Earthwork Type	NB: Cutting	SB: N/A	HAGDMS designation
Earthwork Number	NB: 7_M1_22190	SB: N/A	HAGDMS designation
Earthwork Height	NB: 6.9m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 26°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Scott Bishton	25/04/2017	[redacted]
Checked	Roheel Masrat	14/03/2017	
Reviewed	Gary Summerfield	15/03/2017	
Approved	Thomas Bulteel	06/06/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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DESK STUDY

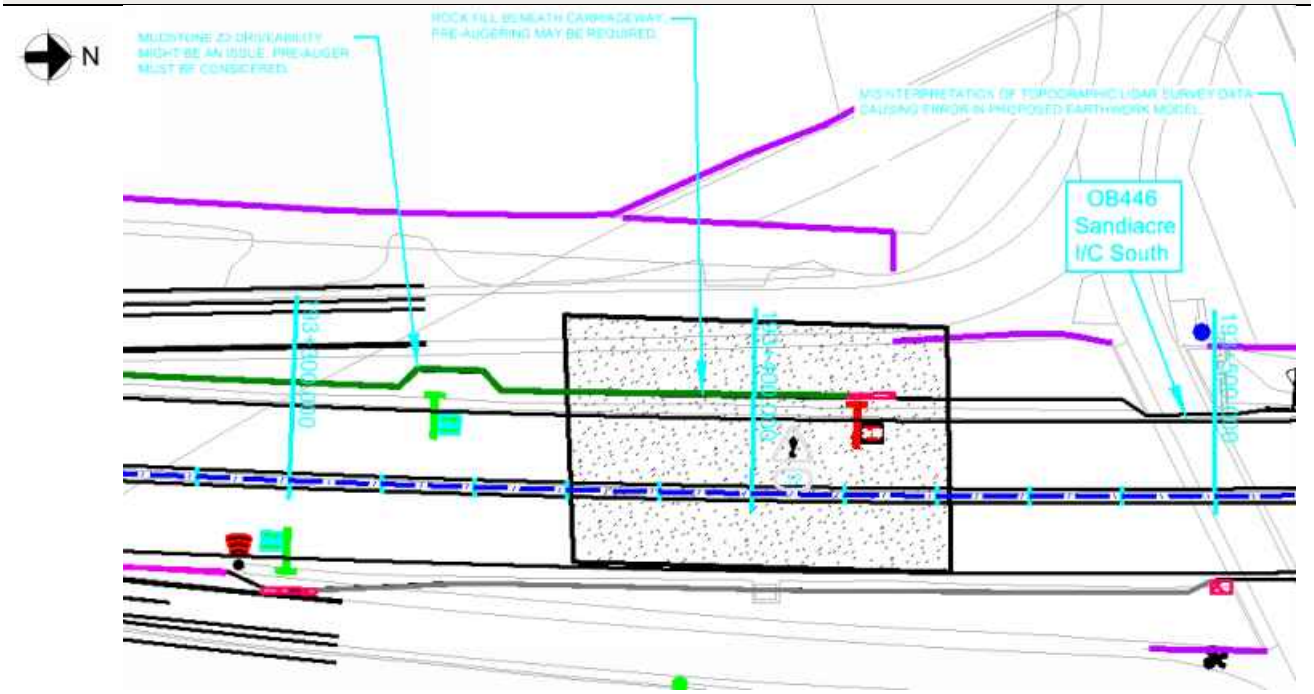


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- 193430-193480 – Gabion Wall.

Proposed Major Structures:

N/A.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a cutting. Across the location extents the cutting ranges from 6.5m to 6.9m in height and a typical slope gradient of 26°.

The critical cross section (the cross section with the greatest retained height) used is at Ch193440.



Figure 2: Topographic Critical Cross Section Chainage 193440

Utilities:

There are no known utilities in close proximity to the proposed earthworks.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 125, Derby; indicates that the site is underlain by:

Superficial Deposits: None recorded

Solid Deposits: Mercia Mudstone Group (Undifferentiated)

Ground Investigation:

There are no historical exploratory holes within the chainage extents, but there are considered to be 9 No. relevant exploratory holes. The closest historical exploratory hole (NWHM5) is located approximately 27m from the critical cross section location (Ch193440) and presented on Drawing No. HA549342-AMAR-HCT-SWI-DR-CE-000039.

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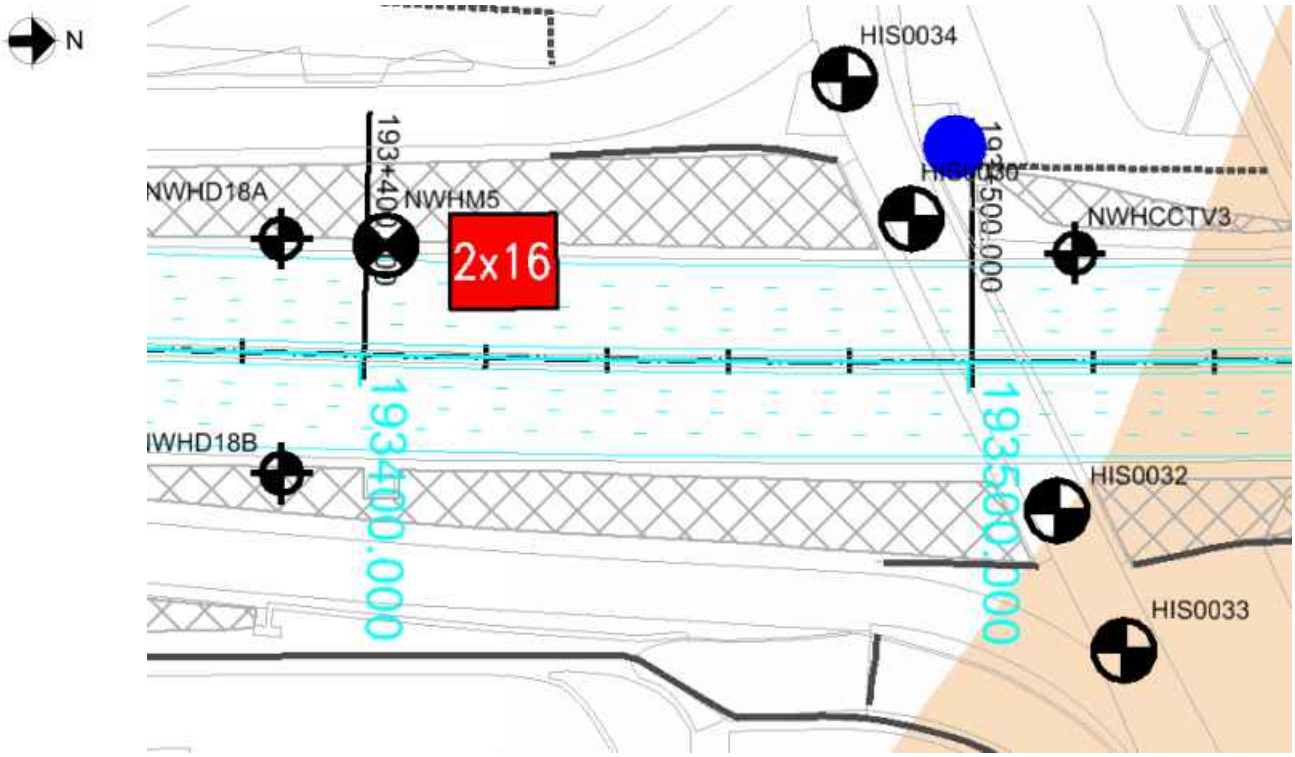


Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	NWHM5	NWHD18A
Borehole Chainage	193403	193386
Borehole Location	Northbound (in existing verge)	Northbound (in existing verge)
National Grid Reference	E 447175, N 335438	E 447174, N 335420
Ground Level at Exploratory Hole	47.67metres above Ordnance Datum (mAOD)	47.60mAOD
RAG Analysis	Green	Amber
Date Drilled	03/09/1999 – 04/09/1999	07/09/1999
Termination Depth	12.00 metres below ground level (mbgl)	1.50mbgl
Other suitable holes	HIS0030- HIS0034, NWHCCTV3, NWHD18B	

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Mercia Mudstone – III/IV	-	-	>150

(1) Ground level is assumed to be at the crest of the cutting
(2) SPT capped at 150.
(3) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

7 No. Standard Penetration Tests (SPTs) were undertaken within historical exploratory hole NWHM5 within Mercia Mudstone – III/IV only; all of these tests gave results >150. These results were considered to be unreliable due to the amount of extrapolation required to produce an SPT 'N' value based on the small amount of penetration recorded from the in situ tests, therefore have not been considered further.

No hand shear vane strength tests were recorded in the historical exploratory holes.

Groundwater:

The following groundwater strikes were recorded in historical exploratory holes for this location:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		mbgl	mAOD	Time	mbgl	mAOD
HIS0030	Mercia Mudstone – III/IV	3.81	49.10	Not recorded	2.44	50.47
HIS0032	Mercia Mudstone – III/IV	3.51	47.69	Not recorded	2.13	49.07
HIS0033	Mercia Mudstone – III/IV	2.13	48.37	-	-	-
HIS0034	Mercia Mudstone – Sandstone	3.05	50.45	-	-	-

No groundwater data was available for NWHCCTV3, NWHD18A, NWHD18B or NWHM5.

Groundwater Design Level:

Due to a lack of groundwater data available a groundwater level of 1.0m below carriageway level has been assumed for GAWACwin analysis for Gabion Walls. When checking the global stability check of the earthwork and sheet pile (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

1 No Atterberg Limit Test and 4 No Moisture Content Tests were undertaken within Mercia Mudstone in historical exploratory hole NWHM5 with the following results:

Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
3.70	12.0	-	-	-	-
4.40	10.0	-	-	-	-
4.60	8.8	-	-	-	-
6.65	9.5	28	16	12	CL

34 No. undrained triaxial tests were undertaken within historical exploratory holes with the following results:

Stratum	Depth to Top of Test (mbgl)	Undrained Shear Strength (kN/m^2)
Mercia Mudstone – III/IV	0.15-13.72	26-302

Lab Test Data – BRE Classification:

The following pH testing data was available from the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Made Ground	pH	Solid	2	7.8-8.7	-
Made Ground	Cl	Solid	2	0.01-0.04	%
Made Ground	Sulphate (Total) as SO_4	Solid	2	0.02-0.06	%
Mercia Mudstone – III/IV	pH	Solid	9	7.2	-
Mercia Mudstone – III/IV	pH	Water	2	7.1-7.3	-
Mercia Mudstone – III/IV	Sulphate (Total) as SO_4	Solid	9	0.01-0.16	%
Mercia Mudstone – III/IV	Sulphate (Total) as SO_4	Water	2	0.16-0.22	g/l

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Assumed Ground Model For Design:

Ground model based on geological long section HA549342-AMAR-HGT-SWI-DR-CE-000039 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outlines the assumed anticipated ground model from cutting crest; to be confirmed with 'Just In Time' Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)		Poisson's Ratio		BRE Classification
								E_u	E'	v_u	v'	
Mercia Mudstone – III/IV	-	-	-	21	30	2	130	10.8	8.6	0.50	0.20	DS-1 AC-1

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths were derived from data recorded in historical boreholes NWHM5, HIS0030- HIS0034, NWHCCTV3, NWHD18A and NWHD18B.
(3) Due to limited localised GI data, typical values for bulk density, friction angle, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) c_u is taken as the typical value from the recorded undrained triaxial test results.
(5) Given the excessively high extrapolated SPT 'N' values, Eu and E' were taken as the typical values from the AMAR GIR rather than deriving using SPT 'N' values using published literature.

Made Ground of 0.5m thickness is anticipated beneath the motorway footprint; typical parameters for Made Ground were not included in the AMAR GIR, so have been derived using published literature for coarse grained soils for Made Ground (coarse grained):

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'	BRE Classification
Made Ground (coarse grained)	20	36	16	0.20	DS-1 AC-1

(1) Bulk density and friction angle for Made Ground (coarse grained) was derived using guidance in BS8002:2015. E' and v' of Made Ground (coarse grained) was derived using guidance in CIRIA 103.

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Imported Granular Fill (Class 6N) was used in the design of gabions; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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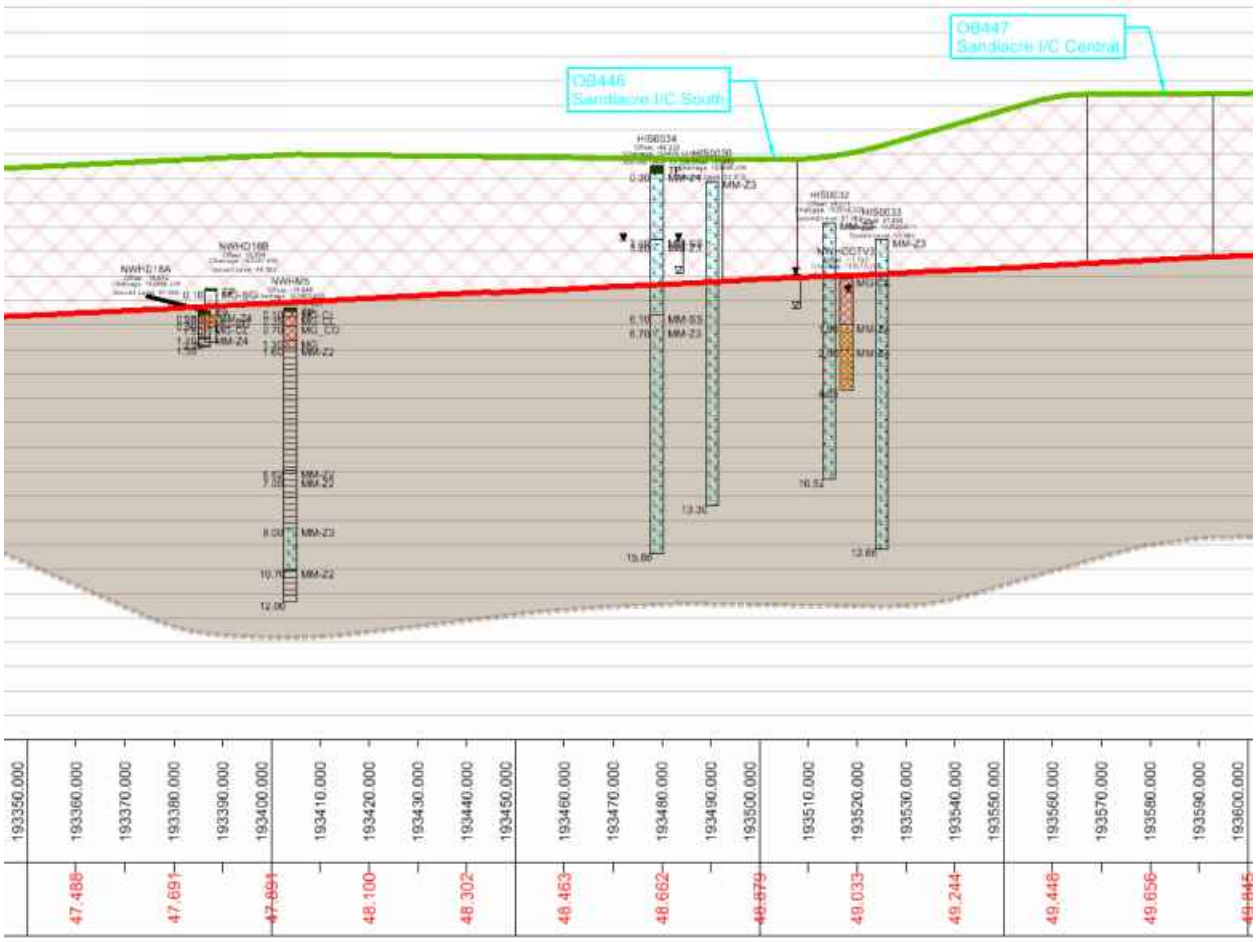


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to an adjacent slip road, this solution was not viable. A gabion wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Carriageway	Solution	Layers	Gabion Wall Dimensions			
					Width (m)	Length (m)	Height (m)	Benching Detail
193430	193480	Northbound	Gabion Wall	Lower	2.0	1.0	1.0	45
				Upper	1.0	1.0	1.0	

Proposed Structural Solution:

N/A.

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-G324 at Ch193331, northbound, dynamic sample with rotary follow on to 12mbgl.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. HIS0030 Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447171.00 - 335524.00	Hole Type CP
Location:		Level: 52.91	Scale 1:50
Client: Highways England		Dates: 22/07/1964 - 25/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.46 - 0.91	U							Stiff to very stiff friable mottled red-brown and gery silty CLAY with bands of sandstone and mudstone (Keuper Marl) MM-Z3
		0.91	D							
		1.37	D							
		1.98 - 2.44	U							
		2.44	D							
		2.90	D							
		3.51 - 3.96	U							
		3.96	D							
		4.42	D							
		5.03 - 5.49	U							
		5.49	D							
		5.94	D							
		6.55 - 7.01	U							
		7.01	D							
		7.47	D							
		8.08 - 8.53	U							
		8.53	D							
		9.30	D							
		9.60 - 10.06	U							

1 2 3 4 5 6 7 8 9 10

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.81m below ground level but had risen to 2.44m below ground level on the morning of 25.07.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. **HIS0030**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447171.00 - 335524.00	Hole Type CP
Location:		Level: 52.91	Scale 1:50
Client: Highways England		Dates: 22/07/1964 - 25/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.06	D							
		11.13 - 11.58	U							
		11.58	D							
		12.80 - 13.26	U							
		13.26 13.26	D W				13.30	39.61		End of borehole at 13.26 m

Remarks
Ground-water was first encountered at a depth of 3.81m below ground level but had risen to 2.44m below ground level on the morning of 25.07.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. HIS0032
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447219.00 - 335548.00	Hole Type CP
Location:		Level: 51.20	Scale 1:50
Client: Highways England		Dates: 15/07/1964 - 27/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.15 - 0.61	U							Stiff to very stiff friable mottled red-brown and gery silty CLAY; bands of mudstone and sandstone below 2.6m MM-Z3
		0.61	D							
		1.68 - 2.13	U							
		2.13	D							
		2.59	D							
		3.05 - 3.51	U							
		3.51	D							
		4.42 - 4.88	U							
		4.88	D							
		5.64 - 6.10	U							
		6.10	D							
		7.62 - 8.08	U							
		8.08	D							
		9.14 - 9.60	U							
		9.60	D							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.51m below ground level but had risen to 2.13m below ground level by the morning of 27.07.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. **HIS0032**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447219.00 - 335548.00	Hole Type CP
Location:		Level: 51.20	Scale 1:50
Client: Highways England		Dates: 15/07/1964 - 27/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.06 - 10.52	U							
		10.52	D				10.52	40.68		End of borehole at 10.52 m
		10.52	W							

Remarks
Ground-water was first encountered at a depth of 3.51m below ground level but had risen to 2.13m below ground level by the morning of 27.07.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. HIS0033
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447242.00 - 335559.00	Hole Type CP
Location:		Level: 50.50	Scale 1:50
Client: Highways England		Dates: 16/07/1964 - 29/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.15 - 0.61	U							Stiff becoming very stiff, friable mottled red-brown and grey silty CLAY with bands of sandstone and mudstone MM-Z3
		0.61	D							
		1.68 - 2.13	U							
	▼	2.13	D							
		3.20 - 3.66	U							
		3.96	D							
		4.42 - 4.88	U							
		4.88	D							
		5.64 - 6.10	U							
		6.10	D							
		7.32 - 7.77	U							
		7.77	D							
		9.14 - 9.60	U							
		9.60	D							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 2.13m below ground level.

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Rotary Core Log

Borehole No. HIS0033
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447242.00 - 335559.00	Hole Type CP
Location:		Level: 50.50	Scale 1:50
Client: Highways England		Dates: 16/07/1964 - 29/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.67 - 11.13	U							
		11.13	D							
		12.19 - 12.65	U							
		12.65	D				12.66	37.84		End of borehole at 12.65 m

Remarks
Ground-water was first encountered at a depth of 2.13m below ground level.

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Rotary Core Log

Borehole No. HIS0034
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447148.00 - 335513.00	Hole Type CP
Location:		Level: 53.50	Scale 1:50
Client: Highways England		Dates: 17/07/1964 - 21/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	D				0.30	53.20		TOPSOIL TP
		0.46 - 0.91	U							Very stiff friable red-brown silty CLAY (Keuper Marl) MM-Z4
		0.91	D							
		1.52	D							
		1.98 - 2.44	U							
		2.44	D							
	▼	3.05	D				3.00	50.50		Grey SANDSTONE MM-SS
		3.35 - 3.81	U				3.20	50.30		Very stiff mottled red-brown and grey silty CLAY with mudstone (Keuper Marl) MM-Z3
		3.81	D							
		4.27	D							
		4.57 - 5.03	U							
		5.03	D							
		5.64 - 6.10	U							
		6.10	D				6.10	47.40		Grey SANDSTONE MM-SS
		6.71	B				6.70	46.80		Stiff to very stiff, becoming hard friable mottled red-brown and grey silty CLAY with bands of sandstone and mudstone (Keuper Marl) MM-Z3
		7.62 - 8.08	U							
		8.08	D							
		8.53	D							
		9.14 - 9.60	U							
		9.60	D							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.1m below ground level.

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Rotary Core Log

Borehole No. HIS0034
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447148.00 - 335513.00	Hole Type CP
Location:		Level: 53.50	Scale 1:50
Client: Highways England		Dates: 17/07/1964 - 21/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.06	D							
		10.67 - 11.13	U							
		11.13	D							
		11.58	D							
		12.19 - 12.65	U							
		12.65	D							
		13.11	D							
		13.72 - 14.17	U							
		14.17	D							
		14.63	D							
		15.24 - 15.70	U							
		15.70	D				15.86	37.64		End of borehole at 15.85 m

11 12 13 14 15 16 17 18 19 20

Remarks
Ground-water was first encountered at a depth of 3.1m below ground level.

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Borehole Log

Borehole No. NWHCCTV3
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447176.66 - 335550.93	Hole Type WS
Location:		Level: 48.89	Scale 1:50
Client: Highways England		Dates: 17/09/1999 - 17/09/1999	Logged By NBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.00	D					MADE GROUND: Reddish brown friable clay with a little fine coarse subrounded gravel sized fragments of sandstone with occasional sandstone cobbles. MG-CL
		0.00 - 1.90	D	Ublow=0				
		1.90 - 2.90	D	Ublow=0	1.90	46.99		Stiff reddish brown slightly sandy CLAY with occasional grey pockets (<50mm) of completely weathered mudstone. (Mercia Mudstone - Grade III?) MM-Z4
		1.90 - 2.90	D	Ublow=0				
		2.90 - 4.55	D	Ublow=0	2.90	45.99		Firm to stiff brownish red slightly sandy CLAY. (Mercia Mudstone - Grade III/IVa?) MM-Z4
		2.90 - 4.55	D	Ublow=0				
					4.55	44.34		End of borehole at 4.55 m

Remarks
1. Hand excavated inspection pit to 0.70m (0.40m x 0.50m). 2. Hole complete at 4.55m. 3. Hole dry. 4. Hole backfilled with grout. 5.Marker Post Ref 193/5

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Borehole Log

Borehole No. **NWHD18A**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447174.27 - 335420.31	Hole Type WS
Location:		Level: 47.60	Scale 1:50
Client: Highways England		Dates: 07/09/1999 - 07/09/1999	Logged By NBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20	47.40		TOPSOIL. TP
		0.60	D	Ublow=0	0.50	47.10		MADE GROUND: Yellow brown medium and coarse gravel of limestone. (Hardcore) MG-SG
		0.60	D	Ublow=0				
		1.10 - 1.50	D	Ublow=0	1.10	46.50		MADE GROUND: Red brown sandy clay with some medium and coarse gravel of mudstone. MG-CL
		1.10 - 1.50	D	Ublow=0				
					1.50	46.10		Red brown mottled blue grey highly locally completely weathered MUDSTONE, weak and very weak. (Mercia Mudstone - Grade IVa?) MM-Z4
								End of borehole at 1.50 m

Remarks
1. Hand excavated inspection pit to 1.00m (0.50m x 0.50m). 2. Hole dry. 3. Marker Post Ref 193/3 +80. 4. Hole backfilled with grout.

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Borehole Log

Borehole No. **NWHD18B**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447212.87 - 335420.34	Hole Type WS
Location:		Level: 48.50	Scale 1:50
Client: Highways England		Dates: 09/09/1999 - 09/09/1999	Logged By NBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.10 - 1.10	D	Ublow=0	0.10	48.40		TOPSOIL. TP
		0.10 - 1.10	D	Ublow=0				Red fine grained, moderately weathered SANDSTONE, weak. (Possible Made Ground) MG-SG
		1.10 - 2.20	D	Ublow=0	1.10	47.40		Soft to firm red slightly sandy CLAY with a little fine to coarse gravel sized mudstone lithorelicts. MM-Z4
		1.10 - 2.20	D	Ublow=0	1.60	46.90		Firm red mottled greenish grey CLAY. MM-Z4
					2.20	46.30		End of borehole at 2.20 m

Remarks
1. Hand excavated to 0.70m (0.50m x 0.50m). 2. Hole terminated at 2.20m due to no penetration. 3. Hole dry. 4. Marker Post Ref 193/3+80. 5. Hole backfilled with grout.

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Rotary Core Log

Borehole No. **NWHM5** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447175.38 - 335437.53	Hole Type RC
Location:		Level: 47.67	Scale 1:50
Client: Highways England		Dates: 03/09/1999 - 04/09/1999	Logged By NBR

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.35	D				0.10	47.56		TOPSOIL. TP
		0.00 - 0.35	D							
		0.35	D				0.35	47.32		MADE GROUND: Brownish grey slightly clayey medium and coarse angular gravel sized fragments of limestone. MG-CL
		0.35 - 0.70	D							
							0.70	46.96		
		0.70 - 1.30		0	0	0				MADE GROUND: Reddish brown very silty clay with some fine and medium subangular gravel sized fragments of mudstone and siltstone. MG-CL
							1.30	46.36		
			98				1.60	46.06		MADE GROUND: Ballast fill. (Driller's description) Openholed from 0.70m to 1.30m. MG_CO
			99							
		1.70 - 2.70	25	40	0	0				MADE GROUND: Grey concrete. MG
		2.70 - 3.00	25	50	0	0				Reddish brown moderately weathered very silty MUDSTONE weak and very weak with extremely closely spaced random fractures tight smooth irregular. (Mercia Mudstone - Zone IIIa/II) MM-Z2
		3.00 - 3.70	97	0	0	0				
		~~3.70~~	~~D~~							
		3.92 - 4.40	25	42	0	0				
		~~4.40~~	~~D~~							
		~~4.60~~	~~C~~							
		4.62 - 5.40	97	0	0	0				
		5.62 - 6.40	97	0	0	0				
		~~6.65~~	~~C~~				6.62	41.04		
			9							Reddish brown very thinly bedded subhorizontal slightly to moderately weathered very silty MUDSTONE, weak with very closely spaced subhorizontal open rough planar. (Mercia Mudstone - Zone II) MM-Z2
		6.62 - 7.40		100	38	0	7.00	40.66		
			25							
		7.62 - 8.00	97	0	0	0				Reddish brown moderately weathered very silty MUDSTONE weak and very weak with extremely closely spaced random fractures tight smooth irregular. (Mercia Mudstone - Zone IIIa/II) MM-Z2
		8.00 - 9.00	25	33	0	0				
							9.00	38.66		Firm reddish brown very silty CLAY with much fine subangular lithorelicts up to 20mm. (Mercia Mudstone - Zone IIIa) MM-Z3
		9.22 - 10.00	98	25	0	0				

Continued on next sheet.

Remarks

1. Inspection pit excavated to 0.70m. 2. Borehole openholed to 1.30m. 3. Borehole complete at 12.00m. 4. Borehole backfilled with grout. 5. Marker Post Ref 193/4N.

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Rotary Core Log

Borehole No. **NWHM5**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447175.38 - 335437.53	Hole Type RC
Location:		Level: 47.67	Scale 1:50
Client: Highways England		Dates: 03/09/1999 - 04/09/1999	Logged By NBR

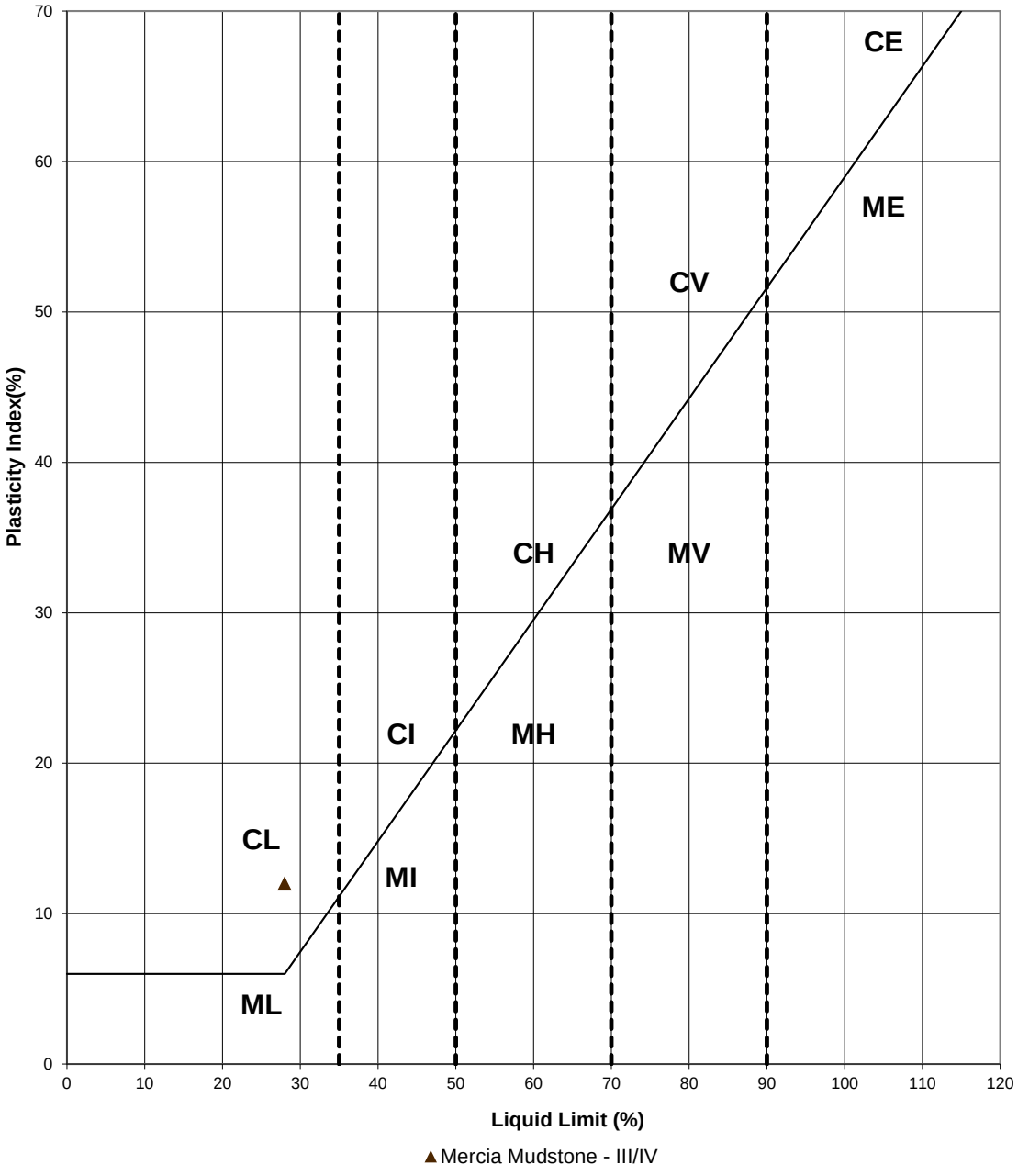
Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.00 - 10.70	98	28	0	0				
							10.70	36.97		Reddish brown very thinly and thinly bedded subhorizontal slightly weathered very silty MUDSTONE, moderately weak and weak with very closely and closely spaced subhorizontal fractures open smooth and rough planar. (Mercia Mudstone Zone II) MM-Z2
		10.92 - 12.00	10	100	76	9				—from 11.65m vertical fracture open smooth planar
							12.00	35.66		End of borehole at 12.00 m

Remarks
1. Inspection pit excavated to 0.70m. 2. Borehole openholed to 1.30m. 3. Borehole complete at 12.00m. 4. Borehole backfilled with grout. 5. Marker Post Ref 193/4N.

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **193430-193480**
Client: **Highways England**	Borehole ID: **NWHM5**	



Key

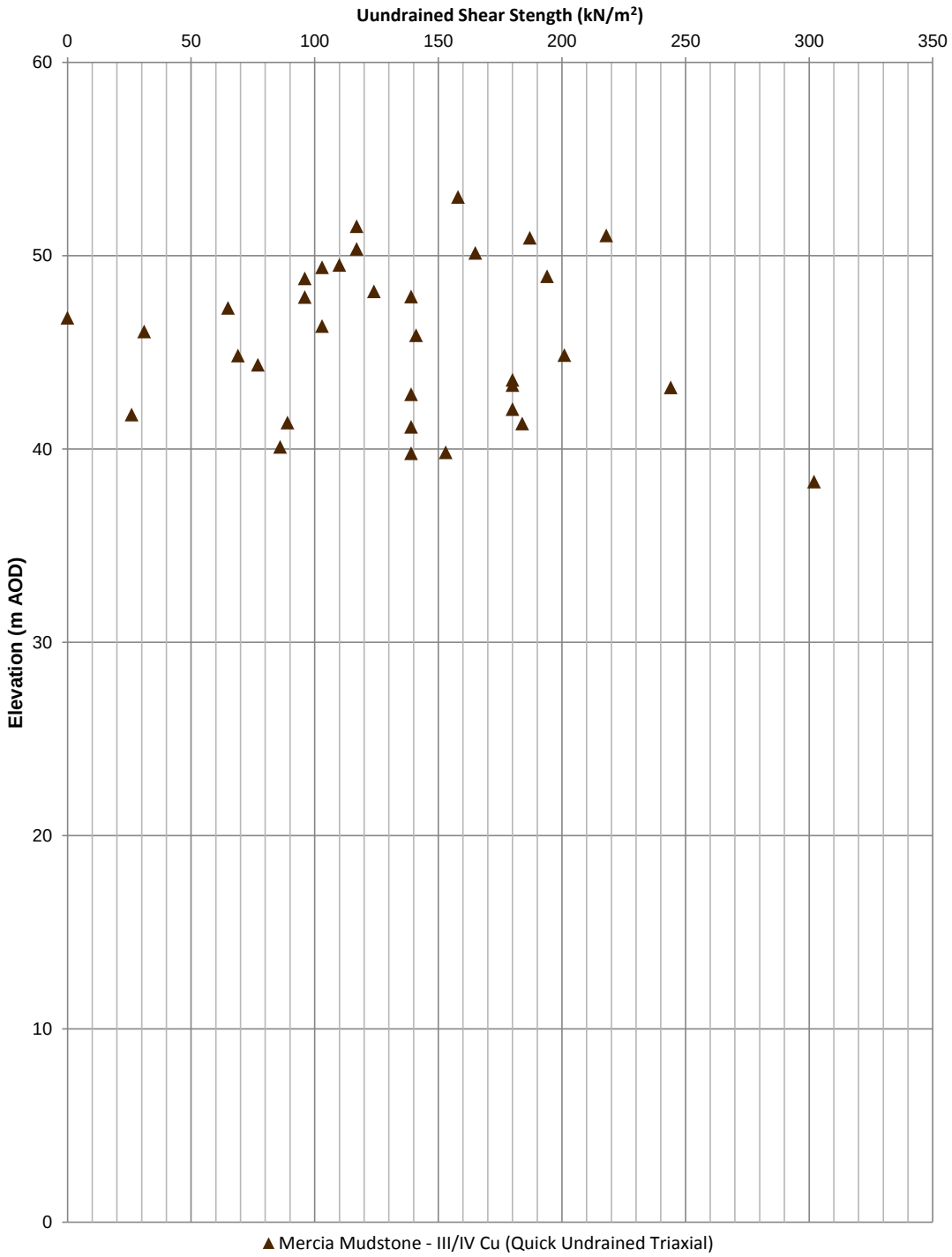
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 05/01/2017 Ref: HA549342-AMAR-HGT-193430-193480-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **193430-193480**
Client: **Highways England**	Borehole ID: **HIS0030-HIS0034**	



Rev: P01 Date: 05/01/2017 Ref: HA549342-AMAR-HGT-193430-193480-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-182100 -182230SB-GSS-000001		
Earthworks Widening Solution	1:2.5 Full Height Regrade and 1:3 Full Height Regrade		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	182100-182230		
Carriageway	Southbound		
Marker Post	MP182/1B+00 – MP182/1B+30		
National Grid Reference	E 446885, N 324569 – E 446902, N 324697		
Existing Ground Level at Location	Carriageway	65.67mAOD	
	Crest of cutting	72.54mAOD	
Earthwork Type	NB: N/A	SB: Cutting	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_42196	HAGDMS designation
Earthwork Height	NB: N/A	SB: 7.30m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 23°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Simon Arinze	08/12/2016	[redacted]
Checked	Alice Bazen	03/02/2017	
Reviewed	Gary Summerfield	28/02/2017	
Approved	Tom Bulteel	03/03/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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DESK STUDY

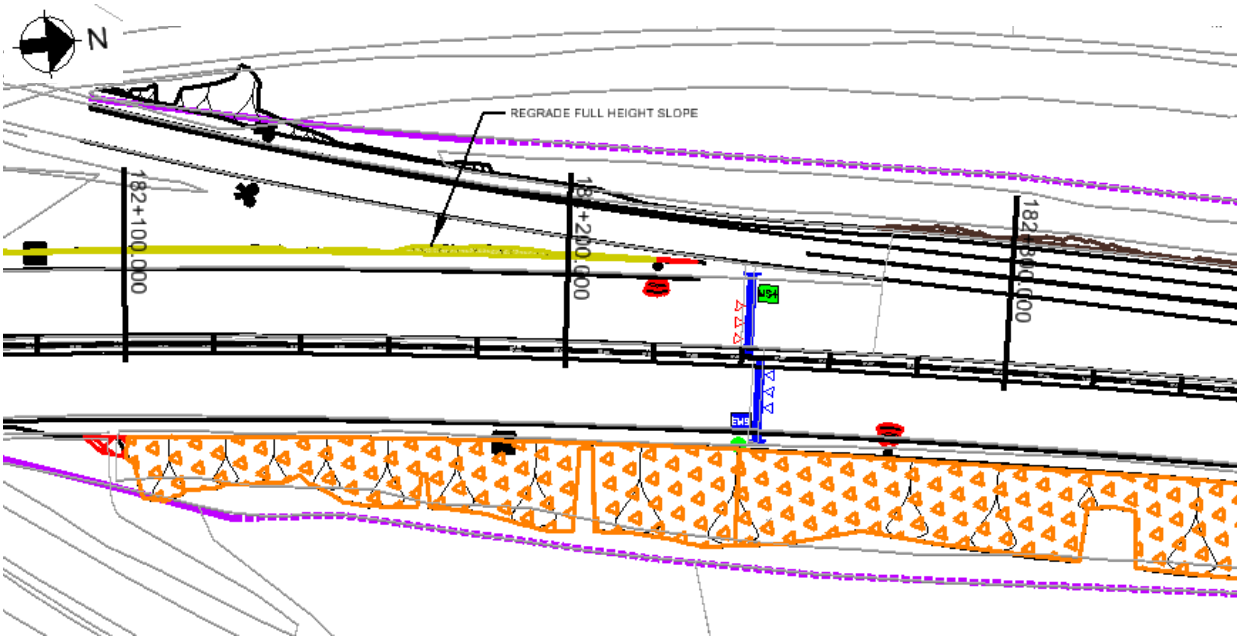


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- 182100-182150 – Full Height Regrade 1:2.5
- 182150-182230 – Full Height Regrade 1:3.0

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on a cutting with heights ranging between 4.2m and 7.3m with a typical slope angle of 23 degrees.

The critical cross section at chainage 182220 is based on the cross section with the greatest earthwork height.



Figure 2: Topographic Critical Cross Section Chainage 182220

Utilities:

There are no known utilities in close proximity to the widening location.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: N/A

Solid Deposits: Diseworth Sandstone (Mercia Mudstone Group), Siltstone and Sandstone

Ground Investigation:

The closest historical exploratory hole is located approx. 95m from the proposed Critical Cross section location and presented on Drawing No. HA549342-AMAR-HCT-SWI-DR-CE-000020.

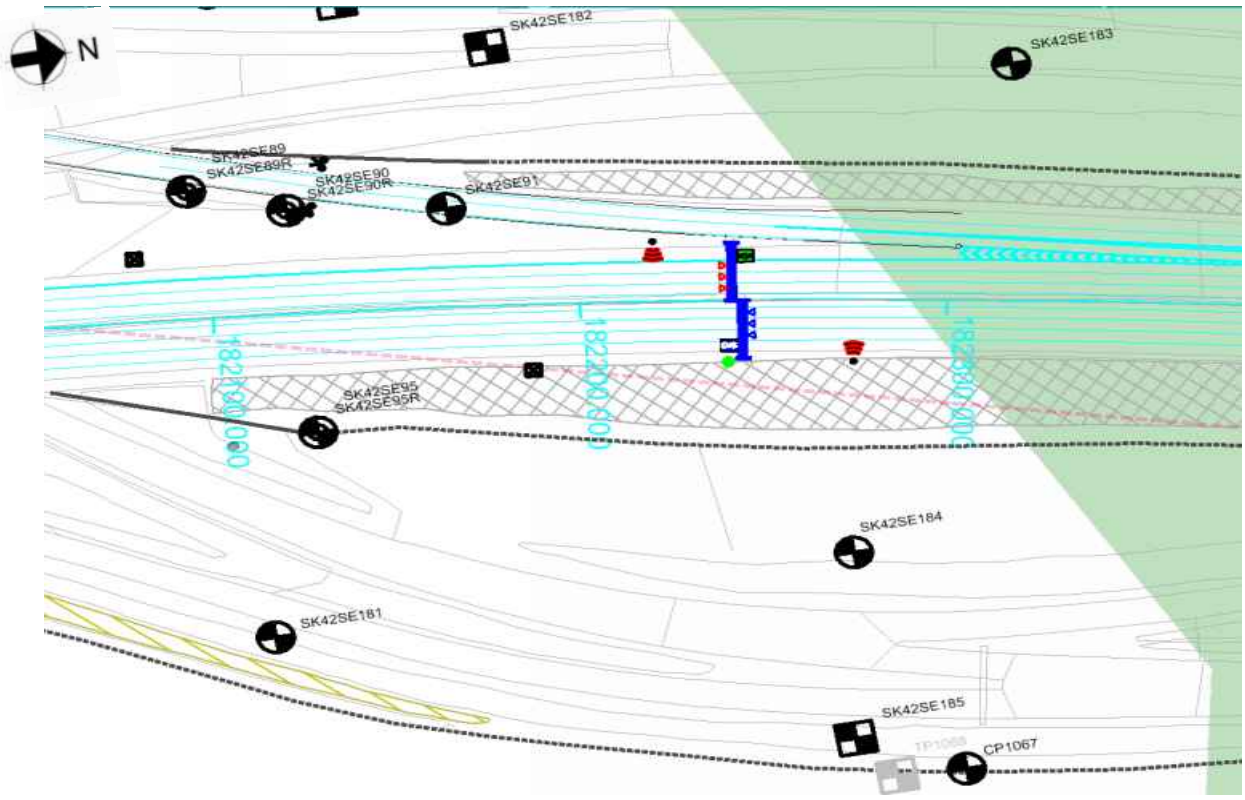


Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical boreholes:

Relevant Borehole Number	SK42SE95/SK42SE95R
Borehole Chainage	182125
Borehole Location	Southbound
National Grid Reference	E 446906, N 324593
Ground Level at Exploratory Hole	62.30mAOD
RAG Analysis	Green
Date Drilled	29/01/1988
Termination Depth	20.15 metres below ground level (mbgl)
Other suitable holes	SK42SE91, SK42SE184, SK42SE181

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR Survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Mercia Mudstone – III/IV	20.15	45.52	14->150 (15)

(1) Ground level is assumed to be at the carriageway level
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes SK42SE181, SK142SE184, SK42SE91, SK42SE95 & SK42SE95R .

Groundwater:

No groundwater data is available in any of the historical boreholes.

Groundwater Design Level:

No local groundwater level is available and therefore a design groundwater level of 1.0m below ground level throughout cutting has been assumed.

Lab Test Data - Geotechnical Testing:

6 No Atterberg Limit Test 11 No. Moisture Content tests were carried out in Mercia Mudstone Layer.

Stratum	Depth (mbgl)	Moisture Content (%)	Liquid Limits (%)	Plastic Limit (%)	Plasticity Index
Mercia Mudstone	0.30	12	-	-	-
Mercia Mudstone	0.30	15	43	30	13
Mercia Mudstone	0.50	19	43	30	13
Mercia Mudstone	1.45	17	43	30	13
Mercia Mudstone	2.00	20	43	30	13
Mercia Mudstone	2.00	13	-	-	-
Mercia Mudstone	2.95	18	43	30	13
Mercia Mudstone	3.00	19	-	-	-
Mercia Mudstone	3.50	-	27	16	11
Mercia Mudstone	5.00	11	-	-	-
Mercia Mudstone	5.00	19	-	-	-
Mercia Mudstone	5.95	16	-	-	-

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Lab Test Data - Chemical:

Table below presents chemical testing completed within the historical exploratory boreholes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Mercia Mudstone	Water Soluble Sulphate as SO4	Water	1	0.02	g/l SO4

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that road level on the base of the cutting is straight on to the Mercia Mudstone III/IV at this location. The below table outlines the assumed anticipated ground model:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Mercia Mudstone – III/IV	0.00 – 10.00	65.67 -55.67	10.00	21	30	2	75	6.3	5.0	-	0.5	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10m bgl)	>10.00	<55.67	>10.00	21	30	2	150	16.8	13.4	-	0.5	0.20	-	DS-2 AC-2

(3) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(4) Stratum types and depths are derived from data recorded on historical borehole SK42SE95R.
(5) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion and Poisson's ratio derived in the AMAR GIR are used.
(6) Design SPT N value of 15 has been used for the Mercia Mudstone III/IV, combined with an f1 value of 5.
(7) Eu for Mercia Mudstone – III/IV can be derived using N values (Bowles) where Eu = 300 (N+6); using a N value of 15 gives Eu = 6.3MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 5.0MN/m^2.
(8) Parameters for Mercia Mudstone iii/iv>10mbgl have been adopted from the AMAR GIR
(9) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Mercia Mudstone, the classification used for the strata in the AMAR GIR was adopted.

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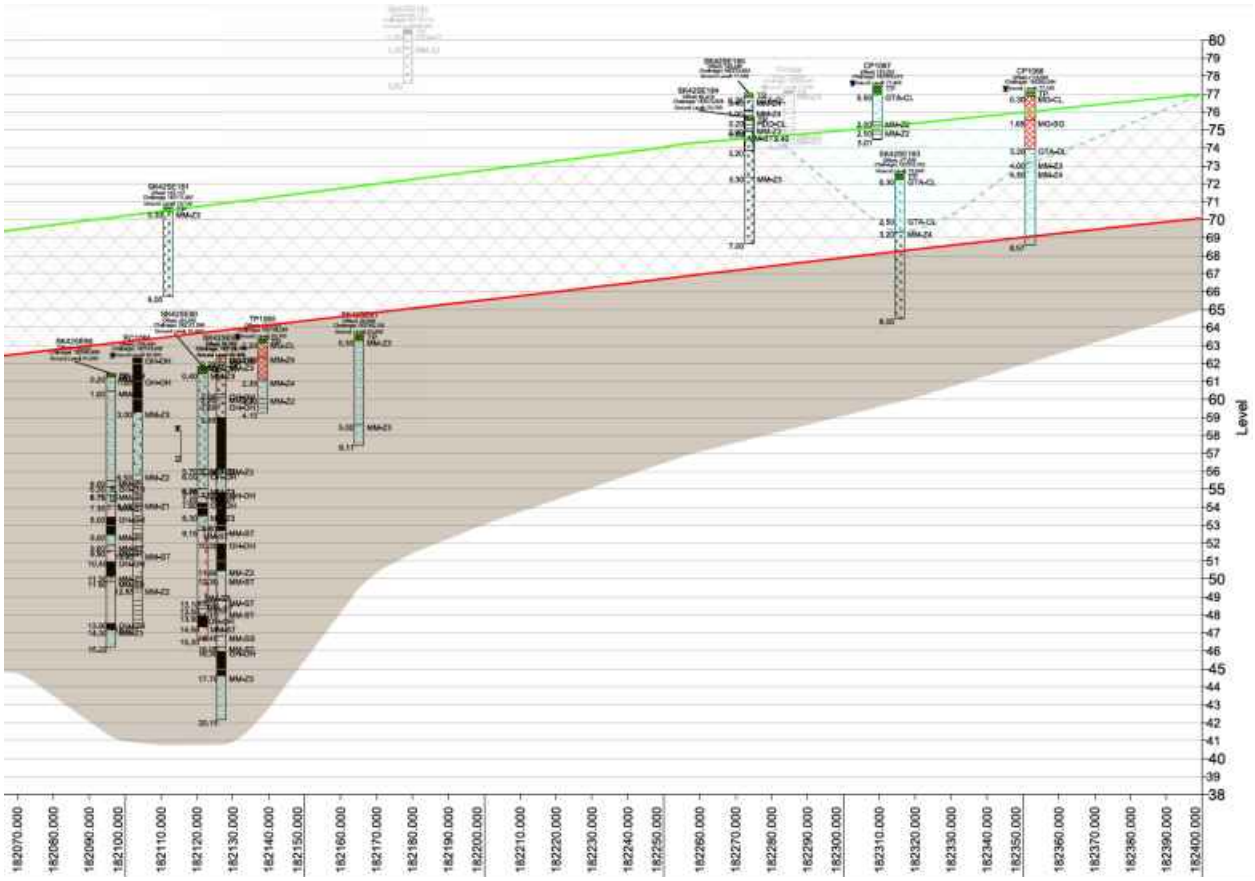


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
182100	182150	Full Height Regrade (1:2.5)
182150	182230	Full Height Regrade (1:3.0)

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FURTHER GROUND INVESTIGATION

No further ground investigation has been proposed between chainage 182100 and 182230.

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HISTORICAL EXPLORATORY HOLES

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Rotary Core Log

Borehole No.
SK42SE95
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446906.00 - 324593.00	Hole Type CP
Location:		Level: 62.30	Scale 1:50
Client: Highways England		Dates: 26/01/1988 - 26/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	62.10		FILL (Foreman's description) MG-CL
							0.40	61.90		TOPSOIL (Foreman's description) TP
										Very dense (hard) red brown friable clayey SILT with fine becoming medium gravel sized lithorelics Below about 1.80m becoming very stiff (hard) red brown locally very silty CLAY locally with medium to coarse grave sized lithorelics and occasional inclusions of light grey green silt and siltstone (KEUPER MARL 3/4a) MM-Z3
		1.50 - 1.65	U							
		1.70	D							
		1.70 - 2.15	D							
		2.60 - 2.90	D							
		3.00 - 3.28	D							
							3.30	59.00		End of borehole at 3.30 m

Remarks
Hand dug inspection pit from ground level to 1.50m

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Rotary Core Log

Borehole No. SK42SE95R

Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446906.00 - 324593.00	Hole Type CP+RC
Location:		Level: 62.30	Scale 1:50
Client: Highways England		Dates: 27/01/1988 - 29/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Cable Tool Boring to 3.30m OH-OH
							2.00	60.30		Assessed zone of core loss OH-OH
		2.00 - 3.50		20	5	0	2.20 2.60	60.10 59.70		Very stiff (hard) red brown silty CLAY with fine gravel sized lithorelics (weathered MUDSTONE (KM 3/4a) MM-Z3 *disturbed by SPT*
										Assessed zone of core loss OH-OH
		3.50 - 4.50		0	0	0				
		4.50 - 5.00		0	0	0				
		5.00 - 5.80		0	0	0				
		5.80 - 7.50		76	38	11	6.20	56.10		Stiff becoming very stiff (hard) red brown silty CLAY with frequent fine gravel sized lithorelics (weathered MUDSTONE). Interbedded with red brown moderately weathered SILTSTONE weak to very weak locally with extremely closely spaced fractures with black speckled stain (KM 3/4a) MM-Z3 *light green grey fine sandy siltstone moderately strong*
		7.50 - 10.30		25	16	0	7.50	54.80		Assessed zone of core loss OH-OH
							9.60	52.70		Red brown moderately weathered locally very clayey SILTSTONE weak becoming moderately
										Continued on next sheet

Remarks
Open hole drilling, air flush to 5.00m, foam flush to 20.15m, using 6.75in rock bit from ground level to 2.00m

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Rotary Core Log

Borehole No. SK42SE95R
Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446906.00 - 324593.00	Hole Type CP+RC
Location:		Level: 62.30	Scale 1:50
Client: Highways England		Dates: 27/01/1988 - 29/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.30	52.00		weak. Closely spaced sub-horizontal fractures with speckled black staining. (KEUPER MARL 2) MM-ST
										50 joint with speckled black stain
										Light greenish grey fine sandy calcareous siltstone strong
		10.30 - 11.80		0	0	0				Assessed zone of core loss OH-OH
							11.80	50.50		Very stiff (hard) red brown CLAY with frequent fine gravel sized lithorelics (weathered MUDSTONE) (KM2/3) MM-Z3
							12.30	50.00		Grey green becoming red brown moderately weathered locally fine sandy SILTSTONE moderately weak with extremely closely to closely spaced fractures stained black (KM 2/3) MM-ST
		11.80 - 13.50		100	38	29				
							13.50	48.80		Angular to sub-rounded medium to coarse gravel sized fragments of red brown SILTSTONE weak (possibly spoil) (KM 3/2?) MM-ST
										Assessed zone of core loss
		13.50 - 15.00		80	53	31	14.15	48.15		Light grey green slightly to moderately weathered slightly fine sandy SILTSTONE strong (KEUPER MARL 2) MM-ST
										very stiff red brown clay with occasional medium gravel sized lithorelics
										hard red brown clayey silt with occasional lithorelics
							15.45	46.85		Light green grey slightly to moderately weathered fine grained SANDSTONE moderately strong with closely spaced sub-horizontal fractures (KM 1/2) MM-SS
		15.00 - 17.00		65	52	43	16.05	46.25		
							16.30	46.00		Light greenish grey fine sandy SILTSTONE weak (KM 2) MM-ST
										Assessed zone of core loss OH-OH
							17.70	44.60		Stiff becoming very stiff (hard) red brown silty CLAY with fine to medium occasionally coarse gravel sized lithorelics (weathered MUDSTONE) Occasional pockets of light grey green silt (KEUPER MARL 3) Below 18.50m thinly interbedded with red brown locally light greenish grey moderately weathered SILTSTONE weak with very closely spaced fractures stained black. From 18.50m to 19.30m non intact MM-Z3
		17.00 - 20.00		77	37	20				
										Continued on next sheet

Remarks
Open hole drilling, air flush to 5.00m, foam flush to 20.15m, using 6.75in rock bit from ground level to 2.00m

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Rotary Core Log

Borehole No. SK42SE95R
Sheet 3 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446906.00 - 324593.00	Hole Type CP+RC
Location:		Level: 62.30	Scale 1:50
Client: Highways England		Dates: 27/01/1988 - 29/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							20.15	42.15		End of borehole at 20.15 m

21
22
23
24
25
26
27
28
29
30

Remarks
Open hole drilling, air flush to 5.00m, foam flush to 20.15m, using 6.75in rock bit from ground level to 2.00m

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Borehole Log

Borehole No.: SK42SE91 HISTORIC Sheet 1 of 1

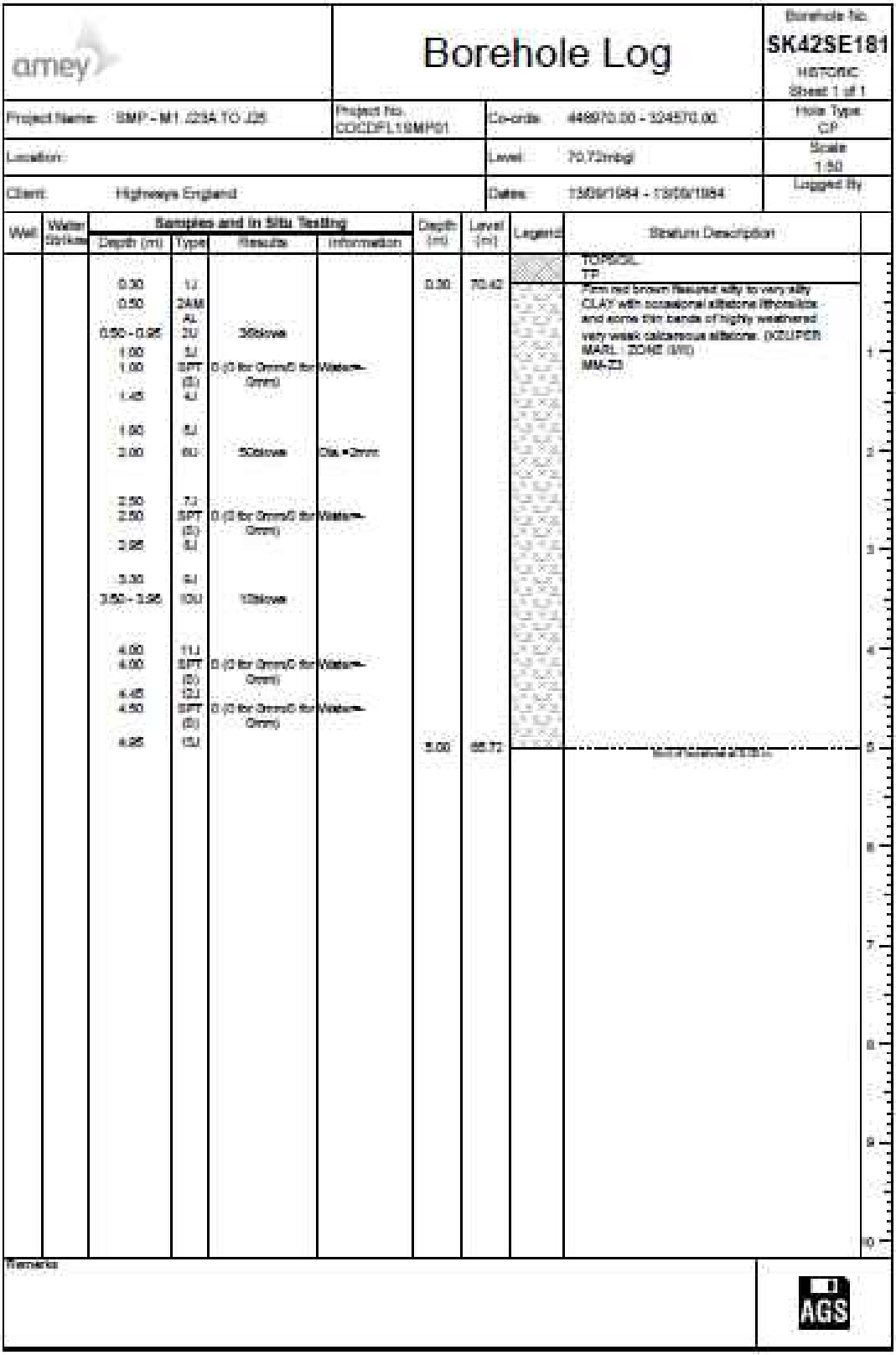
Project Name: SMP - M1 J28A TO J28	Project No.: CDCDFL1SMP01	Co-ords: 446840.00 - 324640.00	Hole Type: CP
Location:		Level: 83.59mbgl	Scale: 1:50
Client: Highways England		Dates: 18/01/1995 - 18/01/1995	Logged By: JAB

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									Clayey topsoil TP
		0.00	1D			0.30	83.29		Stiff becoming very stiff red brown locally very silty CLAY with occasional up to medium gravel sized lithorelics , pockets and lenses of light green grey silt and lenses/laminations of very weak mudstone. (KEUPER MARL 3Hkj) MM-ZD
		0.50 - 0.95	2U	50blows					slightly sandy with occasional siltstone gravel
		1.00	3D						
		1.00	SPT (S)	N=14 (2,2/4,3,3,4)	Water				
		1.00 - 1.45	4D						
		2.00 - 2.45	5U	12blows					
		2.50	6D						
		2.50	SPT (S)	N=30 (4,4/5,7,9,9)	Water				
		2.50 - 2.95	7D						
		3.50 - 3.95	8U	87blows					
		4.00	9D						
		4.00	SPT (S)	N=36 (5,7/7,9,11,11)	Water				
		4.00 - 4.45	10D						
		5.00 - 5.35	11U	150blows		5.00	78.59		Very stiff (hard) red brown extremely closely fissured very silty CLAY with pockets of green grey silt (KEUPER MARL 3Hkj) MM-ZD
		5.40	12D						
		5.40	SPT (S)	50 (14,21/50 for 29mm)	Water				
		5.40 - 5.58	13D						
		5.00	SPT (S)	0 (77 for 100mm/0 for 0mm)	Water	6.11	77.48		End of borehole at 6.11 m
		6.00 - 6.11	14D						

Remarks:

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Borehole Log

Borehole No.: SK42SE181 HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J29A TO J35	Project No.: CDCDFL19MP01	Co-ords: 448970.00 - 324570.00	Hole Type: CP
Location:		Level: 70.72mbgl	Scale: 1:50
Client: Highways England		Dates: 13/09/1994 - 13/09/1994	Logged By:

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									TOPSOIL TP
		0.30	1J			0.30	70.42		Firm red brown fissured silty to very silty CLAY with occasional siltstone lithorelicts and some thin bands of highly weathered very weak calcareous siltstone. (KEUPER MARL: ZONE (MI) MM-ZI)
		0.50	2AM						
			AL						
		0.50 - 0.95	3U	36blows					
		1.00	5J						
		1.00	SPT (S)	0 (3 for 0mm/3 for 0mm)	Water				
		1.45	4J						
		1.90	5J						
		2.00	6U	50blows	Dia. = 0mm				
		2.50	7J						
		2.50	SPT (S)	0 (3 for 0mm/3 for 0mm)	Water				
		2.95	8J						
		3.30	9J						
		3.50 - 3.95	10U	12blows					
		4.00	11J						
		4.00	SPT (S)	0 (3 for 0mm/3 for 0mm)	Water				
		4.45	12J						
		4.50	SPT (S)	0 (3 for 0mm/3 for 0mm)	Water				
		4.95	13J						
						5.00	65.72		End of borehole at 5.00 m

Remarks

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Borehole Log

Borehole No.
SK42SE184
HBTDRC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No.: D0CDFL1SMP01	Co-ords: 445572.00 - 324730.00	Hole Type: CP
Location:		Level: 75.70mbgl	Scale: 1:50
Client: Highways England		Dates: 13/09/1984 - 13/09/1984	Logged By:

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	1J			0.20	75.50		TOPSOIL.
		0.50 - 0.95	2U	35blows					TP.
									Stiff orange brown sandy silty CLAY with zones of clayey sand and occasional subangular fine to medium gravel.
						0.00	74.90		HDDCL.
		1.00	3J						Stiff red brown and grey green silty CLAY with occasional lithorelicts and bands of highly weathered siltstone. (KEUPER MARL : ZONE II/III) MM-Z3
		1.00	SPT (S)	20 (2 for 0mm/20...)	Water				
		1.45	4J						
		1.90	5J						
		2.00 - 2.45	6U	20blows					
		2.00 - 3.00	8C						
		2.50	7J						
		2.50	SPT (S)	22 (2 for 0mm/22...)	Water				
		2.95	8J						
		3.00	9B						
		3.30	10J			3.30	72.40		
		3.50 - 3.95	11U	40blows					Firm and stiff red brown very silty CLAY with occasional mudstone lithorelicts and bands of highly weathered fissured mudstone. (KEUPER MARL : ZONE II/III) MM-Z3
		4.00 - 5.00	12D						
		5.00	13B						
		5.00 - 5.45	13U	47blows					
		5.50	14J						
		5.50	SPT (S)	22 (2 for 0mm/22...)	Water				
		5.95	15J						
		6.00	16J						
		6.50	SPT (S)	46 (2 for 0mm/46...)	Water				
		6.95	17J			7.00	68.70		Mid of borehole at 7.00m

Remarks

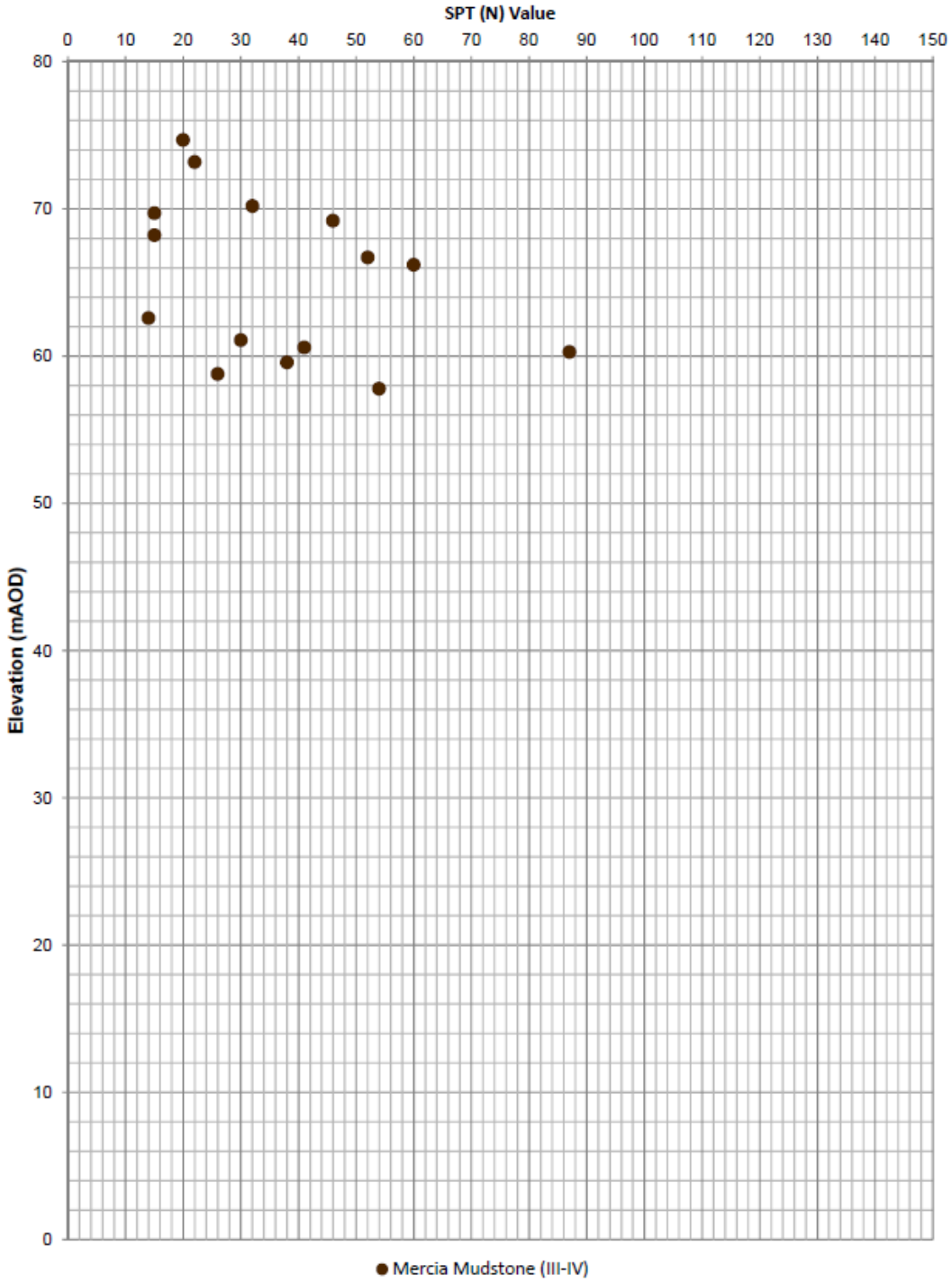
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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182100 - 182230 SB**
Client: **Highways England**	Borehole ID: **SK42SE95 & SK42SE95R**	

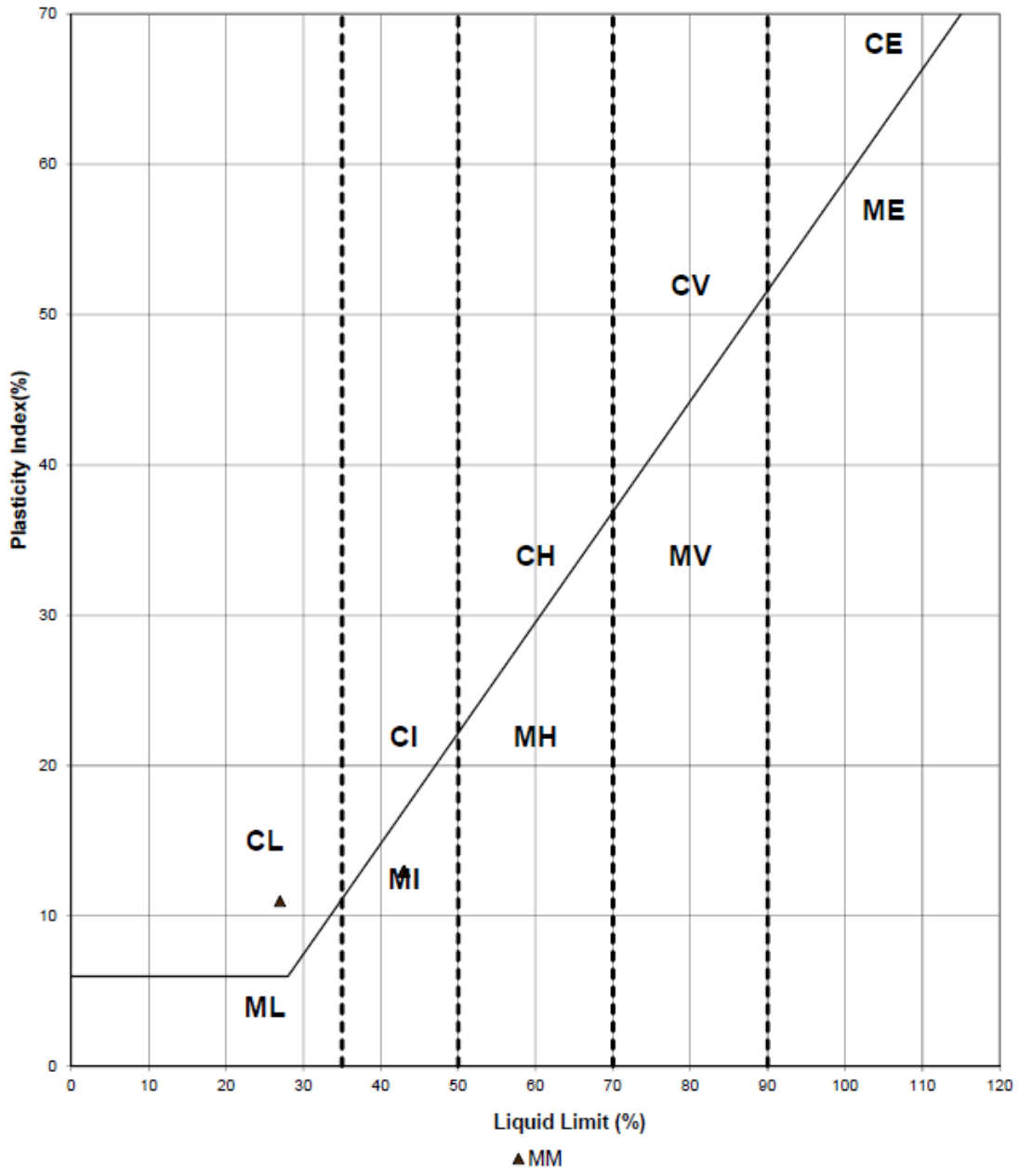


Extrapolated SPT (N) Values >150 have not been shown

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182100-182230SB**
Client: **Highways England**	Borehole ID: **SK42SE184**	



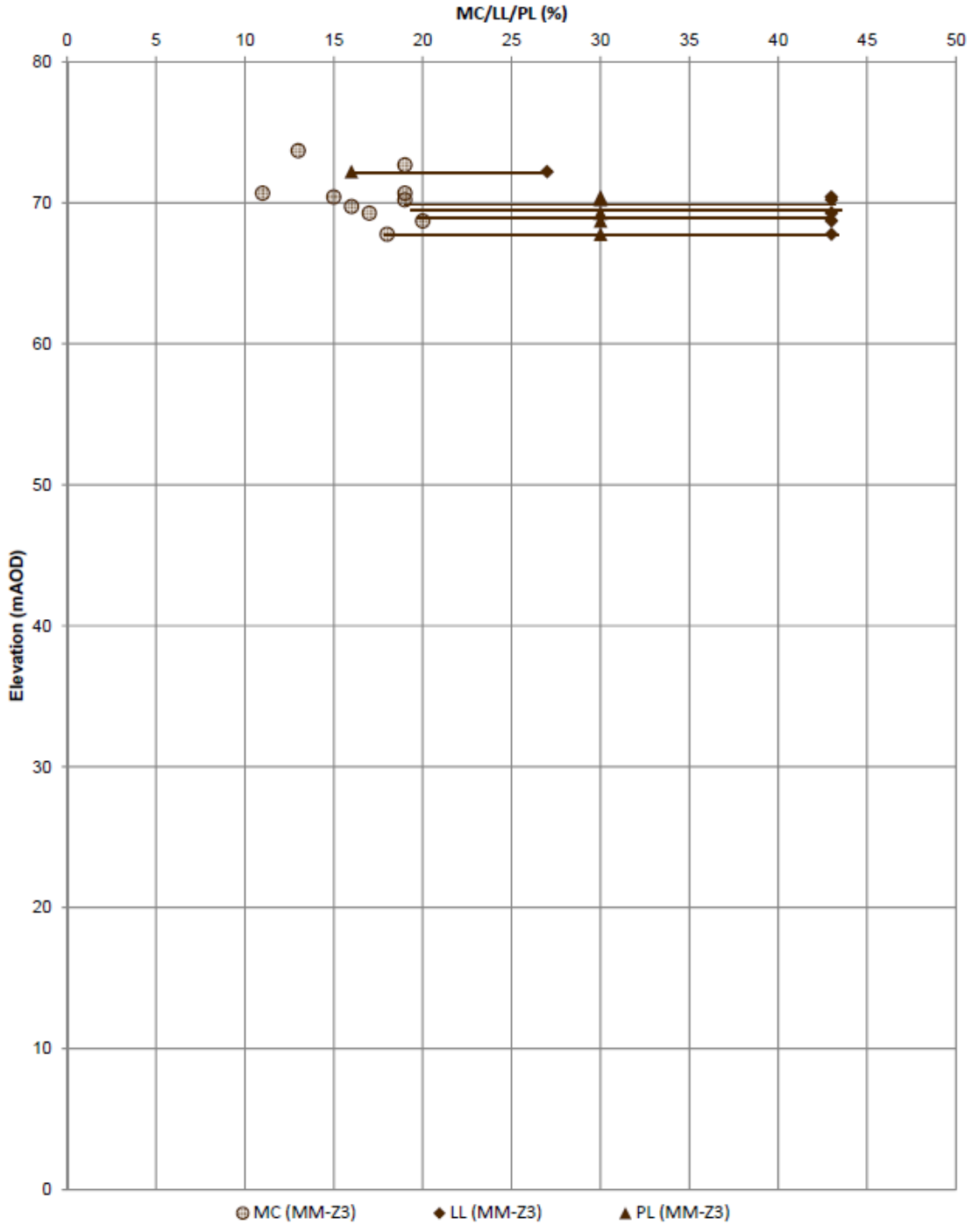
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182100-182230 SB**
Client: **Highways England**	Borehole ID: **SK42SE181**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-182240_182620SB-GSS-000001		
Earthworks Widening Solution	Full Height Regrade (1:3.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	182240-182620		
Carriageway	Southbound		
Marker Post	MP182/2B+40 – MP182/6B+20		
National Grid Reference	E 446903, N 324707 – E 446990, N 325075		
Existing Ground Level at Location	Crest of cutting	78.45mAOD	
	Carriageway	71.21mAOD	
Earthwork Type	NB: N/A	SB: Cutting	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_42196 & 7_M1_42063	HAGDMS designation
Earthwork Height	NB: N/A	SB: 7.10m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 21°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Simon Arinze	03/02/2017	[redacted]
Checked	Alice Bazen	15/02/2017	
Reviewed	Gary Summerfield	16/02/2017	
Approved	Tom Bulteel	03/03/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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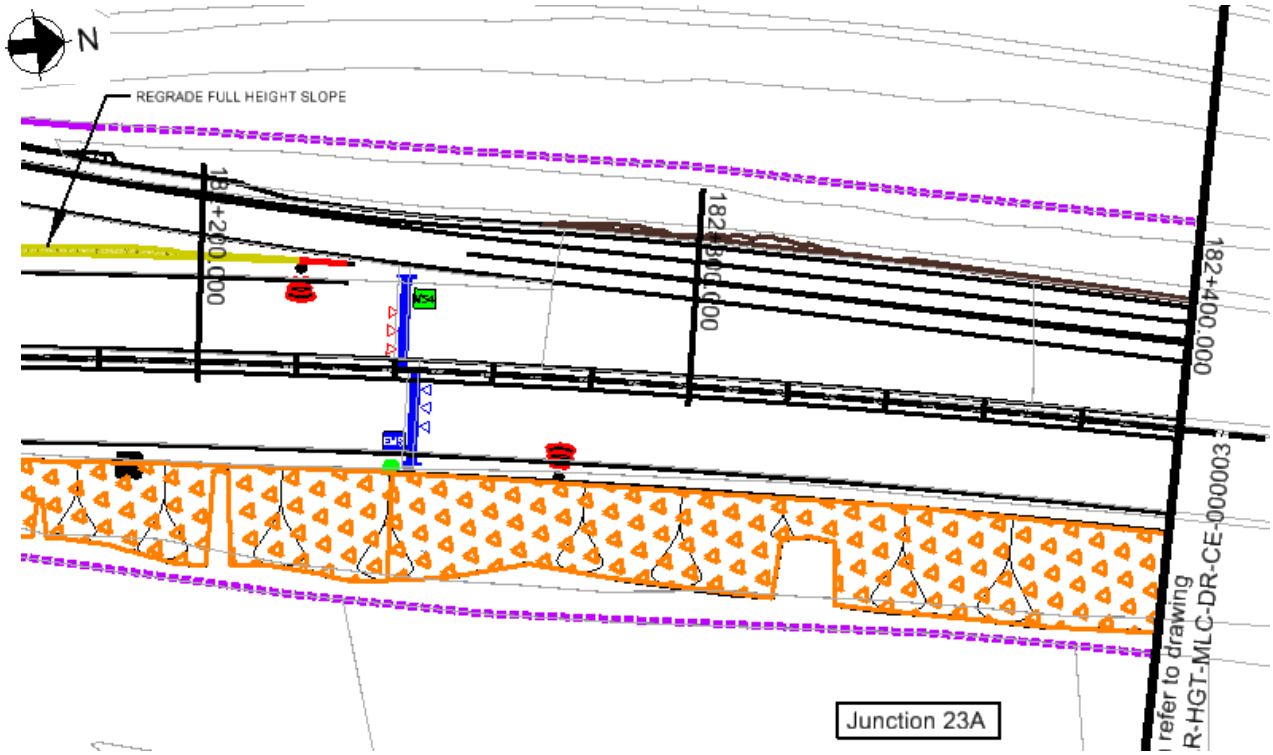


Figure 1.1: Location Plan – 182240-182400

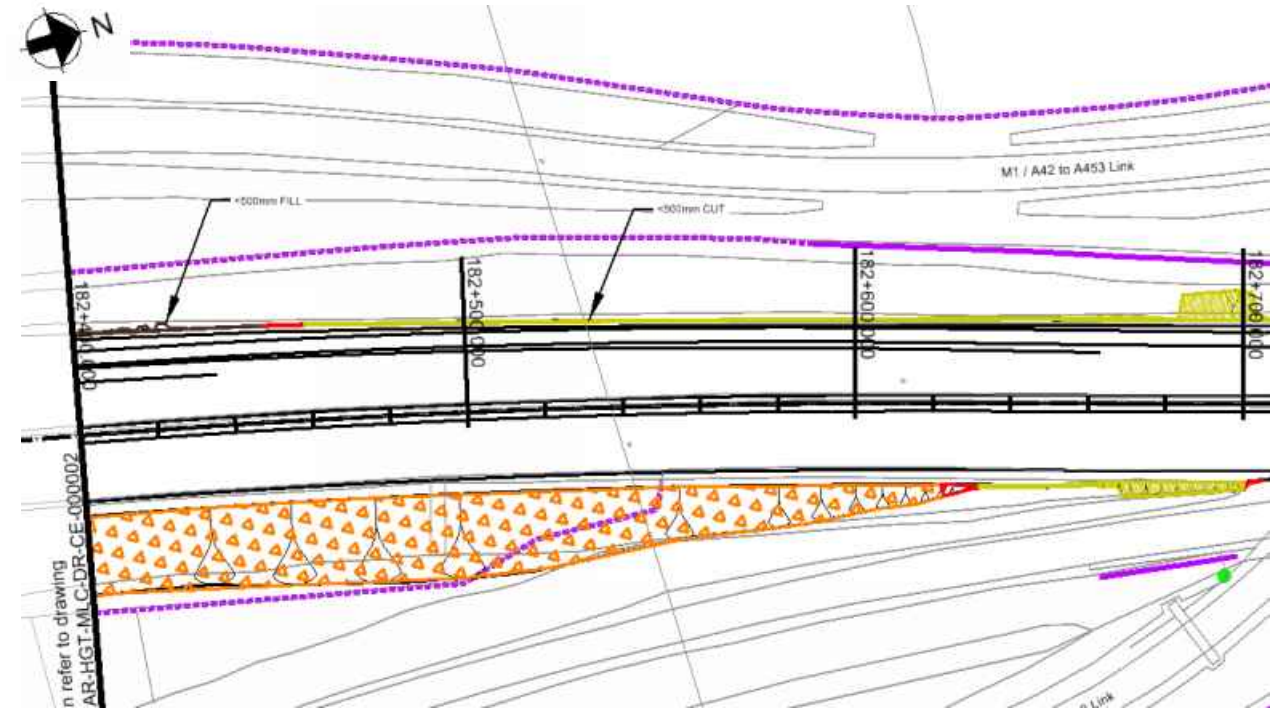


Figure 1.2: Location Plan – 182400-182620

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Full Height Regrade 1:3.0

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a cutting ranging in height between 6.2m and 7.1m with a typical slope angle of 21 degrees.

The critical cross section at Ch182470 is based on the section with the greatest earthwork height.



Figure 2: Topographic Critical Cross Section Chainage 182470

Utilities:

There are no known utilities in close proximity to the widening location.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Oadby Member (Diamicton)

Solid Deposits: Gunthorp Member (Mercia Mudstone Group), Mudstone

Ground Investigation:

There are 5 No. historical exploratory holes recorded within the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000020-21, Rev P01.

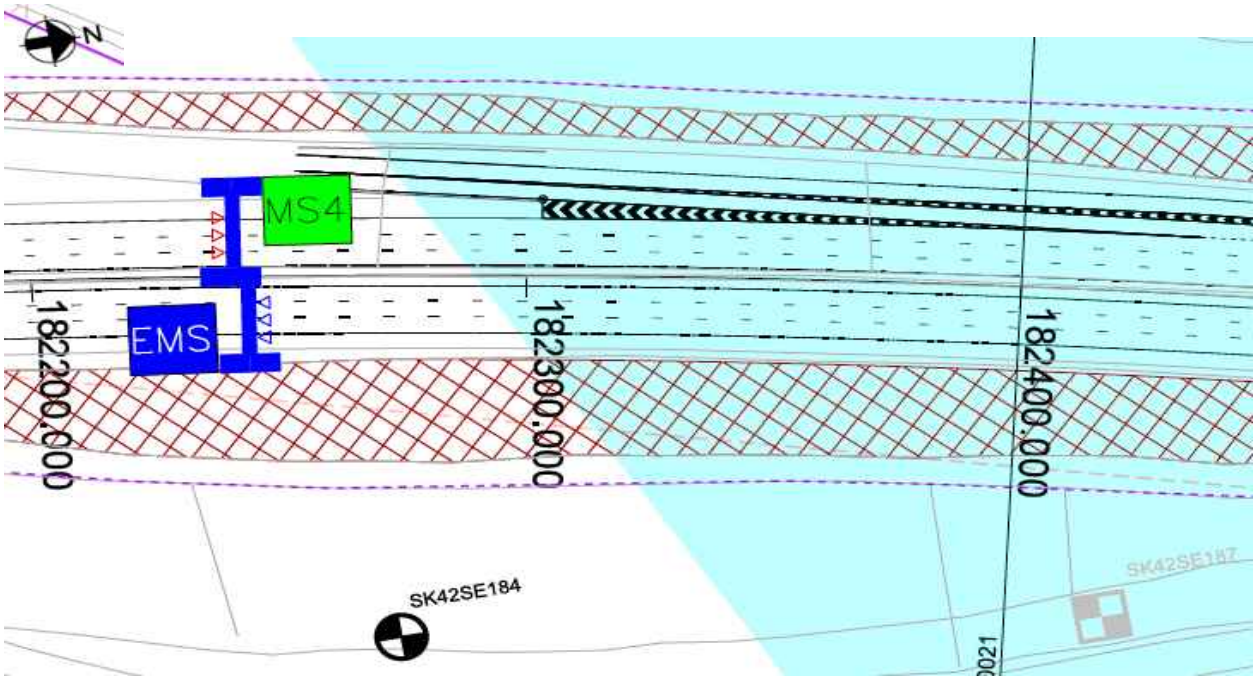


Figure 3.1: Borehole Location Plan – 182240-182400

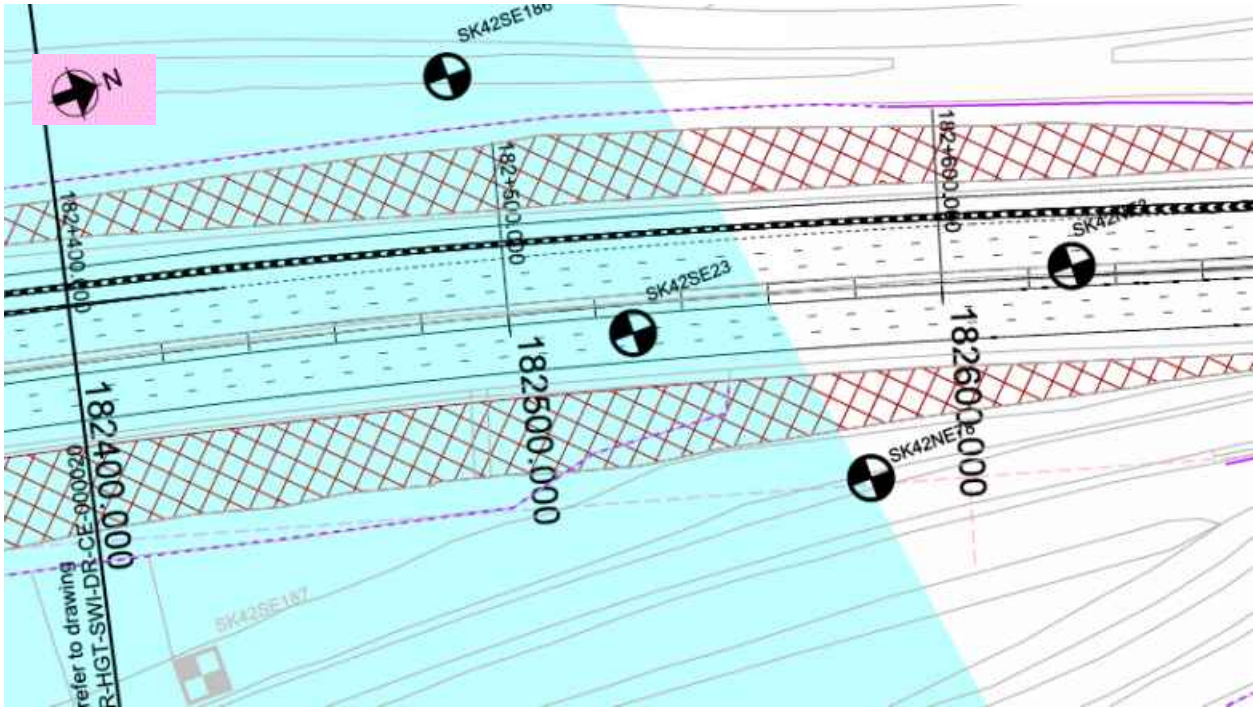


Figure 3.2: Borehole Location Plan – 182400-182620

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42NE78
Borehole Chainage	182580
Borehole Location	Southbound
National Grid Reference	E 446950, N 324990
Ground Level at Exploratory Hole	79.73mAOD
RAG Analysis	Green
Date Drilled	19/09/1984
Termination Depth	8.15 metres below ground level (mbgl)
Other suitable holes	SK42SE23, SK42SE184, SK42SE186 & SK42NE3

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR Survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Mercia Mudstone – III/IV	Not proven	Not proven	20-131 (20)

(1) Ground level is assumed to be at the carriageway level
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes SK42NE78, Sk42SE184 & SK42SE186.

Groundwater:

Groundwater strikes are presented in the table below:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
SK43NE3	Mercia Mudstone	4.57	75.23	-	-	-
SK42SE23	Mercia Mudstone	4.27	74.53	-	-	-

Groundwater Design Level:

Limited groundwater level is available and therefore a design groundwater level of 1.0m below ground level throughout cutting has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

13 No Atterberg Limit Tests and 20 No Natural Moisture Content tests were undertaken within the Mercia Mudstone – III/IV within SK42NE3, SK42NE78, SK42SE23, SK42SE184 & SK42SE186 with the following results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Mercia Mudstone	1.70	24.00	-	-	-	-
Mercia Mudstone	2.00	15.00	34	17	17	CL
Mercia Mudstone	3.20	-	36	18	18	CI
Mercia Mudstone	3.50	-	36	20	16	CI
Mercia Mudstone	2.74	17.00	-	-	-	-
Mercia Mudstone	3.05	-	52	22	30	CH
Mercia Mudstone	4.00	23.00	-	-	-	-
Mercia Mudstone	3.50	15.00	-	-	-	-
Mercia Mudstone	4.50	23.00	-	-	-	-
Mercia Mudstone	4.57	24.00	-	-	-	-
Mercia Mudstone	4.0	22.00	42	22	20	CI
Mercia Mudstone	5.03	-	35	19	16	CI
Mercia Mudstone	4.50	12.00	-	-	-	-
Mercia Mudstone	4.72	-	31	19	12	CL
Mercia Mudstone	2.00	20.00	-	-	-	-
Mercia Mudstone	6.10	13.00	-	-	-	-
Mercia Mudstone	5.79	15.00	-	-	-	-
Mercia Mudstone	7.01	-	34	20	14	CL
Mercia Mudstone	6.95	20.00	-	-	-	-
Mercia Mudstone	3.00	19.00	-	-	-	-
Mercia Mudstone	3.50	-	27	16	11	CL
Mercia Mudstone	7.62	11.00	-	-	-	-
Mercia Mudstone	6.71	16.00	31	18	13	CL
Mercia Mudstone	8.53	-	36	20	16	CI
Mercia Mudstone	8.08	-	36	23	13	CI
Mercia Mudstone	5.0	11.00-19.00	-	-	-	-
Mercia Mudstone	8.53	13.00	-	-	-	-
Mercia Mudstone	5.95	16.00	-	-	-	-

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Lab Test Data – BRE Classification:

The table below presents the chemical testing undertaken within the exploratory boreholes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Mercia Mudstone	Water Soluble Sulphate as SO4	Water	5	0..00-0.05	g/l SO4
Mercia Mudstone	pH	Solid	2	7.6	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that road level on the base of the cutting is straight on to the Mercia Mudstone III/IV at this location. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Mercia Mudstone – III/IV	0.00 – 10.00	71.21 -61.21	10.00	21	30	2	100	7.8	6.2	-	0.5	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10m bgl)	>10.00	<61.21	>10.00	21	30	2	150	16.8	13.4	-	0.5	0.20	-	DS-2 AC-2

.

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical boreholes.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) A design SPT N value of 20 has been used for the Mercia Mudstone III/IV, combined with an f1 value of 5.
(5) Eu for Mercia Mudstone – III/IV <10mbgl can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 20 gives Eu = 7.8MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 6.24MN/m^2.
(6) Geotechnical parameters for Mercia Mudstone >10mbgl is based on values derived in the AMAR GIR due to lack of local data present.
(7) BRE Classification is determined using criteria set out in BRE Special Digest 1. Due to the lack of BRE test data for Mercia Mudstone - III/IV, the classification used for the strata in the AMAR GIR was adopted

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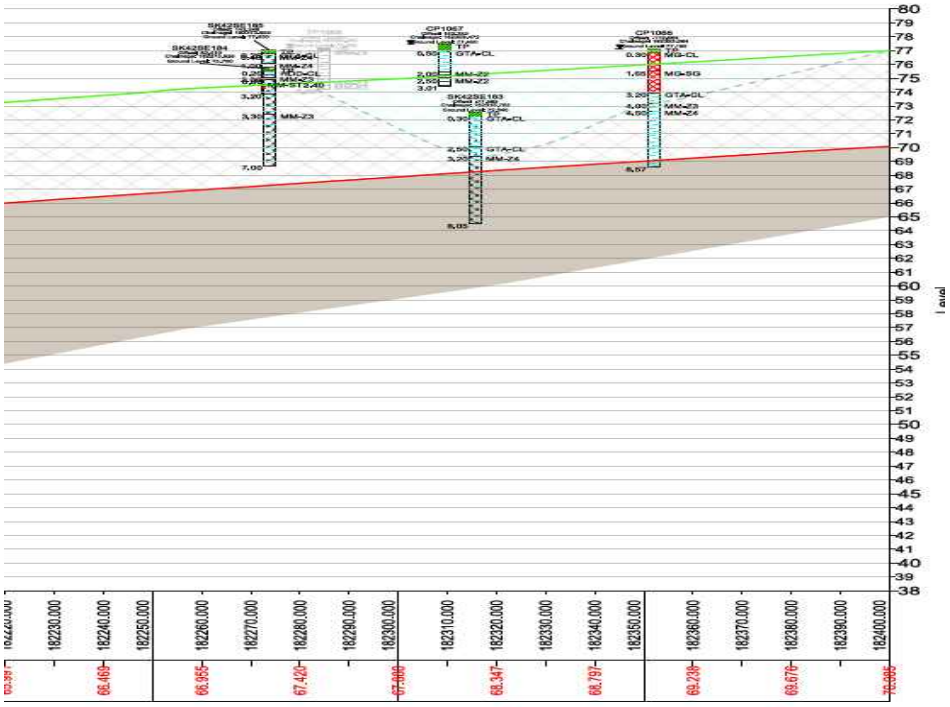


Figure 4.1: Geological Long Section – 182240 - 182400

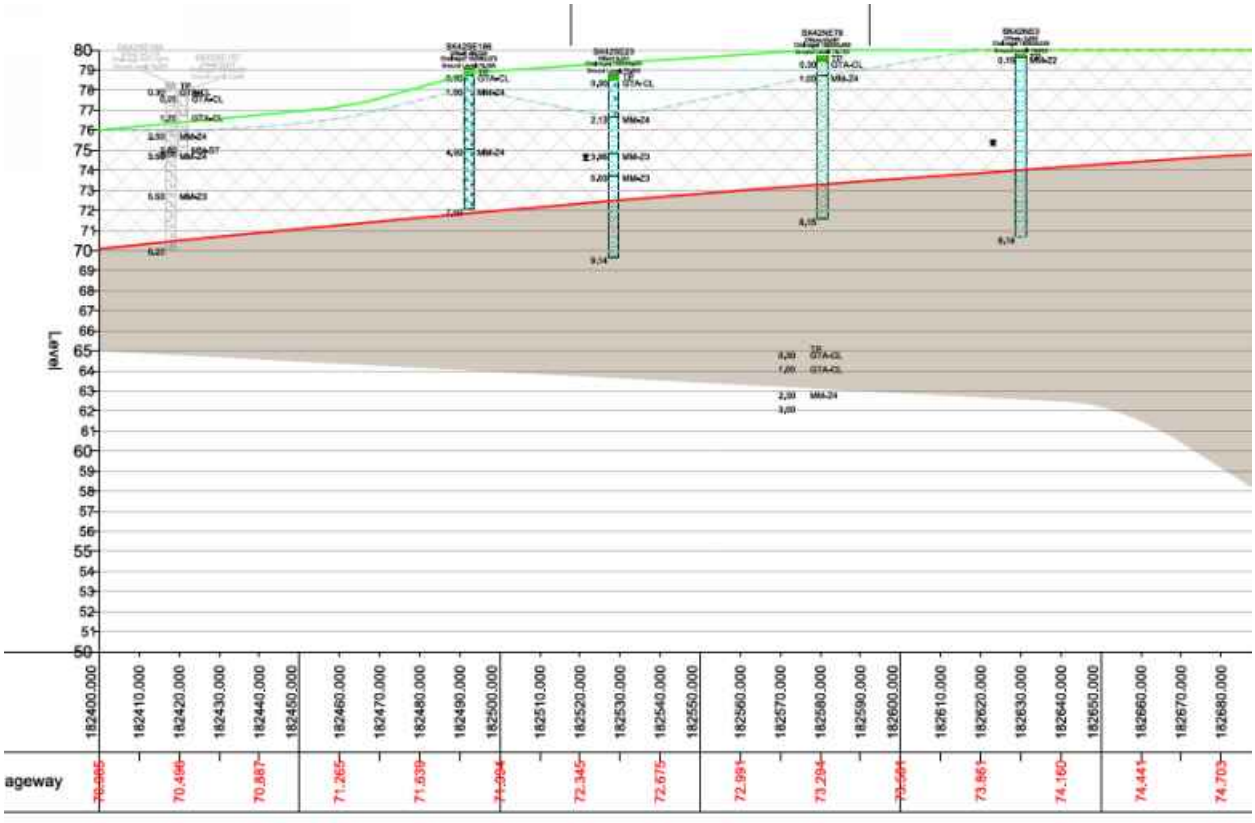


Figure 4.1: Geological Long Section – 182400 - 182620

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
182240	182620	Full Height Regrade (1:3.0)

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Further Ground Investigation

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- T-CCD-5A – ch.182290 (A42 East), Northbound - CPT to a scheduled depth of 5.0mbgl.
- T-CCD-5B – ch.182290 (A42 West), Southbound - CPT to a scheduled depth of 5.0mbgl.
- TP-NW12 – ch.182290 (SB On-slip), Southbound – Trial Pit and Thermal Resistivity Probe – Schedule depth to be confirmed on site.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No.
SK42NE3
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446970.00 - 325090.00	Hole Type CP
Location:		Level: 79.80	Scale 1:50
Client: Highways England		Dates: 21/08/1961 - 22/08/1961	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.15	79.65		Topsoil TP
		0.61	D							Stiff red silty clay MM-Z2
		1.52	D							
		1.52 - 1.98	U							
		3.05	D							
		3.20 - 3.38	U							
	▼	4.57	D							
		4.57	W							
		5.03 - 5.41	U							
		6.10	D							
		7.01 - 7.19	U							
		7.62	D							
		8.53 - 8.69	U							
		9.14	D				9.14	70.66		End of borehole at 9.14 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE78**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 325030.00	Hole Type CP
Location:		Level: 79.73	Scale 1:50
Client: Highways England		Dates: 19/09/1984 - 19/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	J				0.30	79.43		TOPSOIL TP
		0.50 - 0.95	U							Stiff brown silty CLAY with occasional subrounded to angular fine to medium gravel and siltstone. (GLACIAL TILL) GTA-CL
		1.00	J				1.00	78.73		Firm red brown silty CLAY with some mudstone lithorelicts and thin bands of highly weathered very weak grey green mudstone/siltstone. (KEUPER MARL : ZONE II/III) Becoming stiff and firm below 2.50m. Becoming very stiff below 5.00m. MM-Z4
		1.00 - 1.60	SPTL							
		1.00 - 1.60	S							
		1.45	B							
			J							
		1.80	J							
		2.00 - 2.45	U							
		2.50	J							
		2.95	J							
		3.20	J							
		3.50 - 3.95	U							
		4.00	B							
		4.00	J							
		4.00 - 4.50	SPTL							
		4.45	S							
		4.50	J							
		4.70	B							
			J							
		5.00 - 5.40	U							
		5.40	J							
		5.85	J							
		6.00 - 7.00	SPTL							
		6.20	S							
			J							
		6.95	B							
		6.95	J							
		7.20	J							
		8.15	J				8.15	71.58		End of borehole at 8.15 m

Remarks

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446970.00 - 324730.00	Borehole No. SK42SE184 Sheet 1 of 1
Location:		Level: 75.70	Hole Type CP
Client: Highways England		Dates: 13/09/1984 - 13/09/1984	Scale 1:50
			Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	J				0.20	75.50		TOPSOIL. TP
		0.50 - 0.95	U							Stiff orange brown sandy silty CLAY with zones of clayey sand and occasional subangular fine to medium gravel. HDD-CL
							0.80	74.90		Stiff red brown and grey green silty CLAY with occasional lithorelicts and bands of highly weathered siltstone. (KEUPER MARL : ZONE II/III) MM-Z3
		1.00	J							
		1.45	J							
		1.80	J							
		2.00 - 2.45	U							
		2.00 - 3.00	C							
		2.50	J							
		2.95	J							
		3.00	B							
		3.30	J				3.30	72.40		Firm and stiff red brown very silty CLAY with occasional mudstone lithorelicts and bands of highly weathered fissured mudstone. (KEUPER MARL : ZONE II/III) MM-Z3
		3.50 - 3.95	U							
		4.00 - 5.00	B							
		5.00	B							
		5.00 - 5.45	U							
		5.50	J							
		5.95	J							
		6.30	J							
		6.95	J				7.00	68.70		End of borehole at 7.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42SE186**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446880.00 - 324970.00	Hole Type CP
Location:		Level: 79.05	Scale 1:50
Client: Highways England		Dates: 07/09/1984 - 07/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										TOPSOIL. TP
		0.30	J				0.30	78.75		Stiff orange red brown silty CLAY with occasional fine to medium gravel (siltstone and sandstone) (GLACIAL TILL) GTA-CL
		0.50 - 0.95	U							
		1.00	J				1.00	78.05		Very stiff red brown slightly mottled grey green fissured silty CLAY with many mudstone lithorelicts and zones of highly weathered mudstone and siltstone. (KEUPER MARL : ZONE III) MM-Z4
		1.45	J							
		1.70	B							
		1.80	J							
		2.00 - 2.45	U							
		2.50	J							
		2.95	J							
		3.20	J							
		3.50 - 3.95	U							
		4.00	B				4.00	75.05		Very stiff red brown mottled grey green silty CLAY with many mudstone lithorelicts (highly weathered mudstone) and bands of weak and very weak mudstone and siltstone. (KEUPER MARL : ZONE II/III) MM-Z4
		4.05	J							
		4.50	J							
		4.70	J							
		5.00 - 5.40	U							
		5.40	J							
		5.85	J							
		6.20	J							
		7.00	J				7.00	72.05		End of borehole at 7.00 m

Remarks

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Rotary Core Log

Borehole No. SK42SE23

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446950.00 - 324990.00	Hole Type CP
Location:		Level: 78.80	Scale 1:50
Client: Highways England		Dates: 23/08/1961 - 24/08/1961	Logged By

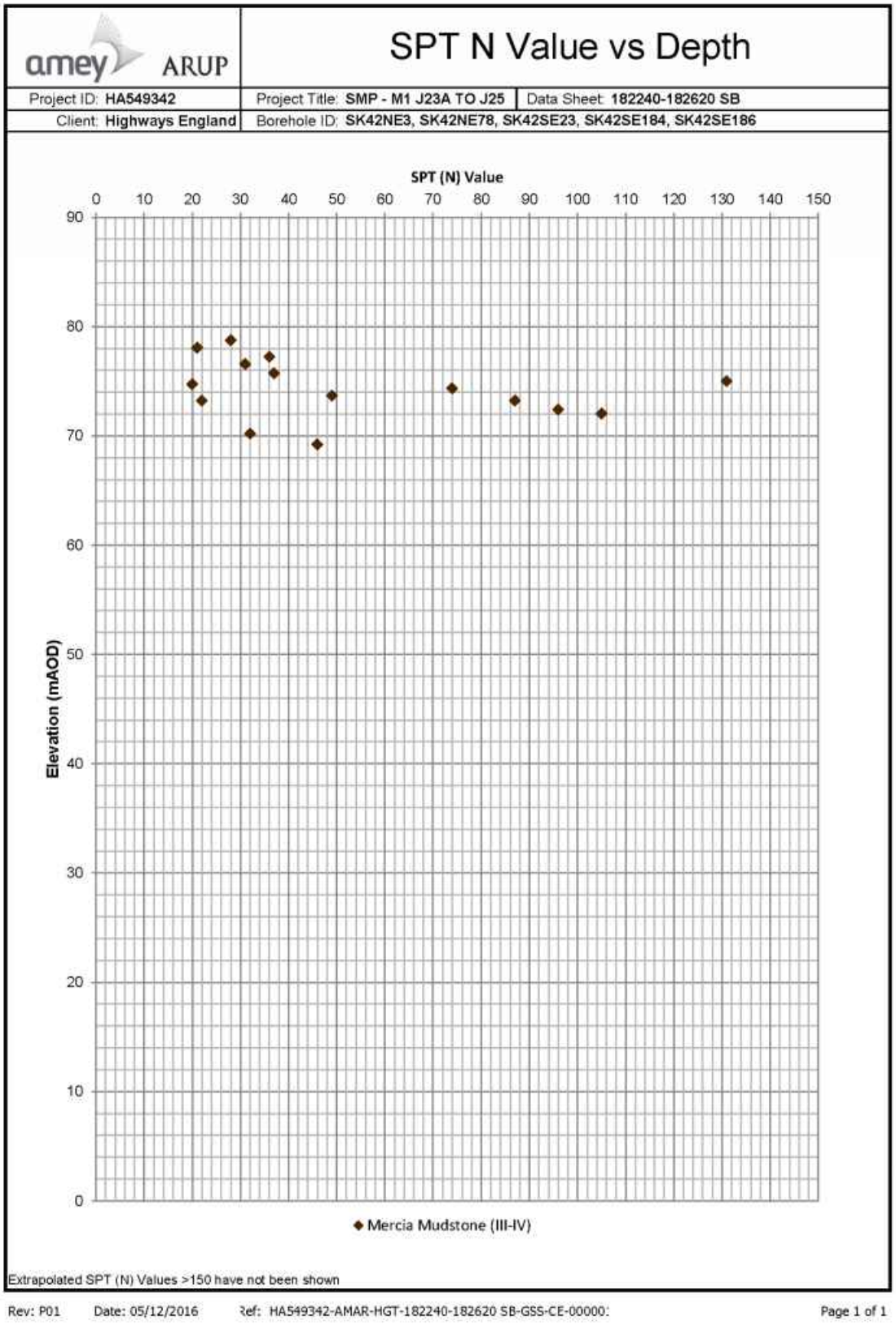
Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	D				0.30	78.50		Topsoil TP
										Stiff brown silty clay & stones inc. chalk GTA-CL
		1.22	D							
		1.52 - 1.98	U							
							2.13	76.67		Firm red silty clay MM-Z4
		2.74	D							
		3.05 - 3.51	U							
							3.96	74.84		Wet marl MM-Z3
	▼	4.27	D							
		4.27	W							
		4.72 - 5.18	U							
							5.03	73.77		Stiff red & grey silty clay MM-Z3
		5.79	D							
		6.71 - 7.09	U							
		7.01	D							
		8.08 - 8.38	U							
		8.53	D							
							9.14	69.66		End of borehole at 9.14 m

Remarks

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PLOTS

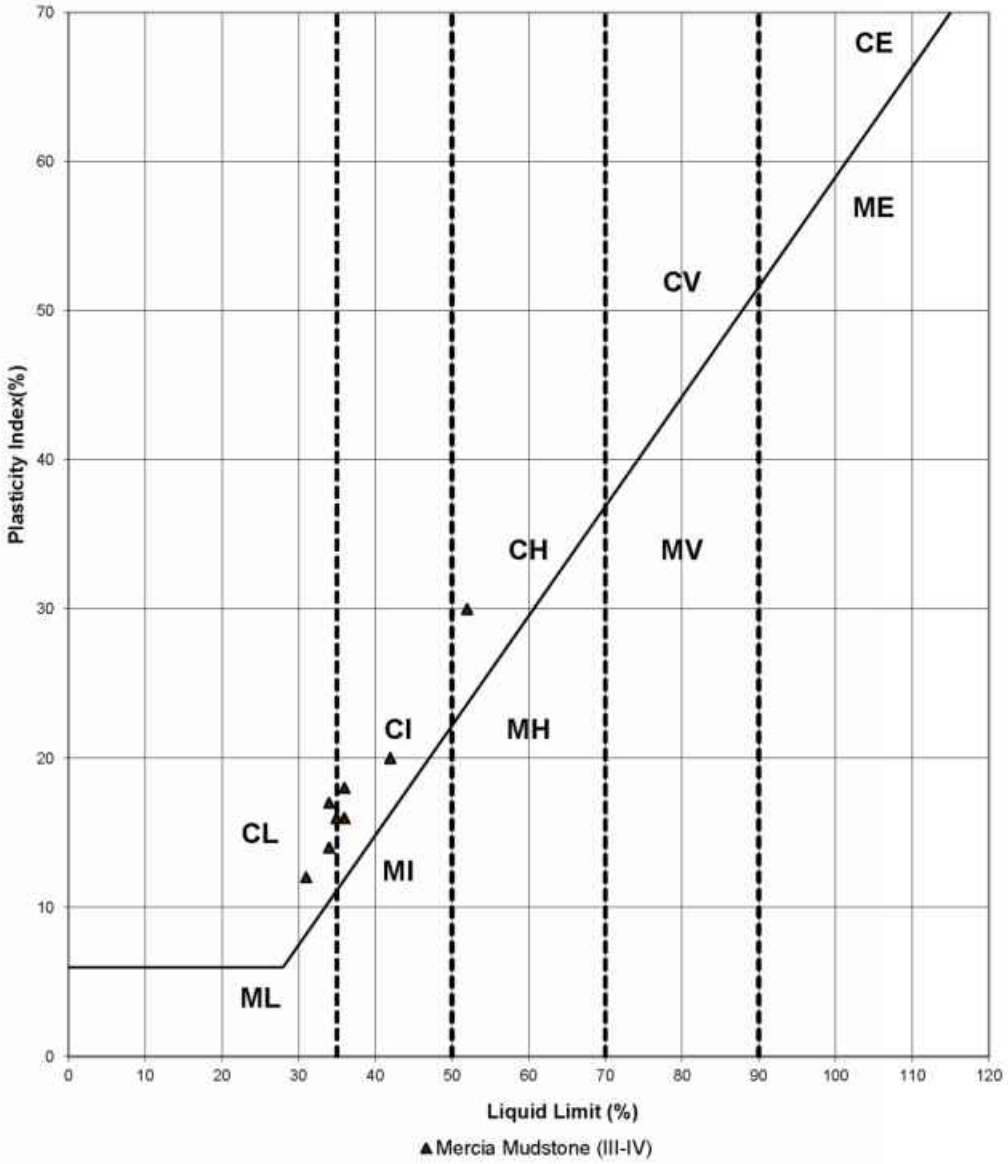


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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182240-182620 SB**
Client: **Highways England**	Borehole ID: **SK42NE3, SK42NE78, SK42SE23, SK42SE184, SK42SE186**	



Key

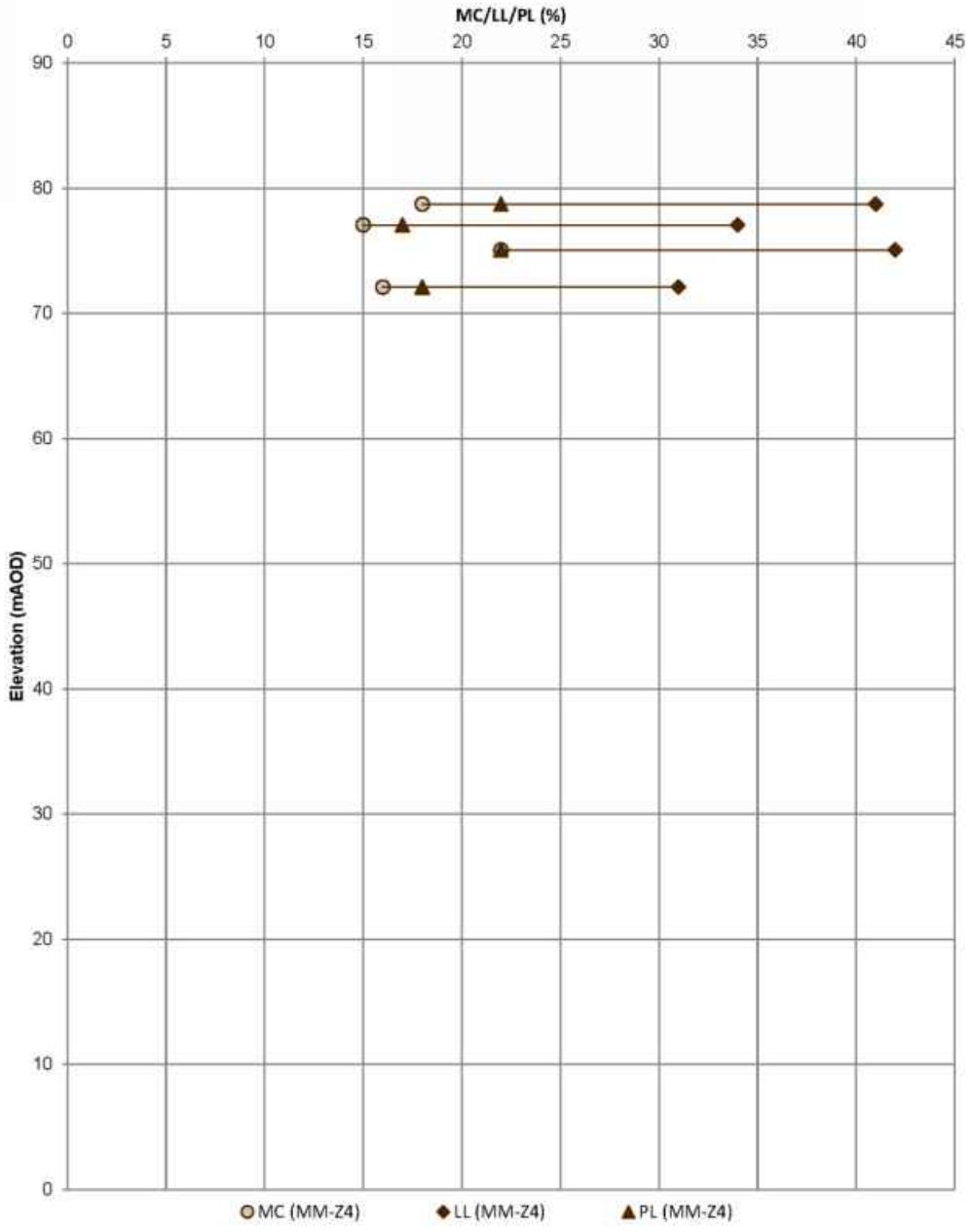
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 05/12/2016 Ref: HA549342-AMAR-HGT-182240-182620 SB-GSS-CE-00000: Page 1 of 1

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182240-182620 SB**
Client: **Highways England**	Borehole ID: **SK42NE78, SK42SE186, SK42SE23**	



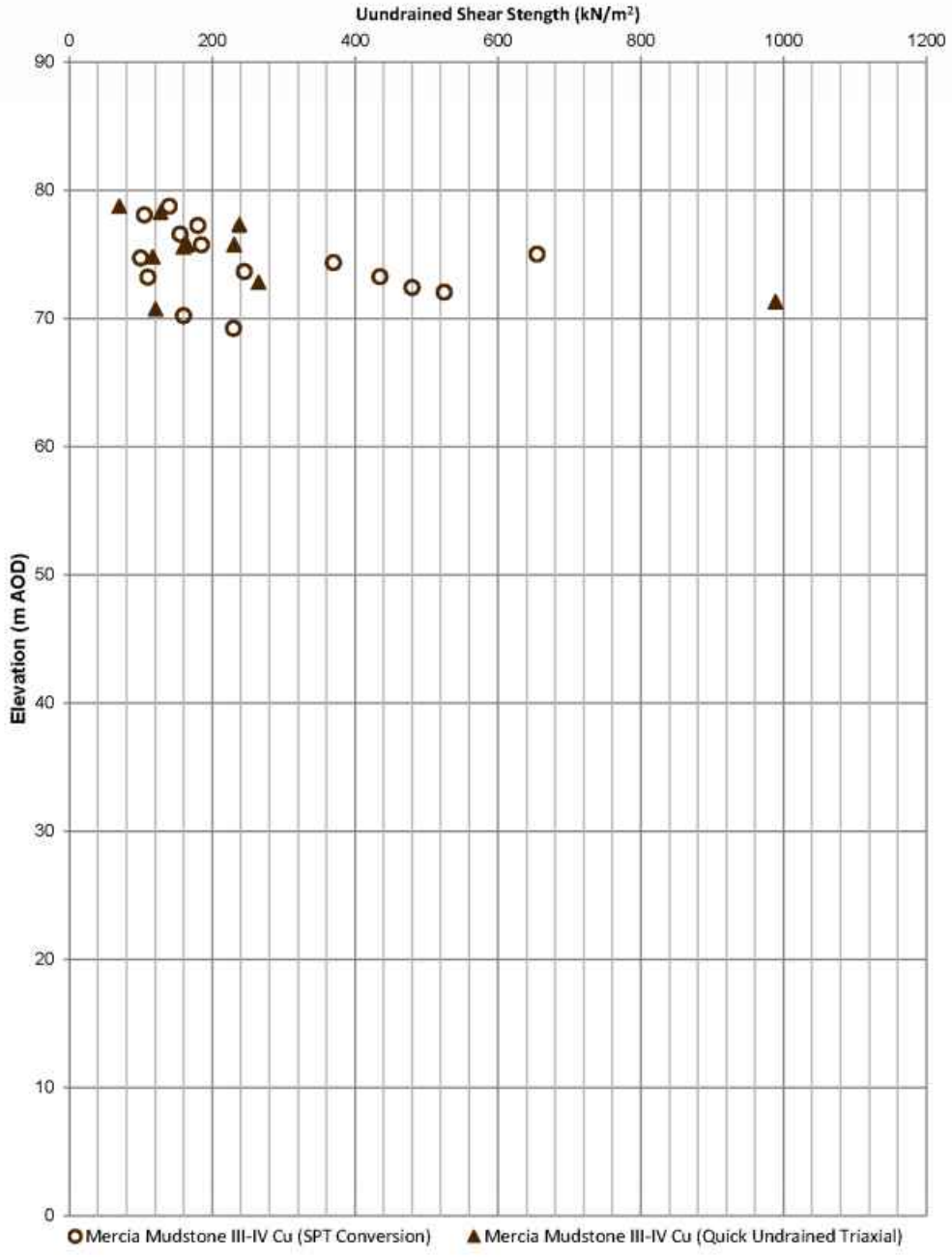
Rev: P01 Date: 05/12/2016 Ref: HA549342-AMAR-HGT-182240-182620 SB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182240-182620 SB**
Client: **Highways England**	Borehole ID: **SK42NE3, SK42NE78, SK42SE23, SK42SE184, SK42SE186**	



Rev: P01 Date: 05/12/2016 Ref: HA549342-AMAR-HGT-182240-182620 SB-GSS-CE-00000: Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-182940_183310SB-GSS-000001		
Earthworks Widening Solution	Granular Wedge at Embankment Crest		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	182940-183310		
Carriageway	Southbound		
Marker Post	MP182/9B+40 – MP183/3B+10		
National Grid Reference	E 447089, N 325378 – E 447196, N 325730		
Existing Ground Level at Location	Carriageway	76.87mAOD	
	Toe of embankment	69.87mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_42062	HAGDMS designation
Earthwork Height	NB: N/A	SB: 7.00	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 25°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Simon Arinze	03/02/2017	[redacted]
Checked	Alice Bazen	15/02/2017	
Reviewed	Gary Summerfield	16/02/2017	
Approved	Tom Bulteel	03/03/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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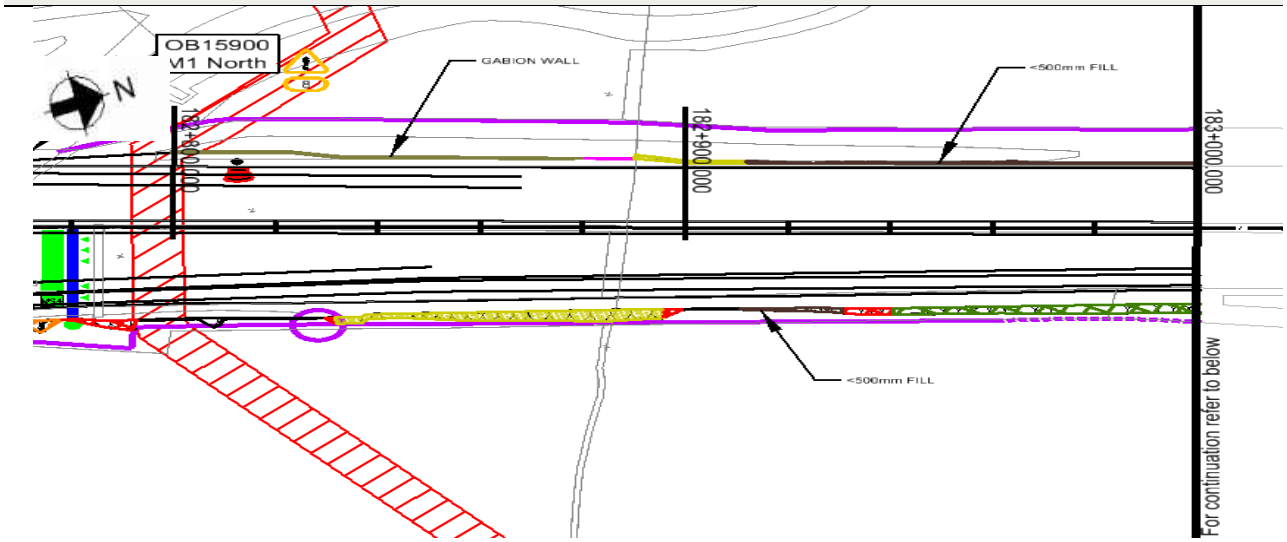


Figure 1.1: Location Plan – 182940-183000

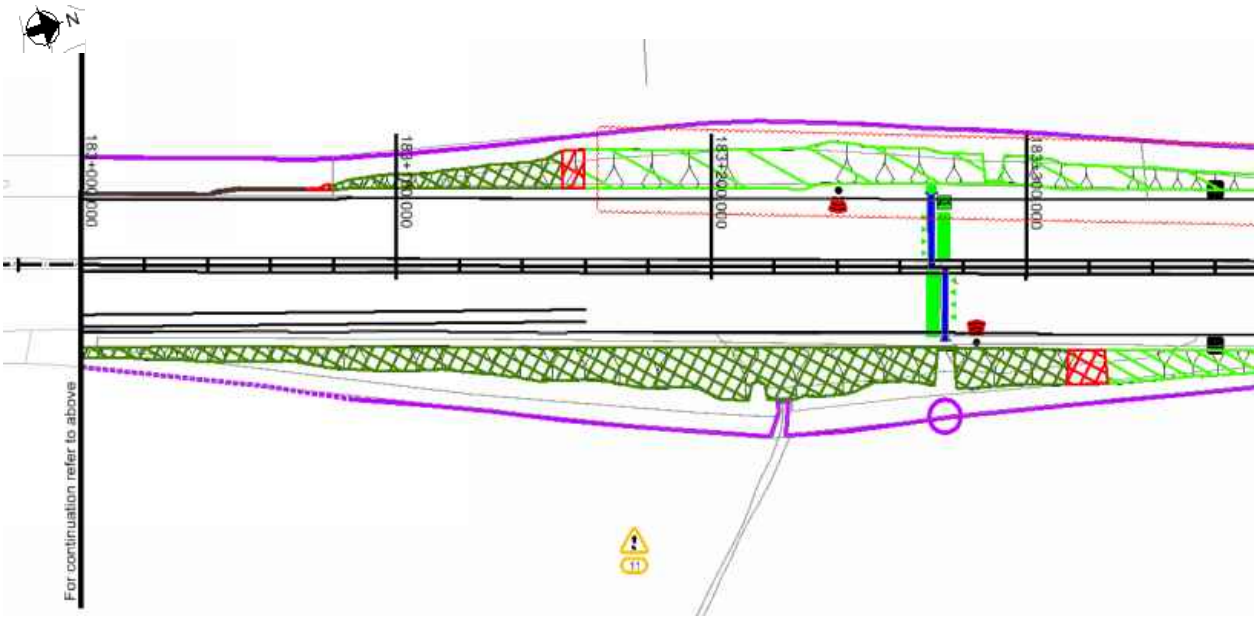


Figure 1.2: Location Plan – 183000-183310

Proposed Earthworks Widening:

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To accommodate earthworks widening for this location, the following solutions have been proposed:

- Granular Wedge at Embankment Crest (1:2.0)

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment with heights ranging between 1.0m and 7.0m with a typical slope angle of 25 degrees.

The critical cross section at chainage 183240 is based on the section with the greatest earthwork height.



Figure 2: Topographic Critical Cross Section Chainage 183240

Utilities:

There are no known utilities in close proximity to the widening location.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: None recorded

Solid Deposits: Gunthorp Member (Mercia Mudstone Group), Mudstone

Ground Investigation:

There are 6 No. historical exploratory holes recorded within the design chainage, with additional 4 no. relevant exploratory holes considered as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000021-22, Rev P01.

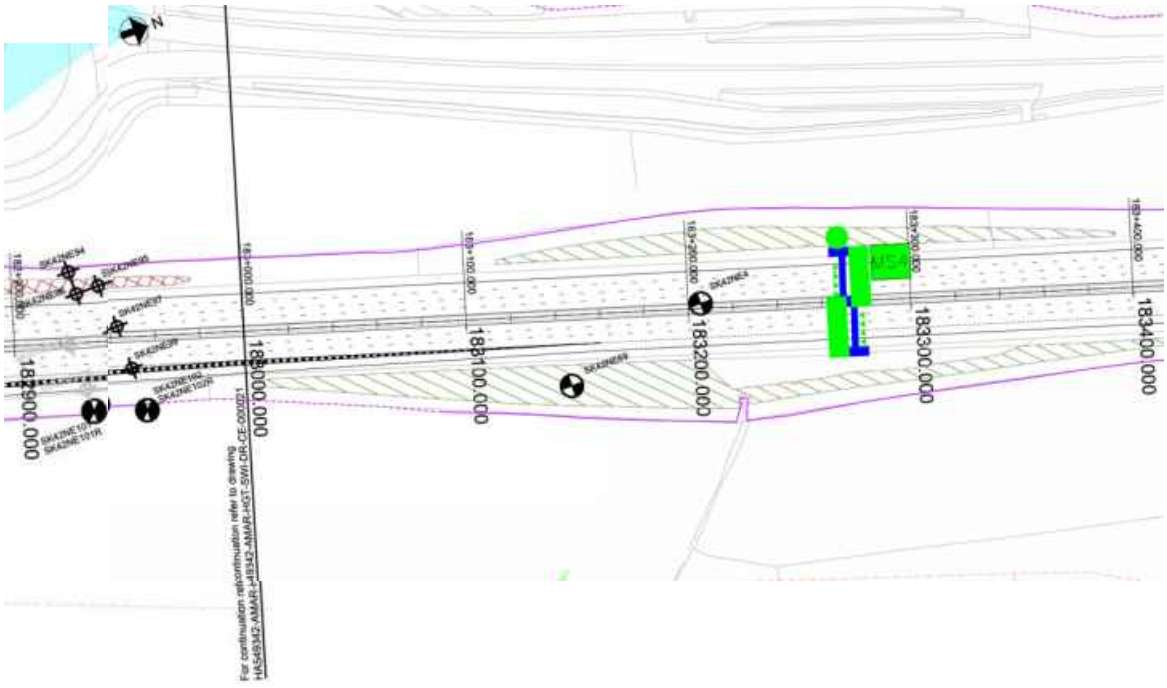


Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relavent Borehole Number	SK42NE69
Borehole Chainage	183146
Borehole Location	Southbound
National Grid Reference	E 447155, N 325573
Ground Level at Exploratory Hole	79.21mAOD
RAG Analysis	Green
Date Drilled	25/01/1988
Termination Depth	7.45 metres below ground level (mbgl)
Other suitable holes	SK42NE101, SK42NE101R, SK42NE102, SK42NE102R, SK42NE4, SK42NE94, SK42NE95, SK42NE97 &

	SK42NE99

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR Survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Made Ground – Embankment Fill	4.76	72.11	17-29 (17)
Mercia Mudstone – III/IV	>4.76	<72.11	20-150 (20)

(1) Ground level is assumed to be at the carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Mercia Mudstone-I/II was encountered in the borehole logs, however given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes SK42NE101, SK42NE102, SK42NE69, SK42NE94, SK42NE95, SK42NE97 & SK42NE99.

Groundwater:

No groundwater data is available for any of the boreholes mentioned above.

Groundwater Design Level:

No local groundwater level is available and therefore a design groundwater level of 1.0m below toe of embankment has been assumed.

GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

14 No Atterberg Limit Tests and 30 No Natural Moisture Content tests were undertaken within the Mercia Mudstone – III/IV within SK42NE3, SK42NE78, SK42SE23, SK42SE184 & SK42SE186 with the following results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Mercia Mudstone - Siltstone	6.10	-	30.00	16.00	14.00	CL
Mercia Mudstone - Siltstone	4.57	13.00	33.00	18.00	15.00	CL
Mercia Mudstone – I/II	1.52	-	37.00	18.00	19.00	CI
Mercia Mudstone – I/II	4.00	23.00	39.00	20.00	19.00	CI
Mercia Mudstone – III/IV	4.00	13.00	30.00	17.00	13.00	CL
Mercia Mudstone – III/IV	2.00	14.00	31.00	19.00	12.00	CL
Mercia Mudstone – III/IV	2.70	19.00	32.00	17.00	15.00	CL
Mercia Mudstone – III/IV	3.00	15.00	31.00	18.00	13.00	CL
Mercia Mudstone – III/IV	0.50	13.00	40.00	20.00	20.00	CI
Mercia Mudstone – III/IV	1.50	16.00	39.00	22.00	17.00	CI
Mercia Mudstone – III/IV	0.50	19.00	49.00	23.00	26.00	CI
Mercia Mudstone – III/IV	2.95	13.00	33.00	19.00	14.00	CL
Mercia Mudstone – III/IV	2.00	14.00	30.00	17.00	13.00	CL

Lab Test Data - Chemical:

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The table below presents chemical testing undertaken within the exploratory boreholes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Mercia Mudstone - III/IV	Water Soluble Sulphate as SO4	Water	4	0.05-0.08	g/l SO4

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that the Embankment, at this location, comprises cohesive fill. The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Made Ground – Embankment Fill	0.00 – 8.87	76.87 - 68.00	8.87	21	27	0	102	7.8	6.20	-	0.5	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV	>8.87	<68.00	5.89	21	30	2	100	7.80	6.24	-	0.5	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2017) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical borehole SK42NE69.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) A SPT N value of 17 has been used for the Made Ground Embankment Fill, combined with an f1 value of 6.Due to no local GI data present for the Embankment Fill, geotechnical parameters have been based on the values derived in the AMAR GIR.
(5) A SPT N value of 20 has been used for the Mercia Mudstone III/IV, combined with an f1 value of 5.
(6) Eu for Mercia Mudstone – III/IV can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 20 gives Eu = 7.8MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 6.24MN/m^2.
(7) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Embankment Fill and Mercia Mudstone-III/IV, the classification used for the strata in the AMAR GIR was adopted.

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Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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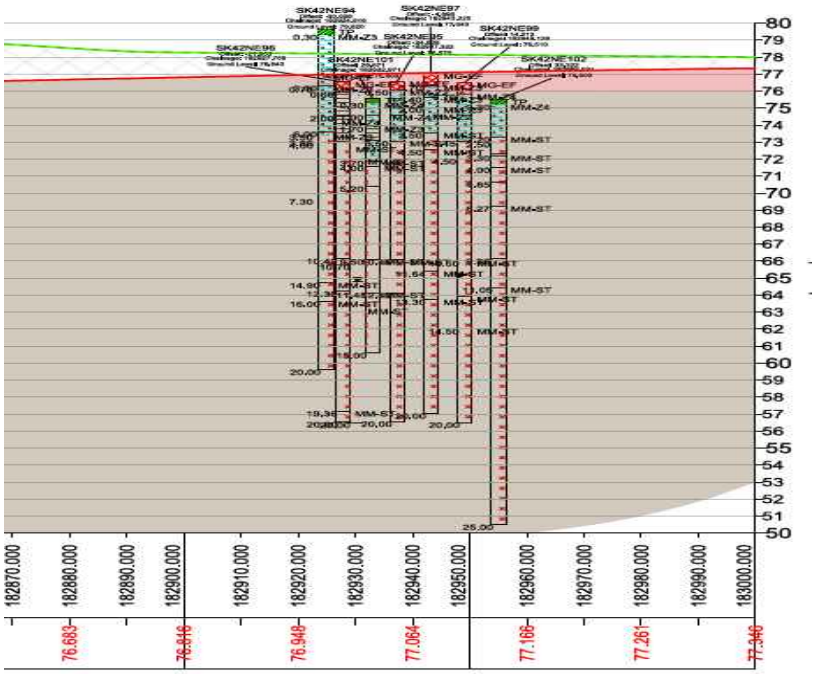


Figure 4.1: Geological Long Section -182940-183000

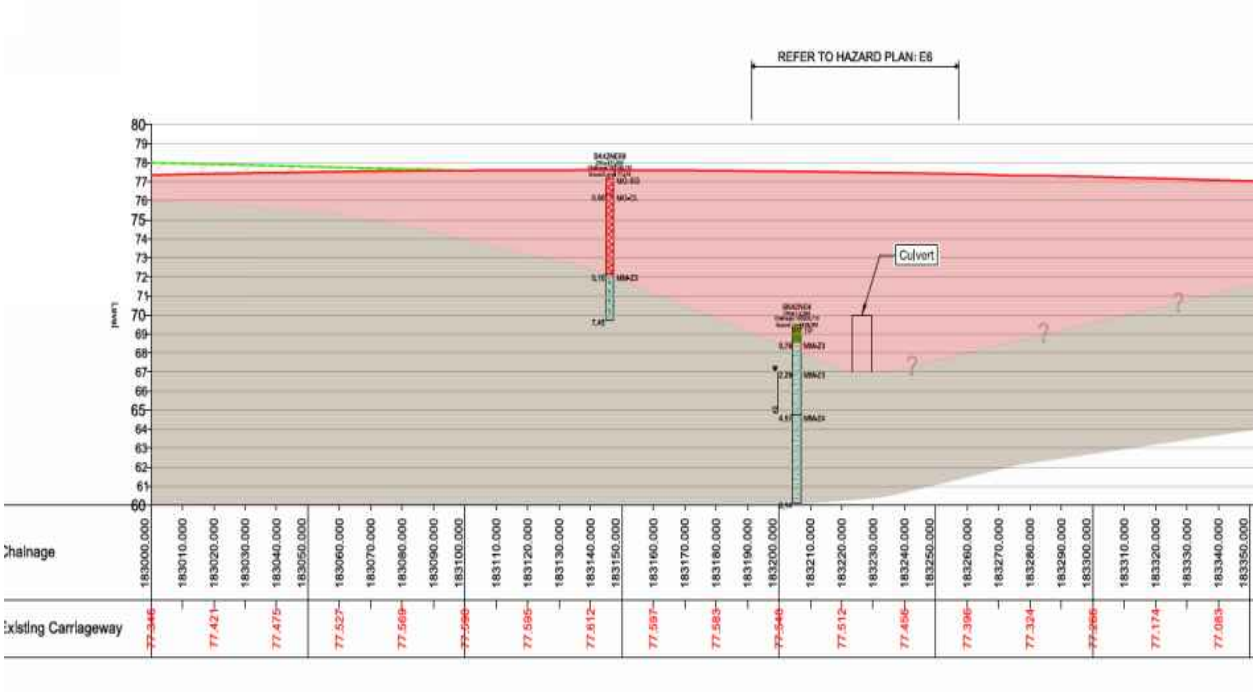


Figure 4.1: Geological Long Section -183000-183310

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
182940	183310	Granular Wedge at Embankment Crest (1:2.0)	7.3	26.6 (1V:2H)

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- T-CCD-8A & 8B , Ch183296, Northbound & Southbound - CPT at a scheduled depth of 5.0bmgl;

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HISTORICAL EXPLORATORY HOLES

Rotary Core Log

Borehole No. SK42NE101 Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447090.00 - 325370.00	Hole Type CP
Location:		Level: 75.60	Scale 1:50
Client: Highways England		Dates: 01/10/1984 - 01/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	J				0.30	75.30		Turf onto TOPSOIL TP
		0.50 - 0.95	U							Very stiff red brown mottled grey green fissured silty CLAY with many mudstone/siltstone lithorelicts and occasional thin bands of highly weathered very weak to weak siltstone. (KEUPER MARL : ZONE III) MM-Z4
		1.00	J				1.00	74.60		
		1.00 - 1.50	B							Stiff red brown and grey green fissured silty to very silty CLAY with some siltstone lithorelicts and occasional thin bands of highly weathered very weak siltstone. (KEUPER MARL : ZONE III) MM-Z4
		1.45	J							
		1.70	J				1.70	73.90		
		2.00 - 2.45	U							Highly weathered fissured red brown very weak MUDSTONE/SILTSTONE with residual silty clay. (KEUPER MARL : ZONE III) MM-Z3
		2.50	J				2.50	73.10		
		2.95	J							Very stiff red brown fissured silty CLAY with many siltstone lithorelicts. (KEUPER MARL : ZONE II/III) Some thin bands of highly weathered fissured grey green very weak siltstone. MM-Z2
		3.20	J							
		3.70	J				3.70	71.90		
		4.45	J							Moderately weathered fissured red brown and grey green weak calcareous SILTSTONE. (KEUPER MARL : ZONE II) Becoming just red brown below 4.90m. MM-ST
		4.50	B							
		4.60	J							
		5.20	J				5.20	70.40		End of borehole at 5.20 m

Remarks

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Rotary Core Log

Borehole No. SK42NE101R

Sheet 1 of 2

Project Name:	SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447090.00 - 325370.00
Location:			Level: 75.60
Client:	Highways England		Dates: 04/10/1984 - 04/10/1984

Hole Type: RC

Scale: 1:50

Logged By:

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Open hole adjacent to previously drilled percussion hole OH-OH
		4.00 - 4.70		100		20	4.00	71.60		Slightly occasionally moderately weathered laminated to thinly bedded red brown occasionally green grey fine grained very weak occasionally weak SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		4.70 - 7.00		98		34				
		7.00 - 8.20		100		9				
		8.20 - 9.80		98		26				
							9.50	66.10		Slightly weathered thinly bedded green grey occasionally red brown fine grained weak and moderately weak SILTSTONE. (KEUPER MARL

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE101R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447090.00 - 325370.00	Hole Type RC
Location:		Level: 75.60	Scale 1:50
Client: Highways England		Dates: 04/10/1984 - 04/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										: ZONE I) MM-ST
		9.80 - 12.50		98		50	11.45	64.15		Slightly to moderately weathered laminated to very thinly bedded red brown occasionally green grey fine grained very weak clayey SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		12.50 - 13.80		97		50				
		13.80 - 15.00		67		19				
							15.00	60.60		End of borehole at 15.00 m

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Rotary Core Log

Borehole No. SK42NE102

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447100.00 - 325390.00	Hole Type CP
Location:		Level: 75.50	Scale 1:50
Client: Highways England		Dates: 28/09/1984 - 28/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	J				0.30	75.20		Turf onto TOPSOIL. TP
		0.50 - 0.95	U							Very stiff and stiff red brown fissured silty to very stiff CLAY with many siltstone lithorelicts. (KEUPER MARL : ZONE III) Some thin bands of highly weathered weak to moderately weak siltstone below 0.30m. Becoming mottled grey green below 1.70m. MM-Z4
		1.00	J							
		1.00 - 1.50	B							
		1.45	J							
		1.70	J							
		2.20	J				2.20	73.30		
							2.50	73.00		Moderately weathered fissured grey green weak to moderately weak calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		2.95	J							Very stiff red brown fissured silty CLAY with many mudstone/siltstone lithorelicts and occasional thin bands of highly weathered very weak mudstone/siltstone. (KEUPER MARL : ZONE II/III) MM-ST
		3.20	J				3.20	72.30		
		3.50 - 4.00	B				3.30	72.20		
		3.95	J							Moderately weathered fissured grey green weak to moderately weak calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		4.00	B							
		4.30	J							
		4.85	J				4.85	70.65		Very stiff red brown mottled grey green silty to very silty CLAY with some thin bands of highly weathered weak calcareous siltstone. (KEUPER MARL : ZONE III) MM-ST
										End of borehole at 4.85 m
		6.27 - 6.56	C							
		6.27 - 6.56	C							
		7.71 - 7.81	C							
		7.71 - 7.81	C							
		7.81 - 7.91	C							
		7.81 - 7.91	C							
		8.50 - 8.60	C							
		8.50 - 8.60	C							
		8.60 - 8.71	C							
		8.60 - 8.71	C							

Remarks

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Rotary Core Log

Borehole No. SK42NE102R

Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447100.00 - 325390.00	Hole Type RC
Location:		Level: 75.50	Scale 1:50
Client: Highways England		Dates: 03/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Rotary Open Holed through overburden alongside Shell and Auger Hole previously drilled to 4.00 OH-OH
		4.00 - 5.50		100		44	4.00	71.50		Highly weathered very fissured red brown very weak calcareous SILTSTONE. Very to extremely closely spaced, rough discontinuities. (KEUPER MARL : ZONE III) MM-ST slightly weathered moderately weak band
		5.50 - 8.50		99		33	6.27	69.23		Slightly weathered fissured red brown very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST subvertical discontinuities slightly weathered grey green moderately weak band subvertical discontinuities 45 deg discontinuities
		8.50 - 10.50		97		39	9.36	66.14		subvertical discontinuities 45 deg discontinuities 45 deg discontinuities Slightly weathered grey green moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
										Continued on next sheet

Remarks

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447100.00 - 325390.00	Borehole No. SK42NE102R Sheet 2 of 3
Location:		Level: 75.50	Hole Type RC Scale 1:50
Client: Highways England		Dates: 03/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
	▼									very weak band
		10.50 - 12.50		95		50	11.05	64.45		Moderately to slightly weathered fissured red brown occasionally grey green very weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal smooth discontinuities. (KEUPER MARL : ZONE II/III) MM-ST slightly weathered grey green moderately strong band slightly weathered grey green moderately strong band highly weathered zone degraded to stiff silty clay with many lithorelicts
		12.50 - 15.20		100		74				highly weathered zone degraded to stiff silty clay with many lithorelicts highly weathered zone degraded to stiff silty clay with many lithorelicts
		15.20 - 17.00		94		41				slightly weathered grey green moderately strong band slightly weathered grey green moderately strong band
		17.00 - 18.30		100		66				slightly weathered grey green moderately strong band highly weathered zone degraded to stiff silty clay with many lithorelicts
		18.30 - 19.80		96		23				slightly weathered grey green moderately strong band
										Continued on next sheet

Remarks

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447100.00 - 325390.00	Borehole No. SK42NE102R Sheet 3 of 3
Location:		Level: 75.50	Hole Type RC
Client: Highways England		Dates: 03/10/1984 - 03/10/1984	Scale 1:50 Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		19.80 - 22.00		98		30				highly weathered zone degraded to stiff silty clay with many lithorelicts
		22.00 - 24.50		97		30				highly weathered zone degraded to stiff silty clay with many lithorelicts
		24.50 - 25.00		88		0				
							25.00	50.50		End of borehole at 25.00 m

21 22 23 24 25 26 27 28 29 30

Remarks

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Rotary Core Log

Borehole No. SK42NE4
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447140.00 - 325640.00	Hole Type CP
Location:		Level: 69.30	Scale 1:50
Client: Highways England		Dates: 24/08/1961 - 28/08/1961	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Topsoil TP
		0.76	D				0.76	68.54		Firm brown clay & stones MM-Z3
		1.52 - 1.98	U							
		1.98	D							
	▼	2.29	D				2.29	67.01		Stiff red & grey silty clay MM-Z3
		3.05	D							
		3.05 - 3.51	U							
		3.81	D							
	▽	4.42	W							
		4.57	D				4.57	64.73		Stiff red & grey silty clay & siltstone MM-Z4
		4.57 - 5.03	U							
		5.03	D							
		5.33	D							
		6.10 - 6.55	U							
		6.55	D							
		6.86	D							
		7.62 - 8.00	U							
		8.08	D							
		8.38	D							
		8.69 - 9.14	U							
		9.14	D				9.14	60.16		End of borehole at 9.14 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE69**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447155.00 - 325573.00	Hole Type CP
Location:		Level: 77.21	Scale 1:50
Client: Highways England		Dates: 25/01/1988 - 25/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 0.60	B							Angular medium to coarse sandstone GRAVEL with some cobbles and a little to some clayey sand. (FILL) MG-SG
		0.85 - 1.30	U				0.90	76.31		
		1.50 - 1.95	D							Very stiff locally stiff red brown silty CLAY with occasional mudstone and siltstone lithorelics and occasional pockets and lenses of light green grey silt and siltstone. Below 3.10m with occasional decayed rootlets and rare wood fragments. Below about 4.20m becoming very stiff (hard) dark brown to brown locally very silty locally with rounded fine to medium gravel and frequent decayed rootlets. (FILL) MG-CL
		2.50 - 2.95	U							
		3.10	D							
		3.10 - 3.55	D							
		4.00 - 4.45	U							
		4.60	D							
		4.60 - 5.05	D							
							5.10	72.11		Very stiff (hard) red brown slightly silty CLAY with frequent fine to medium gravel sized mudstone lithorelics and occasional pockets and lenses of light greenish grey silt (KEUPER MARL 3/4a) Below about 6.10m with very closely spaced subhorizontal fissures occasionally stained black. MM-Z3
		5.50 - 5.95	U							
		6.10	D							
		6.10 - 6.55	D							
		7.00 - 7.45	D							
							7.45	69.76		End of borehole at 7.45 m

Remarks
Hand dug inspection pit from ground level to 0.85m

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Rotary Core Log

Borehole No. **SK42NE94** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325380.00	Hole Type CP+RC
Location:		Level: 79.62	Scale 1:50
Client: Highways England		Dates: 01/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	J				0.30	79.32		TOPSOIL TP
		0.50 - 0.95	U							Very stiff red brown silty CLAY with some mudstone/siltstone lithorelicts, becoming mottled grey/green below 1.00m. (KEUPER MARL : ZONE III) Thin band of highly weathered fissured weak calcareous siltstone with residual silty clay at 1.80m. Clay becoming stiff at 2.50m with occasional thin bands of highly weathered fissured red brown very weak calcareous siltstone with residual silty clay. MM-Z3
		1.00	J							
		1.45	J							
		1.80	J							
		2.00 - 2.45	U							
		2.50	J							
		2.95	J							
		3.30	J				3.30	76.32		Very stiff red brown fissured silty CLAY with some siltstone lithorelicts. Some thin bands of highly weathered fissured red brown and grey green weak calcareous siltstone with residual silty clay between 4.00 and 5.50m. (KEUPER MARL : ZONE III/IVa) MM-Z3
		4.00	J							
		4.45	J							
		4.80	J							
		5.50	J							
		5.75	J							
		6.00	J				6.00	73.62		Slightly weathered laminated and thinly bedded red brown fine grained very weak to weak SILTSTONE. With bands (up to 150mm) of highly weathered very weak clayey siltstone between 6.00 - 9.50m. (KEUPER MARL : ZONE II) MM-ST
		6.00 - 7.00		83		10				siltstone very fractured. Generally intact below 11.20m
		7.00 - 8.00		84		0				
		8.00 - 9.00		85		15				
		9.00 - 10.50		100		0				

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE94**

Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325380.00	Hole Type CP+RC
Location:		Level: 79.62	Scale 1:50
Client: Highways England		Dates: 01/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 - 12.00		93		19				
		12.00 - 13.50		100		37				
		13.50 - 15.00		100		41				
							14.90	64.72		Slightly weathered to fresh very thinly and thinly bedded green grey occasionally red brown fine grained weak to moderately weak SILTSTONE. (KEUPER MARL : ZONE I) MM-ST
		15.00 - 16.65		100		69				
							16.00	63.62		Slightly weathered very thinly and thinly bedded red brown occasionally green grey fine grained very weak to weak SILTSTONE. (KEUPER MARL : ZONE I/II) MM-ST
		16.65 - 17.00		94		43				highly weathered zone of very weak clayey siltstone
		17.00 - 18.50		85		62				highly weathered zone of very weak clayey siltstone
		18.50 - 20.00		99		90				
							20.00	59.62		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE95** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447040.00 - 325390.00	Hole Type CP+RC
Location:		Level: 76.57	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 11/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE BALLAST. (MADE GROUND - MOTORWAY VERGE) MG-EF
		0.50	J				0.50	76.07		Firm red brown friable very silty CLAY with thin bands of highly weathered very weak calcareous mudstone. (KEUPER MARL : ZONE III) MM-Z2
		1.00	J							
		1.50	B							
		1.50 - 1.95	U							
		2.00	J				2.00	74.57		Stiff red brown slightly mottled grey green fissured silty CLAY with many mudstone lithorelicts. Occasional pockets of sand and bands of highly weathered weak and moderately weak calcareous mudstone/siltstone. (KEUPER MARL : ZONE II/III) MM-Z2
		2.45	J							
		2.70	B							
		2.80	J							
		2.90	J							
		3.30	J							
		3.50 - 5.00		98		12	3.50	73.07		Slightly weathered fissured red brown occasionally mottled grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced, rough subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST subvertical discontinuities highly weathered zone degraded to stiff silty clay with many lithorelicts slightly weathered grey green moderately weak band
		5.00 - 6.80		84		5				slightly weathered grey green moderately weak band subvertical discontinuities
		7.60 - 7.72	C							
		7.72 - 7.82	C							
		6.80 - 9.50		100		51				subvertical discontinuities slightly weathered grey green moderately weak band subvertical discontinuities slightly weathered grey green moderately weak band
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE95
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447040.00 - 325390.00	Hole Type CP+RC
Location:		Level: 76.57	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 11/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.08 - 10.19	C							
		10.19 - 10.30	C							
		10.50 - 10.52	C				10.48	66.09		
		10.52 - 10.64	C							Slightly weathered fissured grey green moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		9.50 - 11.80		94		41				45 deg discontinuity very weak siltstone
	▼	12.05 - 12.17	C							
		12.17 - 12.29	C				12.43	64.14		
		11.80 - 13.80		100		47				Slightly weathered fissured red brown occasionally grey green very weak calcareous SILTSTONE. Very to extremely closely spaced, subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST
		13.80 - 15.00		94		32				grey green moderately weak siltstone
		15.38 - 15.50	C							grey green moderately weak siltstone
		16.14 - 16.25	C							
		16.25 - 16.37	C							
		15.00 - 17.90		96		68				subvertical discontinuities
		17.27 - 17.37	C							
		17.37 - 17.47	C							grey green moderately weak siltstone
		17.90 - 20.00		97		68				highly weathered zones
		19.50 - 19.62	C							
		19.62 - 19.72	C							grey green moderately weak siltstone
							20.00	56.57		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE97** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447060.00 - 325390.00	Hole Type CP+RC
Location:		Level: 77.04	Scale 1:50
Client: Highways England		Dates: 27/09/1984 - 28/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPINGS. (MADE GROUND - Motorway central reserve) MG-EF
		0.70	J				0.70	76.34		
		1.00	J							Firm red brown mottled grey green fissured silty CLAY with many mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE III) MM-Z3
		1.40	J				1.40	75.64		
		1.50 - 1.95	U							Firm red brown fissured silty CLAY with occasional mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE IVa) MM-Z3
		2.00	J				2.00	75.04		
		2.45	J							Stiff red brown mottled grey green fissured silty to very silty CLAY with many mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE II/III) Occasional thin bands of highly weathered very weak calcareous siltstone at 2.00m. Very stiff towards base. MM-Z3
		2.50	B							
		2.80	J							
		3.00 - 3.45	U							
		3.50	J				3.50	73.54		
		3.80	J							Highly weathered fissured red brown very weak calcareous SILTSTONE with residual silty clay. (KEUPER MARL : ZONE III) MM-ST
		4.50	J				4.50	72.54		
		4.50 - 4.50	B	98		53				Moderately to slightly weathered fissured red brown very weak calcareous SILTSTONE with occasional thin mudstone bands. Very to extremely closely spaced rough subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		5.54 - 5.90	C							45 deg discontinuity
										highly weathered zone degraded to stiff silty clay with many lithorelicts
										slightly weathered grey green moderately weak band
		6.50 - 7.90		100		18				highly weathered zone degraded to stiff silty clay with many lithorelicts
		8.59 - 8.70	C							
		8.70	C							
		7.90 - 9.95		97		46				subvertical discontinuity
										slightly weathered grey green moderately weak band
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE97**

Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447060.00 - 325390.00	Hole Type CP+RC
Location:		Level: 77.04	Scale 1:50
Client: Highways England		Dates: 27/09/1984 - 28/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.30 - 10.40	C							slightly weathered grey green moderately weak band
		10.40 - 10.50	C							
		9.95 - 12.60		95		58				
		11.40 - 11.50	C							
		11.50 - 11.64	C							
		11.64 - 11.76	C				11.64	65.40		Slightly weathered grey green moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		11.76 - 11.88	C							moderately weathered zone
										subvertical discontinuity
										moderately weathered zone
		12.60 - 13.30		95		54				
		13.08 - 13.19	C							
		13.19 - 13.30	C				13.30	63.74		Moderately to slightly weathered fissured red brown occasionally grey green very weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		13.75	B							slightly weathered grey green moderately weak band
		13.75 - 14.12	C							completely weathered zone degraded to stiff silty clay with many lithorelicts
		13.30 - 15.00		97		38				
										completely weathered zone degraded to stiff silty clay with many lithorelicts
										slightly weathered grey green moderately weak band
		15.00 - 15.70		100		25				
		16.27 - 16.38	C							
		16.38 - 16.50	C							
		15.70 - 18.10		97		58				
		18.10 - 18.20	C							slightly weathered grey green moderately weak band
		18.20 - 18.30	C							
										completely weathered zone degraded to stiff silty clay with many lithorelicts
		18.10 - 20.00		96		81				
		19.10 - 19.21	C							
		19.21 - 19.33	C							
							20.00	57.04		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE99** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447080.00 - 325390.00	Hole Type CP+RC
Location:		Level: 76.51	Scale 1:50
Client: Highways England		Dates: 17/09/1984 - 18/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPING. (MADE GROUND - MOTORWAY VERGE) MG-EF
		0.70	J				0.70	75.81		Firm red brown mottled grey green fissured very silty CLAY with many mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE II/III) Becoming stiff and very stiff with depth. Occasional thin bands of highly weathered fissured grey green weak to very weak siltstone at 1.00m and 2.00m. MM-Z4
		1.00	J							
		1.50 - 1.95	U							
		2.00	J							
		2.45	J							
		2.70	J							
		3.00 - 3.45	U							
		3.45	J				3.45	73.06		Highly weathered fissured red brown mottled grey green very weak SILTSTONE with residual silty clay. (KEUPER MARL : ZONE III) Moderately weak at 4.00m. MM-ST
		3.75	J							
		4.00	J							
		4.50	J				4.50	72.01		Slightly weathered fissured red brown very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST
		4.50 - 5.50		98		60				highly weathered zone slightly weathered grey green moderately weak band
		5.50 - 7.00		98		34				slightly weathered grey green moderately weak band
		7.00 - 8.50		94		60				subvertical discontinuity slightly weathered grey green moderately weak band
		8.50 - 11.35		99		27				slightly weathered grey green moderately weak band subvertical discontinuity

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE99
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447080.00 - 325390.00	Hole Type CP+RC
Location:		Level: 76.51	Scale 1:50
Client: Highways England		Dates: 17/09/1984 - 18/09/1984	Logged By

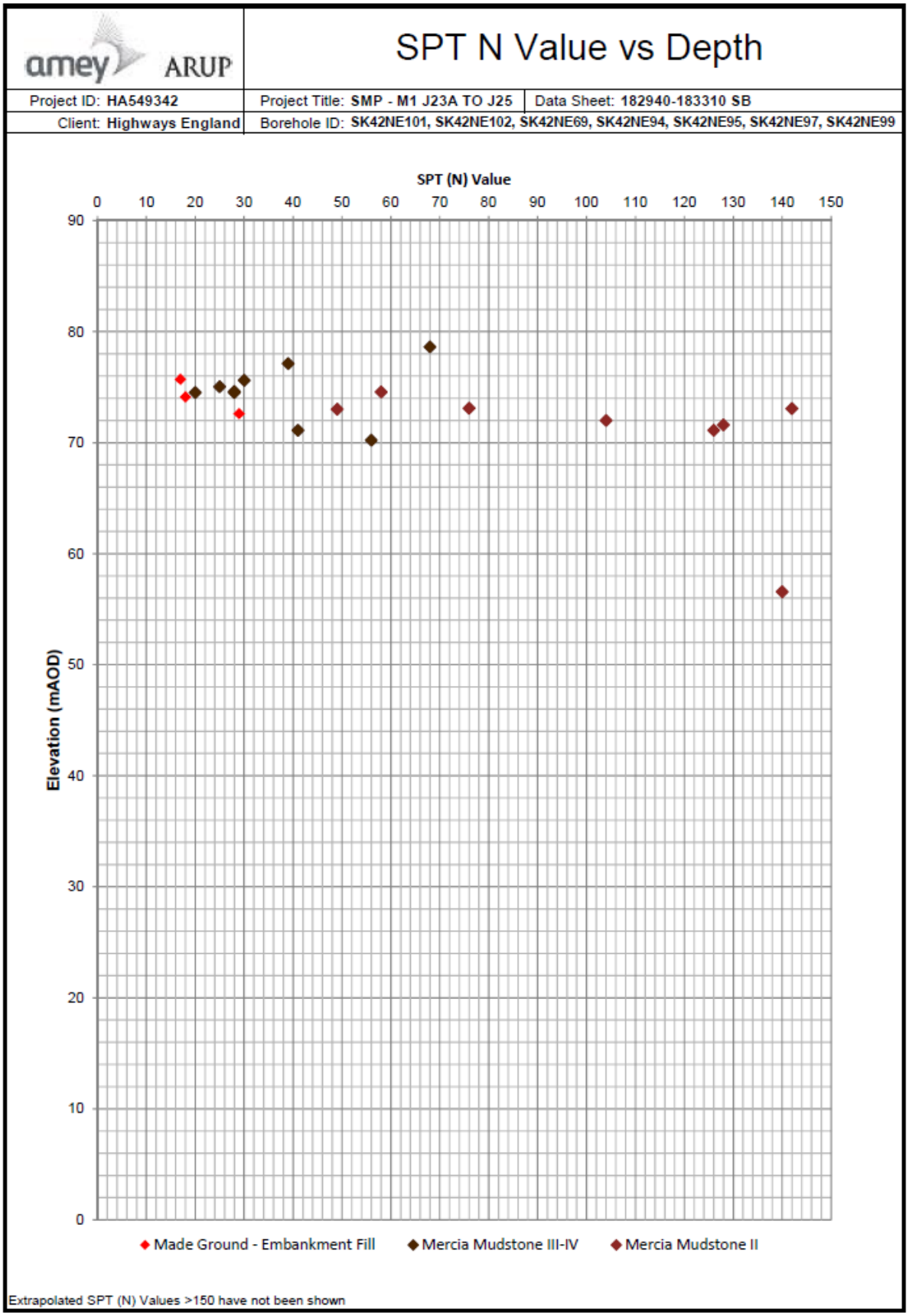
Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 10.50 - 10.74	B C				10.50	66.01		Slightly weathered grey green moderately strong calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST highly weathered very weak zone highly weathered very weak zone highly weathered very weak zone
		11.35 - 13.10		100		69	12.60	63.91		Moderately weathered fissured red brown occasionally mottled grey green very weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST
		13.10 - 14.50		97		49	14.50	62.01		Slightly weathered fissured red brown occasionally mottled grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced smooth subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST 45 deg discontinuity slightly weathered grey green moderately strong band
		14.50 - 17.50		100		62				
		17.50 - 20.00		99		66				slightly weathered grey green moderately strong band
							20.00	56.51		End of borehole at 20.00 m

Remarks

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PLOTS

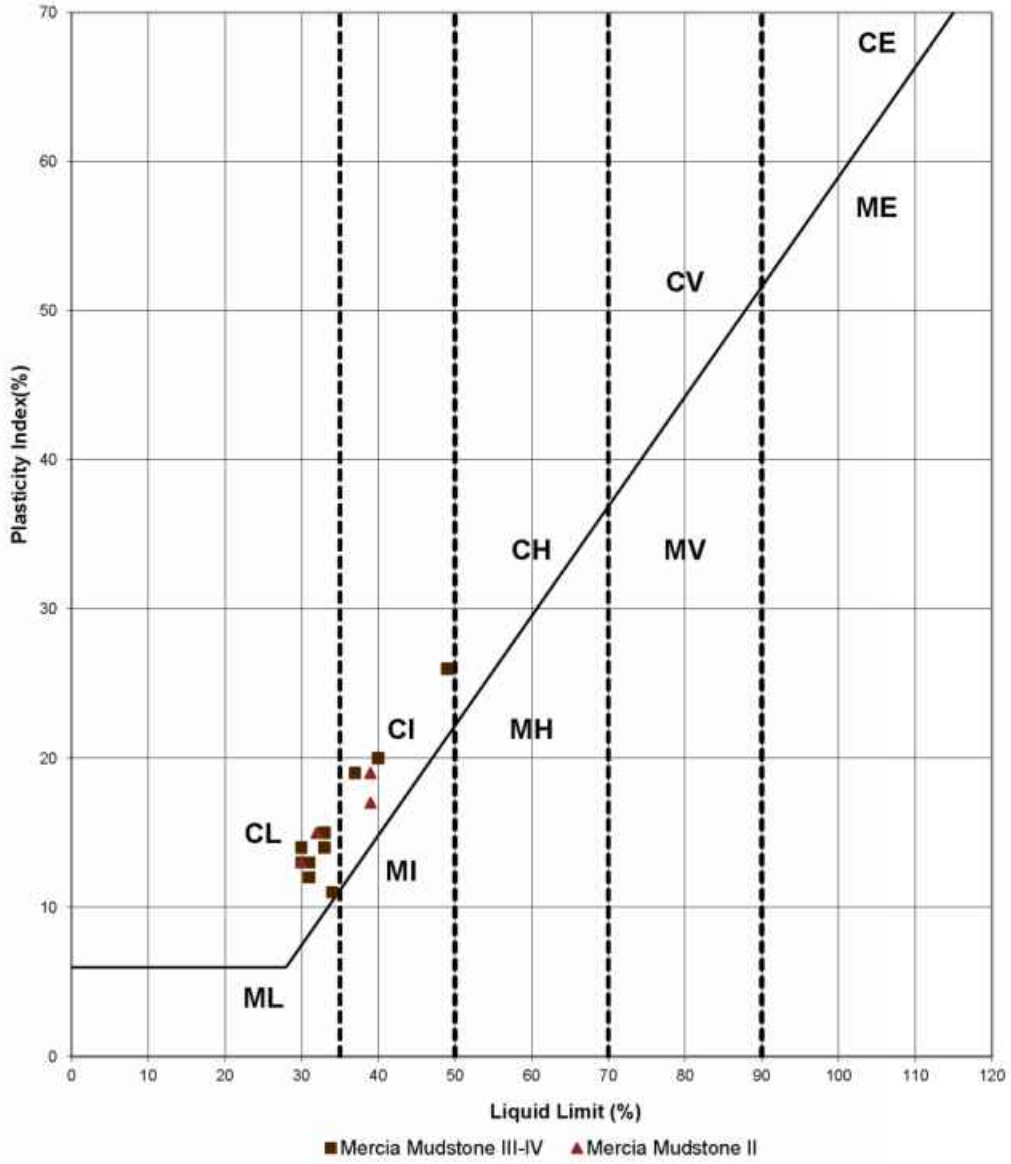


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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182940-183310 SB**
Client: **Highways England**	Borehole ID: **SK42NE101, SK42NE102, SK42NE4, SK42NE94, SK42NE95, SK42NE97, SK42NE99**	



Key

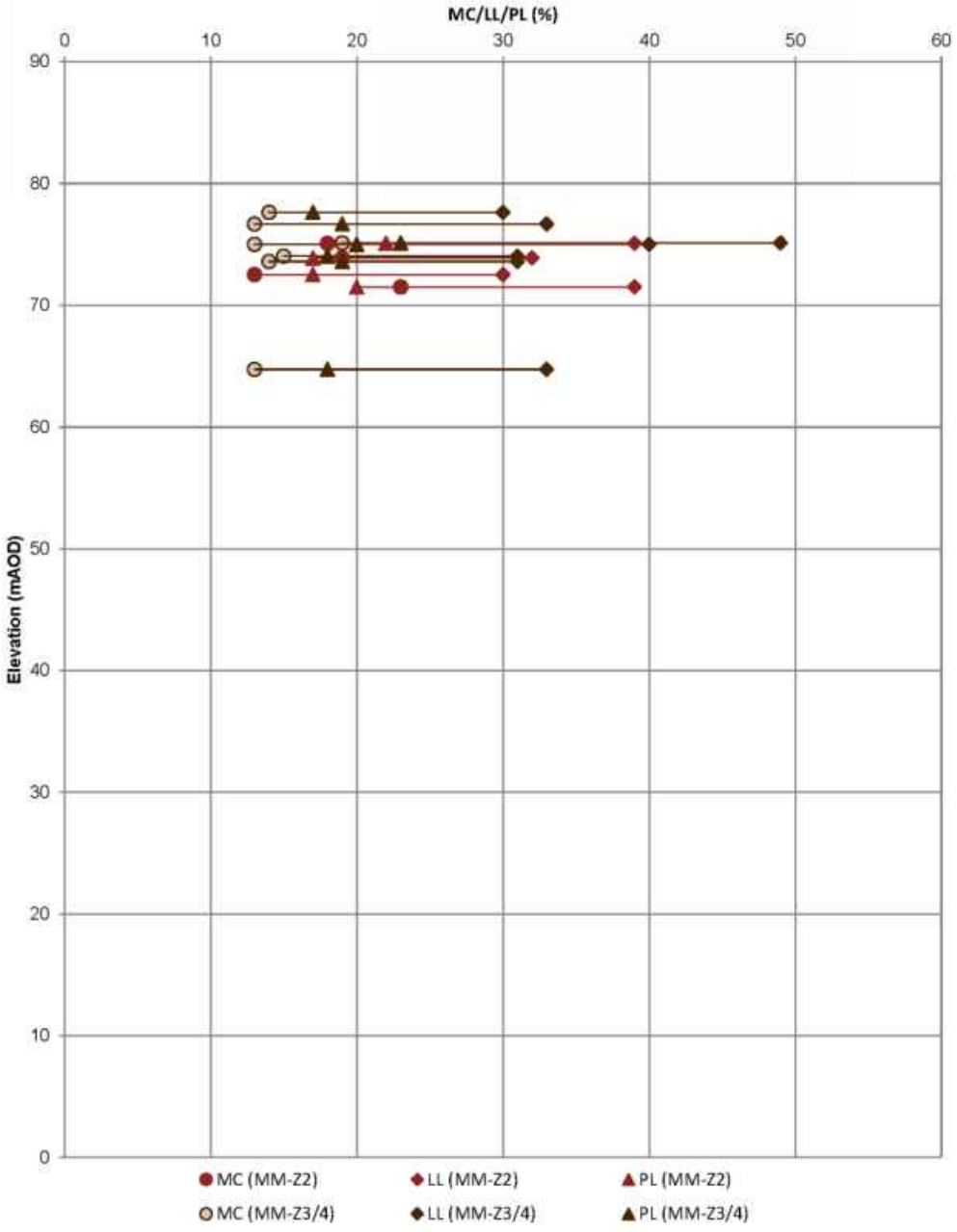
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 07/12/2016 Ref: HA549342-AMAR-HGT-182940-183310 SB-GSS-CE-00000: Page 1 of 1

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182940-183310 SB**
Client: **Highways England**	Borehole ID: SK42NE101, SK42NE102, SK42NE4, SK42NE94, SK42NE95, SK42NE97, SK42NE99	



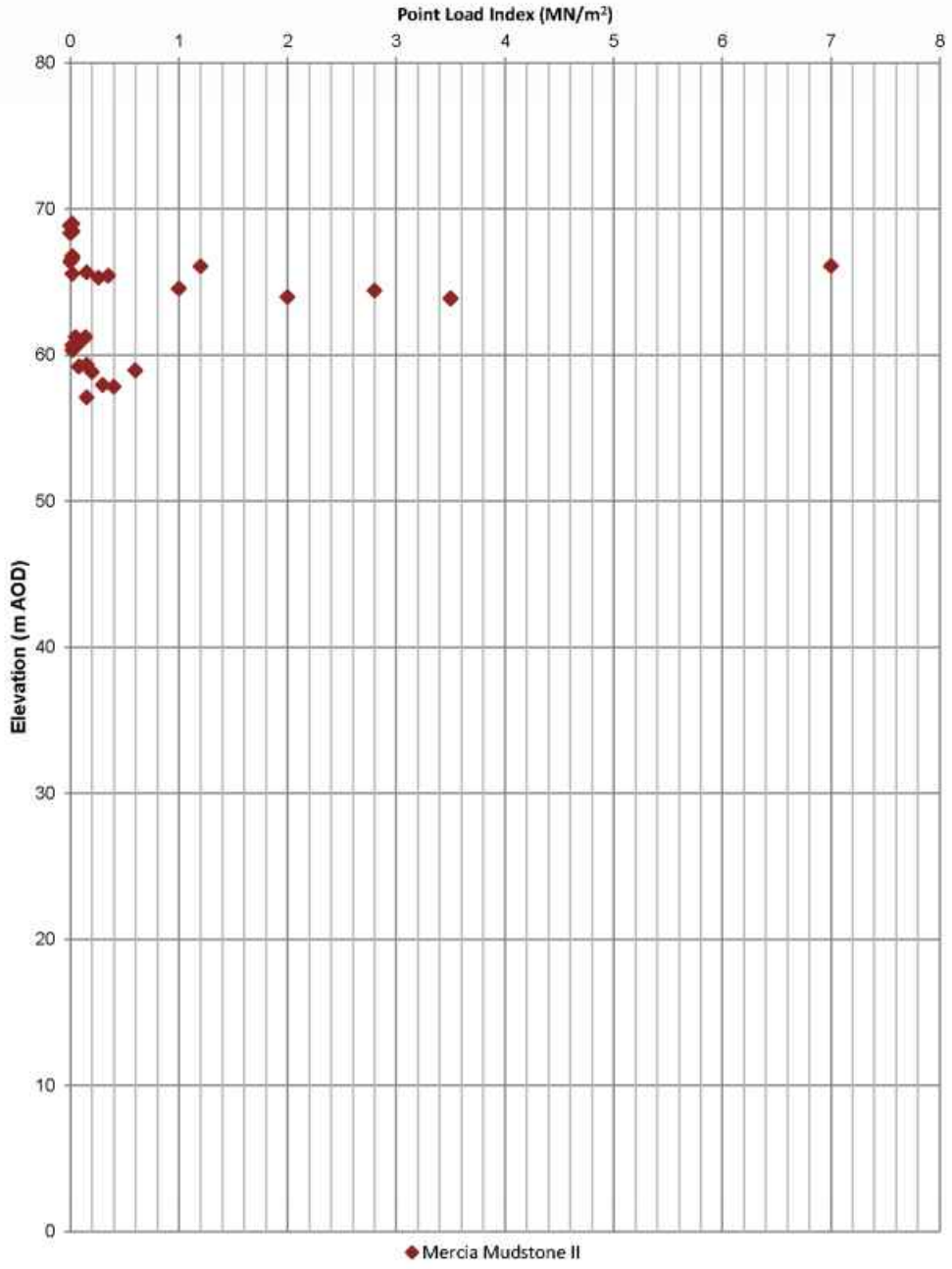
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Point Load vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182940-183310 SB**
Client: **Highways England**	Borehole ID: **SK42NE95, SK42NE97, SK42NE99**	



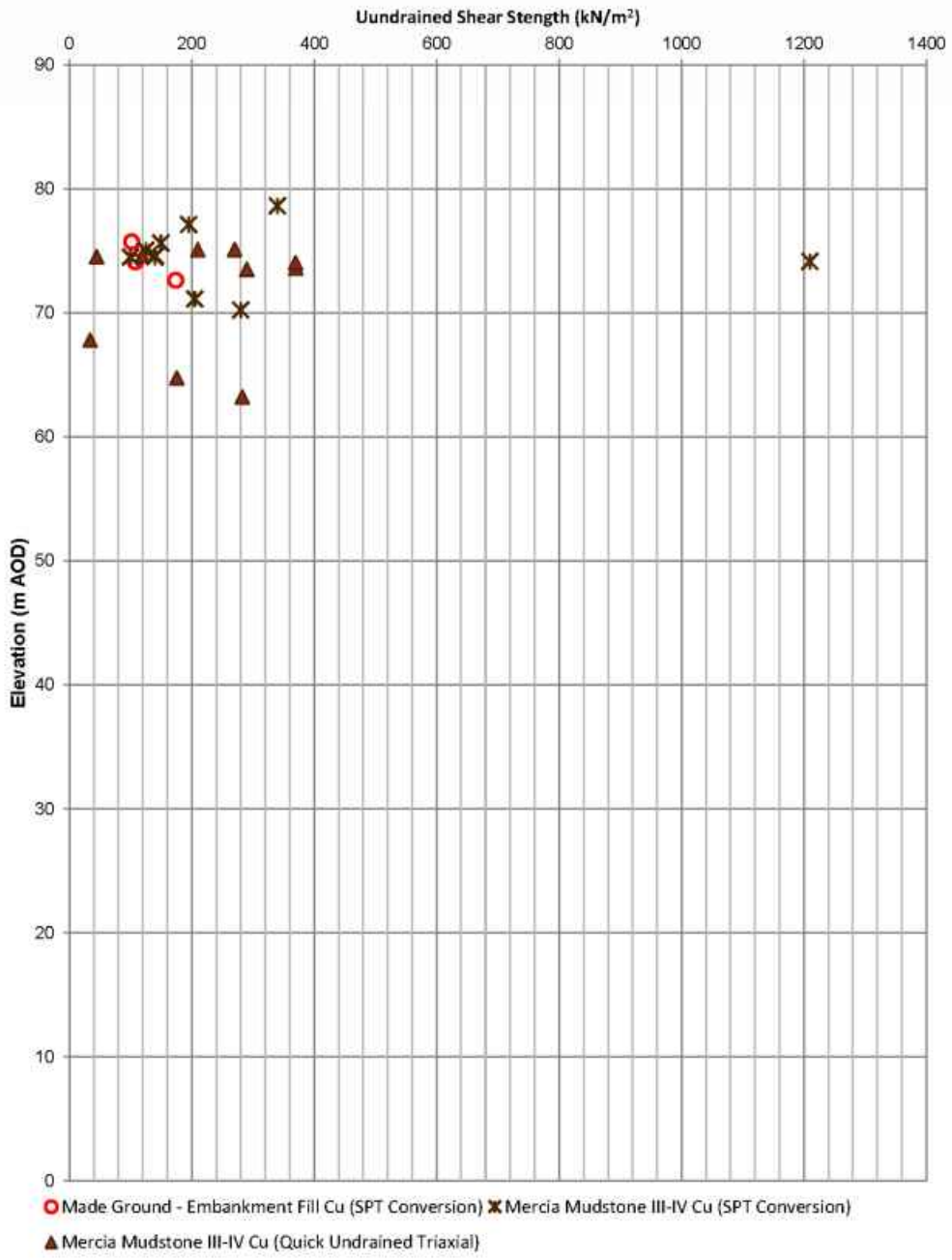
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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182940-183310 SB**
Client: **Highways England**	Borehole ID: SK42NE101, SK42NE102, SK42NE4, SK42NE69, SK42NE94, SK42NE95, SK42NE97, SK42NE99	



Rev: P01 Date: 07/12/2016 Ref: HA549342-AMAR-HGT-182940-183310 SB-GSS-CE-00000: Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-183320_183430SB-GSS-CE-000001		
Widening Solution	Full Height Embankment Widening 1:2.0		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	183320-183430		
Carriageway	Southbound		
Marker Post	MP183/3B+20 – MP183/4B+30		
National Grid Reference	E 447199, N 325741 – E 447232, N 325847		
Existing Ground Level at Location	Carriageway	77.05 mAOD	
	Toe of Embankment	72.18mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_42062	HAGDMS designation
Earthwork Height	NB: N/A	SB: 5.20m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 22°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Simon Arinze	03/02/2017	[redacted]
Checked	Alice Bazen	06/02/2017	
Reviewed	Gary Summerfield	09/02/2017	
Approved	Tom Bulteel	03/03/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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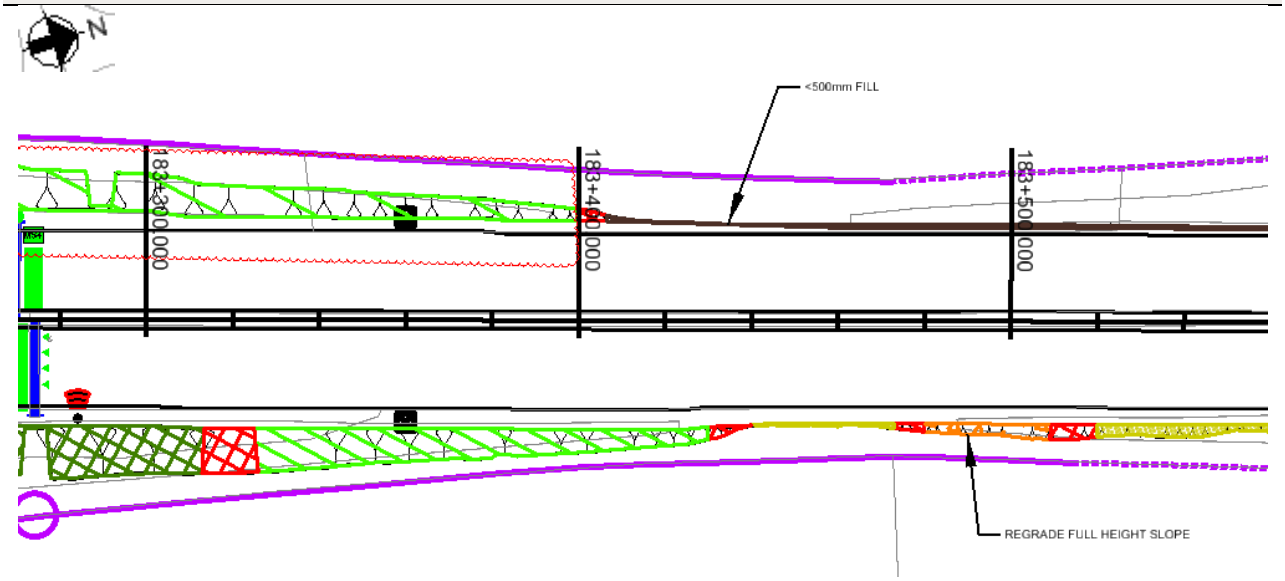


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Full Height Embankment Widening 1:2.0

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment with heights ranging between 1.6m and 5.2m with a typical slope angle of 22 degrees.

The critical cross section at Ch.183350 is based on the cross section with the greatest earthwork height



Figure 2: Topographic Critical Cross Section Chainage 183350

Utilities:

There are no known existing utilities within the vicinity of the chainage extents

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: N/A

Solid Deposits: Gunthorpe Member (Mercia Mudstone Group), Mudstone

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however 2 No. exploratory holes outside the design chainage have been considered as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000022, Rev P01.

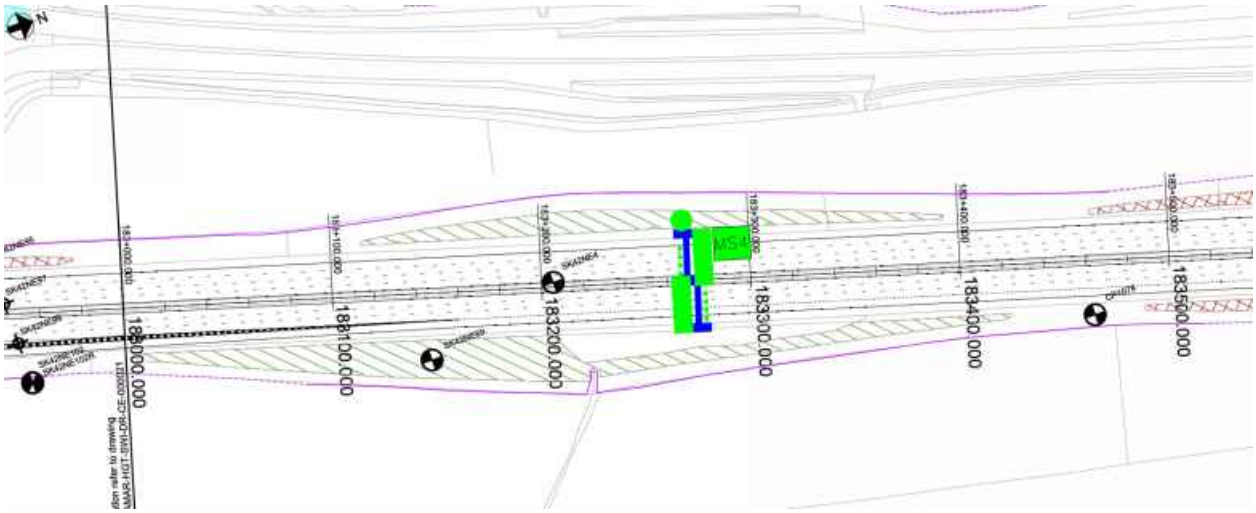


Figure 3: Borehole Location Plan

Flood Risk:

This location is not in an area at risk from flooding.

Historical Boreholes:

Relevant Borehole Number	SK42NE4
Borehole Chainage	183206
Borehole Location	Southbound
National Grid Reference	E 447140, N 325640
Ground Level at Exploratory Hole	69.30mAOD

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RAG Analysis	Amber
Date Drilled	24/08/1961
Termination Depth	9.14 metres below ground level (mbgl)
Other suitable holes	CP1078

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Embankment Fill / Made Ground	5.55	71.50	-
Mercia Mudstone – III/IV	10.89	>60.16	>150

(1) Ground level is assumed to be at the carriageway level.
(2) Embankment Fill was not encountered from the historical exploratory logs, however, the Lidar survey data shows an embankment present.
(3) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(4) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory hole CP1078.

Groundwater:

Groundwater was encountered in exploratory hole SK42NE4 at 4.42mbgl (64.88mAOD) and rose to 2.29mbgl (67.01mAOD).

Groundwater Design Level:

Due to limited groundwater level available, a design groundwater level of 70.50mAOD (1.00m below the toe of the embankment) has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

5 No Atterberg Limit Tests and 30 No Natural Moisture Content tests were undertaken within the Mercia Mudstone – III/IV within CP1078 & SK42NE4 with the following results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Mercia Mudstone – III/IV	2.00	9.00	29.00	13.00	16.00	CL
Mercia Mudstone – III/IV	0.76	12.00	-	-	-	-
Mercia Mudstone – III/IV	1.52	-	37.00	18.00	19.00	CI
Mercia Mudstone – III/IV	2.29	19.00	-	-	-	-
Mercia Mudstone – III/IV	3.05	-	34.00	23.00	11.00	CL
Mercia Mudstone – III/IV	4.57	13.00	33.00	18.00	15.00	CL
Mercia Mudstone – III/IV	5.33	21.00	-	-	-	-
Mercia Mudstone – III/IV	6.10	-	30.00	16.00	14.00	CL
Mercia Mudstone – III/IV	7.62	12.00	-	-	-	-

Lab Test Data – BRE Classification:

No chemical laboratory testing data is available for this structure location.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole that the embankment comprises cohesive fill. The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Made Ground – Embankment Fill	0.00 – 5.55	77.05 – 71.50	5.55	21	27	0	100	7.8	6.2	-	0.50	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV	5.55 – 15.55	71.50 – 61.50	10.00	21	30	2	50	10.8	8.6	-	0.50	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10m bgl)	>15.55	<61.50	>10.00	21	30	2	50	16.8	13.4	-	0.50	0.20	-	DS-2 AC-2

(5) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2017) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(6) Stratum types and depths are derived from the interpreted geological long section.
(7) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion Young's modulus and Poisson's ratio derived in the AMAR GIR are used.

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Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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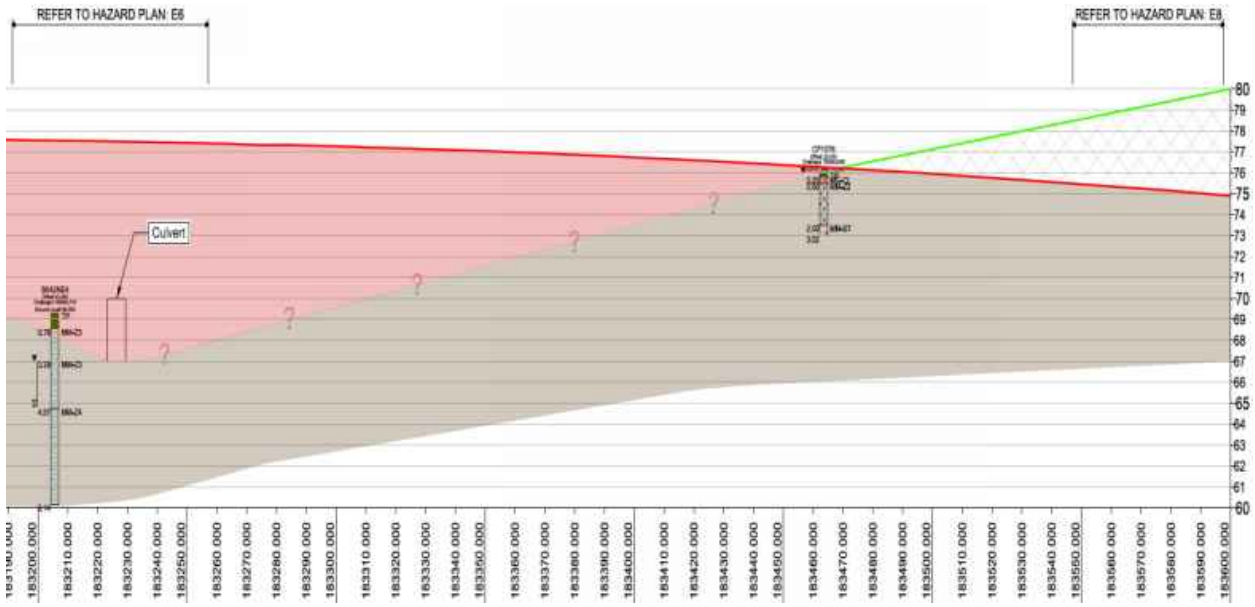


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
183320	183430	Full Height Embankment Widening (1:2.0)	4.5	26.6 (1V:2H)

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Further Ground Investigation

No further ground investigation has been proposed between chainage 183320-183430.

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LOGS

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Rotary Core Log

Borehole No.
CP1078
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447243.00 - 325878.00	Hole Type CP
Location:		Level: 76.00	Scale 1:50
Client: Highways England		Dates: 25/10/2006 - 25/10/2006	Logged By MW

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	B				0.20	75.80		TOPSOIL. TP
		0.50	B				0.50	75.50		MADE GROUND: Stiff brown friable slightly sandy silt locally silt/clay with occasional gravel of fine to coarse subangular sandstone and siltstone. With rare subangular cobbles of flint. With rootlets. MG-CL
		1.50 - 1.95	U							Stiff friable red brown occasionally grey green SILT, locally silt/clay. MM-Z2
		2.00	D							
		2.50	D				2.50	73.50		Weak grey green SILTSTONE recovered as medium to coarse subangular to angular gravel size fragments. MM-ST
		2.50 - 3.00	B							
		3.00	D				3.02	72.98		End of borehole at 3.02 m

Remarks
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 2.00m.;The borehole was advanced by chiselling methods from 2.50m to 3.00m (1 hour). No visual or olfactory indication of contamination was observed.;The borehole was backfilled on completion with grout.;

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447140.00 - 325640.00	Borehole No. SK42NE4 Sheet 1 of 1
Location:		Level: 69.30	Hole Type CP
Client: Highways England		Dates: 24/08/1961 - 28/08/1961	Scale 1:50
			Logged By

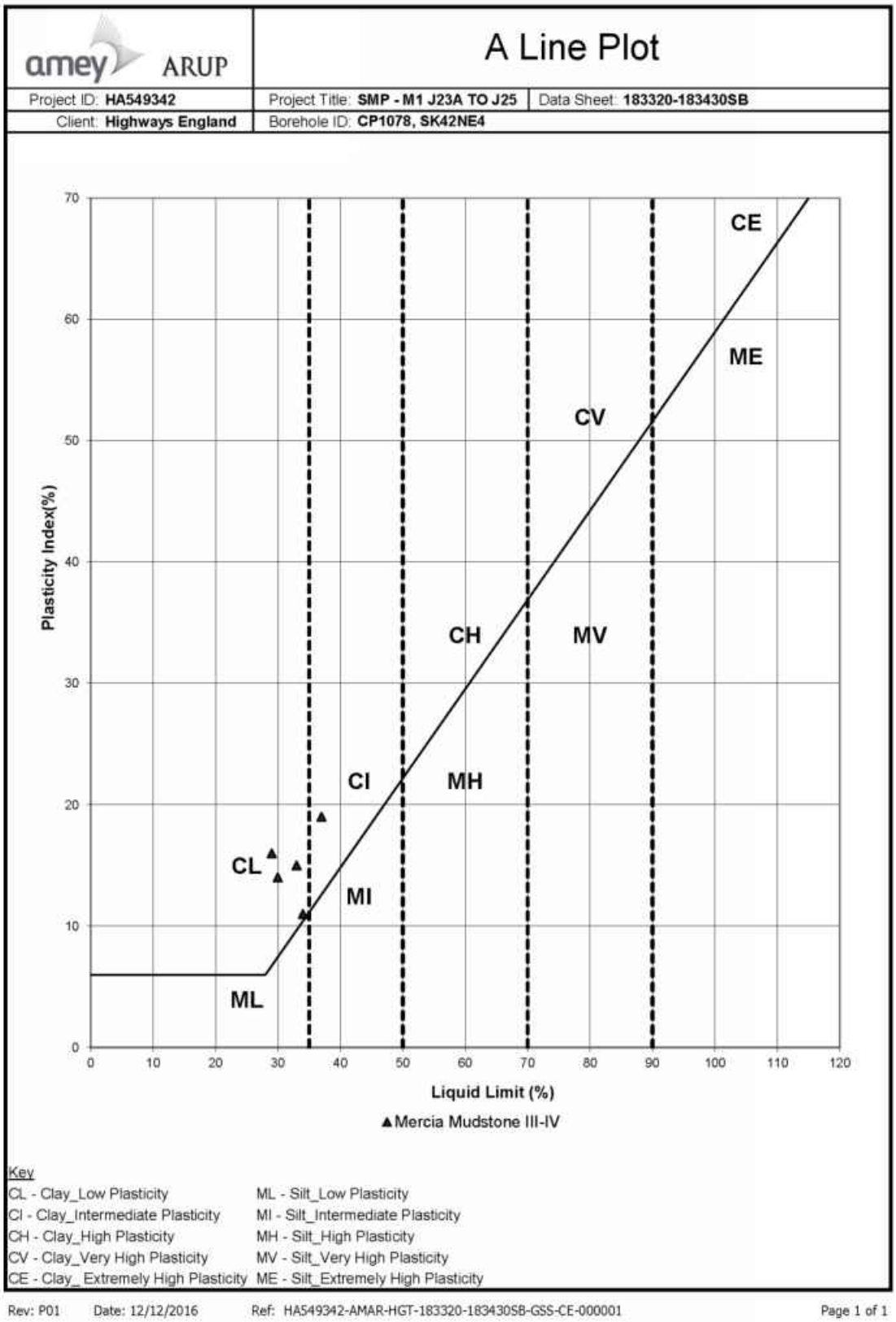
Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.76	D				0.76	68.54		Topsoil TP
		1.52 - 1.98	U							Firm brown clay & stones MM-Z3
		1.98	D							
	▼	2.29	D				2.29	67.01		
		3.05	D							Stiff red & grey silty clay MM-Z3
		3.05 - 3.51	U							
		3.81	D							
	▽	4.42	W							
		4.57	D				4.57	64.73		
		4.57 - 5.03	U							Stiff red & grey silty clay & siltstone MM-Z4
		5.03	D							
		5.33	D							
		6.10 - 6.55	U							
		6.55	D							
		6.86	D							
		7.62 - 8.00	U							
		8.08	D							
		8.38	D							
		8.69 - 9.14	U							
		9.14	D				9.14	60.16		End of borehole at 9.14 m

Remarks

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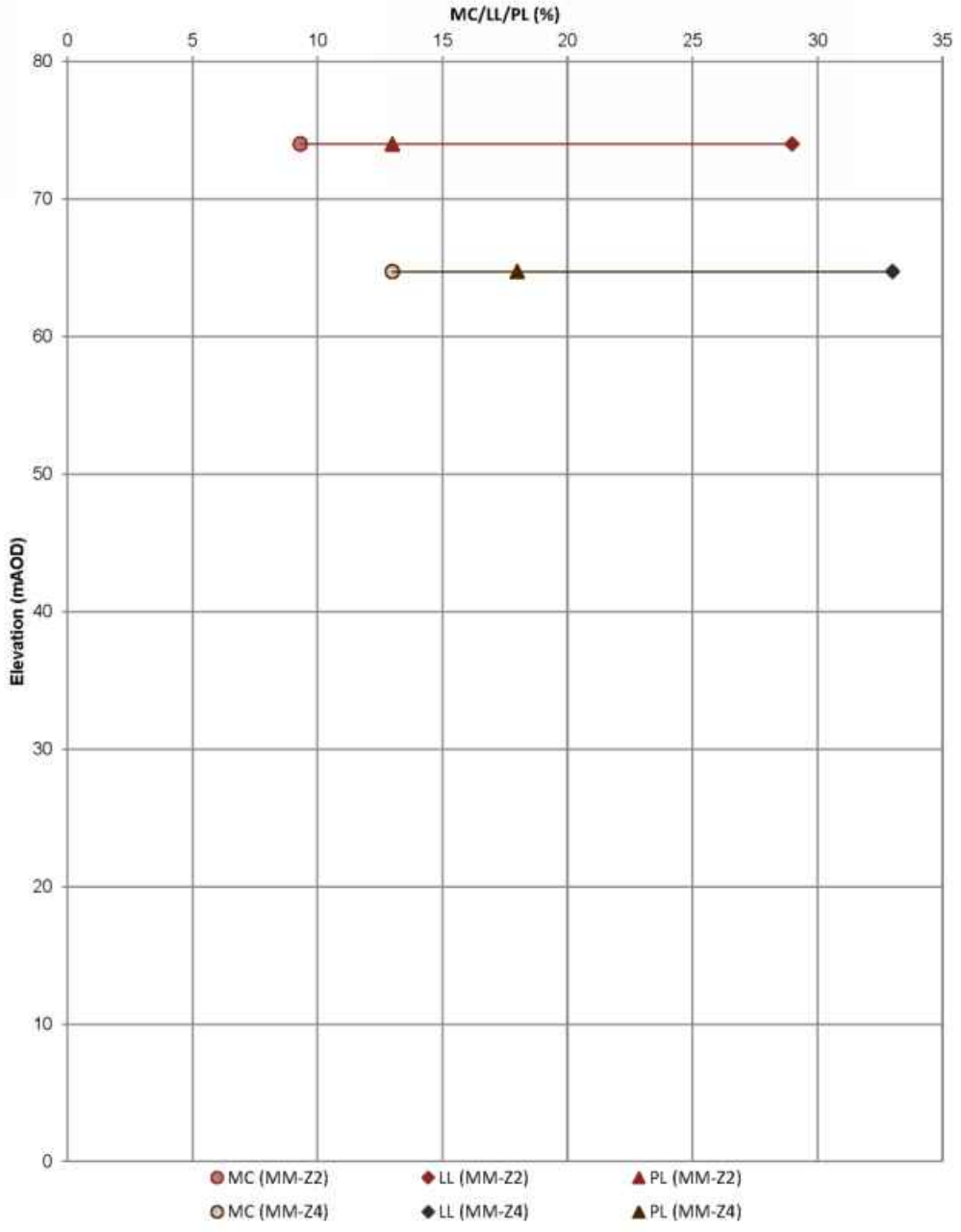
PLOTS



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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183320-183430SB**
Client: **Highways England**	Borehole ID: **CP1078, SK42NE4**	



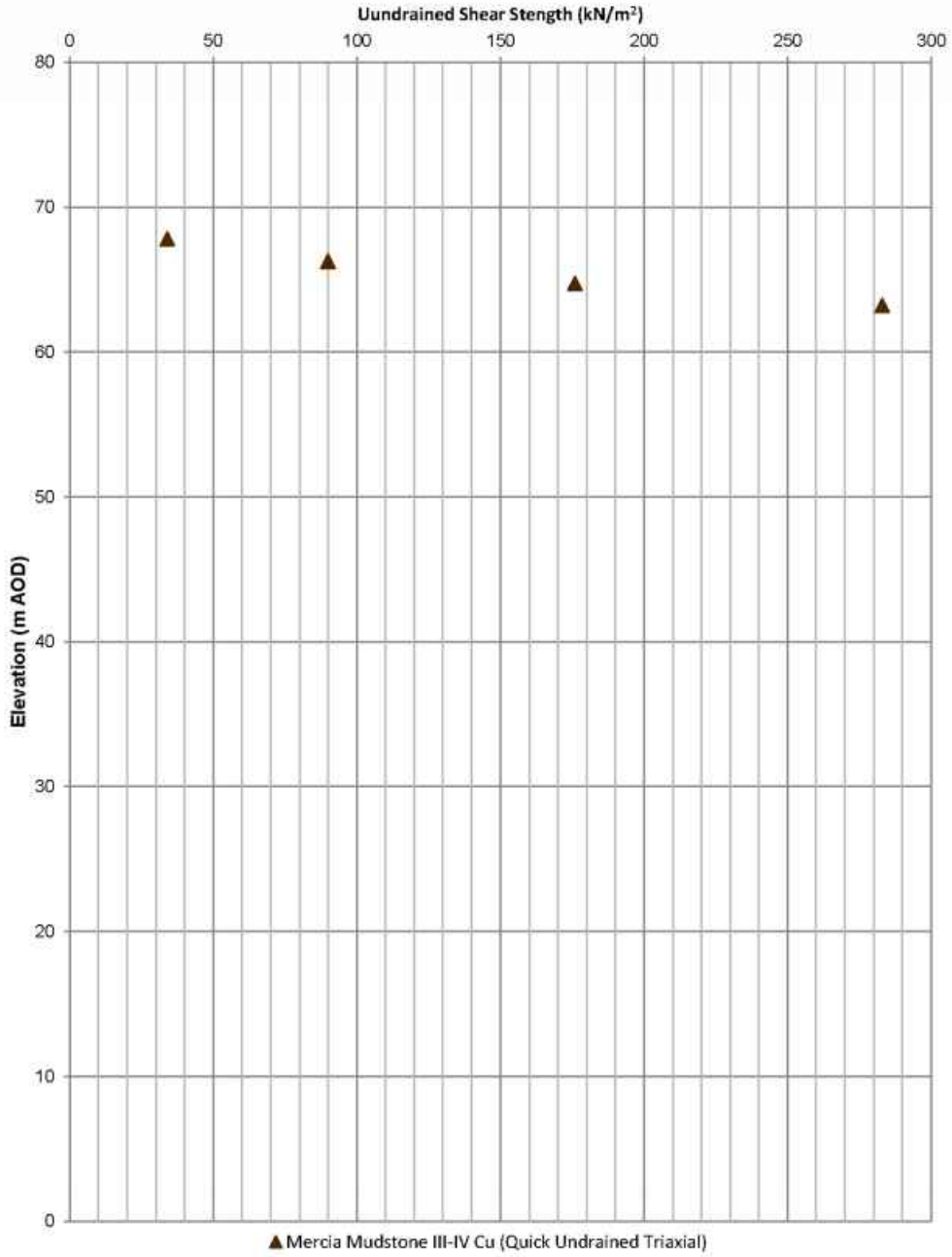
Rev: P01 Date: 12/12/2016 Ref: HA549342-AMAR-HGT-183320-183430SB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183320-183430SB**
Client: **Highways England**	Borehole ID: **SK42NE4**	



Rev: P01 Date: 12/12/2016 Ref: HA549342-AMAR-HGT-183320-183430SB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-183480_183510SB-GSS- CE-000001		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	183480-183510		
Carriageway	Southbound		
Marker Post	MP183/4B+80 – MP183/5B+10		
National Grid Reference	E 447247, N 325895 – E 447254, N 325921		
Existing Ground Level at Location	Crest of cutting	76.69 mAOD	
	Carriageway	75.64 mAOD	
Earthwork Type	NB: N/A	SB: Cutting	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_42061	HAGDMS designation
Earthwork Height	NB: N/A	SB: 1.05m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 23°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	04/02/2017	[redacted]
Checked	Alice Bazen	06/02/2017	
Reviewed	Gary Summerfield	09/02/2017	
Approved	Tom Bulteel	03/03/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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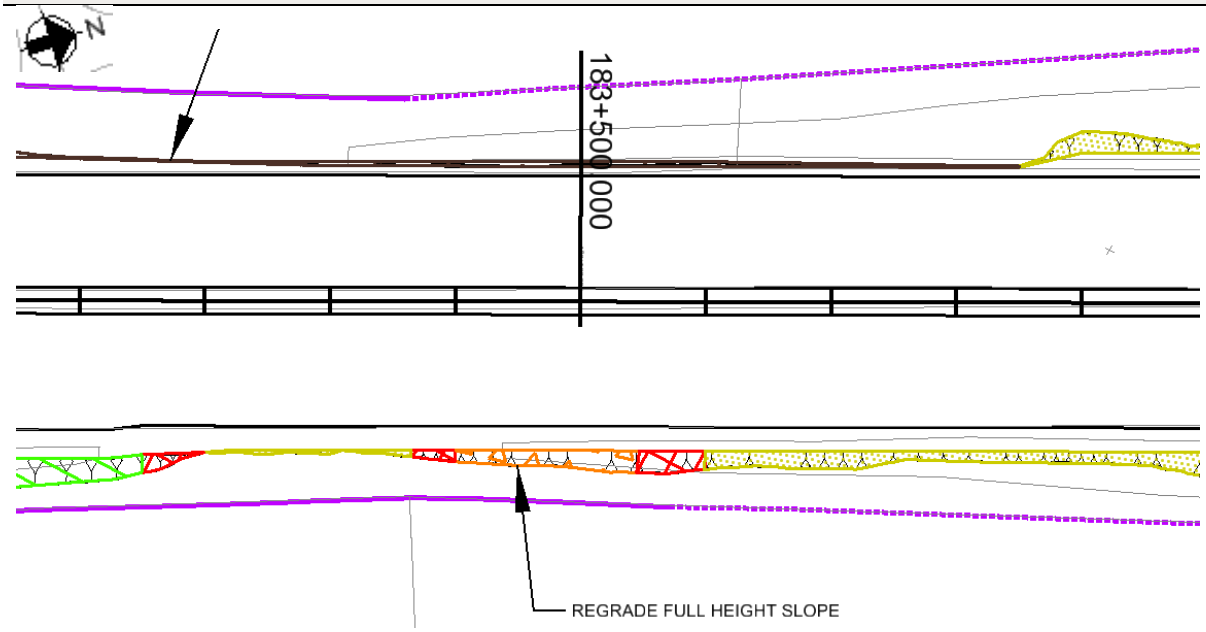


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Full Height Regrade at 1 in 3 gradient.

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the existing earthwork is classified as a cutting with height ranging between 1.0m and 1.46m with a typical slope angle of 23 degrees.

The critical cross section at chainage 183500 is based on the section with the greatest earthwork height.

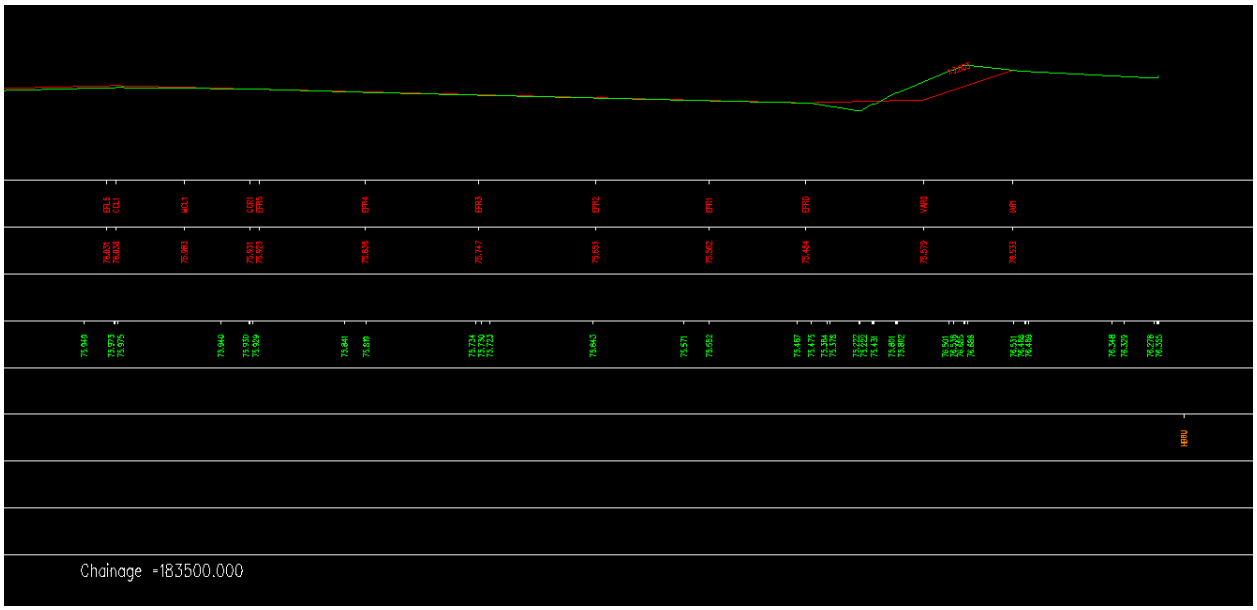


Figure 2: Topographic Critical Cross Section Chainage 183500

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: None recorded

Solid Deposits: Gunthorp Member (Mercia Mudstone Group), Mudstone

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage. However 1 relevant exploratory hole outside the design chainage is considered; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000022, Rev P01

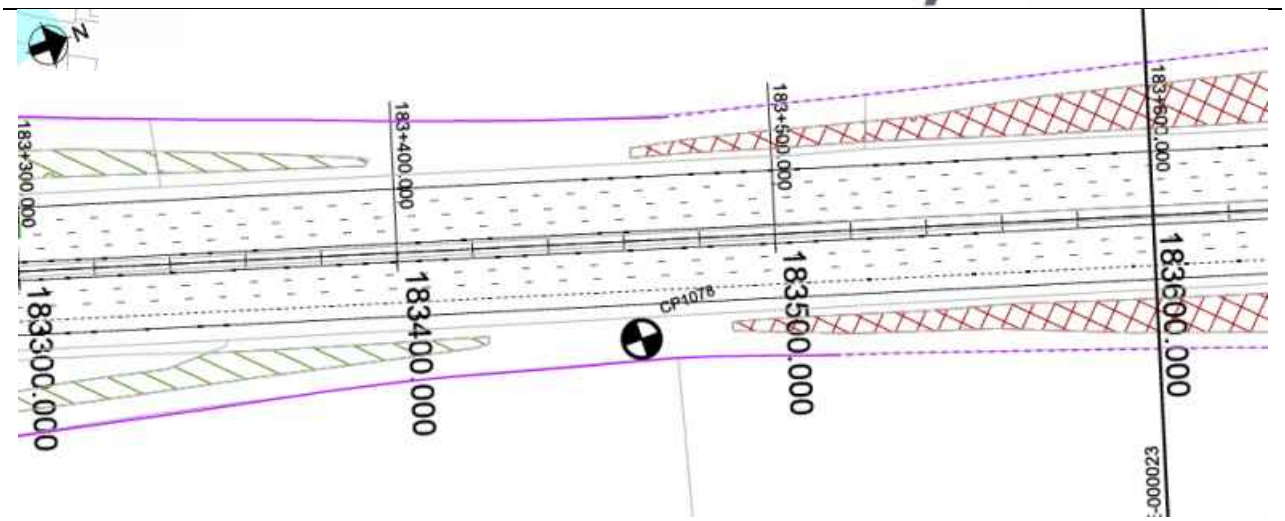


Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	CP1078
Borehole Chainage	183463
Borehole Location	Southbound
National Grid Reference	E 447243, N 325878
Ground Level at Exploratory Hole	76.00mAOD
RAG Analysis	Amber
Date Drilled	25/10/2006
Termination Depth	3.0 metres below ground level (mbgl)
Other suitable holes	None

Existing Ground itions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Mercia Mudstone – III/IV (0-10mbgl)	10.00	66.69	-
Mercia Mudstone - III/IV (>10mbgl)	>10.00	<66.59	-

(1) Ground level is assumed to be at the crest of the cutting;
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(3) Note: the historical exploratory hole CP1078 was not advanced in the cutting slope, and therefore it has been assumed that the cutting is of Mercia Mudstone based on the geological section (HA549342-AMAR-HGT-SWI-DR-CE-000022).

In Situ Testing:

Standard Penetration Tests (SPTs) have been not been undertaken within the exploratory hole.

Groundwater:

No groundwater data is available for any of the boreholes mentioned above.

Groundwater Design Level:

No local groundwater level is available and therefore a design groundwater level of 1.0m below toe of embankment has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

1 No. Atterberg Limit Test and 1 No. Moisture content test was undertaken within the Mercia Mudstone. The results are presented in the table below:

Stratum	Depth (mbgl)	Moisture Content (%)	Plastic Limit (%)	Liquid Limit (%)	Plasticity Index	Classification
Mercia Mudstone	2.00	9.00	13	29	16	CL

Lab Test Data – BRE Classification :

No chemical test data is available at this location.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that road level on the base of the cutting is straight on to the Mercia Mudstone III/IV at this location.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Mercia Mudstone – III/IV (0-10mbgl)	0.00 – 10.00	76.69 – 66.69	10.00	21	30	2	100	10.8	8.6	-	0.50	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10mbgl)	>10.00	<66.69	-	21	30	2	150	16.8	13.4	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2017) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Due to the lack of localised GI data present, average Cu, Eu and E' values for the Mercia Mudstone layer have been adopted from the AMAR GIR.
(4) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Mercia Mudstone, the classification used for the strata in the AMAR GIR was adopted.

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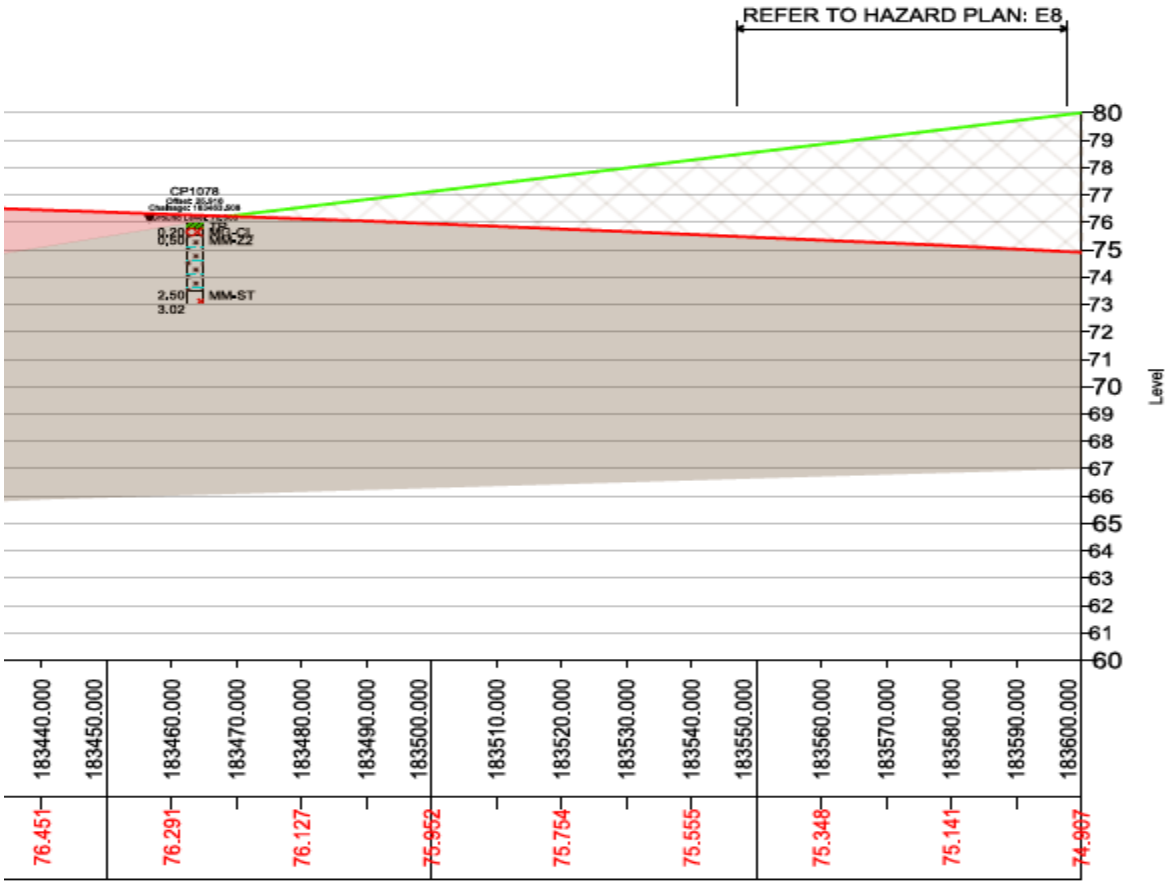


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
183480	183510	Full Height Regrade 1:3.0

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FURTHER GROUND INVESTIGATION

No further ground investigation has been proposed between Ch.183480-183510.

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HISTORICAL EXPLORATORY HOLES

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Borehole Log

Borehole No. **CP1078** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447243.00 - 325878.00	Hole Type CP
Location:		Level: 76.00mbgl	Scale 1:50
Client: Highways England		Dates: 25/10/2006 - 25/10/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.20	1B			0.20	75.80		TOPSOIL. TP
		0.50	2B			0.50	75.50		MADE GROUND: Stiff brown friable slightly sandy silt locally silt/clay with occasional gravel of fine to coarse subangular sandstone and siltstone. With rare subangular cobbles of flint. With rootlets. MG-CL
		1.50 - 1.95	3U	100blows					Stiff friable red brown occasionally grey green SILT, locally silt/clay. MM-Z2
		2.00	4D						
		2.50	5D			2.50	73.50		Weak grey green SILTSTONE recovered as medium to coarse subangular to angular gravel size fragments. MM-ST
		2.50	SPT (S)	50 (10 for 75mm/50 for 35mm)	Casing=2.50m Water=1.20m				
		2.50 - 3.00	6B			3.02	72.98		End of borehole at 3.02m
		3.00	7D						
		3.00	SPT (S)	25 (25 for 10mm/25 for 10mm)	Casing=2.50m Water=1.60m				

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 2.00m.;The borehole was advanced by chiselling methods from 2.50m to 3.00m (1 hour).;No visual or olfactory indication of contamination was observed.;The borehole was backfilled on completion with grout.;

AGS

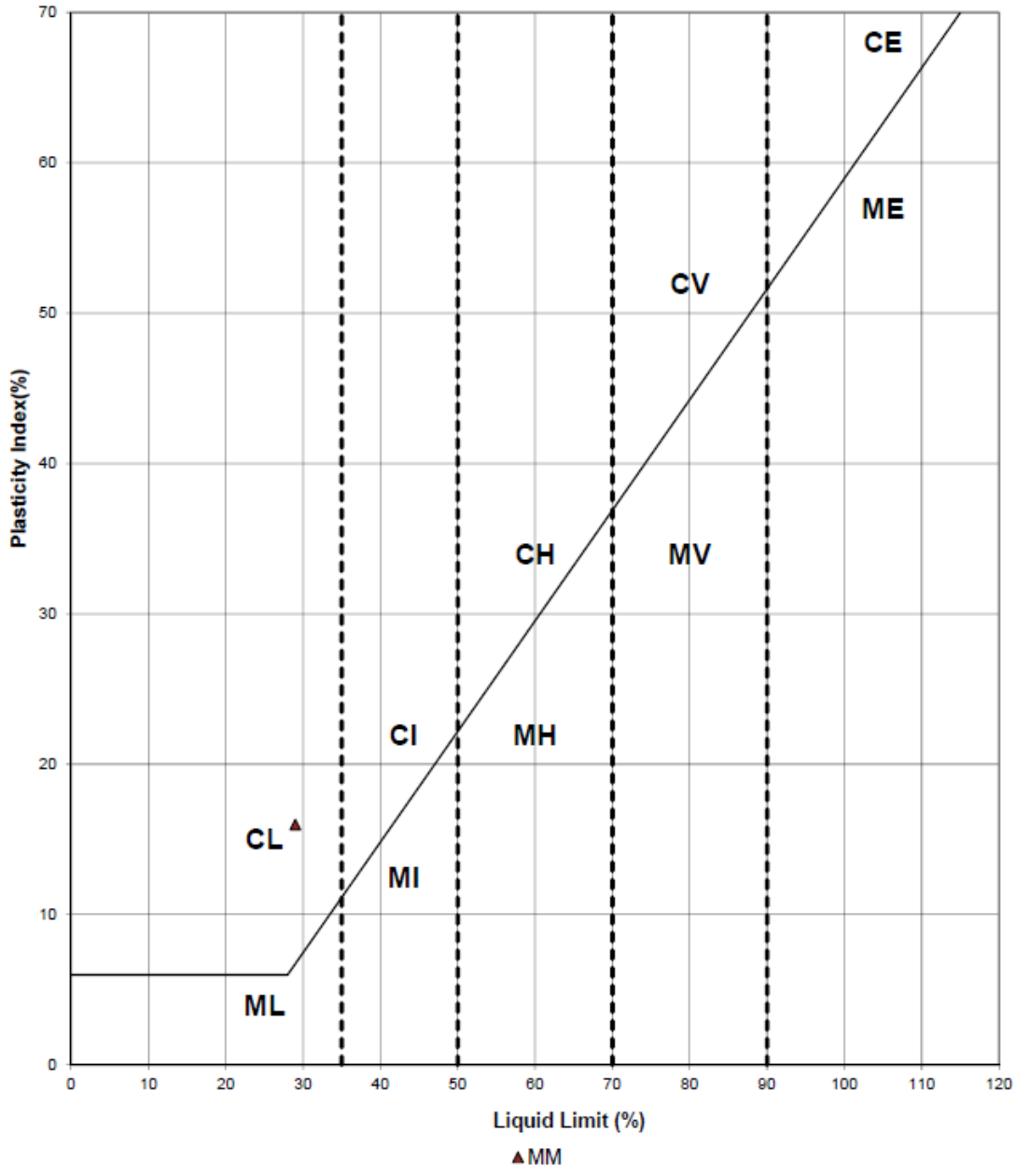
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PLOTS

amey ARUP

A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183480-183510SB**
Client: **Highways England**	Borehole ID: **CP1078**	



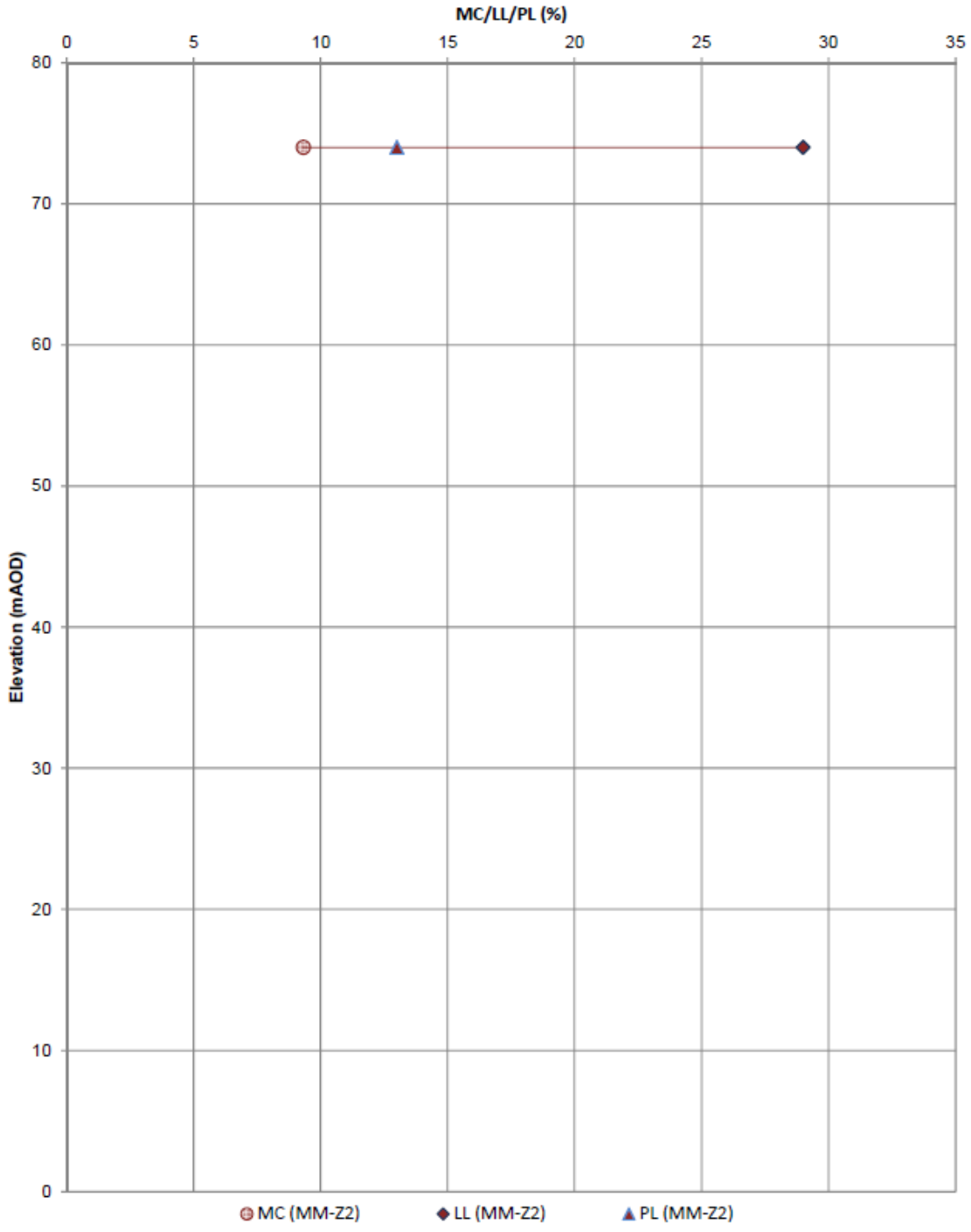
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183480-183510 SB**
Client: **Highways England**	Borehole ID: **CP1078**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-183780-183950SB-GSS-CE-000001		
Earthworks Widening Solution	Partial Height Regrade (1:2.5), King Sheet Pile Retaining Wall		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	183780-183950		
Carriageway	Southbound		
Marker Post	MP183/7B+80 – MP183/9B+50		
National Grid Reference	E 447327, N 326183 – E 4473781, N 326344		
Existing Ground Level at Location	Crest of cutting	81.29mAOD	
	Carriageway	70.97mAOD	
Earthwork Type	NB: N/A	SB: Cutting	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_42061	HAGDMS designation
Earthwork Height	NB: N/A	SB: 10.00	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 20°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Simon Arinze	10/04/2017	[redacted]
Checked	Alice Bazen	12/04/2017	
Reviewed	Gary Summerfield	12/04/2017	
Approved	Tom Bulteel	18/04/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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DESK STUDY

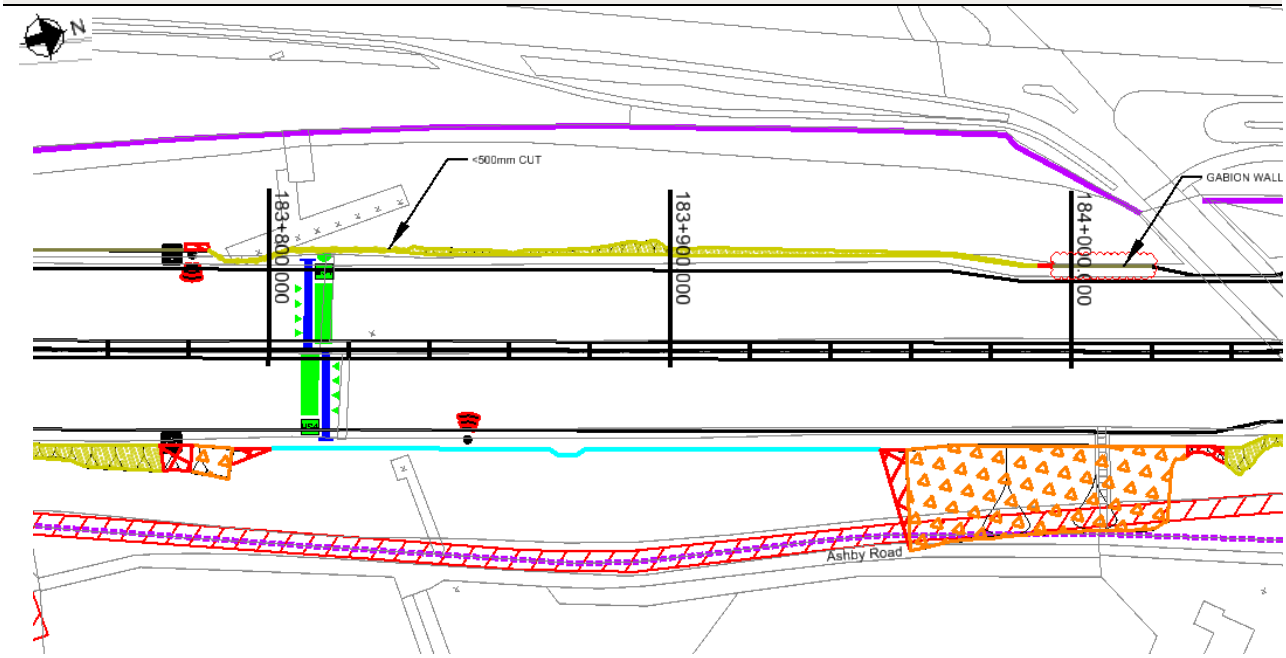


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate verge widening for this location, the following earthworks widening solutions have been proposed:

- 183780-183790 – Partial Height Regrade 1:2.5
- 183800-183950 – King Sheet Pile Retaining wall.

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a cutting ranging in height between 9.6m and 10.3m with a typical slope angle of 20 degrees.

Between chainage 183780 to 183790, the critical cross section at Ch183790 was based on the earthwork with the greatest height.

Between chainage 183780 to 183790, the critical cross section at Ch183875 was based on the earthwork with the greatest retained height.

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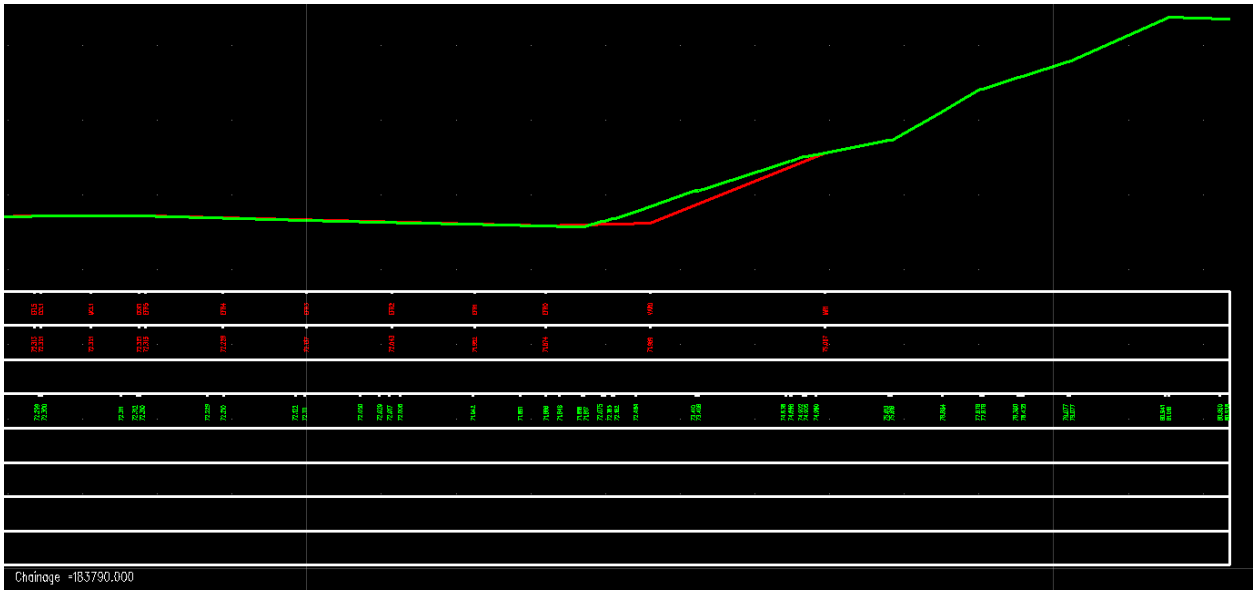


Figure 2.1: Topographic Critical Cross Section Chainage 183790

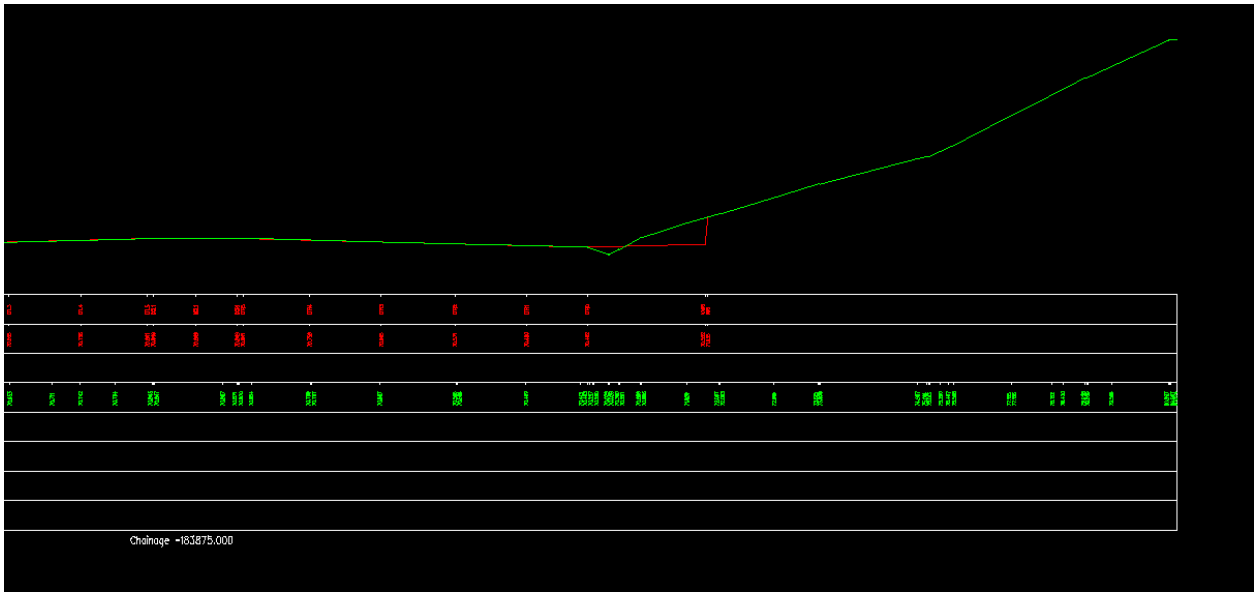


Figure 2.2: Topographic Critical Cross Section Chainage 183875

Utilities:

Electric cables are likely to be present in the vicinity of this earthwork due to presence of airport lighting.

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Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: None recorded

Solid Deposits: Gunthorpe Member (Mercia Mudstone Group), Mudstone

Ground Investigation:

There are 2 No. historical exploratory holes recorded within the design chainage, with an additional 2 no. relevant exploratory holes considered outside the design chainage; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000023, Rev P01.



Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Closest Borehole Number	SK42NE6	SK42NE65
Borehole Chainage	183854	183788
Borehole Location	Southbound	Southbound
National Grid Reference	E 447330, N 326260	E 447362, N 326181
Ground Level at Exploratory Hole	82.30mAOD	79.88mAOD
RAG Analysis	Amber	Green

Date Drilled	18/08/1961	22/01/1988-23/01/1988
Termination Depth	15.24 metres below ground level (mbgl)	7.50 metres below ground level (mbgl)
Other suitable holes	SK42NE64, SK42NE65R & SK42NE66	

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR Survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Mercia Mudstone – III/IV	Not Proven	Not Proven	12->150 (12)

(1) Ground level is assumed to be at carriageway level.
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(3) Mercia Mudstone-I/II and Mercia Mudstone- Sandstone and Siltstote were encountered within the boreholes. Given the uncertainties on ground conditions, Mercia Mudstone –III/IV has been used in the ground model

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes SK42NE64, SK42NE65, SK42NE65R & SK42NE66.

Groundwater:

No groundwater data is available for any of the boreholes mentioned above.

Groundwater Design Level:

King Sheet Pile Wall:

No local groundwater data is available and therefore a groundwater level of 1.0m below carriageway level has been assumed for WALLAP analysis for king and intermediate sheet piles. When checking the global stability check of the earthwork and king and intermediate sheet piles (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata**.**

Regrade Partial Height 1 :2.5:

No local groundwater level is available and therefore a design groundwater level of 1.0m below ground level throughout cutting has been assumed.

GEOTECHNICAL PARAMETERS

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Lab Test Data - Geotechnical Testing:

8 No Atterberg Limit Tests and 13 No Natural Moisture Content tests were undertaken within the Mercia Mudstone – III/IV within SK42NE6 with the following results:

Stratum	Depth to Top of Test (mAOD)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Mercia Mudstone – III/IV	0.76	14.00	-	-	-	-
Mercia Mudstone – III/IV	1.52	24.00	33	19	14	CL
Mercia Mudstone – III/IV	2.29	21.00	-	-	-	-
Mercia Mudstone – III/IV	3.05	-	34	19	15	CL
Mercia Mudstone – III/IV	3.81	14.00	-	-	-	-
Mercia Mudstone – III/IV	4.57	15.00	33	19	14	CL
Mercia Mudstone – III/IV	5.33	15.00	-	-	-	-
Mercia Mudstone – III/IV	6.10	15.00	32	18	14	CL
Mercia Mudstone – III/IV	6.86	20.00	-	-	-	-
Mercia Mudstone – III/IV	7.62	-	33	16	17	CL
Mercia Mudstone – III/IV	7.92	19.00	-	-	-	-
Mercia Mudstone – III/IV	9.41	-	33	19	14	CL
Mercia Mudstone – III/IV	9.91	19.00	-	-	-	-
Mercia Mudstone – III/IV	10.67	-	28	19	9	CL
Mercia Mudstone – III/IV	12.19	22.00	-	-	-	-
Mercia Mudstone – III/IV	12.80	-	30	20	10	CL
Mercia Mudstone – III/IV	13.72	21.00	-	-	-	-
Mercia Mudstone – III/IV	14.48	20.00	-	-	-	-

Lab Test Data – BRE Classification:

1 No sulphate tests and 1 No pH testes were undertaken within the Mercia Mudstone III-IV in

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borehole SK42NE6 with the following results.

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Mercia Mudstone – III/IV	Sulphate (Total) as SO4	Solid	-	-	%SO4
Mercia Mudstone – III/IV	Water Soluble Sulphate as SO4	Water	1	0	g/l SO4
Mercia Mudstone – III/IV	pH	Solid	1	7.2	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that road level on the base of the cutting is straight on to the Mercia Mudstone III/IV at this location. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Mercia Mudstone – III/IV	0.00-20.32	81.29 – 60.97	20.32	21	30	2	60	5.40	4.32	-	0.50	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV	>20.32	<60.97	-	21	30	2	250	16.50	13.20	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical borehole SK42NE6, SK42NE64, SK42NE65, SK42NE65R & SK42NE66.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) A conservative SPT N value of 12 has been used for the Mercia Mudstone III/IV, combined with an f1 value of 5.
(5) Eu for Mercia Mudstone – III/IV can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 12 gives Eu = 5.4MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 4.32MN/m^2.
(6) BRE Classification is determined using criteria set out in BRE Special Digest 1. Due to limited BRE test data for Mercia Mudstone, the classification used for the strata in the AMAR GIR was adopted.

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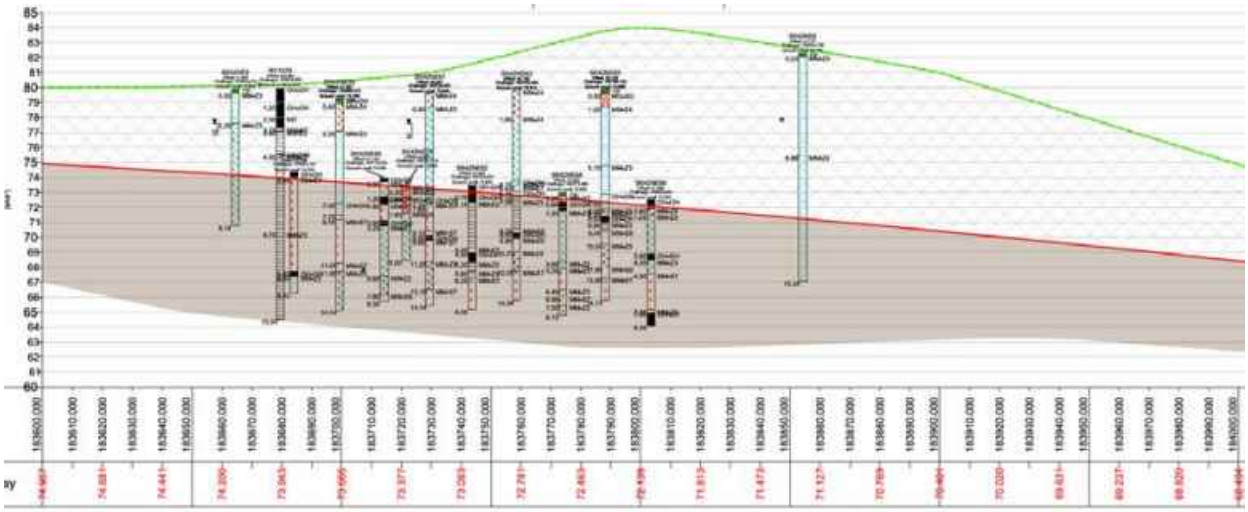


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
183780	186790	Partial Height Regrade 1:2.5
183800	183950	King Sheet Pile retaining wall

Earthwork regrade was considered at this location, however due to the presence of East Midlands Airport lighting on the cutting slope, there is insufficient space to allow for a regrade solution or a gravity retaining wall:

The table below present the king sheet pile wall details.

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
183800	183950	AZ-12 S 390 GP	1.4	4.1	5.5	90	64	31	35.1

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

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FURTHER GROUND INVESTIGATION

The following ground investigation has been proposed in the 'Just In Time' ground investigation:

- CPT-01, Ch183875, Southbound – CPT proposed to a scheduled depth of 6.0mbgl.

HISTORICAL EXPLORATORY HOLES

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Rotary Core Log

Borehole No. SK42NE6
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447330.00 - 326260.00	Hole Type CP
Location:		Level: 82.30	Scale 1:50
Client: Highways England		Dates: 18/08/1961 - 22/08/1961	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.23	82.07		Topsoil TP
		0.76	D							Firm to stiff red & grey silty clay MM-Z3
		1.52 - 1.98	U							
		2.29	D							
		3.05 - 3.51	U							
		3.35	D							
		3.81	D							
	▼	4.57	D							
		4.57	W							
		4.57 - 4.88	B							
		5.33	D							
		6.10 - 6.48	U							
		6.86	D				6.86	75.44		Stiff red silty clay and siltstone MM-Z4
		7.62 - 7.92	U							
		7.92	D							
		8.38	D							
		9.14 - 9.32	U							
		9.91	D							
										Continued on next sheet

Remarks

AGS

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Rotary Core Log

Borehole No. SK42NE6
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447330.00 - 326260.00	Hole Type CP
Location:		Level: 82.30	Scale 1:50
Client: Highways England		Dates: 18/08/1961 - 22/08/1961	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.67 - 11.13	U							
		11.13	D							
		12.19	D							
		12.80 - 13.26	U							
		13.72	D							
		14.48	D							
		14.94 - 15.24	U				15.24	67.06		End of borehole at 15.24 m

11 12 13 14 15 16 17 18 19 20

Remarks

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Rotary Core Log

Borehole No. SK42NE64

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447340.00 - 326173.00	Hole Type RC
Location:		Level: 72.95	Scale 1:50
Client: Highways England		Dates: 25/01/1988 - 26/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	72.75		TOPSOIL TP
							0.60	72.35		Red brown moderately weathered SILTSTONE moderately weak to moderately strong with frequent black staining. (KEUPER MARL) MM-ST
		0.60 - 1.50		33	9	0				Assessed zone of core loss OH-OH
							1.20	71.75		Very stiff (hard) red brown very silty CLAY with medium gravel sized mudstone lithorelics. (Weathered MUDSTONE. Frequent pockets and lenses of light greenish grey silt and siltstone. (KEUPER MARL 3) Below 2.50m, with medium to coarse gravel sized lithorelics. Locally with subvertical fissures with speckled black staining. MM-Z3
		1.50 - 2.80		77	46	11				assessed zone of core loss disturbed by SPT light greenish grey slightly fine sandy siltstone strong reddish brown moderately weathered siltstone band
		2.80 - 4.60		83	65	47				
							4.60	68.35		Stiff to very stiff red brown very silty CLAY. (Weathered MUDSTONE) (KEUPER MARL 4b) MM-Z2
		4.60 - 6.45		100	100	75	5.05	67.90		disturbed by SPT Greenish brown slightly to moderately weathered sandy SILTSTONE weak becoming moderately weak with very closely spaced fractures with black speckled staining. (KEUPER MARL 2) At 5.75m, becoming red brown with occasional reduction spots. MM-ST
							6.45	66.50		Very stiff red brown very clayey SILT locally with up to coarse gravel sized lithorelics. (Weathered SILTSTONE) (KEUPER MARL 3/4a) MM-Z3
		6.45 - 8.00		87	87	23	6.95	66.00		assessed zone of core loss Red brown slightly to moderately weathered sandy SILTSTONE moderately weak. (KEUPER MARL 2) MM-ST
							7.50	65.45		Very stiff (hard) red brown clayey SILT locally with closely spaced subhorizontal fissures. (Weathered SILTSTONE) (KEUPER MARL 3) MM-Z2
							8.15	64.80		End of borehole at 8.15 m

Remarks
Hand dug inspection pit from ground level to 0.60m

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Rotary Core Log

Borehole No. SK42NE65

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447362.00 - 326181.00	Hole Type CP
Location:		Level: 79.88	Scale 1:50
Client: Highways England		Dates: 22/01/1988 - 23/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										TOPSOIL TP
		0.30	D				0.30	79.58		Angular medium to coarse gravel sized fragments of greenish grey slightly weathered silty fine grained SANDSTONE moderately strong to strong with red brown clay smearing. (Possibly MADE GROUND) MG-SG
		0.50 - 0.95	D							
		1.20	D				1.20	78.68		Stiff becoming very stiff (hard) red brown silty CLAY with occasional pockets and lenses of light greenish grey silt and siltstone. Locally with very closely spaced fissures with speckled black staining. (KEUPER MARL 3/4a) Below 1.80m with fine to coarse gravel sized lithorelics. From 2.80m to 3.30m; Light grey green fine sandy SILT with medium to coarse gravel sized lithorelics and occasional bands and lenses of very stiff red brown silty clay. At 4.60m; Grey green SILTSTONE band moderately weak to moderately strong. MM-Z4
		1.30 - 1.75	U							
		1.80	D							
		1.80 - 2.25	D							
		2.80 - 3.25	U							
		3.30	D							
		3.30 - 3.75	D							
		4.30 - 4.60	U							
		4.65	D							
		4.65 - 5.10	D							
		5.10	W				5.10	74.78		Very stiff (hard) red brown silty CLAY with frequent medium to coarse gravel sized silty mudstone lithorelics and occasional pockets and lenses of light greenish grey silt and siltstone. (KEUPER MARL 3) By 6.60m becoming moderately weathered MUDSTONE very weak MM-Z3
		5.60 - 6.05	D							
		6.60 - 6.80	D							
		7.20 - 7.31	D							
							7.50	72.38		End of borehole at 7.50 m

Remarks

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Rotary Core Log

Borehole No. SK42NE65R
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447362.00 - 326181.00	Hole Type CP+RC
Location:		Level: 79.88	Scale 1:50
Client: Highways England		Dates: 11/02/1988 - 12/02/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		7.00 - 8.50		33	30	13	8.00	71.88		Assessed zone of core loss OH-OH
							8.20	71.68		Very stiff (hard) red brown very silty CLAY with occasional fine gravel sized lithorelics. (Weathered MUDSTONE) (KEUPER MARL 3/4a) MM-Z3
		8.50 - 9.80		65	28	8	8.50	71.38		Red brown slightly to moderately weathered SILTSTONE weak to moderately weak. (KEUPER MARL 2) MM-ST
							8.95	70.93		Assessed zone of core loss OH-OH
							9.45	70.43		Red brown moderately to highly weathered silty MUDSTONE locally altered to a very stiff silty
										Continued on next sheet

Remarks
Open hole drilling, air flush, using 6.75in rock bit from ground level to 7.00m

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Rotary Core Log

Borehole No. SK42NE65R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447362.00 - 326181.00	Hole Type CP+RC
Location:		Level: 79.88	Scale 1:50
Client: Highways England		Dates: 11/02/1988 - 12/02/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.80 - 11.50		82	68	8	10.34	69.54		clay with coarse gravel sized lithorelics. (KEUPER MARL 2/3) MM-Z3
										Light greenish brown locally red brown slightly to moderately weathered very silty fine SANDSTONE. (KEUPER MARL) From 9.80m to 10.10m stiff red brown silty CLAY with frequent fine to medium gravel sized lithorelics. MM-SS
										assessed core loss
		11.50 - 14.00		96	86	52	11.90	67.98		Very dense (hard) red brown clayey SILT with occasional fine gravel sized lithorelics. (Weathered SILTSTONE) (KEUPER MARL 3) From 10.60m to 11.60m with coarse gravel sized lithorelics. Below 11.60m becoming slightly fine sandy. MM-Z3
										assessed zone of core loss
							12.60	67.28		Light reddish green slightly to moderately weathered very silty fine SANDSTONE weak closely spaced subhorizontal fractures. (KEUPER MARL 2/3) MM-SS
										irregular 70 deg joint
										subvertical joint
							14.13	65.75		Red brown slightly to moderately weathered SILTSTONE weak to moderately weak with moderately widely becoming widely spaced subhorizontal fractures. (KEUPER MARL 2) MM-ST
										stiff red brown very silty CLAY
										End of borehole at 14.13 m

Remarks
Open hole drilling, air flush, using 6.75in rock bit from ground level to 7.00m

AGS

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Rotary Core Log

Borehole No. SK42NE66
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447349.00 - 326201.00	Hole Type RC
Location:		Level: 72.50	Scale 1:50
Client: Highways England		Dates: 27/01/1988 - 27/01/1988	Logged By AAC

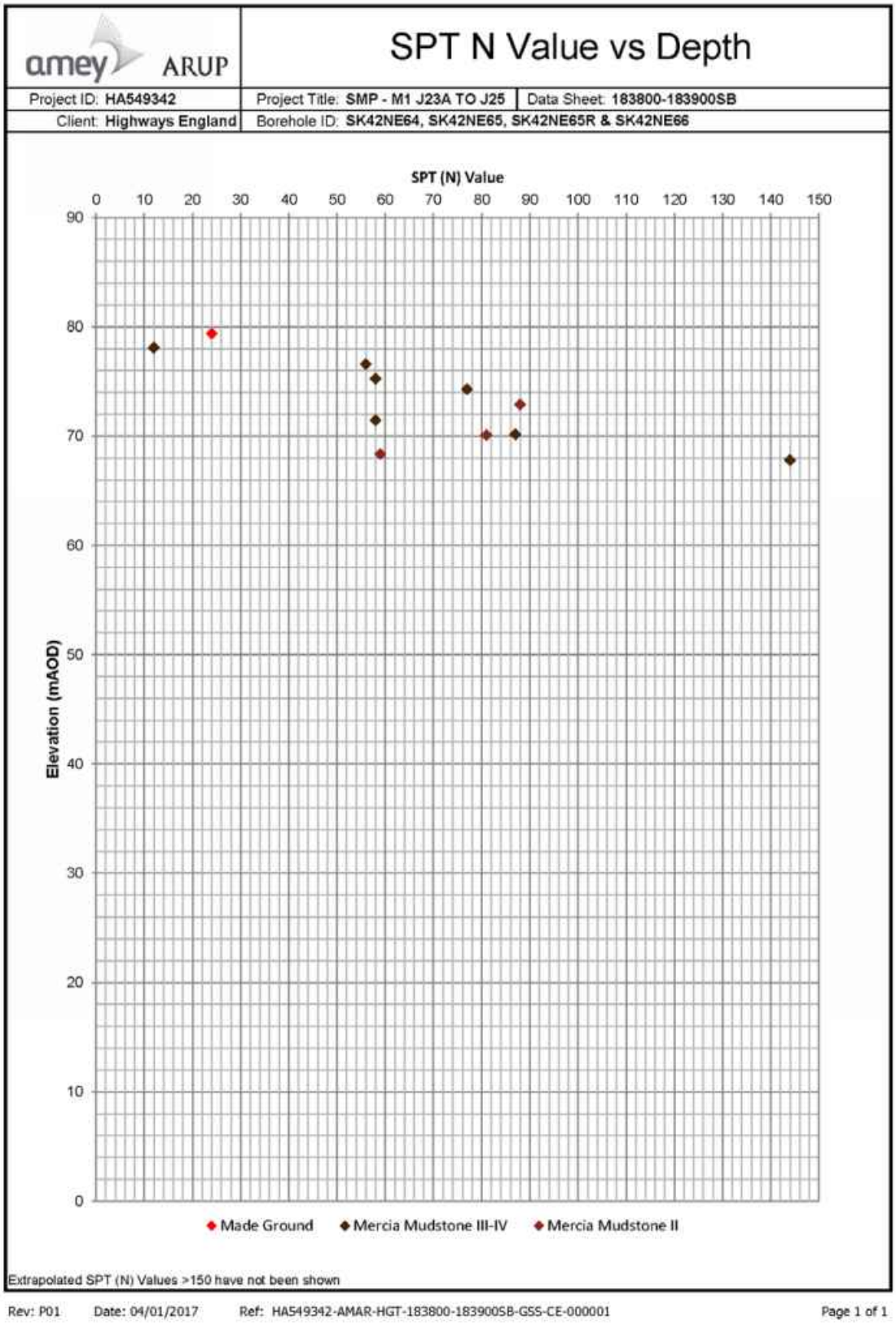
Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Inspection pit OH-OH
							0.60	71.90		Dense light greenish grey locally friable SILT with occasional lithorelics. (KEUPER MARL 4a) MM-Z4
		0.60 - 2.10		100	93	72	1.03	71.47		Very stiff (hard) red brown locally very silty CLAY with occasional bands and lenses of light greenish grey and red brown siltstone very weak. (KEUPER MARL 3/4a) MM-Z3
		2.10 - 3.60		87	77	59				assessed zone of core loss disturbed by SPT
							3.60	68.90		Assessed zone of core loss OH-OH
		3.60 - 4.70		59	59	0	4.05	68.45		Very stiff locally stiff red brown very silty CLAY locally with occasional lithorelics. (Weathered MUDSTONE) (KEUPER MARL 3) From 4.84m to 4.93m band of light greenish grey silt. MM-Z3
		4.70 - 6.90		100	89	64	4.95	67.55		red brown siltstone disturbed by SPT Red brown slightly to moderately weathered SILTSTONE very weak to weak with occasional mudstone bands up to 80mm thick; closely locally very closely spaced often tight fractures occasionally with speckled black staining. (KEUPER MARL 2) MM-ST
		6.90 - 8.00		36	0	0	7.35 7.50	65.15 65.00		Stiff red brown very silty CLAY with occasional lithorelics. (Weathered MUDSTONE) (KEUPER MARL 4a) MM-Z3
										Assessed zone of core loss OH-OH
							8.38	64.12		End of borehole at 8.38 m

Remarks
Hand dug inspection pit from ground level to 0.60m

AGS

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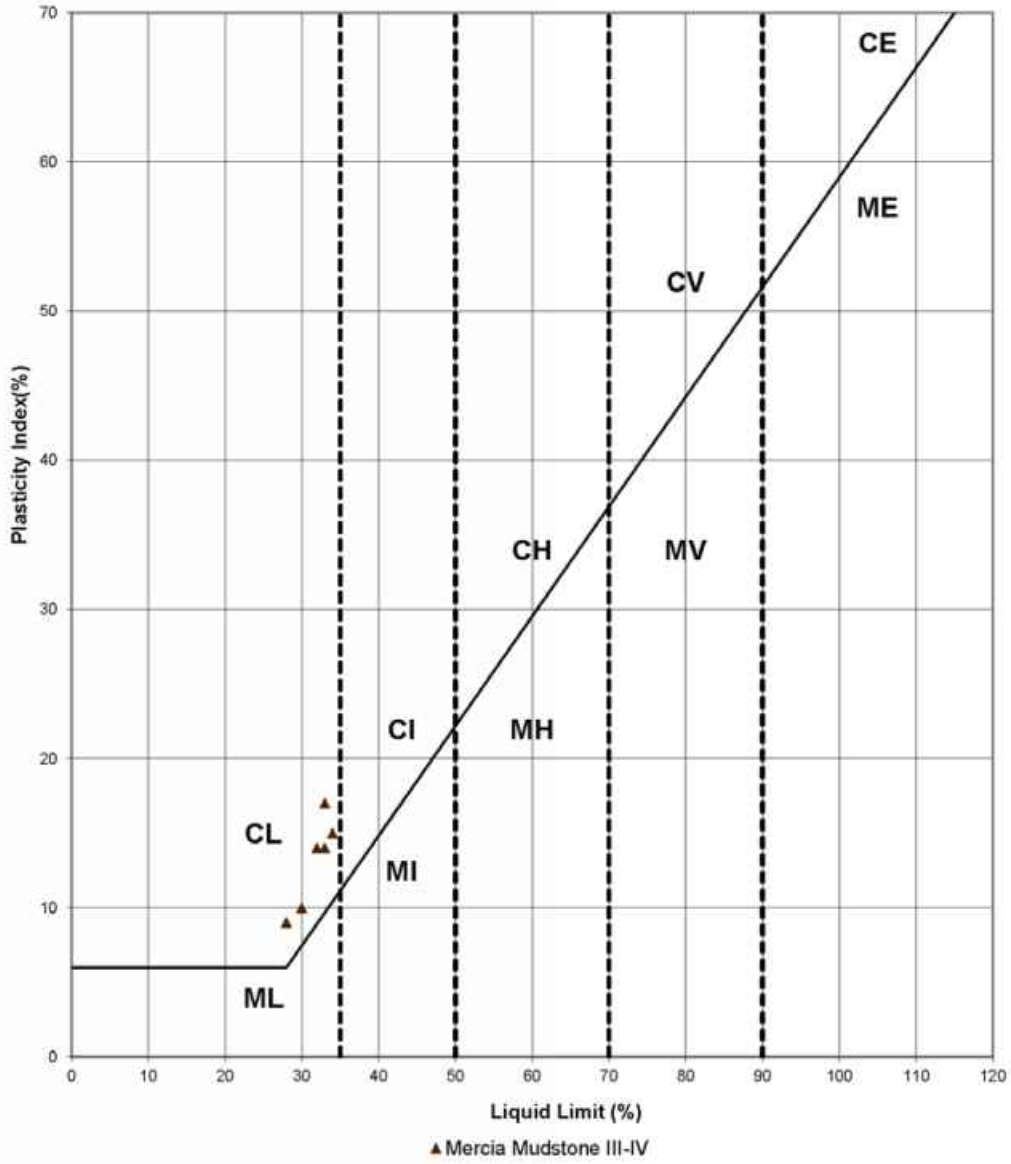
PLOTS



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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183800-183900SB**
Client: **Highways England**	Borehole ID: **SK42NE6**	



Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

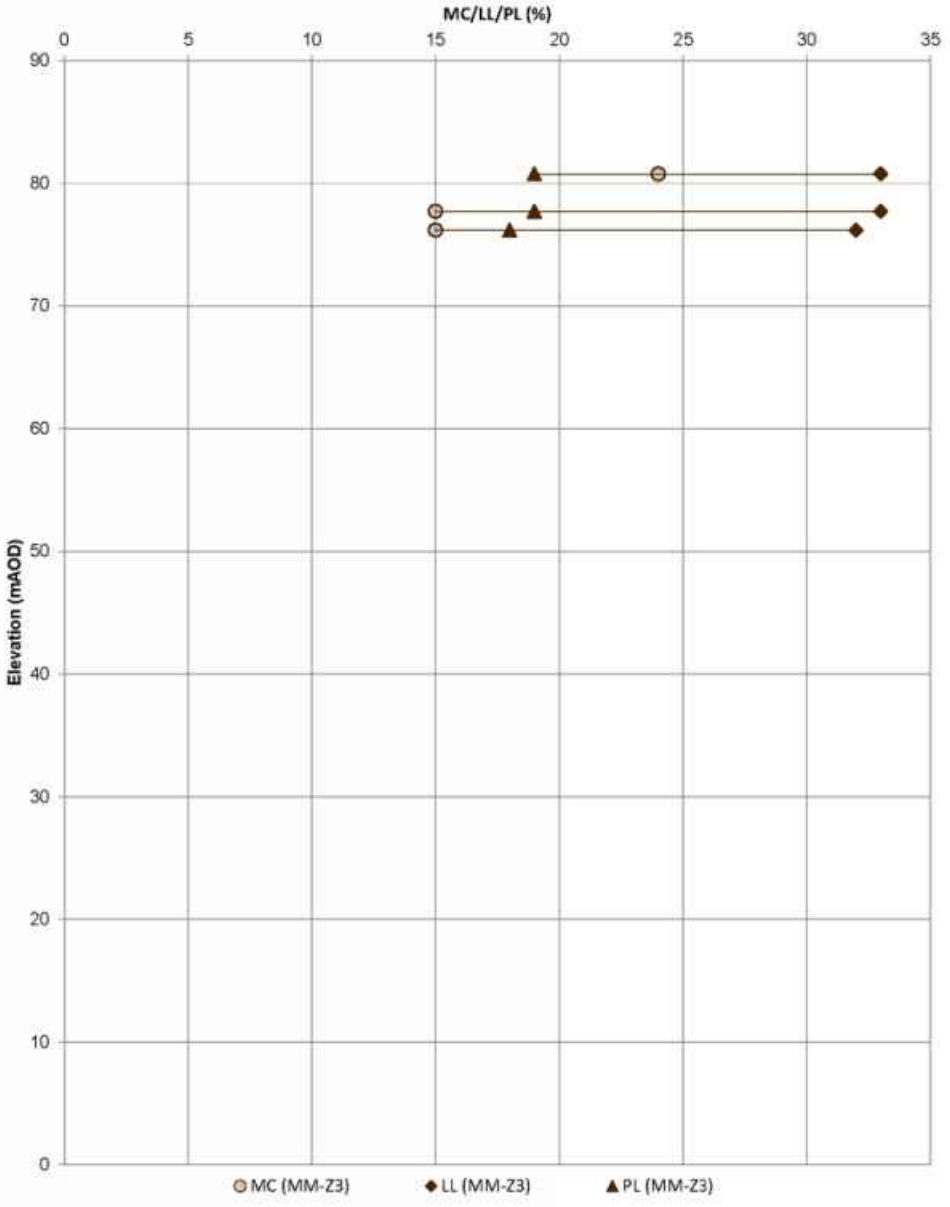
Rev: P01 Date: 04/01/2017 Ref: HA549342-AMAR-HGT-183800-183900SB-GSS-CE-000001 Page 1 of 1

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183800-183900SB**
Client: **Highways England**	Borehole ID: **SK42NE6**	



Rev: P01 Date: 04/01/2017 Ref: HA549342-AMAR-HGT-183800-183900SB-GSS-CE-000001 Page 1 of 1

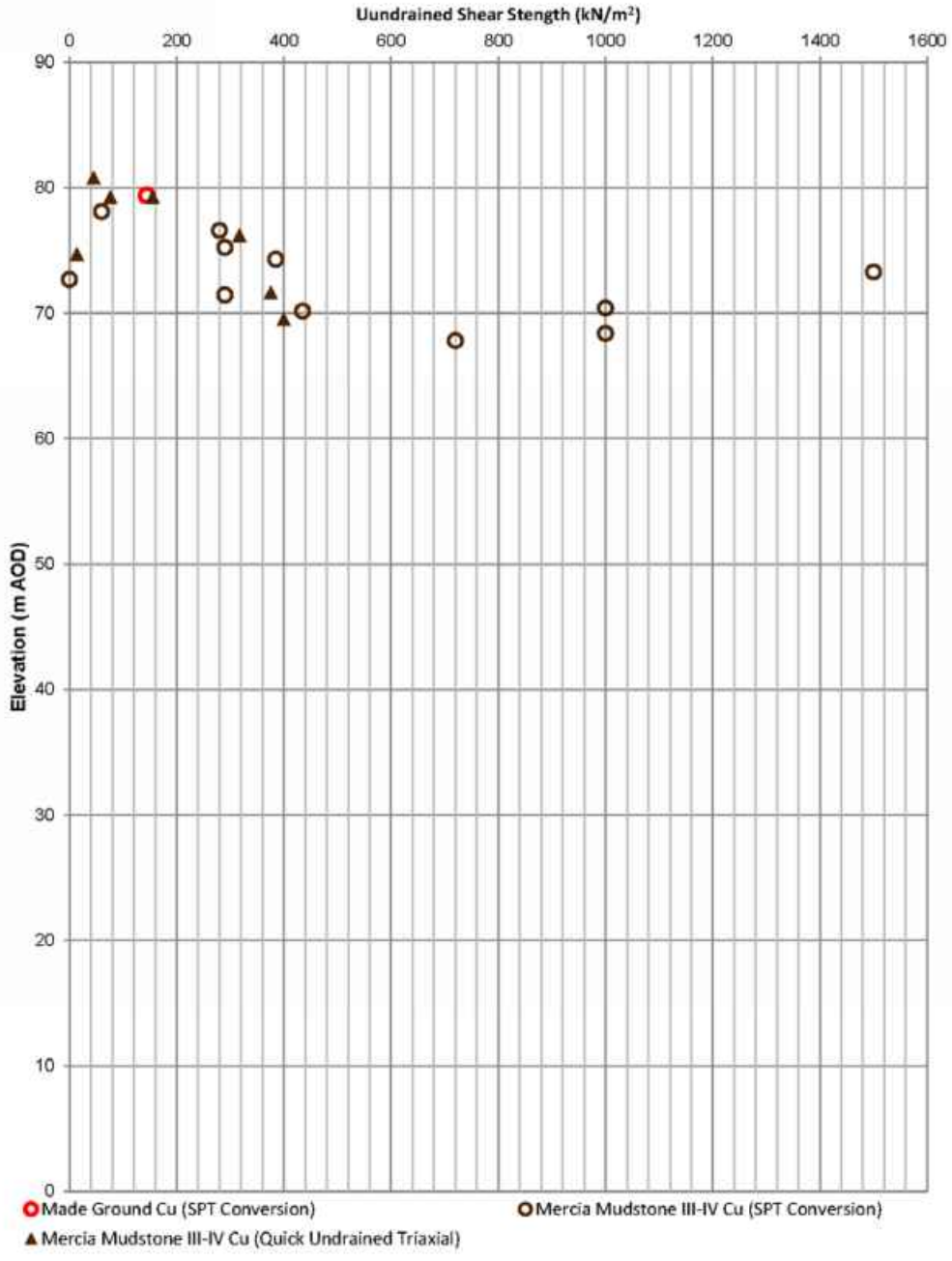
LocationDetails. Top Depth LocationDetails Plastic Limit Moisture Con Liquid Limit

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183800-183900SB**
Client: **Highways England**	Borehole ID: **SK42NE6, SK42NE64, SK42NE65, SK42NE65R & SK42NE66**	



Rev: P01 Date: 04/01/2017 Ref: HA549342-AMAR-HGT-183800-183900SB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-183960-184020SB-GSS-000001		
Earthwork Widening Solution	1:3.0 Full Height Regrade		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	183960-184020		
Carriageway	Southbound		
Marker Post	MP183/9B+60 – MP184+20		
National Grid Reference	E 447331, N 326344 – E 447406, N 326410		
Existing Ground Level at Location	Carriageway	68.94mAOD	
	Crest of cutting	77.46mAOD	
Earthwork Type	NB: N/A	SB: Cutting	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_42061	HAGDMS designation
Earthwork Height	NB: N/A	SB: 8.5m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 22°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	21/12/2016	[redacted]
Checked	Alice Bazen	09/02/2017	
Reviewed	Gary Summerfield	10/02/2017	
Approved	Tom Bulteel	03/03/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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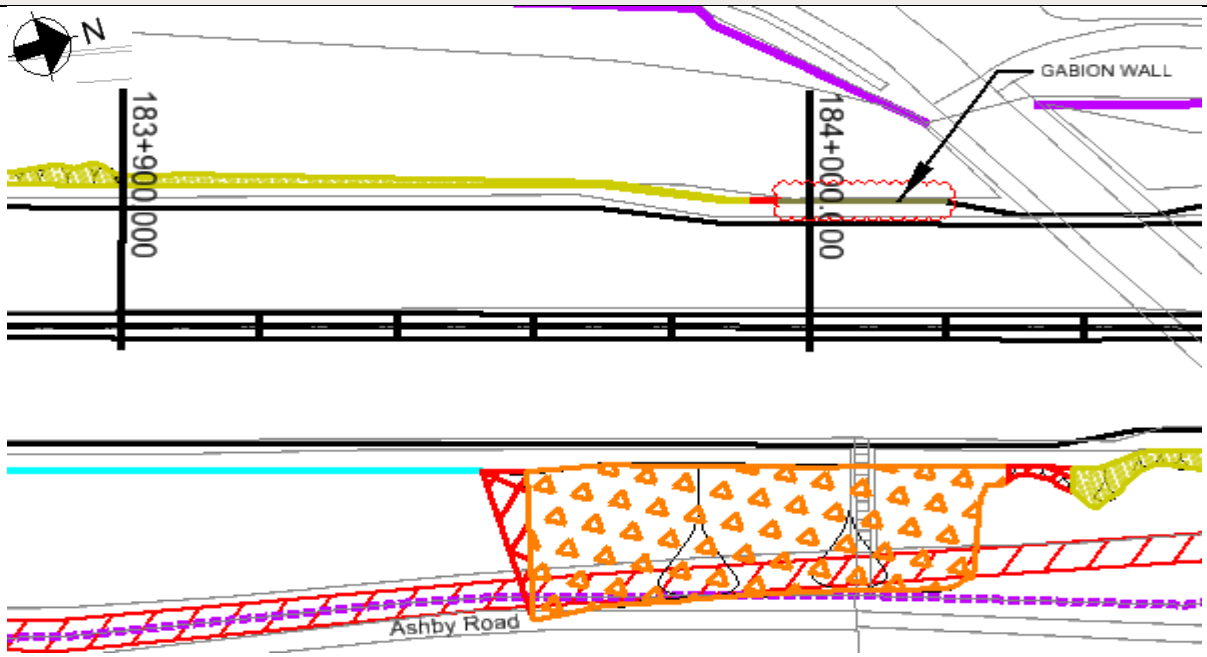


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Full Height Regrade at 1 in 3 gradient.

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a cutting ranging in height from 6.7m to 8.5m with a typical slope angle of 22 degrees.

The critical cross section is based on the cross section with the greatest earthwork height, which is at Ch183960.

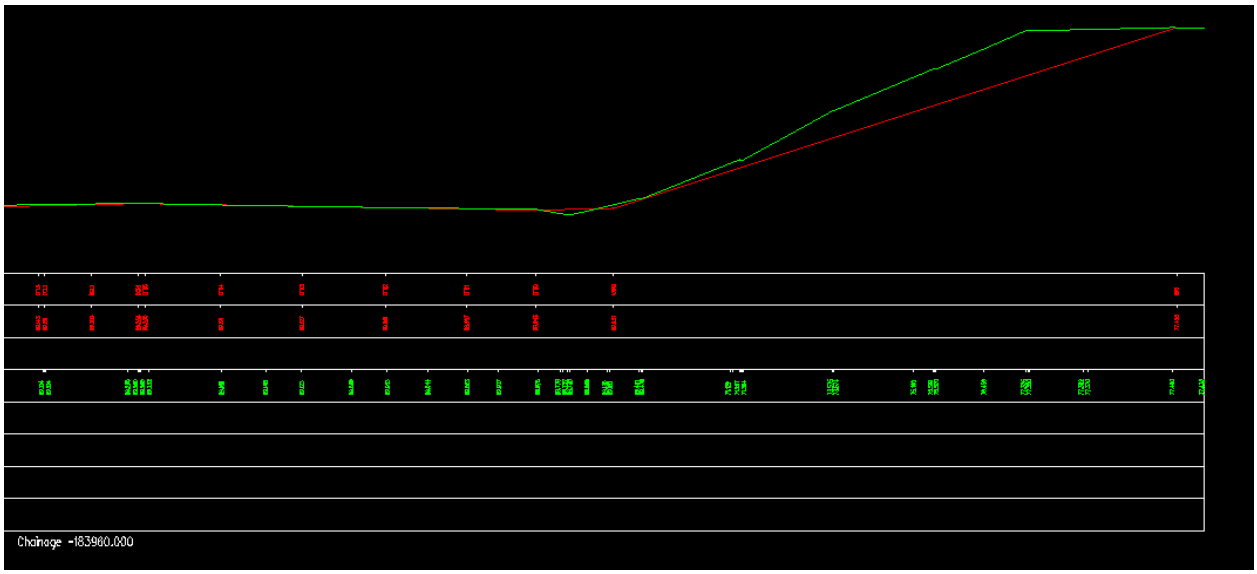


Figure 2: Topographic Critical Cross Section Chainage 183960

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: N/A

Solid Deposits: Gunthorpe Member (Mercia Mudstone Group), Mudstone

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage. Additional 2 no. relevant exploratory holes were considered outside the design chainage, as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000023, Rev P01.

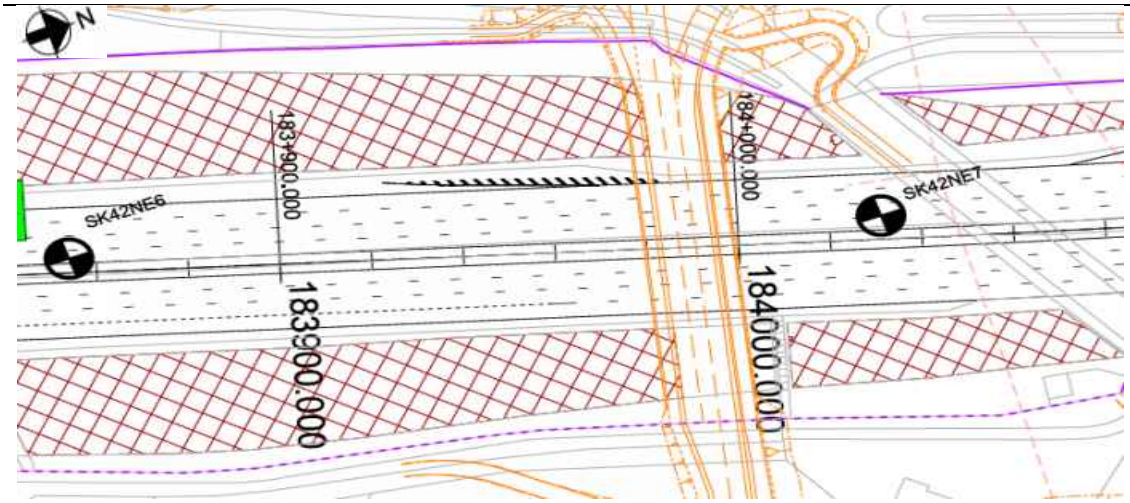


Figure 3: Borehole Location Plan

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Flood Risk:

This location is not in an area at risk from flooding.

Historical Boreholes:

Relevant Borehole Number	SK42NE6	SK42NE7
Borehole Chainage	183854	184035
Borehole Location	Northbound Carriageway	Northbound Carriageway
National Grid Reference	E 447330, N 326260	E 447380, N 326430
Ground Level at Exploratory Hole	82.30mAOD	75.00mAOD
RAG Analysis	Amber	Amber
Date Drilled	18/08/1961-22/08/1961	15/08/1961-17/08/1961
Termination Depth	15.24 metres below ground level (mbgl)	12.19 metres below ground level (mbgl)
Other suitable holes	None	

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Mercia Mudstone – III/IV	Not Proven	Not Proven	-

(1) Ground level is assumed to be at the crest of the cutting;
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have not been undertaken in any of the historical boreholes.

Groundwater:

Groundwater was encountered at 4.57mbgl (77.73mAOD) and 4.57mbgl (70.43mAOD) in boreholes SK42NE6 and SJ42NE7 respectively.

Groundwater Design Level:

Due to lack of local groundwater level available, a design groundwater level of 1.0m below ground level throughout cutting has been assumed.

GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

12 No Atterberg Limit Tests and 4 No. Natural Moisture Content tests were undertaken within the Mercia Mudstone – III/IV within SK42NE6 and SK42NE7 with the following relevant results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Mercia Mudstone-III/IV	1.98	19	37	20	17	CI
Mercia Mudstone-III/IV	1.98	24	33	19	14	CL
Mercia Mudstone-III/IV	3.35	-	31	16	15	CL
Mercia Mudstone-III/IV	3.51	-	34	19	15	CL
Mercia Mudstone-III/IV	4.88	15	33	19	14	CL
Mercia Mudstone-III/IV	4.88	-	39	17	22	CL
Mercia Mudstone-III/IV	6.48	15	32	18	14	CL
Mercia Mudstone-III/IV	6.40	-	30	19	11	CL
Mercia Mudstone-III/IV	7.92	-	33	16	17	CL
Mercia Mudstone-III/IV	9.32	-	33	19	14	CL
Mercia Mudstone-III/IV	11.13	-	28	19	9	CL
Mercia Mudstone-III/IV	13.26		30	20	10	CL

7 No. quick undrained triaxial tests were undertaken in the Mercia Mudstone III/IV.

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Mercia Mudstone-III/IV	10.67	376
Mercia Mudstone-III/IV	12.80	400
Mercia Mudstone-III/IV	1.52	45
Mercia Mudstone-III/IV	3.05	155
Mercia Mudstone-III/IV	6.10	317
Mercia Mudstone-III/IV	4.57	141
Mercia Mudstone-III/IV	1.52	141

Lab Test Data – BRE Classification:

No chemical laboratory testing data is available for this location.

Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that road level on the base of the cutting is straight on to the Mercia Mudstone III/IV at this location.

The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Mercia Mudstone – III/IV	0.00-10.00	77.46-67.46	10.00	21	30	2	100	10.8	8.6	-	0.5	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10m bgl)	>10.00	<67.46	>10.00	21	30	2	100	16.8	13.4	-	0.5	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from the interpreted geological long section.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion, c_u Young's modulus and Poisson's ratio derived in the AMAR GIR are used.
(4) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Mercia Mudstone, the classification used for the strata in the AMAR GIR was adopted.

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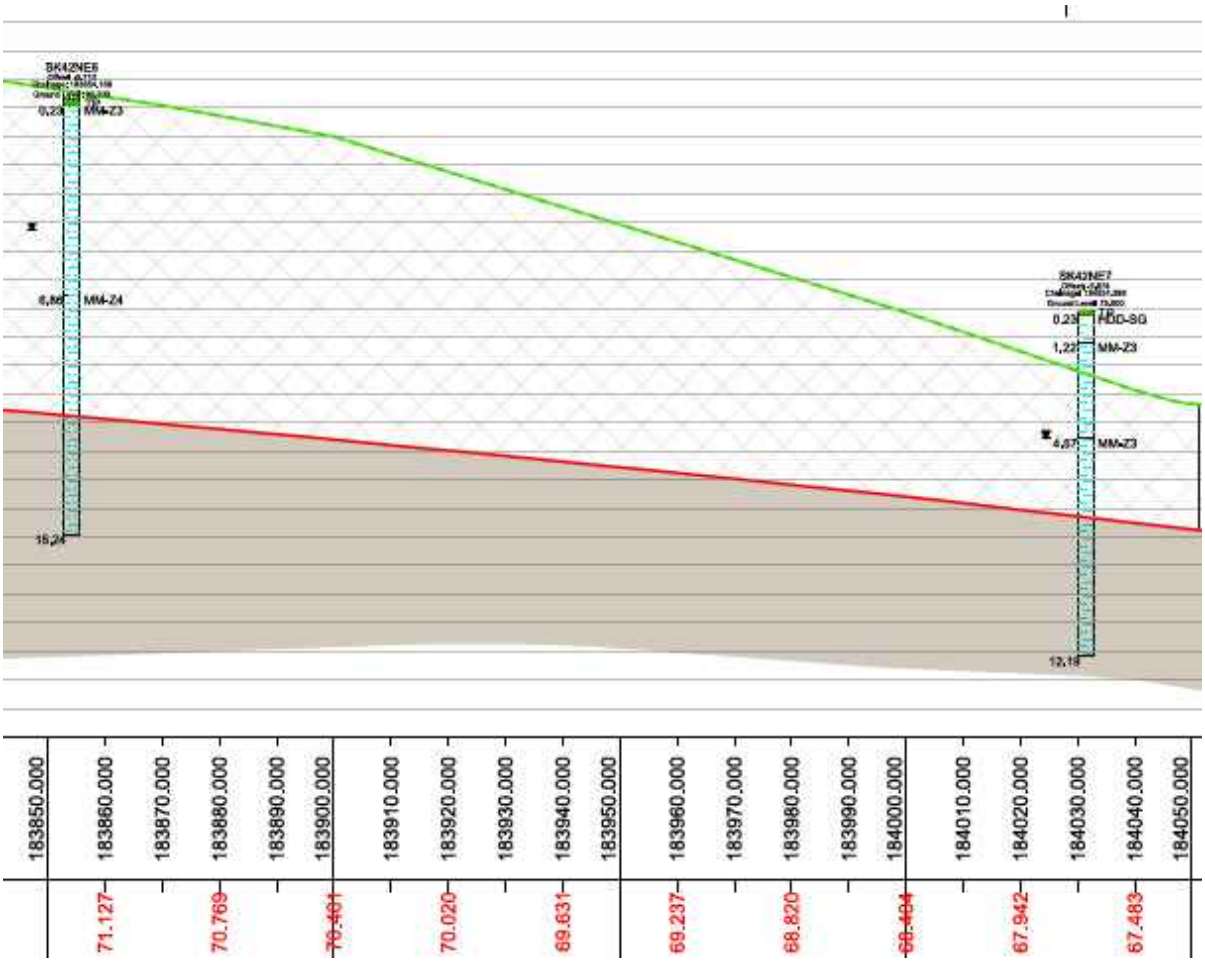


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
183960	184020	Full Height Regrade (1:3.0)

Proposed Structural Solution:

N/A

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- L-CCD -6A, Ch184012, Northbound - CPT to a scheduled depth of 5.0mbgl.
- L-CCD -6B, Ch184012, Southbound - CPT to a scheduled depth of 5.0mbgl.

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HISTORICAL EXPLORATORY HOLES

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Borehole Log

Borehole No. **SK42NE6** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447330.00 - 326260.00	Hole Type CP
Location:		Level: 82.30mbgl	Scale 1:50
Client: Highways England		Dates: 18/08/1961 - 22/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.23	82.07		Topsoil TP
									Firm to stiff red & grey silty clay MM-Z3
		0.76	533D						
		1.52 - 1.98	534U						
		2.29	535D						
		3.05 - 3.51	536U						
		3.35	537D						
		3.81	538D						
	▼	4.57	539D						
		4.57	555A W						
		4.57 - 4.88	540B						
		5.33	541D						
		6.10 - 6.48	542U	125blows					
		6.86	543D			6.86	75.44		Stiff red silty clay and siltstone MM-Z4
		7.62 - 7.92	544U	229blows					
		7.92	545D						
		8.38	546D						
		9.14 - 9.32	547U	140blows					
		9.91	548D						
									Continued on next sheet

Remarks

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Borehole Log

Borehole No. **SK42NE6**
HISTORIC
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447330.00 - 326260.00	Hole Type CP
Location:		Level: 82.30mbgl	Scale 1:50
Client: Highways England		Dates: 18/08/1961 - 22/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		10.67 - 11.13	549U	104blows					
		11.13	550D						
		12.19	551D						
		12.80 - 13.26	552U	181blows					
		13.72	553D						
		14.48	554D						
		14.94 - 15.24	555U	184blows					
						15.24	67.06		End of borehole at 15.24 m

Remarks

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Borehole Log

Borehole No. **SK42NE7** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447380.00 - 326430.00	Hole Type CP
Location:		Level: 75.00mbgl	Scale 1:50
Client: Highways England		Dates: 15/08/1961 - 17/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.23	74.77		Topsoil TP
		0.76	556D						Silty soil HDD-SG
		1.22	557D			1.22	73.78		Stiff red silty clay MM-Z3
		1.52	558D						
		1.52 - 1.98	559U						
		2.29	560D						
		3.05	561D						
		3.05 - 3.35	562B						
		3.81	563D						
	▼	4.42	577 W			4.57	70.43		Stiff red and grey silty clay and siltstone MM-Z3
		4.57 - 4.88	564U						
		4.72	565D						
		5.33	566D						
		6.10 - 6.40	567U						
		6.86	568D						
		7.62	569D						
		8.23 - 8.38	570U	100blows					
		9.14	571D						
		9.14 - 9.45	572U	130blows					
		9.91	573D						
									Continued on next sheet

Remarks

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Borehole Log

Borehole No. **SK42NE7**
HISTORIC
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447380.00 - 326430.00	Hole Type CP
Location:		Level: 75.00mbgl	Scale 1:50
Client: Highways England		Dates: 15/08/1961 - 17/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		10.67	574D						
		11.43	575D						
		12.19	576D			12.19	62.81		End of borehole at 12.19 m

Remarks

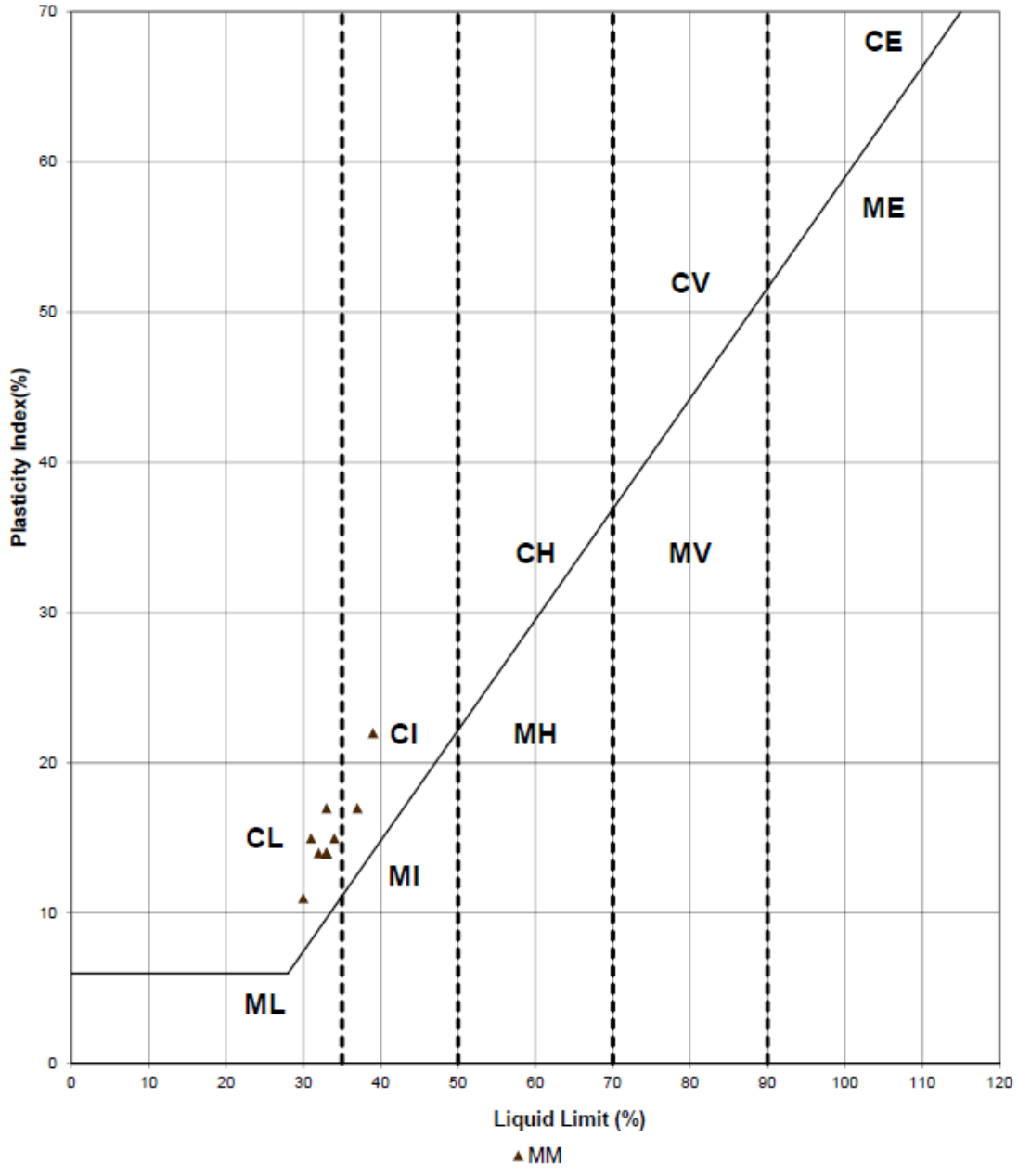
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PLOTS

A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183910-184020SB**
Client: **Highways England**	Borehole ID: **SK42SE6 and SK42SE7**	



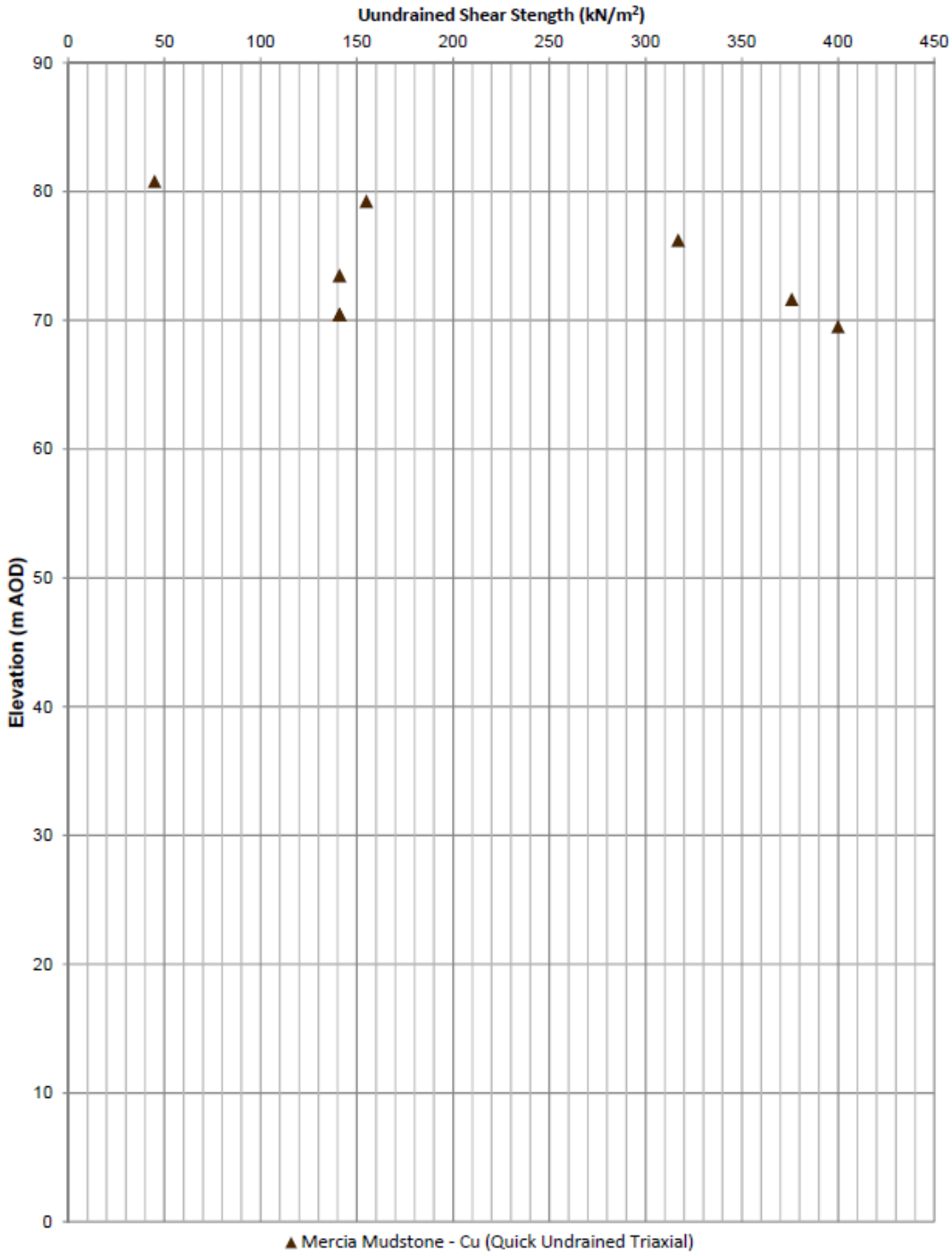
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **183910-184020SB**
Client: **Highways England**	Borehole ID: **SK42SE6 and SK42SE7**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-184110-184770SB-GSS-CE-000001		
Earthwork Widening Solution	1:2.5 Full Height Regrade, 1:2.5 Partial Height Regrade		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	184110-184470		
Carriageway	Southbound		
Marker Post	MP184/1B+10 – MP184/4B+70		
National Grid Reference	E 447429, N 326494 – E 447515, N 326851		
Existing Ground Level at Location	Crest of Cutting	72.91mAOD	
	Carriageway	66.19mAOD	
Earthwork Type	NB: N/A	SB: Cutting	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_42060	HAGDMS designation
Earthwork Height	NB: N/A	SB: 6.5m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 21°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	09/02/2017	[redacted]
Checked	Alice Bazen	11/02/2017	
Reviewed	Gary Summerfield	13/02/2017	
Approved	Tom Bulteel	03/03/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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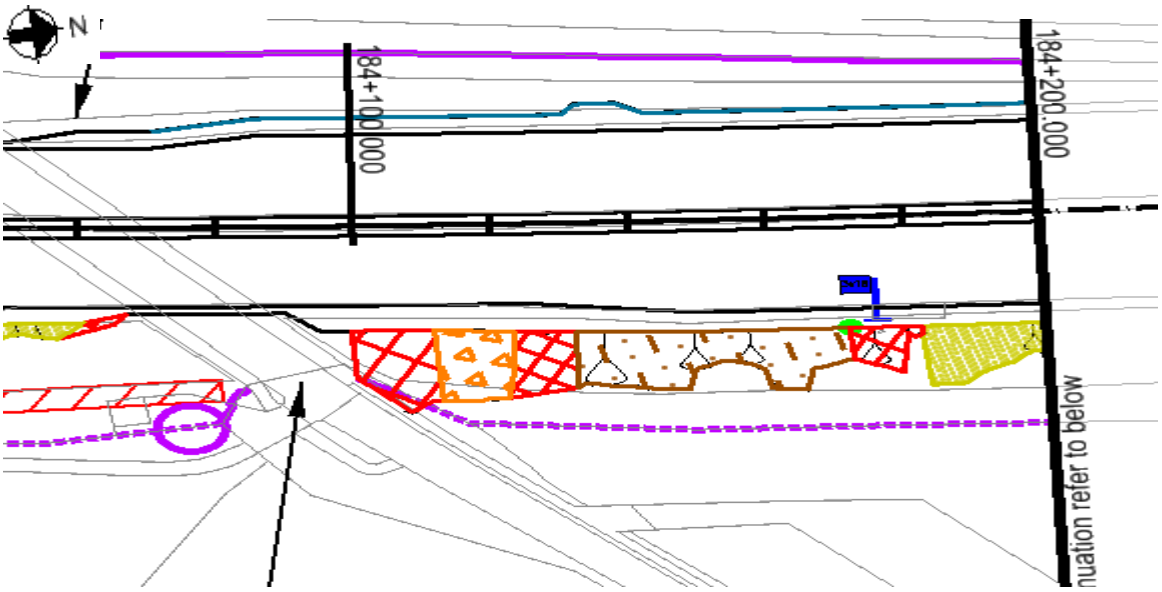


Figure 1.1: Location Plan – 184110-184200

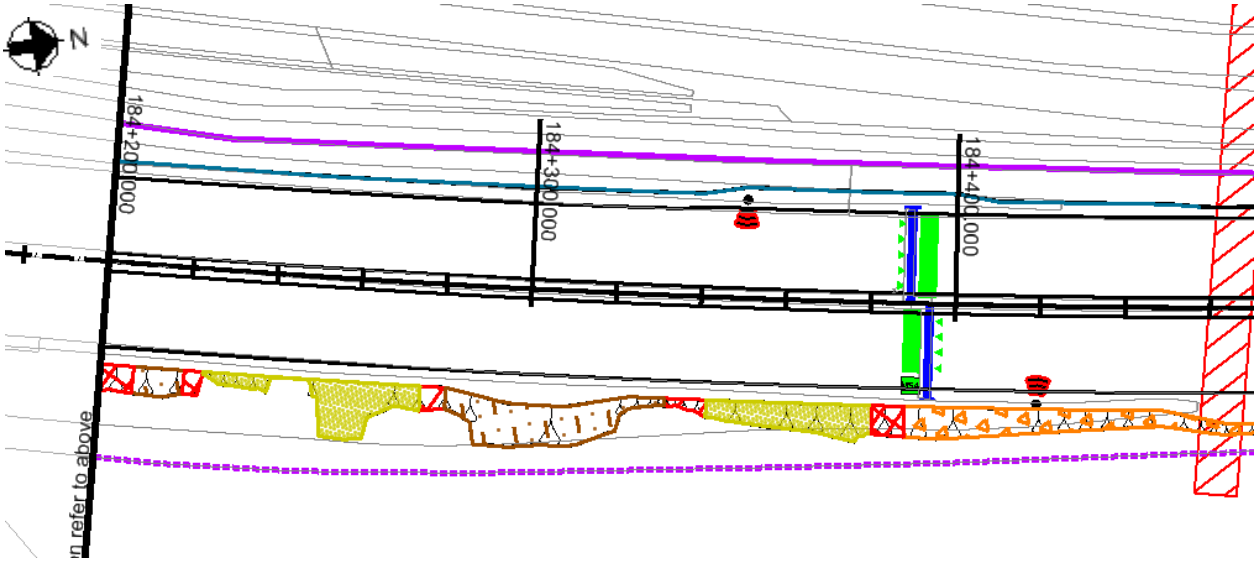


Figure 1.2: Location Plan – 184200-184470

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- 184110-184130: 1:2.5 Full Height Regrade
- 184130-184180: 1:2.5 Partial Height Regrade
- 184210-184220: 1.2.5 Partial Height Regrade
- 184280-184330: 1:2.5 Partial Height Regrade
- 184390-184470: 1.2.5 Full Height Regrade

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a cutting ranging in height from 2.5m to 6.5m with a typical slope angle of 21 degrees. Design is to be completed for 1:2.5 Full Height and 1:2.5 Partial Height Regrade for the worst case critical sections as presented in Figure 2 and Figure 3.

The critical cross sections at chainage 184110 and 184170 was based on sections with the greatest earthwork height.

Critical Section – 184110-184130 & 184390-184470

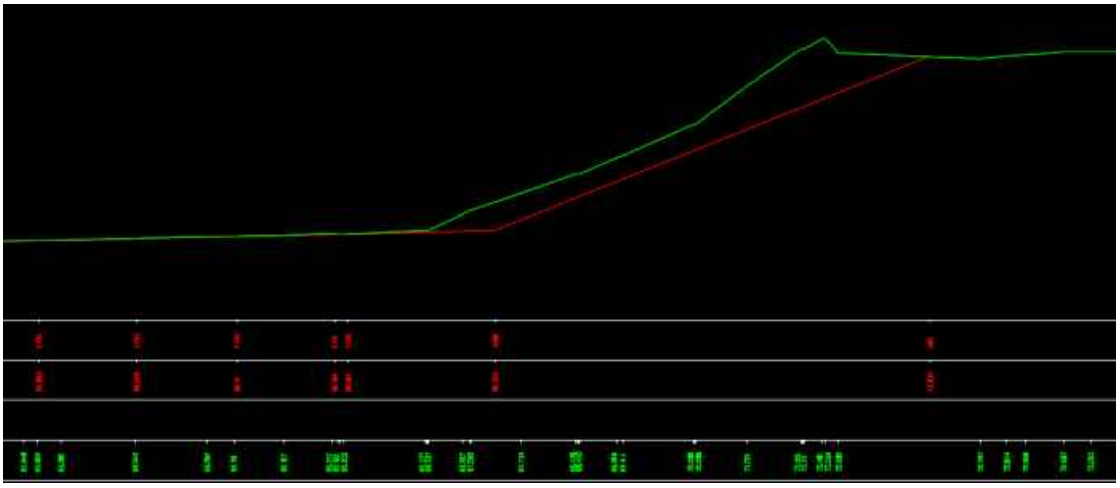


Figure 2.1: Topographic Critical Cross Section Chainage 184110

Critical Section – 184130-184180, 184210-184220 and 184280-184330

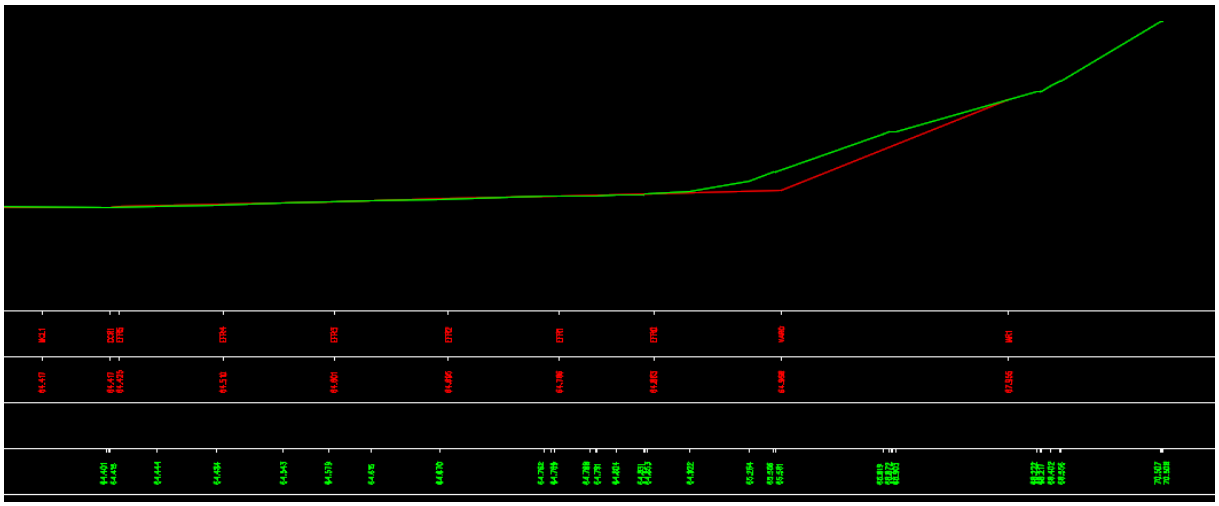


Figure 2.2: Topographic Critical Cross Section Chainage 184170

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Utilities:

Severn Trent Water pipe – Foul present at approximate chainage 184466-184465 running from south to north. Western Power HV cable present at approximately ch. 18470 along the north bound VRS/Earthwork. May be possible this crosses the south bound. Extra care/caution when excavating at or in vicinity of this location.

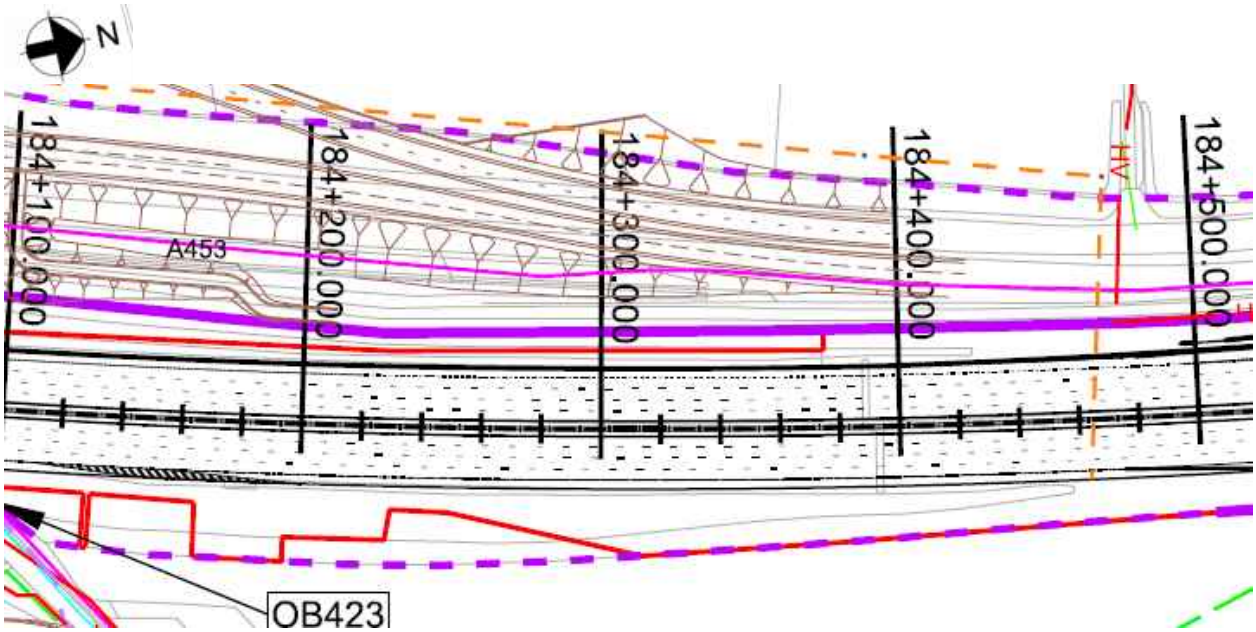


Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: None recorded

Solid Deposits: Tarporley Siltstone Formation - Siltstone, Mudstone And Sandstone

Ground Investigation:

There is 1 No. historical exploratory holes recorded within the design chainage, with additional 2 no. relevant exploratory holes considered outside the design chainage; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000024, Rev P01.

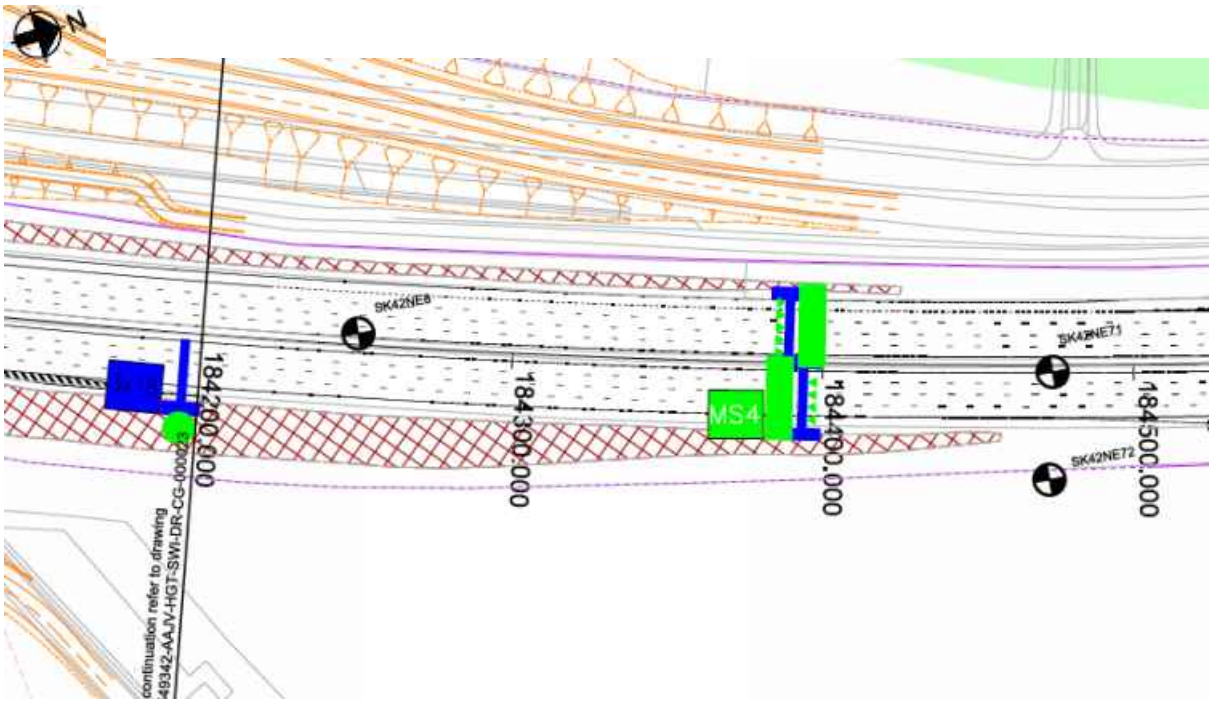


Figure 4: Borehole Location Plan

Flood Risk:

This location is not in an area at risk from flooding.

Historical Boreholes:

Relevant Borehole Number	SK42NE8
Borehole Chainage	184250
Borehole Location	Northbound
National Grid Reference	E 447440, N 326640
Ground Level at Exploratory Hole	66.10mAOD
RAG Analysis	Amber
Date Drilled	17/08/1961-18/08/1961
Termination Depth	7.62 metres below ground level (mbgl)
Other suitable holes	SK42NE71 and SK42NE72

Existing Ground Conditions

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Mercia Mudstone – III/IV	>16.26	<56.65	53-150 (53)

(1) Ground level is assumed to be at the crest of the cutting ;
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken in SK42NE71 and SK42NE72.

Groundwater:

Groundwater was not encountered in any of the historical boreholes.

Groundwater Design Level:

No local groundwater level is available and therefore a design groundwater level of 1.0m below ground level throughout cutting has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

5 No Atterberg Limit Tests and 6 No Natural Moisture Content tests were undertaken within the Mercia Mudstone – III/IV within SK42NE8 with the following relevant results:

Stratum	Depth to Top of Test (mAOD)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Mercia Mudstone – III/IV	0.61	8	36	17	19	CI
Mercia Mudstone – III/IV	1.52	15	31	19	12	CL
Mercia Mudstone – III/IV	3.05	14	-		-	-
Mercia Mudstone – III/IV	3.35	-	28	20	8	CL
Mercia Mudstone – III/IV	4.57	7	-	-	-	-
Mercia Mudstone – III/IV	5.18	-	34	19	15	CL
Mercia Mudstone – III/IV	6.10	21	-	-	-	-
Mercia Mudstone – III/IV	6.71	-	26	17	9	CL
Mercia Mudstone – III/IV	7.62	15	-	-	-	-

3 No. quick undrained triaxial tests were undertaken in the Mercia Mudstone III/IV.

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Mercia Mudstone – III/IV	1.52	97.0
Mercia Mudstone – III/IV	5.18	210.0
Mercia Mudstone – III/IV	6.71	90

Lab Test Data - Chemical:

No chemical laboratory testing data is available for this location.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that road level on the base of the cutting is straight on to the Mercia Mudstone III/IV at this location. The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γ_b (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Mercia Mudstone – III/IV	0.00-10.00	72.91-62.91	10.00	21	30	2	100	10.8	8.6	-	0.50	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10-16.26m bgl)	10.00-16.26	62.91-56.65	6.26	21	30	2	150	16.8	13.4	-	0.50	0.20	-	DS-2 AC-2
Mercia Mudstone >16.26mbgl	>16.26	<56.65	-	21	30	2	355	17.7	14.16	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from the interpreted geological long section.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion, and Poisson's ratio derived in the AMAR GIR are used.
(4) Due to limited GI data available for the Mercia Mudstone III/IV, the geotechnical parameters are based on values derived from the AMAR GIR.
(5) Due to limited SPT data available for the Mercia Mudstone between 10mbgl and 16.26mbgl, the geotechnical parameters are based on values derived in the AMAR GIR.
(6) A design SPT N value of 53 has been used for the Mercia Mudstone III/IV >16.26mbgl, with a PI of 12 combined with an f1 value of 6.7, which gives a Cu of355 kN/m^2.
(7) Eu for Mercia Mudstone – III/IV can be derived using N values (Bowles) where Eu = 300 (N+6); using a N value of 53 gives Eu = 17.7MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu.
(8) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Mercia Mudstone - III/IV, the classification used for the strata in the AMAR GIR was adopted.

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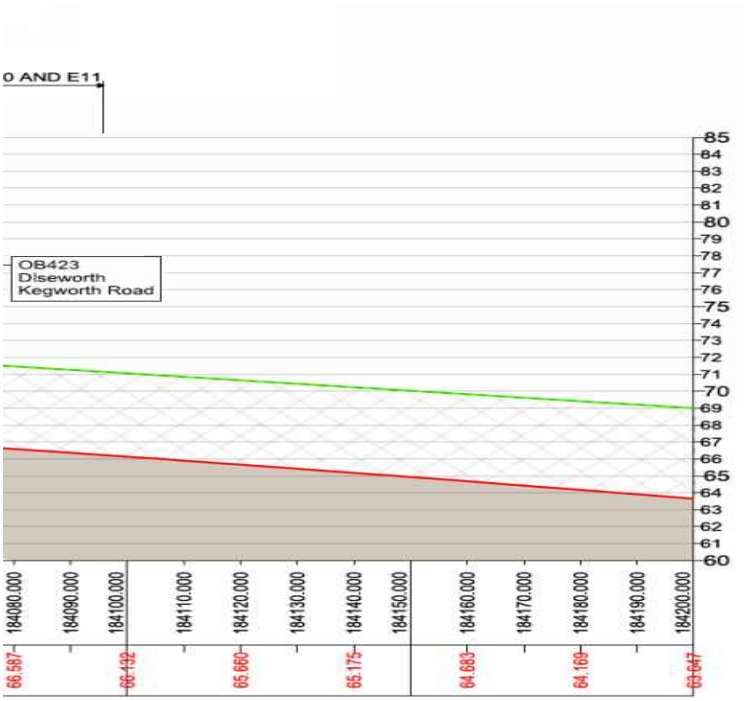


Figure 4.1: Geological Long Section – 184110-184200

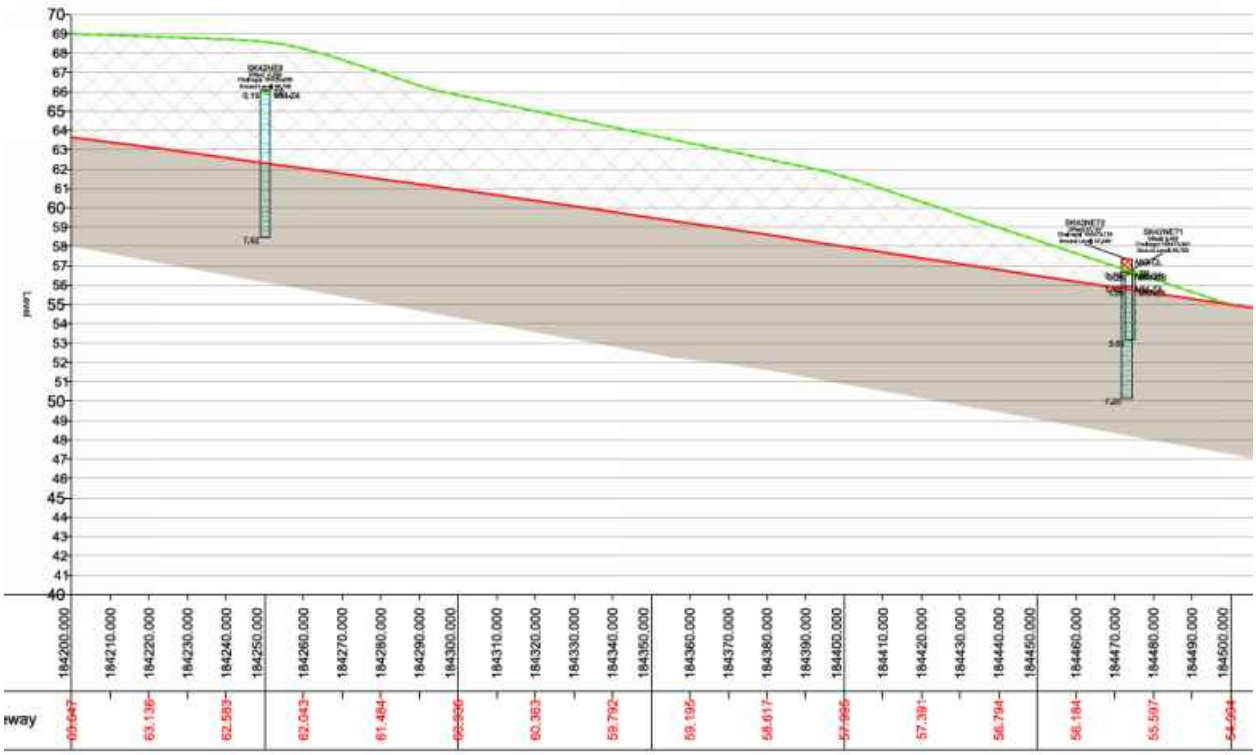


Figure 4.2: Geological Long Section – 184200-184510

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
184110	184130	Full Height Regrade (1:2.5)
184130	184180	Partial Height Regrade (1:2.5)
184210	184220	Partial Height Regrade (1:2.5)
184280	184330	Partial Height Regrade (1:2.5)
184390	184470	Full Height Regrade (1:2.5)

FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- T – CCD-10B – Ch.184372, Southbound – CPT to a scheduled depth of 5.0mbgl.

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LOGS

Borehole Log

Borehole No. **SK42NE8** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447440.00 - 326640.00	Hole Type CP
Location:		Level: 66.10mbgl	Scale 1:50
Client: Highways England		Dates: 17/08/1961 - 18/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.15	65.95		Topsoil TP Stiff red & grey silty clay & siltstone MM-Z4
		0.61	577D						
		1.52	578D						
		1.52 - 1.98	579U	93blows					
		3.05	580D						
		3.35 - 3.51	581U	250blows					
		4.57	582D						
		5.18 - 5.46	583U	380blows					
		6.10	584D						
		6.71 - 6.93	585U	180blows					
		7.62	586D			7.62	58.48		End of borehole at 7.62m

Remarks
No groundwater

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Borehole Log

Borehole No. **SK42NE71** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447491.00 - 326858.00	Hole Type CP
Location:		Level: 56.75mbgl	Scale 1:50
Client: Highways England		Dates: 02/02/1988 - 02/02/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.20 - 0.80	1B			0.20	56.55		TOPSOIL TP Light grey green moderately weathered silty fine grained porous SANDSTONE weak to very weak with occasional red brown siltstone lenses and occasional black speckled staining. (KEUPER SERIES SANDSTONE 3) MM-SS
		1.00	SPT (S)	N=98 (8,9/12,15,24,47)	Water=-	1.00	55.75		
		1.00 - 1.45	2D						Very stiff (hard) red brown CLAY with occasional fine gravel sized lithorelics thinly to thickly interlaminated very dense light grey green SILT. Below 2.30m stiff becoming very stiff red brown locally thinly laminated locally very silty CLAY with occasional fine to medium occasionally coarse gravel sized lithorelics and occasional bands and lenses of light greenish grey slightly fine sandy siltstone. (KEUPER SERIES MARL 3/4a) MM-Z3
		1.70	SPT (S)	N=53 (7,15/19,9,8,17)	Water=-				
		1.70 - 2.15	3D						
		2.50	SPT (S)	N=98 (8,14/17,21,26,34)	Water=-				
		2.50 - 2.95	4D						
		3.00	SPT (S)	50 (12,37/50 for 40mm)	Water=-				
		3.00 - 3.19	5D						
		3.40	SPT (S)	50 (9,28/50 for 55mm)	Water=-	3.61	53.14		End of borehole at 3.61m
		3.40 - 3.61	6D						

Remarks
Hand dug inspection pit from ground level to 1.00m

AGS

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Borehole Log

Borehole No. **SK42NE72** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447525.00 - 326851.00	Hole Type CP
Location:		Level: 57.35mbgl	Scale 1:50
Client: Highways England		Dates: 25/01/1988 - 26/01/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	1D						Very stiff red brown very silty locally slightly fine sandy CLAY with occasional fine gravel sized lithorelics and a little to some angular medium to coarse mudstone and sandstone gravel. (Possible FILL) MG-CL
		0.50 - 0.95	2U	150blows		0.70	56.65		
		1.00	3D						Light grey green moderately weathered silty fine grained SANDSTONE weak to very weak with black speckled staining. Below 1.00m becoming fine silty SAND with frequent medium to coarse gravel sized lithorelics. (KEUPER SERIES SANDSTONE 3) MM-SS
		1.00	SPT (S)	N=64 (3,10/15,12,17,20)	Water=-	1.40	55.95		
		1.00 - 1.45	4D						
		2.00	SPT (S)	N=92 (7,12/17,23,25,27)	Water=-				Very stiff red brown locally thinly laminated CLAY with occasional fine to medium gravel sized lithorelics and occasional pockets and lenses of light grey green silt and siltstone. Frequent bands of light reddish green silty fine SAND with occasional fine to medium gravel sized lithorelics. (KEUPER SERIES MARL 3/4a) Below 7.00m becoming probably sandstone MM-Z3
		2.00 - 2.45	5D						
		3.00	SPT (S)	50 (15,36/50 for 50mm)	Water=-				*red brown probably moderately weathered SILTSTONE very weak*
		3.00 - 3.20	6D						
		4.00	SPT (S)	50 (17,31/50 for 42mm)	Water=-				
		4.00 - 4.19	7D						
		5.00	SPT (S)	0 (70 for 115mm/0 for 0mm)	Water=-				
		5.00 - 5.12	8D						
		6.00	SPT (S)	50 (17,36/50 for 75mm)	Water=-				
		6.00 - 6.23	9D						
		7.00	SPT (S)	0 (72 for 125mm/0 for 0mm)	Water=-	7.20	50.15		End of borehole at 7.20 m
		7.00 - 7.12	10D						

Remarks

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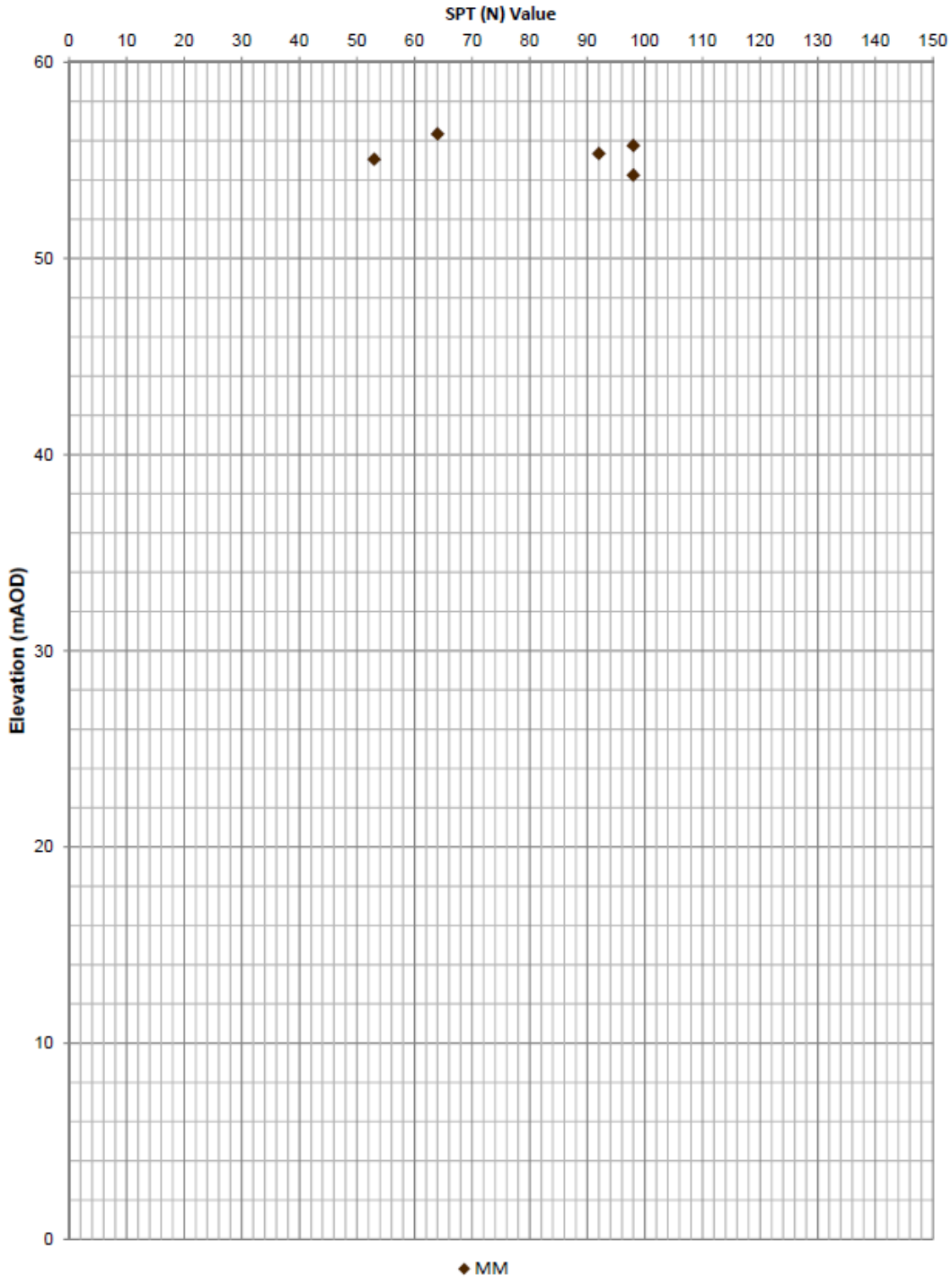
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PLOTS

amey ARUP

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184110-184470**
Client: **Highways England**	Borehole ID: **SK42NE71 and SK42NE72**	

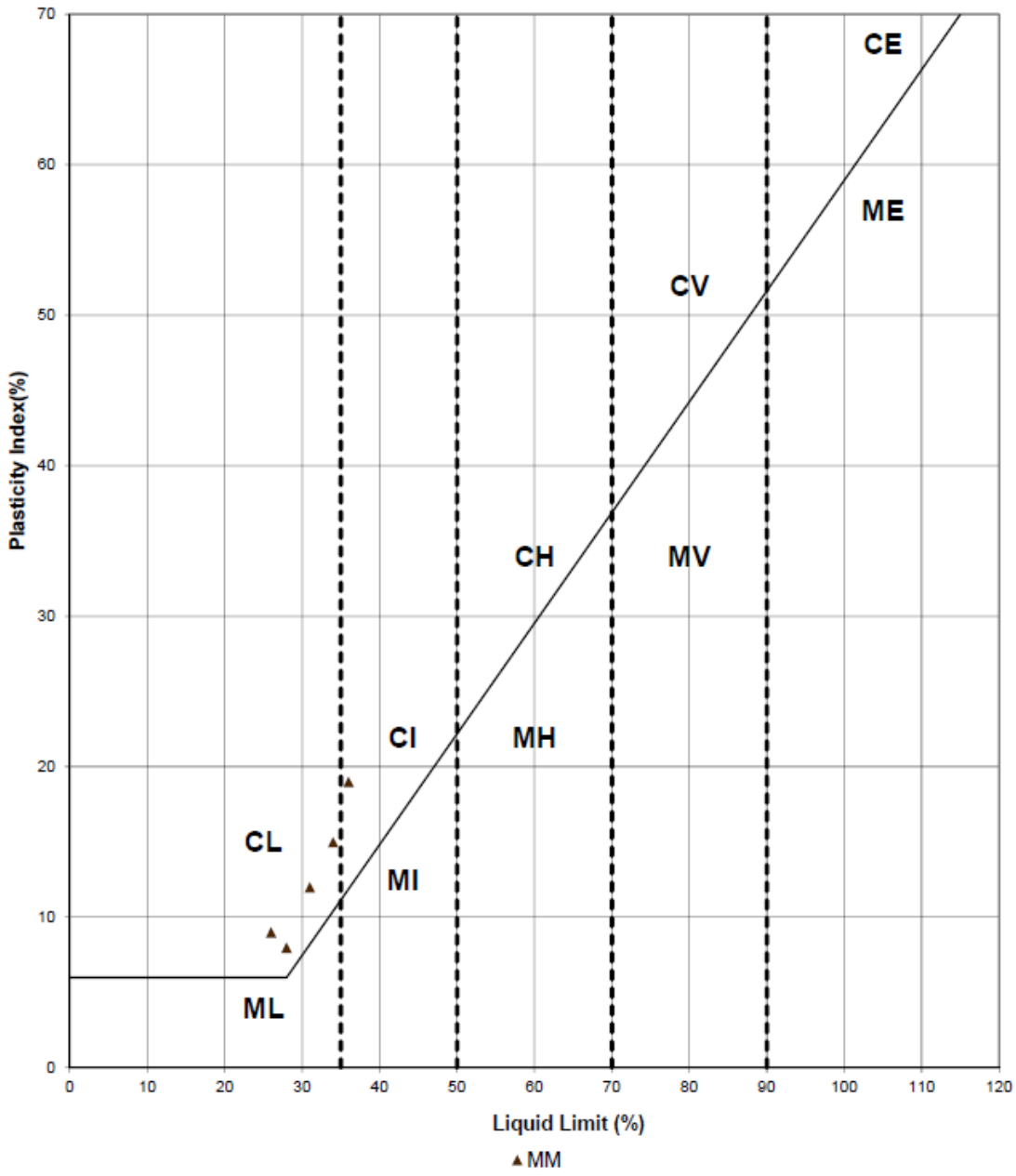


Extrapolated SPT (N) Values >150 have not been shown

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184110-184470**
Client: **Highways England**	Borehole ID: **SK42NE8**	



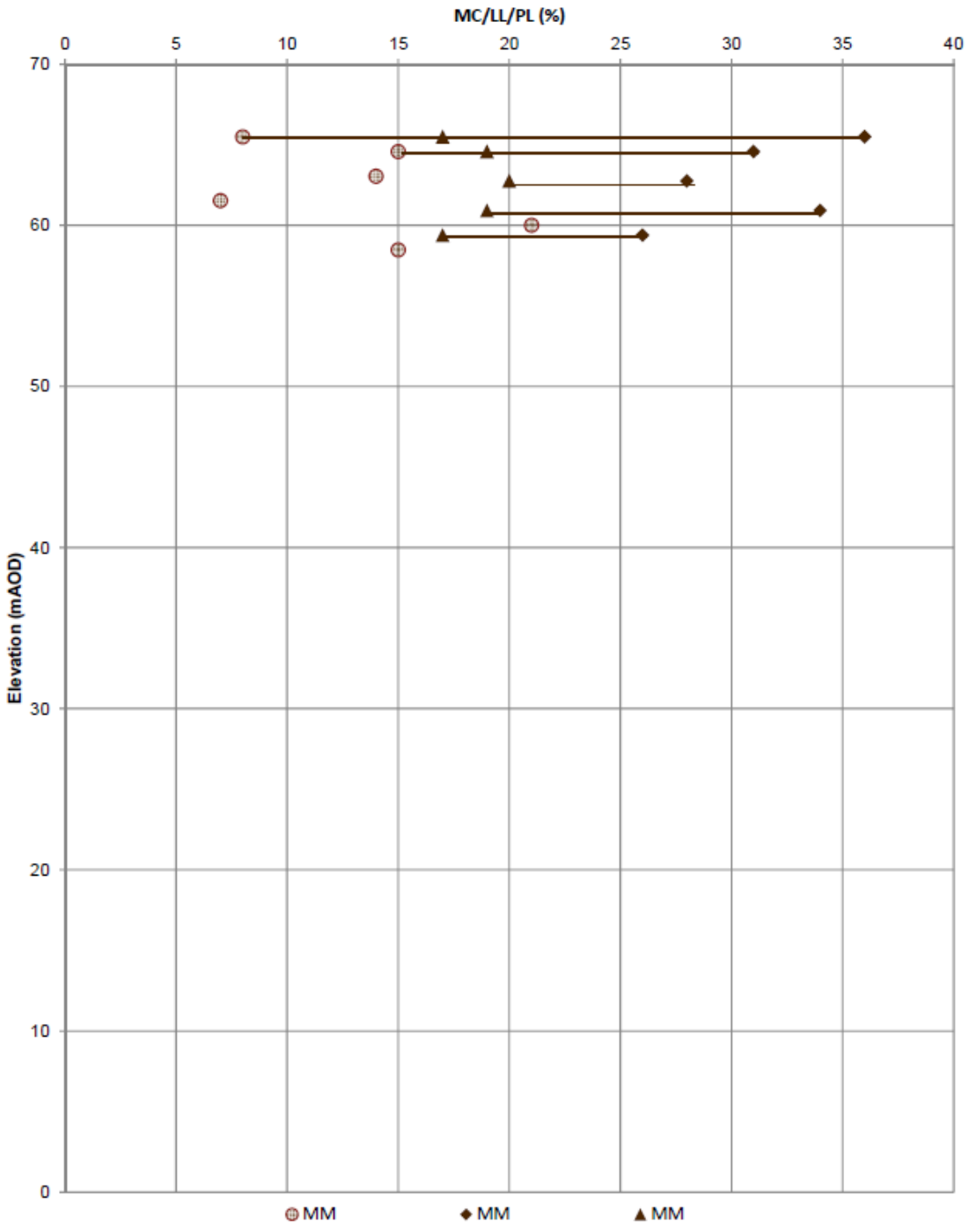
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

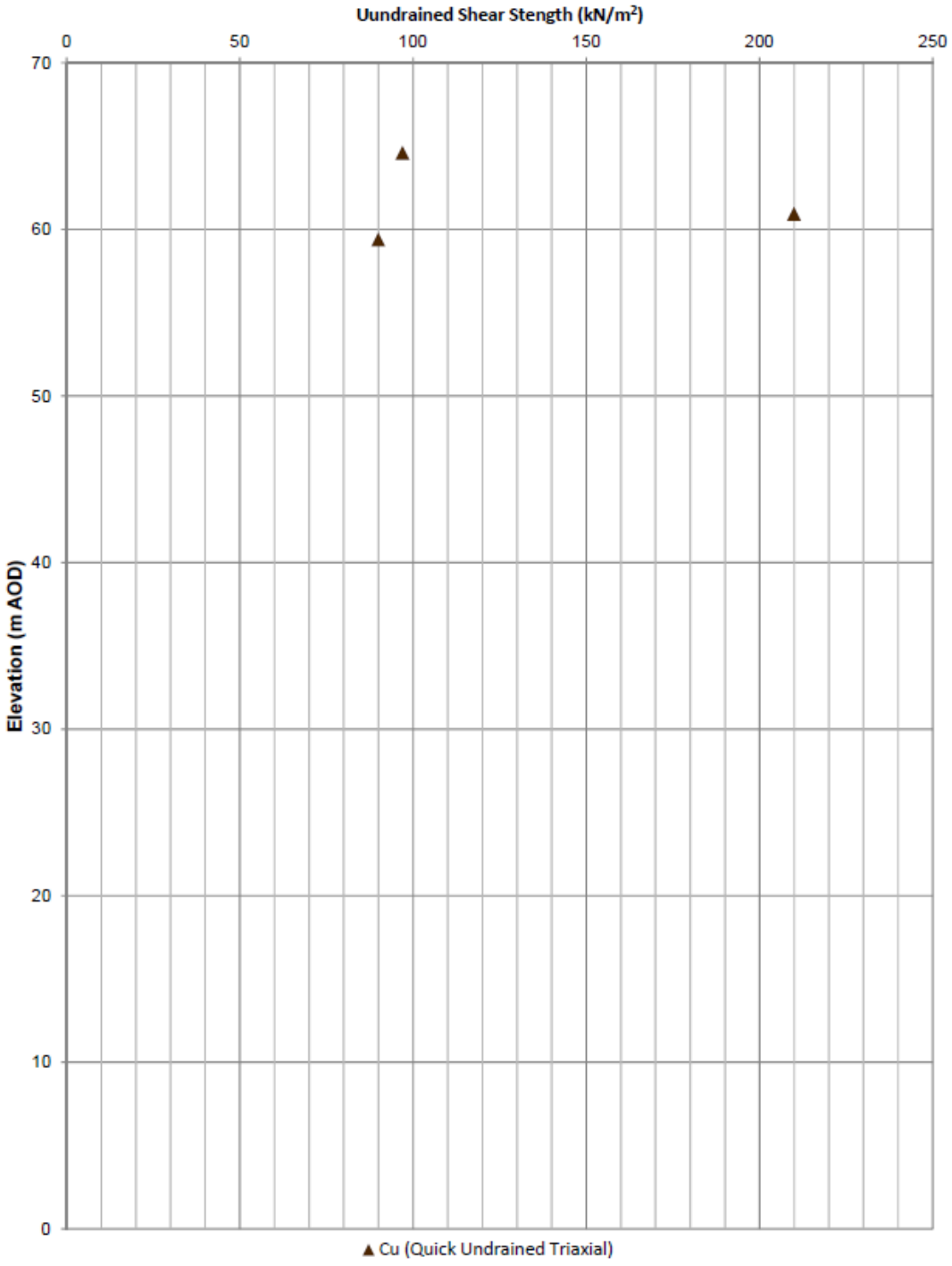
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184110-184470**
Client: **Highways England**	Borehole ID: **SK42NE8**	



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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184110-184470**
Client: **Highways England**	Borehole ID: **SK42NE8**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-184630-184740SB-GSS-CE-000001		
Earthwork Widening Solution	Full Height Embankment Widening 1:2.0		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	184630-184740		
Carriageway	Southbound		
Marker Post	MP184/6B+30 – MP184/7B+40		
National Grid Reference	E 447537, N 327005 – E 447550, N 327124		
Existing Ground Level at Location	Carriageway	49.18mAOD	
	Toe embankment	46.53mAOD	
Earthwork Type	NB: N/A	SB: At Grade	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_62641	HAGDMS designation
Earthwork Height	NB: N/A	SB: 2.65m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 26°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	04/02/2017	[redacted]
Checked	Alice Bazen	09/02/2017	
Reviewed	Gary Summerfield	10/02/2017	
Approved	Tom Bulteel	17/02/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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DESK STUDY

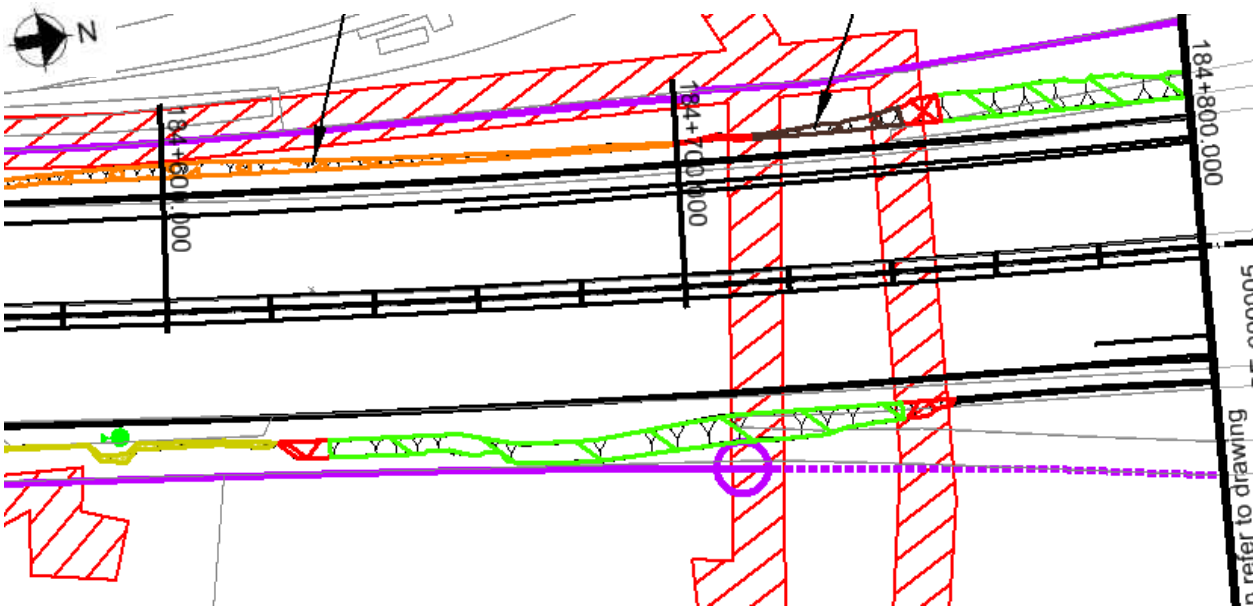


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Full height embankment widening (1:2.0)

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as at grade. The earthwork is a shallow embankment ranging in height from 1.6m to 2.65m with a typical slope angle of 26 degrees

The critical cross section at Ch.184710 was based on the section with the greatest earthwork height.

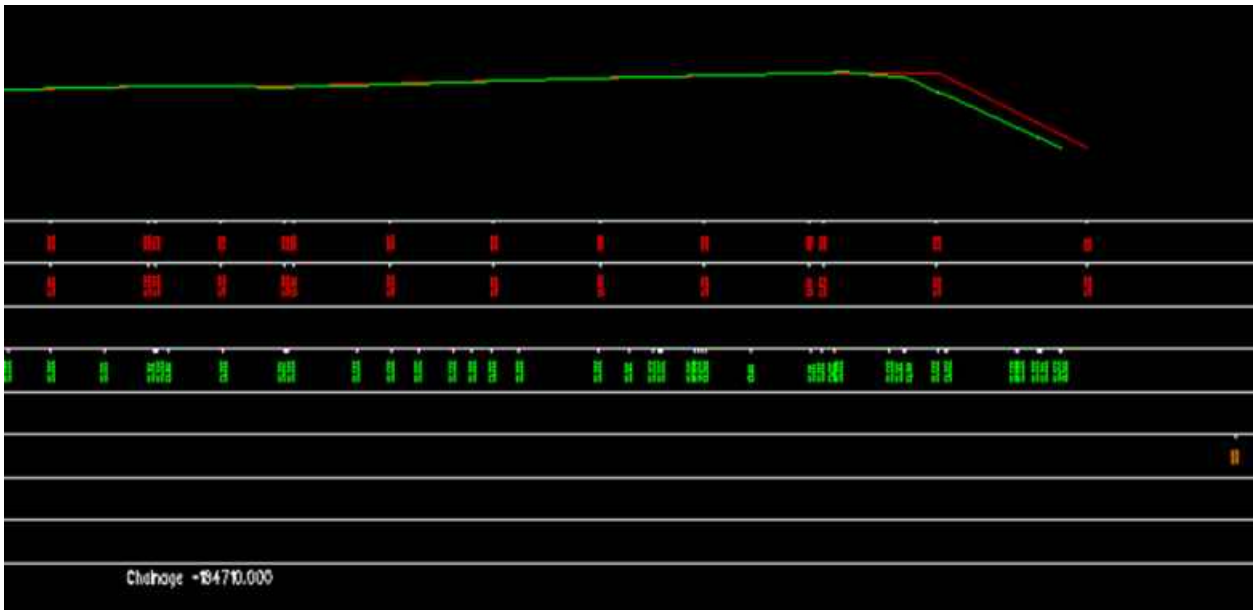


Figure 2: Topographic Critical Cross Section Chainage 184710

Utilities:

Western Power HV cable present at approximately Ch. 184740 running east to west. National Grid Medium Pressure Pipe running west to east.

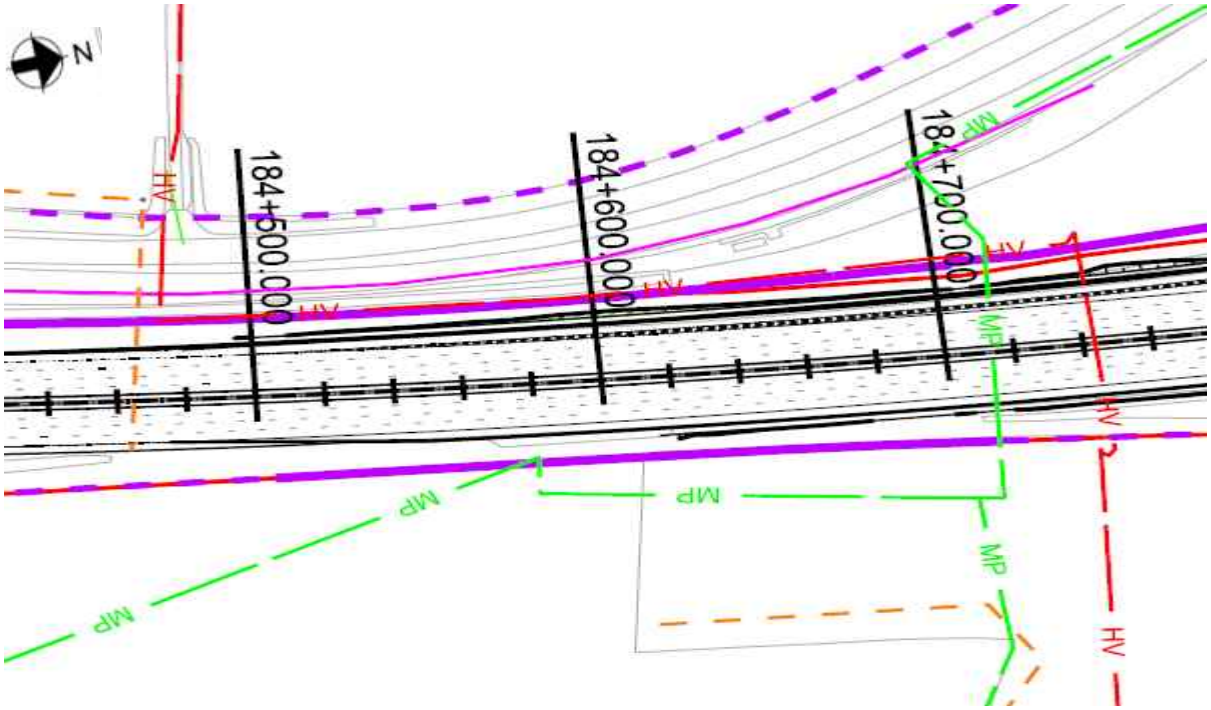


Figure 3: Utilities location plan

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Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Egginton Common Sand And Gravel Member - Sand And Gravel

Solid Deposits: Bromsgrove Sandstone Formation – Sandstone & Edwalton Member-Mudstone

Ground Investigation:

There is 1 No.historical exploratory hole recorded within the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000024, Rev P01.

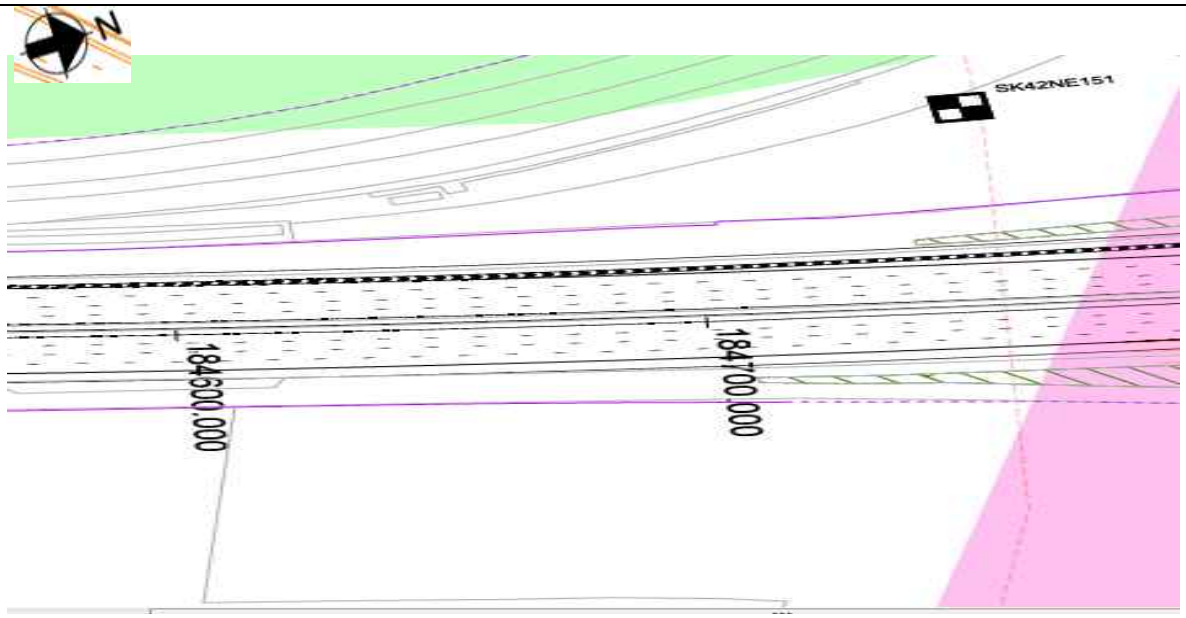


Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42NE151
Borehole Chainage	184755
Borehole Location	Northbound
National Grid Reference	E 447446, N 327144
Ground Level at Exploratory Hole	44.60mAOD

RAG Analysis	Amber
Date Drilled	10/05/1988
Termination Depth	3.0 metres below ground level (mbgl)
Other suitable holes	None

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Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Embankment Fill*	2.65	46.53	-
Mercia Mudstone III-IV	<10.00	>39.18	-

(1) Ground level is assumed to be at the carriageway level;
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) Due to lack of GI data at this location, it has been assumed based on the Geological Long sections and the topographic survey that embankment fill sits on top of Mercia Mudstone.
(4) Sandstone was encountered in the exploratory boreholes however given the uncertainties on ground conditions , only Mercia Mudstone – III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPTs) have not been undertaken between 184630 and 184740.

Groundwater:

Groundwater was not encountered in any of the historical boreholes.

Groundwater Design Level:

No local groundwater level is available and therefore a design groundwater level of 1.0m below toe of embankment has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

No geotechnical lab tests have been undertaken between 184630 and 184740

Lab Test Data – BRE Classification:

No chemical laboratory testing data is available between 184630 and 184740.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that the embankment comprises cohesive embankment fill constructed straight on to the Mercia Mudstone III/IV at this location. The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0.00-2.65	49.18 – 46.53	10.00	21	27	0	100	7.80	6.20	-	0.50	0.20	-	DS-2 AC-2
Mercia Mudstone – III-IV <10.0mbgl	2.65 – 10.00	46.53 – 39.18	7.35	21	30	2	100	10.80	8.60	-	0.50	0.20	-	DS-2 AC-2
Mercia Mudstone >10.0mbgl	>10.00	<56.65	-	21	30	2	200	16.80	13.40	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from the interpreted geological long section.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion, and Poisson's ratio derived in the AMAR GIR are used.
(4) Due to limited GI data available for the Mercia Mudstone III/IV<10mbgl, the geotechnical parameters are based on values derived from the AMAR GIR.
(5) Due to limited GI data available for the Mercia Mudstone III/IV>10mbgl, the geotechnical parameters are based on values derived from the AMAR GIR
(6) Due to limited GI data available for the Embankment Fill, the geotechnical parameters are based on values derived from the AMAR GIR.
(7) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

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Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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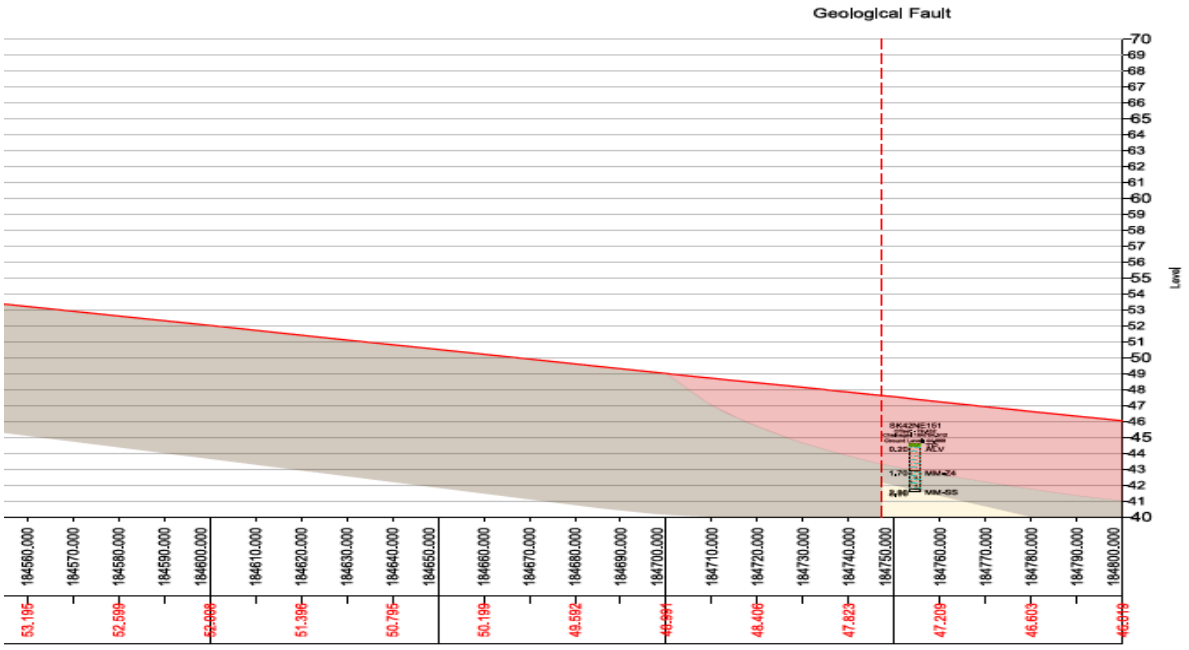


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
184630	184740	Full Height Embankment Widening (1:2.0)	1.94	26.6 (1V:2H)

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-CCD10B at chainage 184372, southbound – CPT test to a depth of 5.0mbgl.

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LOGS

Trial Pit Log

Trialpit No **SK42NE151** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447446.10 - 327143.80 Level: 44.60mbgl	Date 10/05/1988
Location:		Dimensions: 3.00m (0.70m) Inclination: ° Orientation: ° Depth: 3.00m	Scale 1:50 Logged
Client: Highways England			

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
					0.20	44.40		Firm greyish brown sandy CLAY (TOPSOIL) TP
	1.00 1.00	B2B D1D						Firm slightly reddish brown very sandy CLAY tending to SAND in places with a little medium to coarse subrounded gravel (RIVER TERRACE DEPOSIT) ALV
					1.70	42.90		Firm to stiff pale greenish grey mottled greenish brown very silty, slightly sandy in part CLAY, closely fissured, with some medium gravel size angular siltstone fragments. Becoming with many siltstone fragments (KEUPER MARL - ZONE IV) MM-Z4
	1.90 1.90	B4B D3D						
	2.60	D5D						
					2.90	41.70		Greenish grey fine grained well cemented SANDSTONE, moderately weak (KEUPER MARL - SKERRY) MM-SS
	3.00 3.00	B6B D7D			3.00	41.60		End of pit at 3.00 m

Shift Information				Backfill			Water Strike						Depth Related Remarks		
Date & Time	Depth	Water	Remarks	Top	Base	Description	Struck	Rose to	Date	Time	Sealed	Remarks	Top	Base	Remarks

Remarks:

Stability: Good

AGS

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PLOTS

No Plots Available.

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-185170-185210-GSS-CE-000001		
Earthworks Widening Solution	Full Height Regrade 1:3.0		
Structure Number	GANTRY_112 [1]		
Structure Type	New Super Cantilever Gantry with MS4 + AMI		
Design Chainage	185170-185210		
Carriageway	Southbound		
Marker Post	185/1B+70 – 185/2B+10		
National Grid Reference	E 447558, N 3275460 - E 447547, N 327586		
Existing Ground Level	Crest of cutting	39.15mAOD	
	Carriageway level	35.74mAOD	
Earthwork Type	NB: N/A	SB: Cutting	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: N/A	SB: 7_M1_42058	HAGDMS designation
Earthwork Height	NB: N/A	SB: 3.4m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 15°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Roheel Masrat	15/02/2017	[redacted]
Checked	Alice Bazen	15/02/2017	
Reviewed	Gary Summerfield	16/02/2017	
Approved	Tom Bulteel	23/02/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this structure. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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DESK STUDY

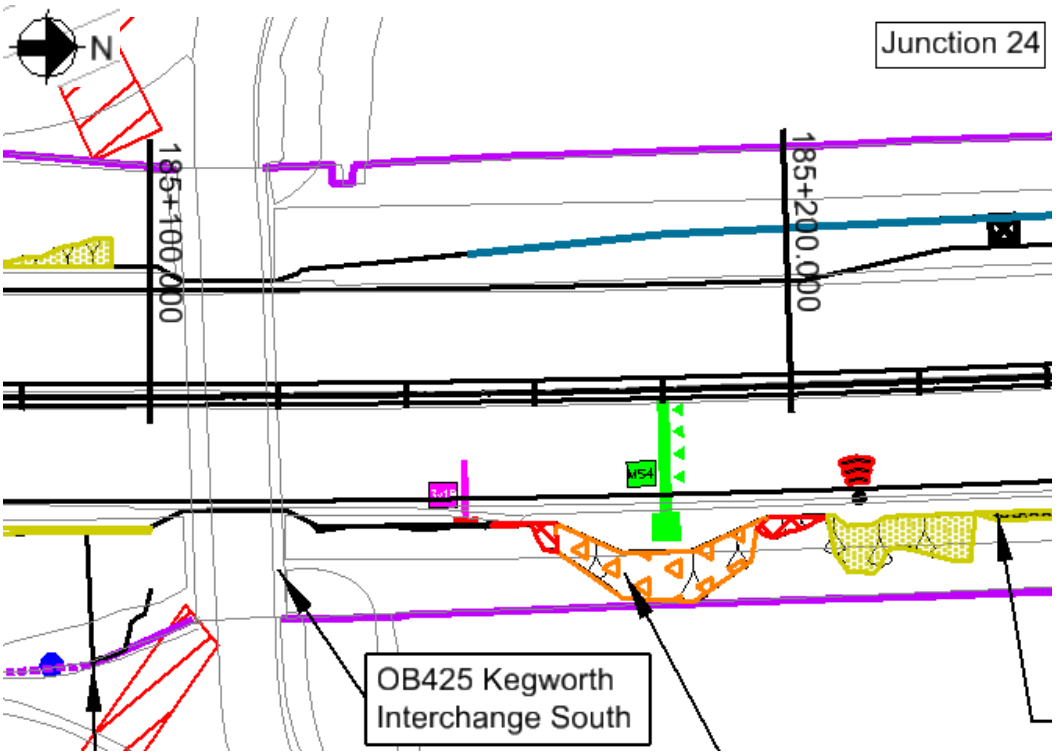


Figure 1: Location Plan

Proposed New Structure:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Full height Regrade at 1 in 3 gradient.

Proposed Major Structures:

Super cantilever gantry structure which will incorporate a new MS4 and AMI, situated on the southbound carriageway. This new gantry will replace an existing MS3 Gantry.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a cutting. The earthwork height is approximately 3.4m with an angle of 12°.

The critical cross section at Ch.185210 is based on the section with the greatest earthwork height.

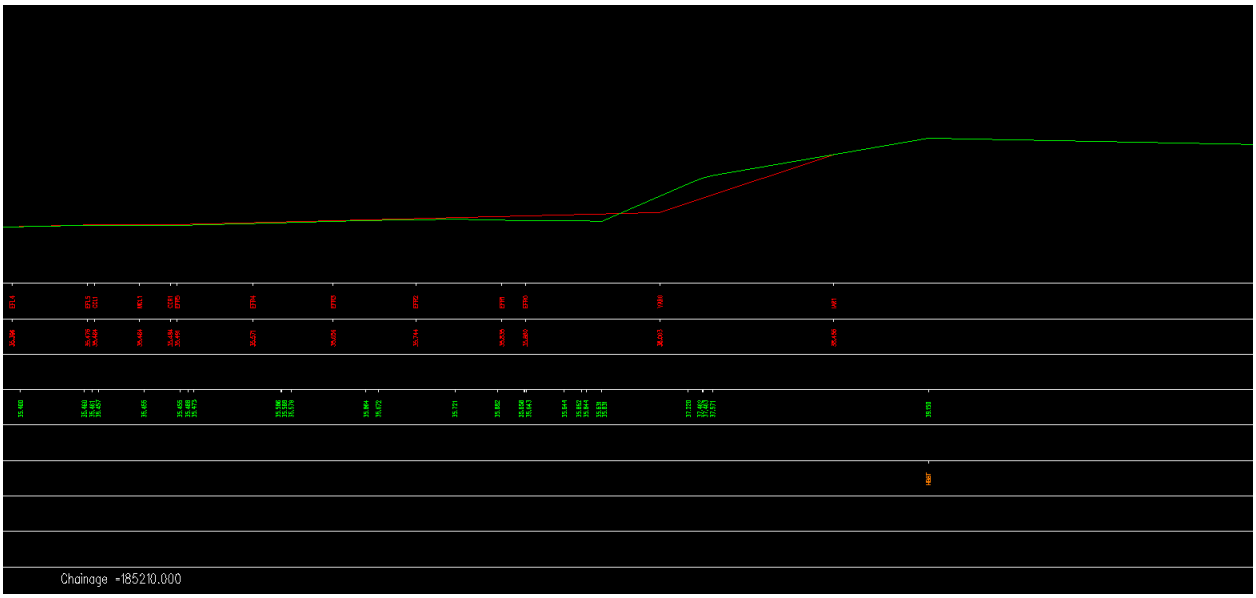


Figure 2: Topographic Cross Section Chainage 185210

Utilities:

No utilities are present in the vicinity of the gantry.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Wanlip Member – Sand and Gravel

Solid Deposits: Edwalton Member (Mudstone – Mercia Mudstone Group)

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however 1 no. relevant exploratory hole is considered outside the design chainage; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000025, Rev P01.

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Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Closest Borehole Number	SK42NE10
Borehole Chainage	185119
Borehole Location	Northbound Carriageway
National Grid Reference	E 447530, N 327500
Ground Level at Exploratory Hole	39.2mAOD
RAG Analysis	Amber
Date Drilled	12/08/1961
Termination Depth	9.1 metres below ground level (mbgl)
Other Suitable Holes	None

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survery.

Depth to Top (mbgl)	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Embankment Fill	4.75	34.4	-
Mercia Mudstone –III/IV	>11.5	<28.10	-

(1) Ground level is assumed to be at the crest of the cutting / carriageway level

(2) Due to the proximity of Junction 24, this location is situated within a cutting comprised of Embankment Fill forming the embankment that carries the elevate roundabout.

In Situ Testing:

No in-situ testing data is available.

Groundwater:

Groundwater was encountered in SK42NE10 at 35.2mAOD.

Groundwater Design Level:

No local groundwater level is available and therefore a design groundwater level of 1.0m below ground level throughout cutting.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

3 No Atterberg Limit Test and 2 No Natural Moisture Content tests were undertaken within the Mercia Mudstone with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Mercia Mudstone- III/IV	5.64	-	29	15	14	CL
Mercia Mudstone- III/IV	7.16	-	30	18	12	CL
Mercia Mudstone- III/IV	8.69	-	47	30	17	MI
Mercia Mudstone- III/IV	4.27	16.00	-	-	-	-
Mercia Mudstone- III/IV	9.14	26	-	-	-	-

Three triaxial tests were undertaken within the Mercia Mudstone with the following results:

Depth to Top of Test (mbgl)	Undrained Shear Strength (kN/m^2)
5.64	482
7.16	62
8.69	62

Lab Test Data – BRE Classification:

No chemical laboratory testing data is available for this location.

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Assumed Ground Model For Design:

Ground model is based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-000034, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01.

The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γ_b (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment Fill	0-4.75	39.15-34.40	1.70	21	27	0	100	7.8	6.2	-	0.50	0.20	-	2.6	0.45	-	6.2*	-	DS-2 AC-2
Mercia Mudstone – III/IV (<10m bgl)	4.75-10.00	34.40-29.15	8.30	21	27	2	62	10.8	8.6	-	0.50	0.20	-	3.6	0.54	-	9.0	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10m bgl)	10.00->13.05	<26.10	-	21	30	2	100	16.8	13.4	-	0.50	0.20	-	5.6	0.45	-		-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical borehole SK42NE10.
(3) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) Due to the absence of local data for Embankment Fill, the generalised parameters derived in the AMAR GIR are used for Embankment Fill.
(5) The ϕ' for Mercia Mudstone – III/IV 1-10m bgl is derived using plasticity index lab data (based on Table 2 in BS 8002:2015). The ϕ' obtained has a value of 27°. Three triaxial tests were undertaken in the Mercia Mudstone – III/IV 1-10m bgl, however no friction angles were recorded. No local geotechnical lab data is available for Mercia Mudstone – III/IV at >10m bgl, therefore generalised AMAR GIR parameters are used for ϕ' of Mercia Mudstone –III/IV >10m bgl.
(6) No local SPT N values are available for current ground conditions, however three triaxial tests were undertaken within the Mercia Mudstone 1-10m bgl in hole SK42NE10 with results for c_u of 480, 62 and 62kN/m^2. 62kN/m^2 is assumed to be representative for Mercia Mudstone – III/IV 1-10m bgl. For Mercia Mudstone >10m bgl, the AMAR GIR gives a range of 50-200kN/m^2 and Tomlinson gives an approximate of 100kN/m^2 for firm to stiff clay; 100kN/m^2 is considered appropriate for Mercia Mudstone – III/IV >10m bgl.
(7) Due to the lack of local SPT N values for current ground conditions, E for Mercia Mudstone – III/IV is based on derivations in the AMAR GIR.
(8) Shear modulus is based on G = E/2(1+v).
(9) Adhesion factor is based on BS8004 (equation 41).
(10) Nc is based on on CIRIA C570.

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(11) *Nc increases to 9 from 3.6mbgl.
(12) +Embankment fill assumed to be primarily comprised of reworked Mercia Mudstone therefore an NC value of 6.2 has been assumed.
(13) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all materials, the classification used for the strata in the AMAR GIR was adopted.
(14)

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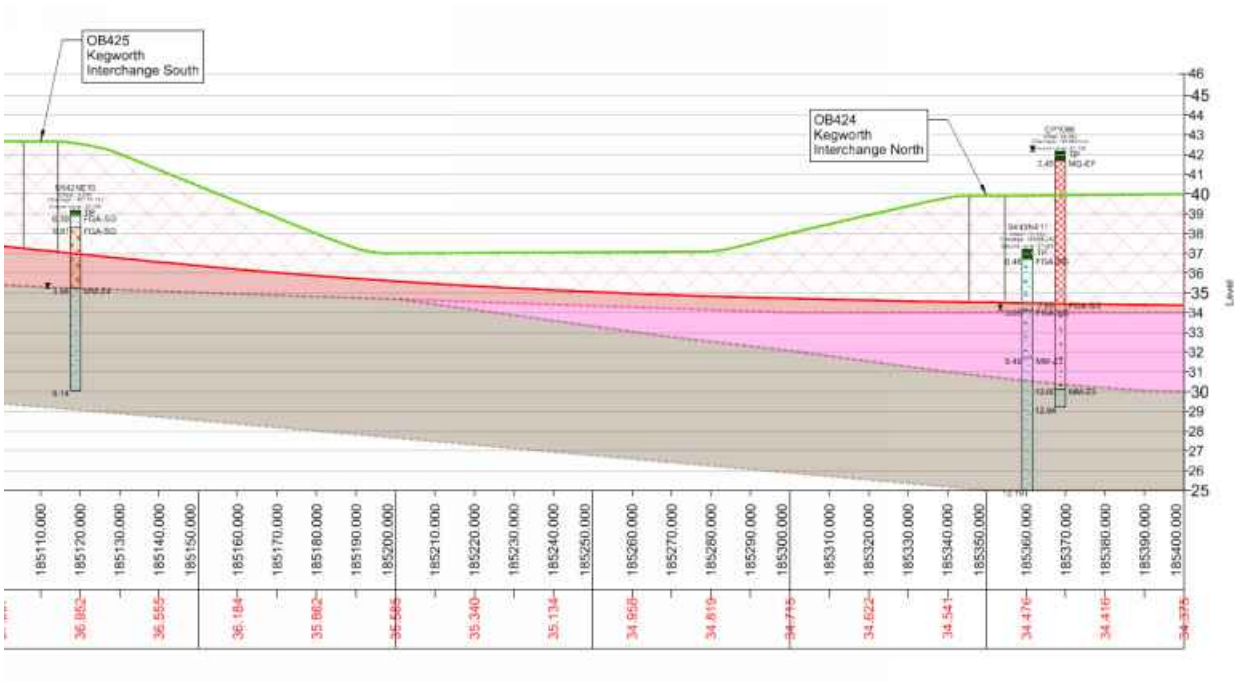


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
185170	185210	Full Height Regrade 1 :3.0

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	900	28	2.70	12	741	1475

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-G112 , Ch 151180, Southbound – Dynamic Sample with a Rotary Core follow on to a scheduled depth of 33.0mbgl.

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HISTORICAL EXPLORATORY HOLES

Borehole Log

Borehole No. **SK42NE10**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447530.00 - 327500.00	Hole Type CP
Location:		Level: 39.20mbgl	Scale 1:50
Client: Highways England		Dates: 12/08/1961 - 15/08/1961	Logged By

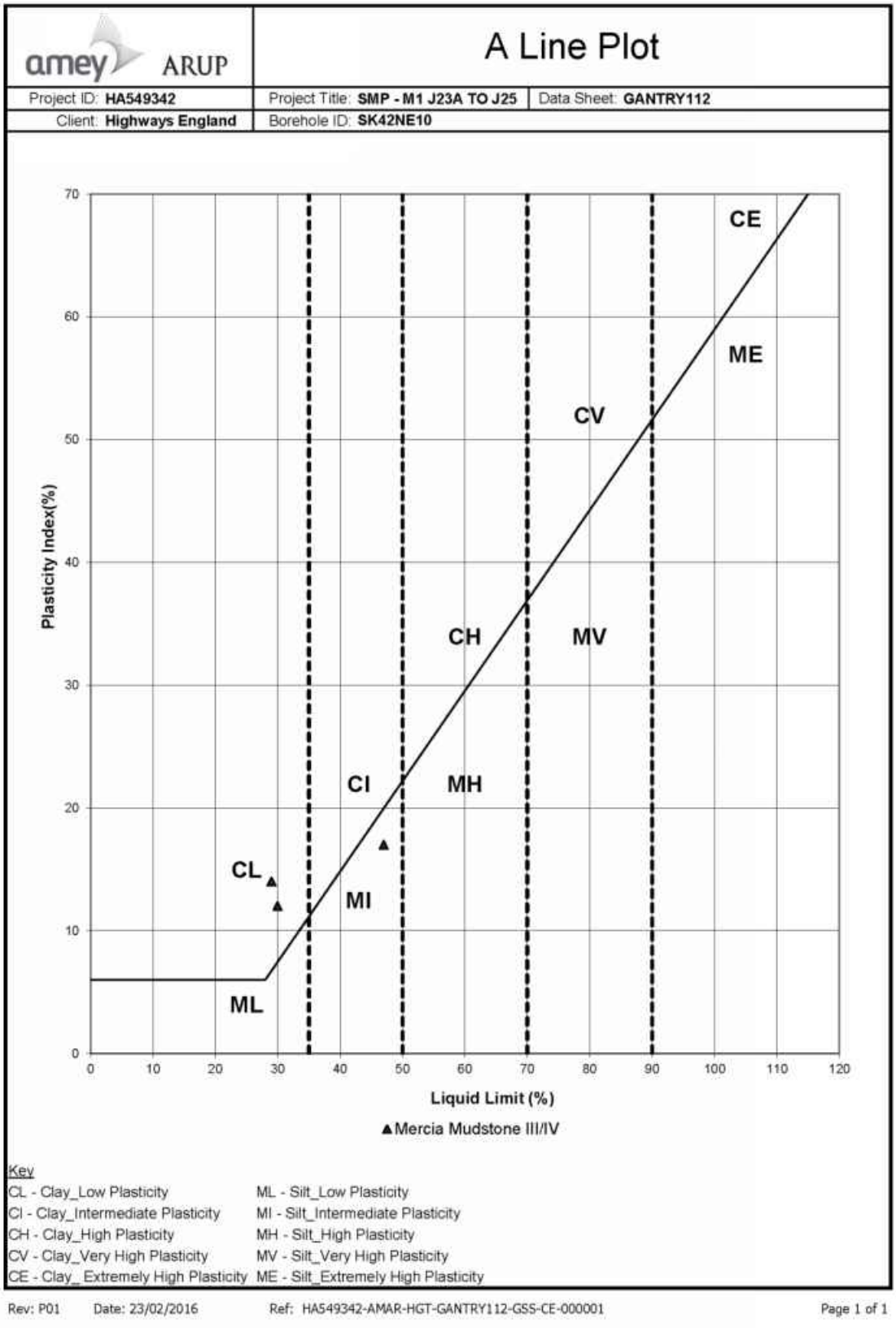
Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	597D			0.30	38.90		Topsoil TP
		0.61	598D						Sandy soil & stones FGA-SG
		1.07	SPT (S)	159 (0 for 0mm/159,...)	Water=-	0.91	38.29		Gravel with soft sandy clay becoming clayey sand & gravel FGA-SG
		1.52	599D						
		3.05	600D						
		3.05	601B						
		3.05 - 3.20	602U	124blows					
	▼	3.96	604 W			3.96	35.24		Firm and stiff red and grey silty clay MM-Z4
		3.96 - 4.06	603U	200blows					
		4.27	605D						
		5.64 - 6.02	606U	98blows					
		6.10	607D						
		7.16 - 7.54	608U	114blows					
		7.62	609D						
		8.69 - 9.14	610U						
		9.14	611D			9.14	30.06		End of borehole at 9.14m

Remarks

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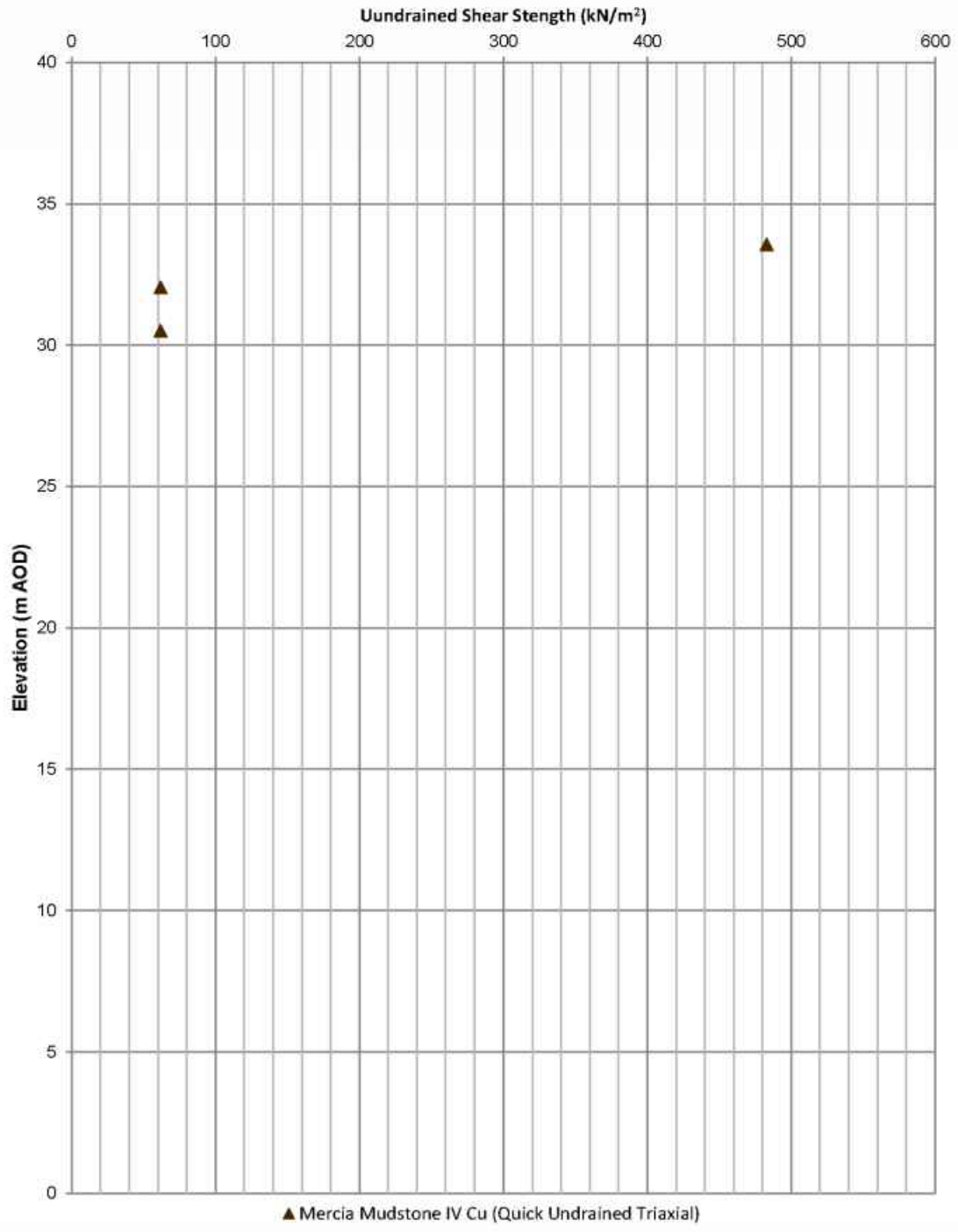
PLOTS



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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **GANTRY112**
Client: **Highways England**	Borehole ID: **SK42NE10**	



Rev: P01 Date: 23/02/2016 Ref: HA549342-AMAR-HGT-GANTRY112-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-185510-185600SB-GSS-000001		
Earthwork Widening Solution	Regrade Full Height 1:3.0		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	185510-185600		
Carriageway	Southbound		
Marker Post	MP185/5B+10 – MP185/6B+00		
National Grid Reference	E 447539, N 327900 – E 447525, N 327983		
Existing Ground Level at Location	Crest of Cutting	37.48mAOD	
	Carriageway	34.40mAOD	
Earthwork Type	NB: N/A	SB: Cutting	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_62641	HAGDMS designation
Earthwork Height	NB: N/A	SB: 3.1m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 18°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	05/02/2017	[redacted]
Checked	Alice Bazen	10/02/2017	
Reviewed	Gary Summerfield	17/02/2017	
Approved	Tom Bulteel	24/02/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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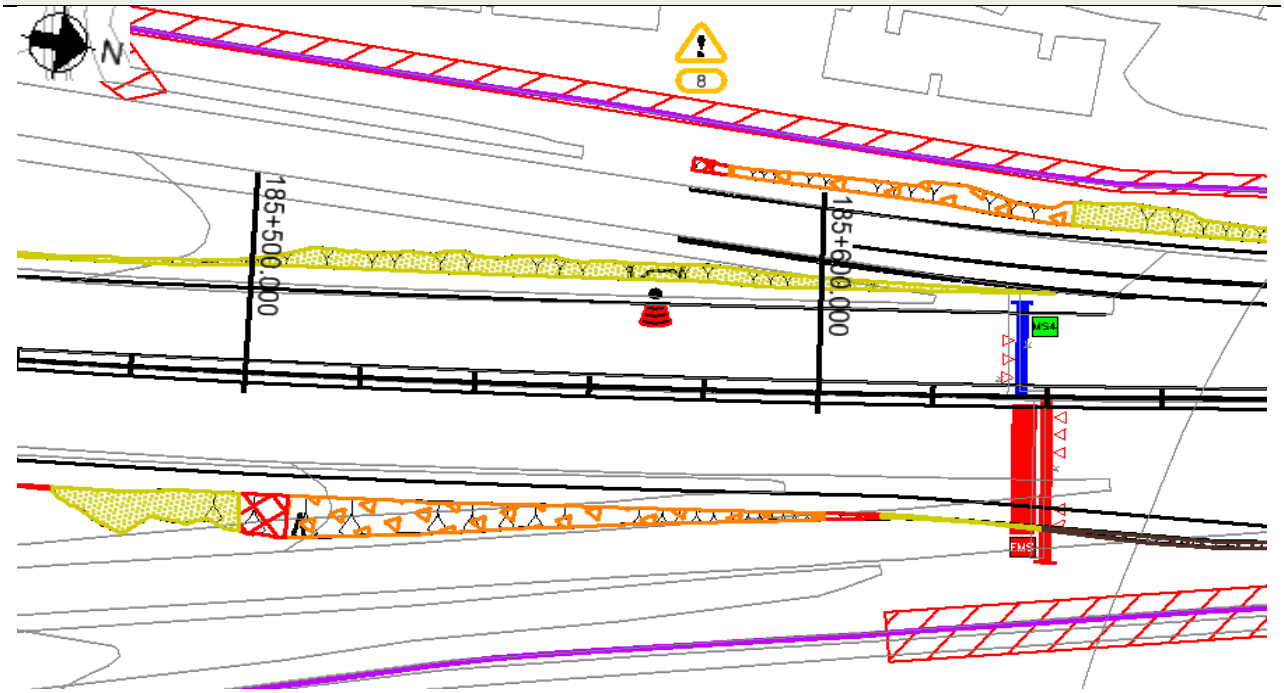


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Full Height Regrade (1:3.0)

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a cutting ranging in height from 1.0m to 3.21m with a typical slope angle of 18 degrees.

The critical cross section at Ch.185510 was based on the section with the greatest earthwork height.

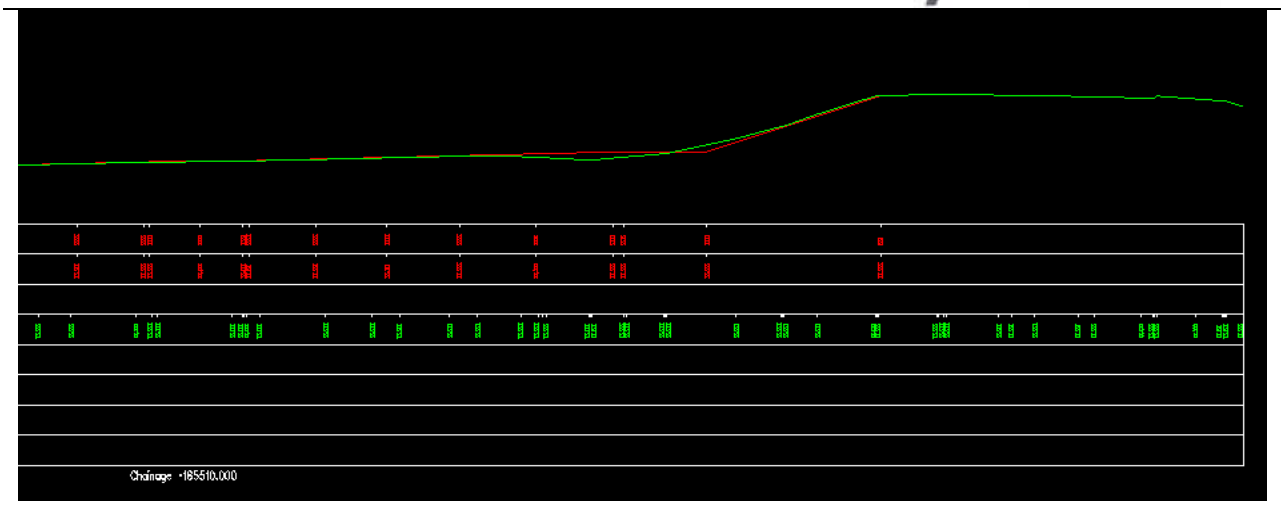


Figure 2: Topographic Critical Cross Section Chainage 185510

Utilities:

No known utilities are present between chainage 185510 and 185600.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Wanlip Member - Sand And Gravel

Solid Deposits: Edwalton Member – Mudstone / Arden Sandstone Formation - Sandstone

Ground Investigation:

There are 3 No. historical exploratory holes recorded within the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000026, Rev P01.

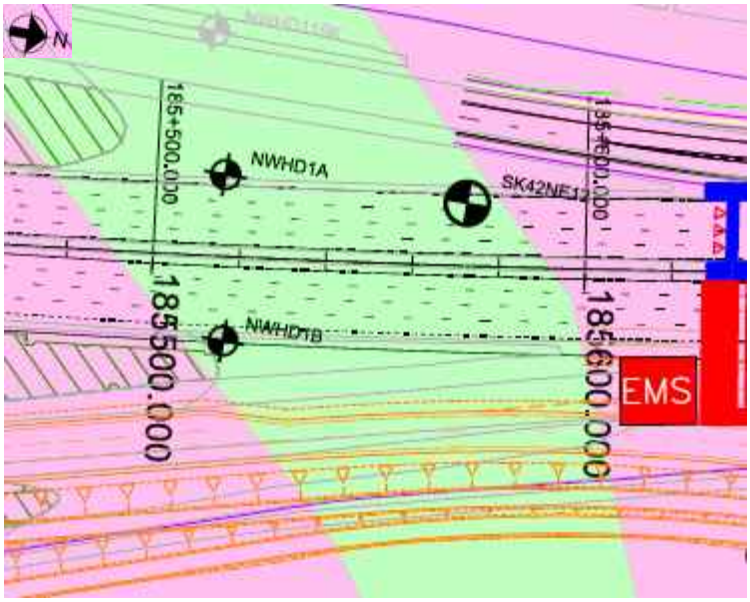


Figure 3: Borehole Location Plan

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Flood Risk:

This location is not in an area at risk from flooding.

Historical Boreholes:

Relevant Borehole Number	NWHD1A	NWHB1B	SK42NE12
Borehole Chainage	185516	185517	185572
Borehole Location	Northbound	Southbound	Northbound
National Grid Reference	E 447493, N 327894	E 447493, N 327894	E 447490, N 327950
Ground Level at Exploratory Hole	33.87mAOD	34.60mAOD	34.70mAOD
RAG Analysis	Amber	Amber	Amber
Date Drilled	13/09/1999	15/09/1999	09/08/1961 – 10/08/1961
Termination Depth	3.10 metres below ground level (mbgl)	3.00 metres below ground level (mbgl)	9.14 metres below ground level (mbgl)
Other suitable holes	None		

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Glaciofluvial Deposits (Fine Grained)	5.83	31.65	20 (20)
Mercia Mudstone III-IV (<10mbgl)	>10.00	<27.48	-

(1) Ground level is assumed to be at the crest of the cutting;
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(3) Due to lack of GI data at this location, it has been assumed based on the Geological Long sections and the topographic survey that embankment fill sits on top of Mercia Mudstone.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken in exploratory hole SK42NE12.

Groundwater:

Groundwater was not encountered in any of the historical boreholes.

Groundwater Design Level:

No local groundwater level is available and therefore a design groundwater level of 1.0m below ground level throughout cutting has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

No geotechnical lab tests have been undertaken between 185510 and 185600.

Lab Test Data - BRE Classification:

No chemical laboratory testing data is available between 185510 and 185600.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Glaciofluvial Deposits (Fine Grained)	0.00-5.83	37.48 – 31.65	5.83	21	26	0	100	7.80	6.20	-	0.50	0.20	-	DS-3 AC-3
Mercia Mudstone – III-IV <10.0mbgl	5.83 – 10.00	31.65 – 27.48	4.17	21	30	2	100	10.80	8.60	-	0.50	0.20	-	DS-2 AC-2
Mercia Mudstone >10.0mbgl	>10.00	<27.48	-	21	30	2	200	16.80	13.40	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from the interpreted geological long section.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion, and Poisson's ratio derived in the AMAR GIR are used.
(4) Due to limited GI data available for the Mercia Mudstone III/IV<10mbgl, the geotechnical parameters are based on values derived from the AMAR GIR.
(5) Due to limited GI data available for the Mercia Mudstone III/IV>10mbgl, the geotechnical parameters are based on values derived from the AMAR GIR
(6) Due to limited GI data available for the Glaciofluvial Deposits (Coarse Grained), the geotechnical parameters are based on values derived from the AMAR GIR.
(7) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

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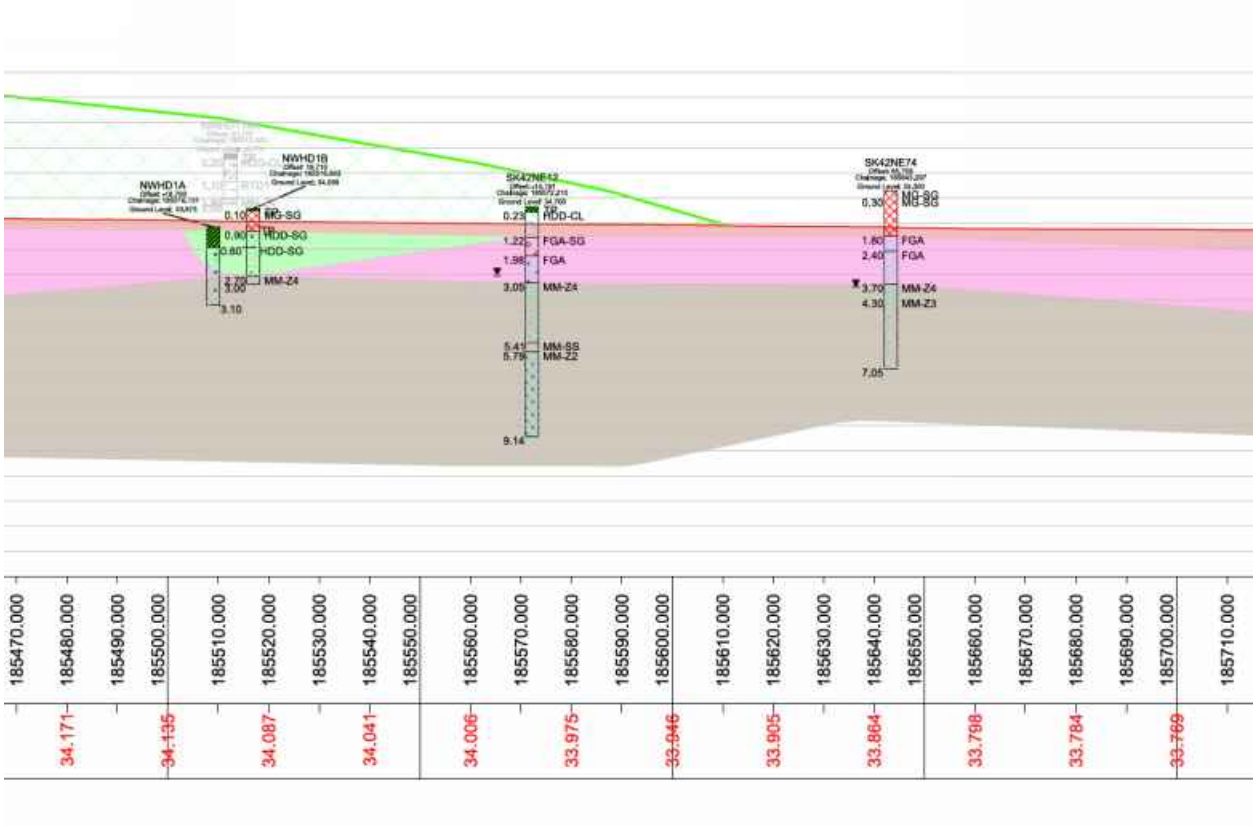


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
185510	185600	Full Height Regrade 1:3.0

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FURTHER GROUND INVESTIGATION

'Just In Time' GI has not been proposed between chainage 185510 and 185600.

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LOGS

Borehole Log

Borehole No. **NWHD1A** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447493.18 - 327893.83	Hole Type WS
Location:		Level: 33.87mbgl	Scale 1:50
Client: Highways England		Dates: 13/09/1999 - 13/09/1999	Logged By NBR

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.00 - 0.80	01D		Dia.=0mm				TOPSOIL with some fine to coarse subangular to subrounded gravel of limestone and quartz. TP
		0.00 - 0.80	D		Dia.=0mm				
		0.80 - 3.10	02D		Dia.=0mm	0.80	33.07		Reddish brown clayey coarse SAND with some subrounded fine to coarse quartz gravel. HDD-SG
		0.80 - 3.10	D		Dia.=0mm				
						3.10	30.77		End of borehole at 3.10m

Remarks

1. Hand excavated inspection pit to 0.70m (0.50m x 0.50m). 2. Hole complete at 3.10m. 3. Hole damp below 0.90m. 4. Hole backfilled withgrout. 5. Marker Post Ref 185/5 +50

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Borehole Log

Borehole No. **NWHD1B** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447531.12 - 327899.87	Hole Type WS
Location:		Level: 34.60mbgl	Scale 1:50
Client: Highways England		Dates: 15/09/1999 - 15/09/1999	Logged By NBR

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.10 - 0.90 0.10 - 0.90	01D D		Dia.=0mm Dia.=0mm	0.10	34.50		TOPSOIL with a little fine to coarse subrounded quartz gravel. TP MADE GROUND: Brown fine sand and fine to coarse, subangular to subrounded gravel sized fragments of quartz and sandstone. MG-SG
		0.90 - 2.70 0.90 - 2.70	02D D		Dia.=0mm Dia.=0mm	0.90	33.70		Soft reddish brown very sandy CLAY with a little medium subrounded quartz gravel. HDD-SG ---from 2.50m pale brown
		2.70 - 3.00 2.70 - 3.00	03D D		Dia.=0mm Dia.=0mm	2.70	31.90		Soft reddish brown slightly sandy CLAY. MM-Z4
						3.00	31.60		End of borehole at 3.00m

Remarks

1. Hand excavated inspection pit to 0.70m (0.50m x 0.50m). 2. Hole complete at 3.00m. 3. Hole dry. 4. Hole backfilled with grout. 5.Marker Post Ref 185/5 +50.

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Borehole Log

Borehole No. **SK42NE12**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447490.00 - 327950.00	Hole Type CP
Location:		Level: 34.70mbgl	Scale 1:50
Client: Highways England		Dates: 09/08/1961 - 10/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.23	34.47		Topsoil TP
									Brown clayey sand and stones HDD-CL
		0.76	373D						
		1.22	374D			1.22	33.48		
		1.52	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				Grey sand & stones FGA-SG
		1.98	376D			1.98	32.72		
		2.29 - 2.74	377U	37blows					Firm brown sandy clay and stones FGA-SG
		2.44	378D						
	▼	2.44	386 W						
						3.05	31.65		Firm red & grey sandy clay MM-Z4
		3.81	379D						
		4.57 - 5.03	380U	58blows					
		5.41 - 5.79	381D			5.41	29.29		Grey skerry MM-SS
						5.79	28.91		Stiff red silty clay and siltstone MM-Z2
		6.10 - 6.55	381A U						
		6.55	382D						
		7.62 - 7.92	383U	107blows					
		8.38	384D						
		8.84 - 9.14	385U	126blows					
						9.14	25.56		End of borehole at 9.14m

Remarks

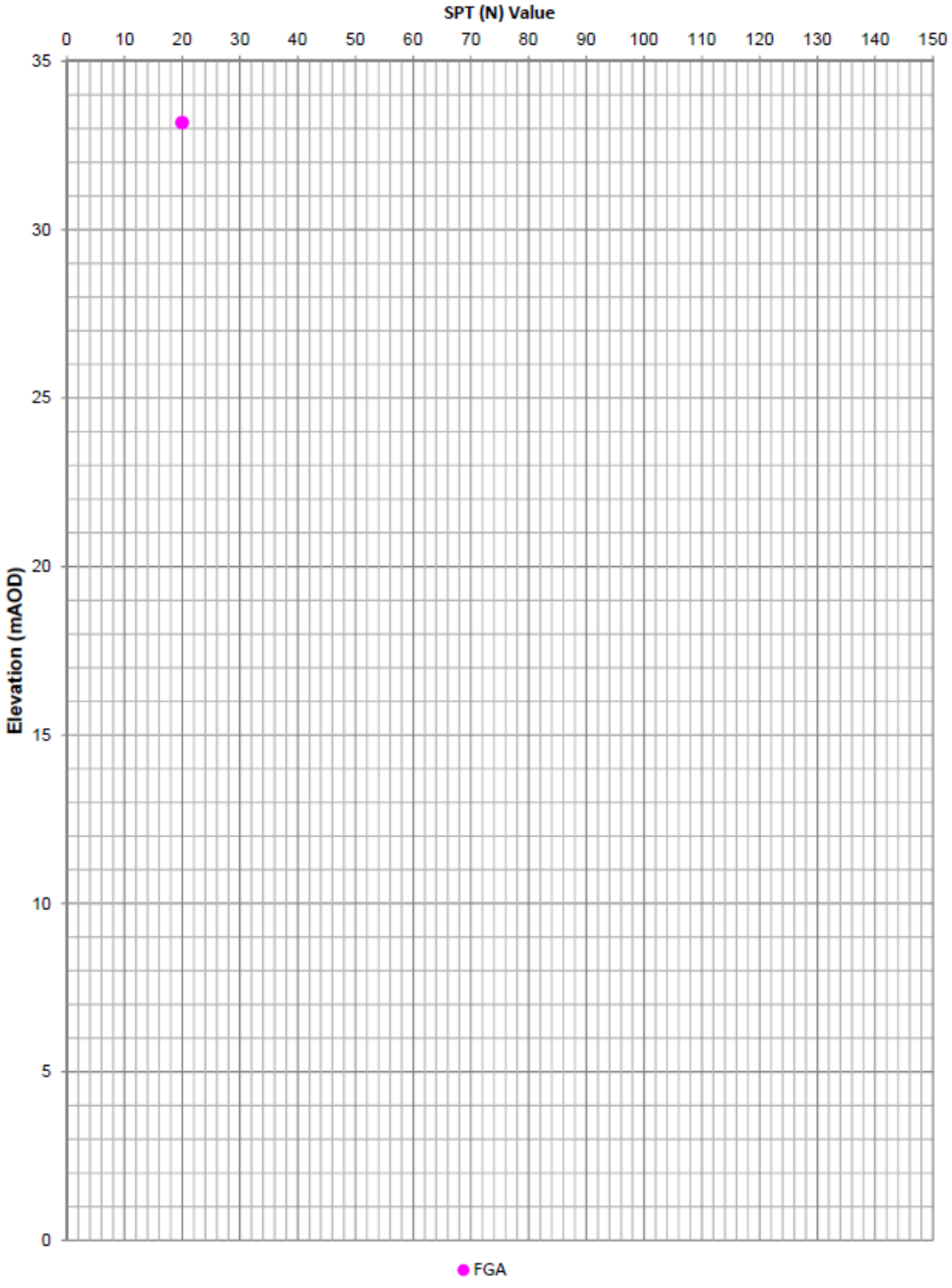
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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185510-185600SB**
Client: **Highways England**	Borehole ID: **SK42NE12**	



Extrapolated SPT (N) Values >150 have not been shown

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-185870-186200SB-GSS-000001		
Earthwork Widening Solution	Granular Wedge at Embankment Crest 1:2.0		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	185870-186200		
Carriageway	Southbound		
Marker Post	MP185/8B+70 – MP186/2B+00		
National Grid Reference	E 447469, N 328252 – E 447379, N 328569		
Existing Ground Level at Location	Crest of Cutting	34.02mAOD	
	Carriageway	30.30mAOD	
Earthwork Type	NB: N/A	SB: Cutting	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_24390	HAGDMS designation
Earthwork Height	NB: N/A	SB: 3.70m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 22°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	06/03/2017	[redacted]
Checked	Alice Bazen	14/03/2017	
Reviewed	Gary Summerfield	15/03/2017	
Approved	Tom Bulteel	22/03/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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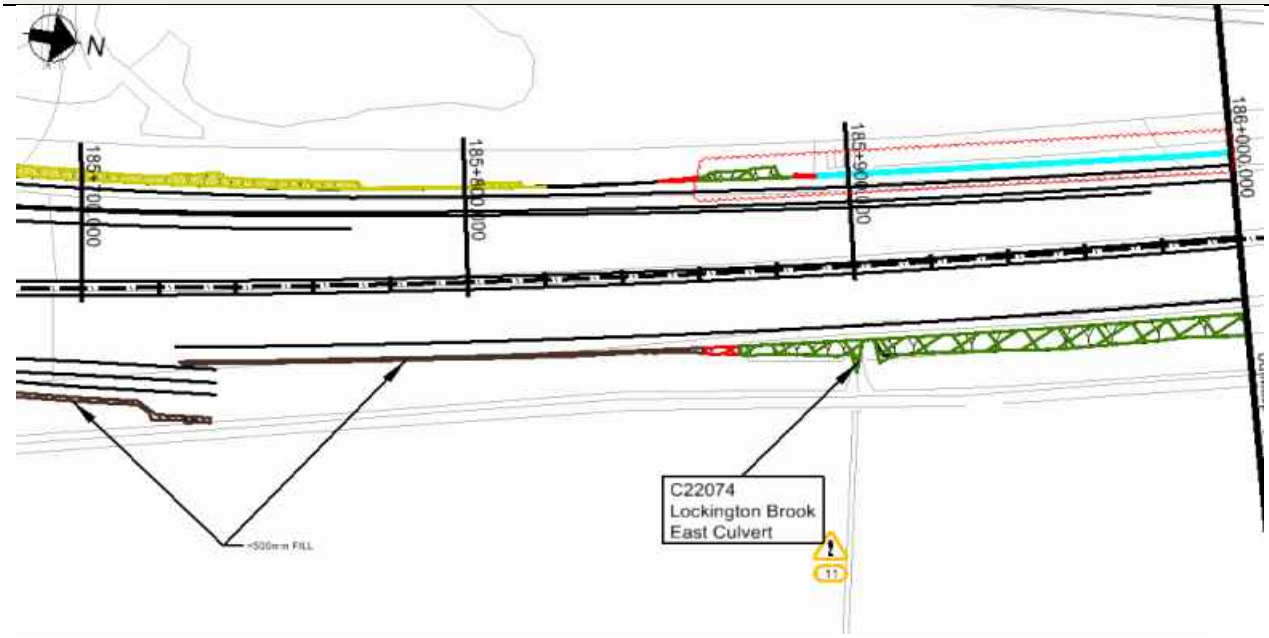


Figure 1.1: Location Plan – 185870-186000

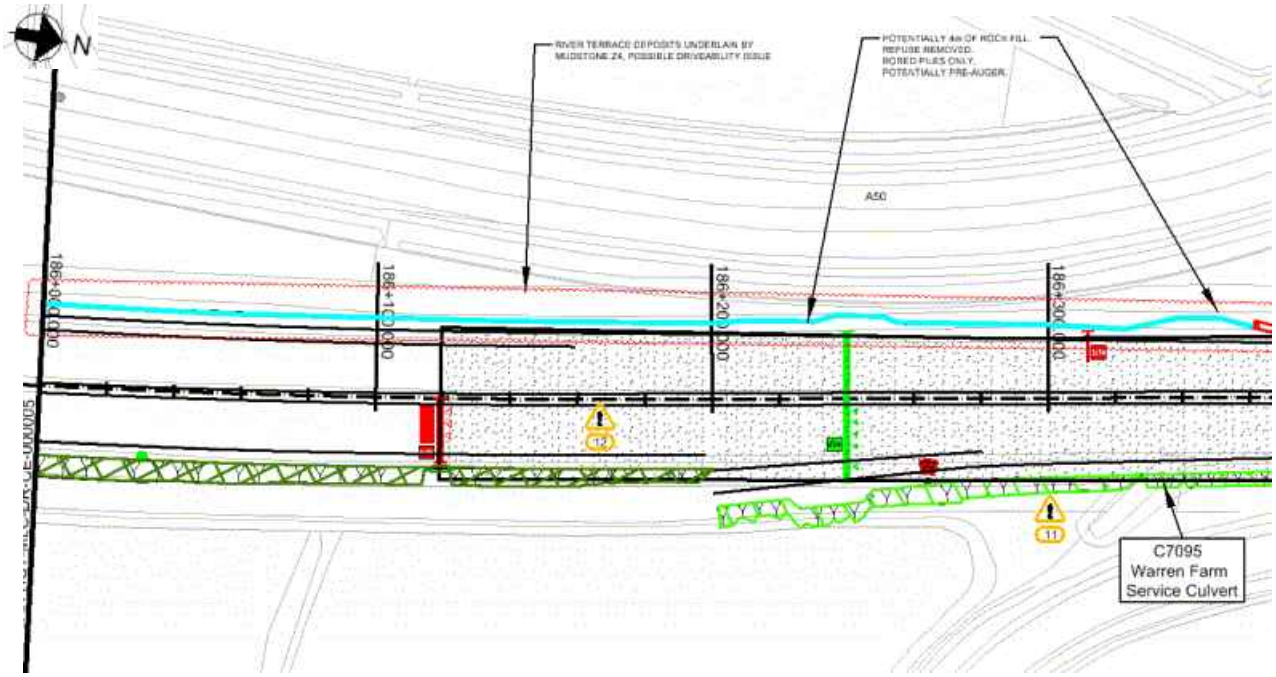


Figure 1.2: Location Plan – 186000-186200

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Granular Wedge at Embankment Crest (1:2.0)

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment ranging in height from 2.8m to 3.7m with a typical slope angle of 22 degrees.

The critical cross section with the highest earthwork height is used at Ch185950.

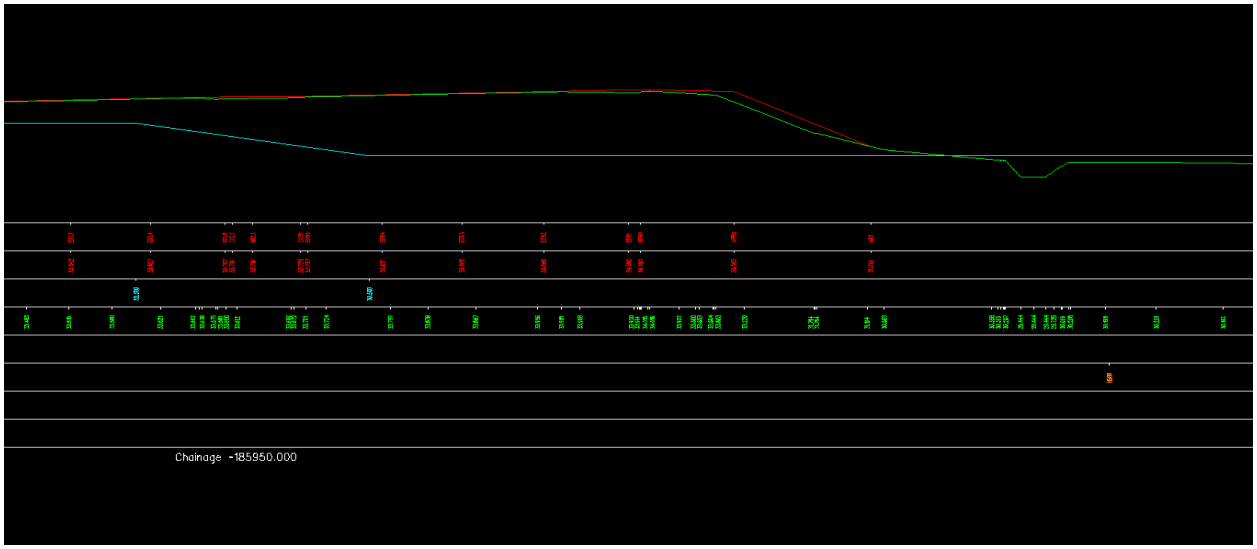


Figure 2: Topographic Critical Cross Section Chainage 185950

Utilities:

Western Power Low Voltage Supply Meter Connection running east to west at chainage 185895.

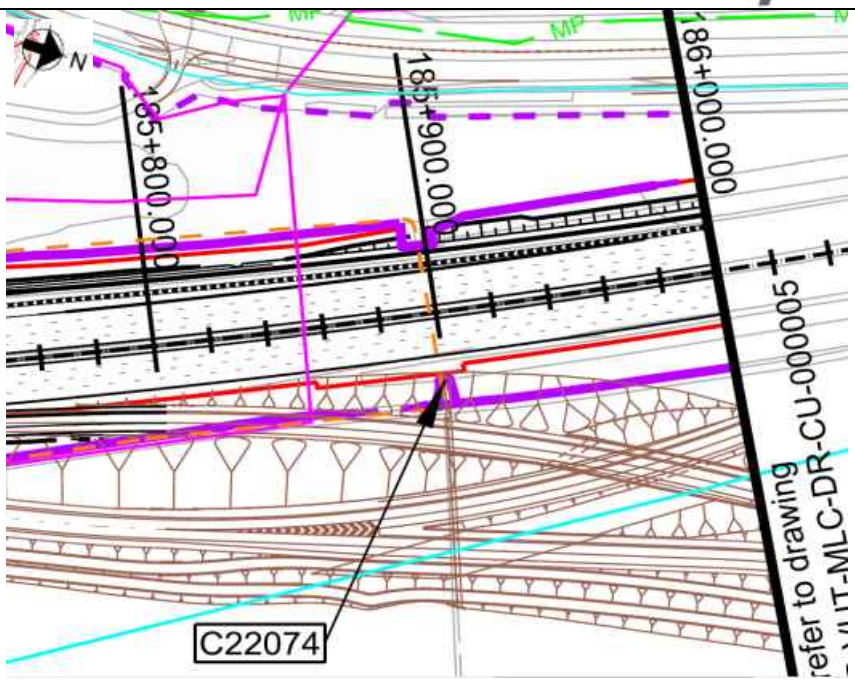


Figure 3: Utilities location plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Hemington Member - Silt And Gravel / Holme Pierrepont Sand And Gravel Member - Sand And Gravel

Solid Deposits: Branscombe Mudstone Formation - Mudstone.

Ground Investigation:

There are 3 No. historical exploratory holes recorded within the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000026-27, Rev P01.

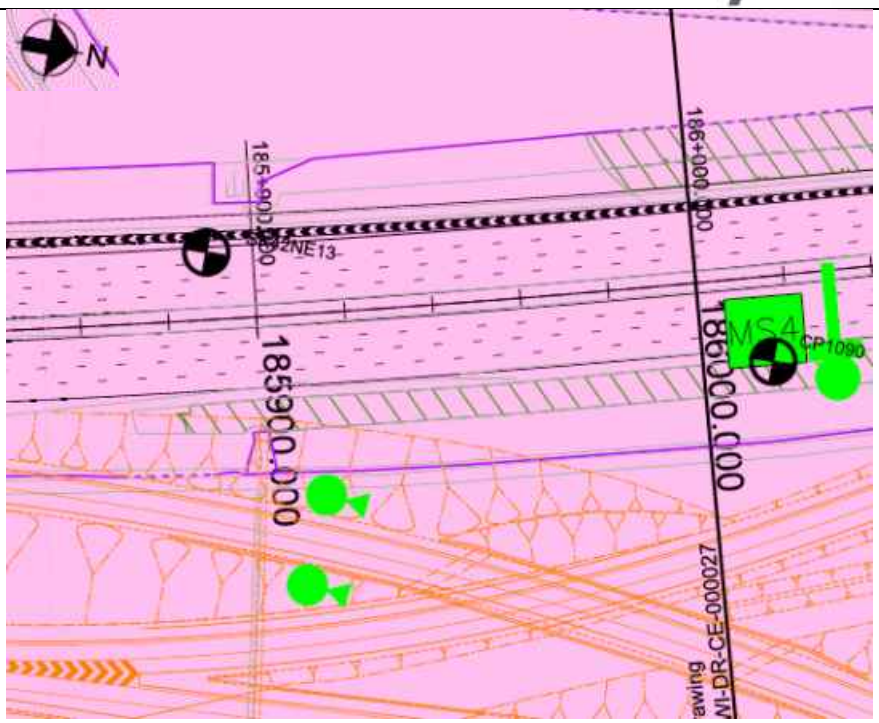


Figure 4.1: Borehole Location Plan – 185870-186000

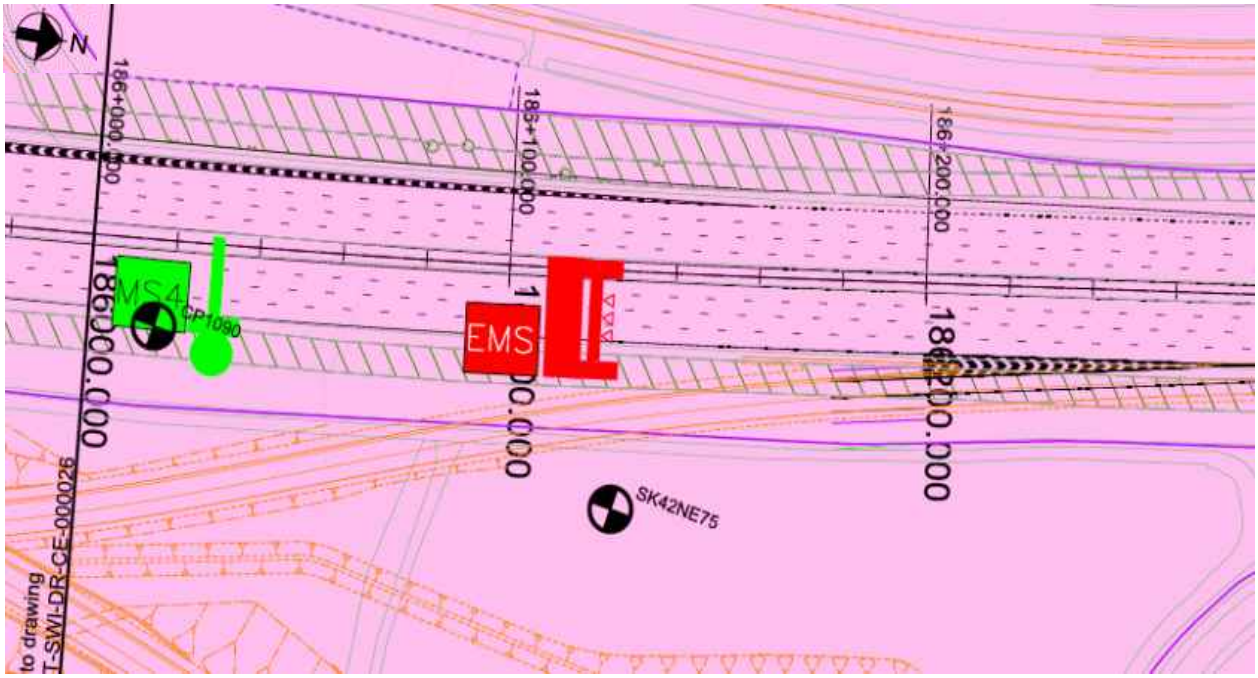


Figure 4.2: Borehole Location Plan – 186000-186200

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Flood Risk:

This is earthwork is located in an area where there is a risk of flooding. Flood Level at this location is 30.56mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	SK42NE13	CP1090	SK42NE75
Borehole Chainage	185883	186016	186126
Borehole Location	Northbound	Southbound	Southbound
National Grid Reference	E 447430, N 328260	E 447432, N 328391	E 447433, N 328508
Ground Level at Exploratory Hole	30.40mAOD	33.85mAOD	33.80mAOD
RAG Analysis	Amber	Green	Amber
Date Drilled	11/08/1961 – 12/08/1961	23/11/2006	03/02/1988
Termination Depth	9.14 metres below ground level (mbgl)	11.39 metres below ground level (mbgl)	3.00 metres below ground level (mbgl)
Other suitable holes	None		

Existing Ground itions:

The following ground conditions are assumed based on previous GI data.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Embankment Fill	4.97	29.05	19-41 (19)
Glaciofluvial Deposits (Coarse Grained)	9.02	25.00	15-130 (37)
Mercia Mudstone – III-IV <10mbgl	>9.02	<25.00	120->150 (50)**

(1) Ground level is assumed to be at carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Mercia Mudstone Siltstone was encountered in the borehole logs, however given the uncertainties on ground conditions, only Mercia Mudstone – III/IV has been used in the ground model for a conservative design.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken in exploratory hole CP1090 and SK42NE75.

Groundwater:

Groundwater was encountered in exploratory hole SK42NE13 1.97mbgl (29.03mAOD) and rose to 0.76mbgl (29.64mAOD).

Groundwater Design Level:

A design groundwater level of 30.56mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

7 No. Atterberg Limit Tests and 8 No. Moisture content tests were undertaken within Embankment Fill, Glaciofluvial Deposits and Mercia Mudstone layers, with the results presented below:

Stratum	Depth (m)	Plastic Limit (%)	Moisture Content (%)	Liquid Limit (%)	Plasticity Index	Classification
Embankment Fill	3.7	12	14.46	26	14	CL
Embankment Fill	5.7	10	12.13	27	17	CL
Embankment Fill	7.5	14	15.28	28	14	CL
Glaciofluvial Deposits*	0.76	27	28	54	27	ML
Mercia Mudstone	4.11	20	-	28	8	CL
Mercia Mudstone	5.33	21	-	23	2	ML
Mercia Mudstone	15	26	24	37	11	MI

*Plasticity Index for Glaciofluvial Deposits is not considered as the material is predominately granular with pockets of cohesive material.

2 No.Quick Undrained Triaxial Tests were completed in exploratory borehole CP1090 within the Embankment Fill and Mercia Mudstone materials with the results presented below:

Stratum	Depth (m)	Undrained Shear Strength (kN/m^2)
Embankment Fill	1.5	147.2
Mercia Mudstone	5.33	117

Lab Test Data – BRE Classification:

The table below present the chemical tests completed in the exploratory boreholes.

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Glaciofluvial Deposits	pH	Water	1	7.0	-
Glaciofluvial Deposits	Water Soluble Sulphate as SO4	Water	1	1.00	g/l SO4

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0.00 – 4.97	34.02 – 29.05	4.97	21	26	0	100	7.5	6.0	-	0.5	0.20	-	DS-2 AC-2
Glaciofluvial Deposits (Coarse Grained)	4.97 – 9.02	29.02 – 25.00	4.05	21	37	-	-	-	51.6	-	-	0.25	-	DS-3 AC-3
Mercia Mudstone – III-IV <10.0mbgl	9.02 – 10.00	29.02– 24.02	0.88	21	30	2	200	10.80	8.60	-	0.5	0.20	-	DS-2 AC-2
Mercia Mudstone >10.0mbgl	>10.00	<24.02	-	21	30	2	250	16.80	13.40	-	0.5	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.

(2) Stratum types and depths are derived from the interpreted geological long section.

(3) Due to limited localised GI data, typical values for bulk density, cohesion, and Poisson's ratio derived in the AMAR GIR are used.

(4) ϕ' of Embankment Fill was determined using Table 2 in BS8002:2015 using typical PI of 14% gives 27°.

(5) cu of Embankment Fill was derived using the Stroud correlation. A typical PI of 14% gives an f1 value of 6.8, combined with a SPT 'N' value of 19, this gives a typical cu of 129kN/m^2. Cu value from the triaxial test in 73kN/m^2, a value of 100kN.m^2 has been adopted for design.

(6) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using SPT 'N' value of 19, Eu = 7.5MN/m2. Therefore E' = 6.0MN/m2.

(7) ϕ' of Glaciofluvial Deposits was determined using correlation with SPT 'N' values (Peck 1974). Using a typical 'N' value of 37 gives an angle of 37°.

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(8) E' of Glaciofluvial Deposits was determined using Bowles correlation E' = 1200 (N + 6) which (using typical 'N' value of 37) gives a value of 51.6MN/m2.
(9) ϕ' of Mercia Mudstone was has been based on typical values from CIRIA C570.
(10) cu of Mercia Mudstone – III/IV was derived using the Stroud correlation. In the absence of sufficient PI data, the typical f1 value of 5.0 for Mercia Mudstone (CIRIA C570) was adopted; combined with a typical SPT 'N' value of 50, this gives a cu of 250kN/m2. Due to this value being greater than the range supplied in the AMAR GIR, a value of 200kN/m^2 has been adopted as per the AMAR GIR.
(11) Eu & E' for Mercia Mudstone – III/IV (<10mbgl) is based in values derived in AMAR GIR due to lack of data present within this layer.
(12) Eu & E' for Mercia Mudstone – III/IV (>10mbgl) is based in values derived in AMAR GIR due to lack of data present within this layer.
(13) BRE Classification is determined using criteria set out in BRE Special Digest 1. Due to the lock of BRE test data for All strata, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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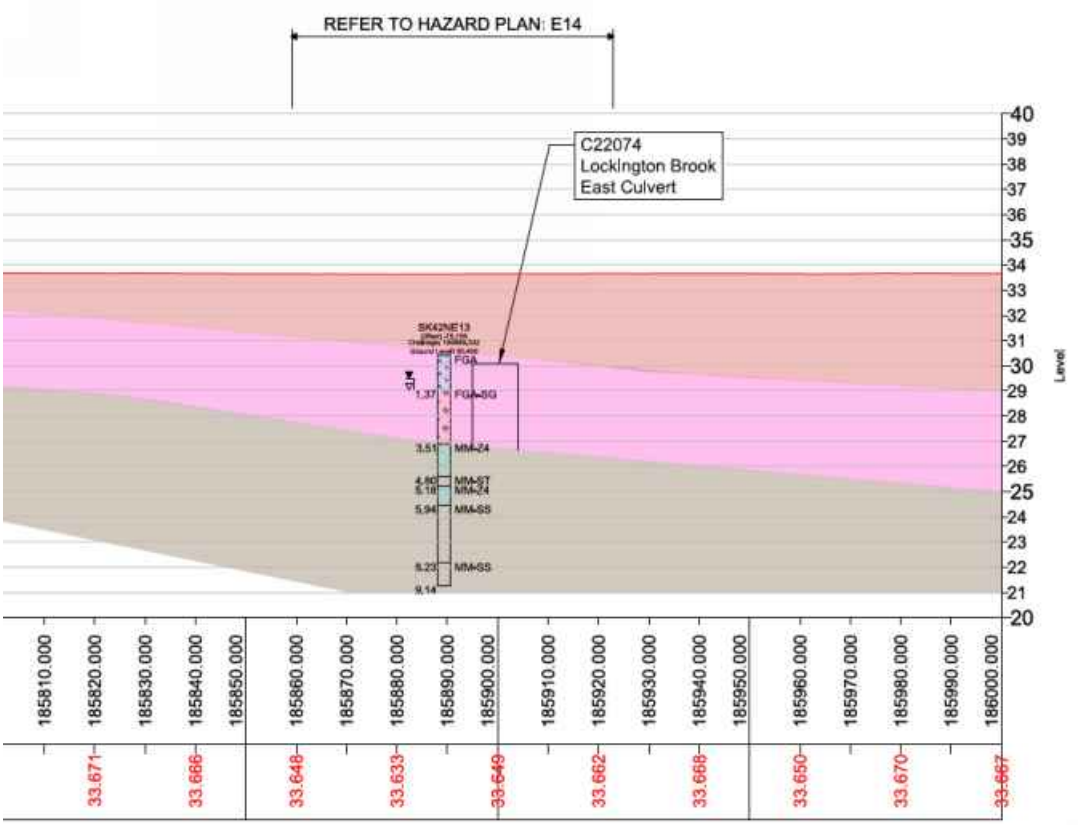


Figure 4.1: Geological Long Section

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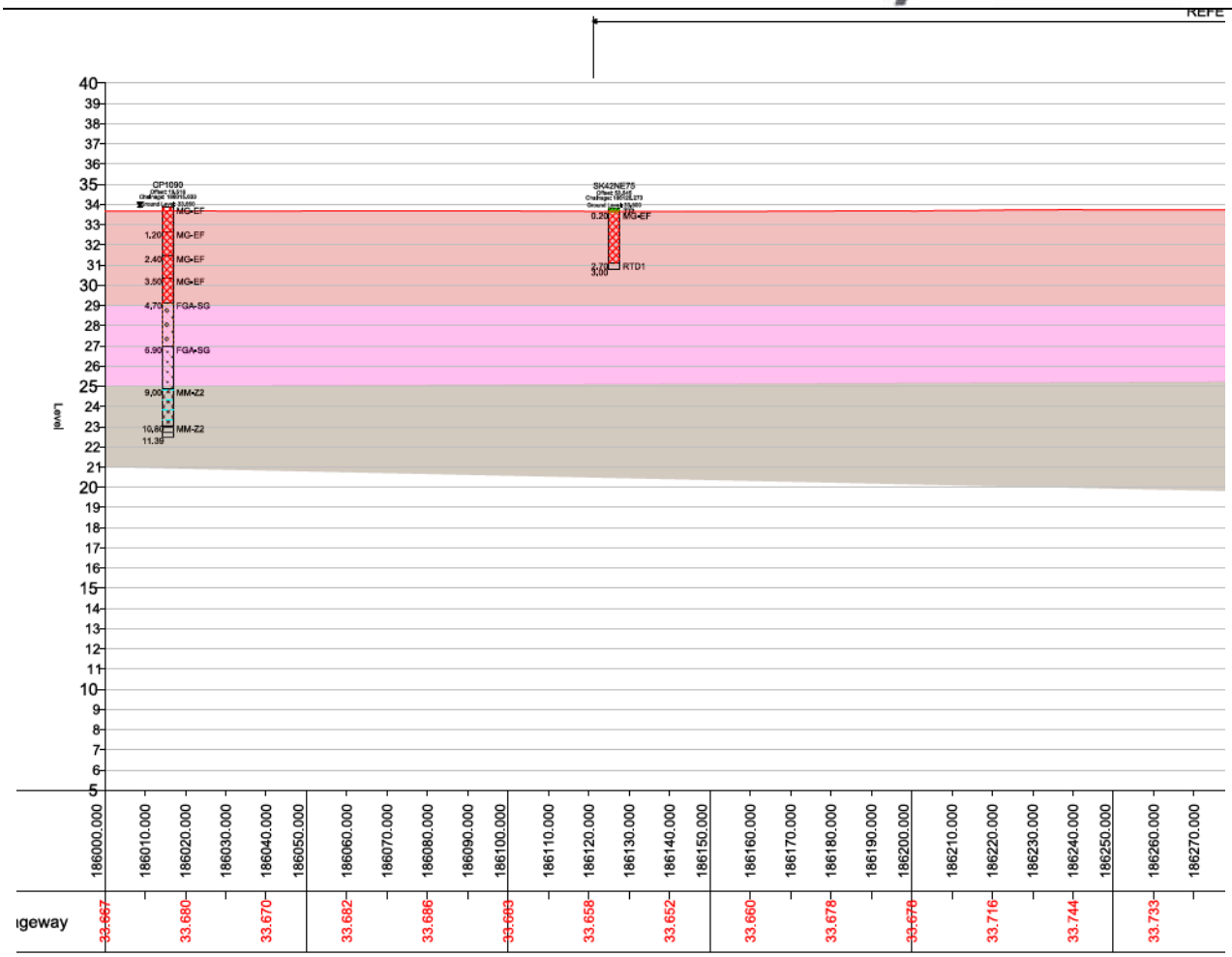


Figure 4.1: Geological Long Section

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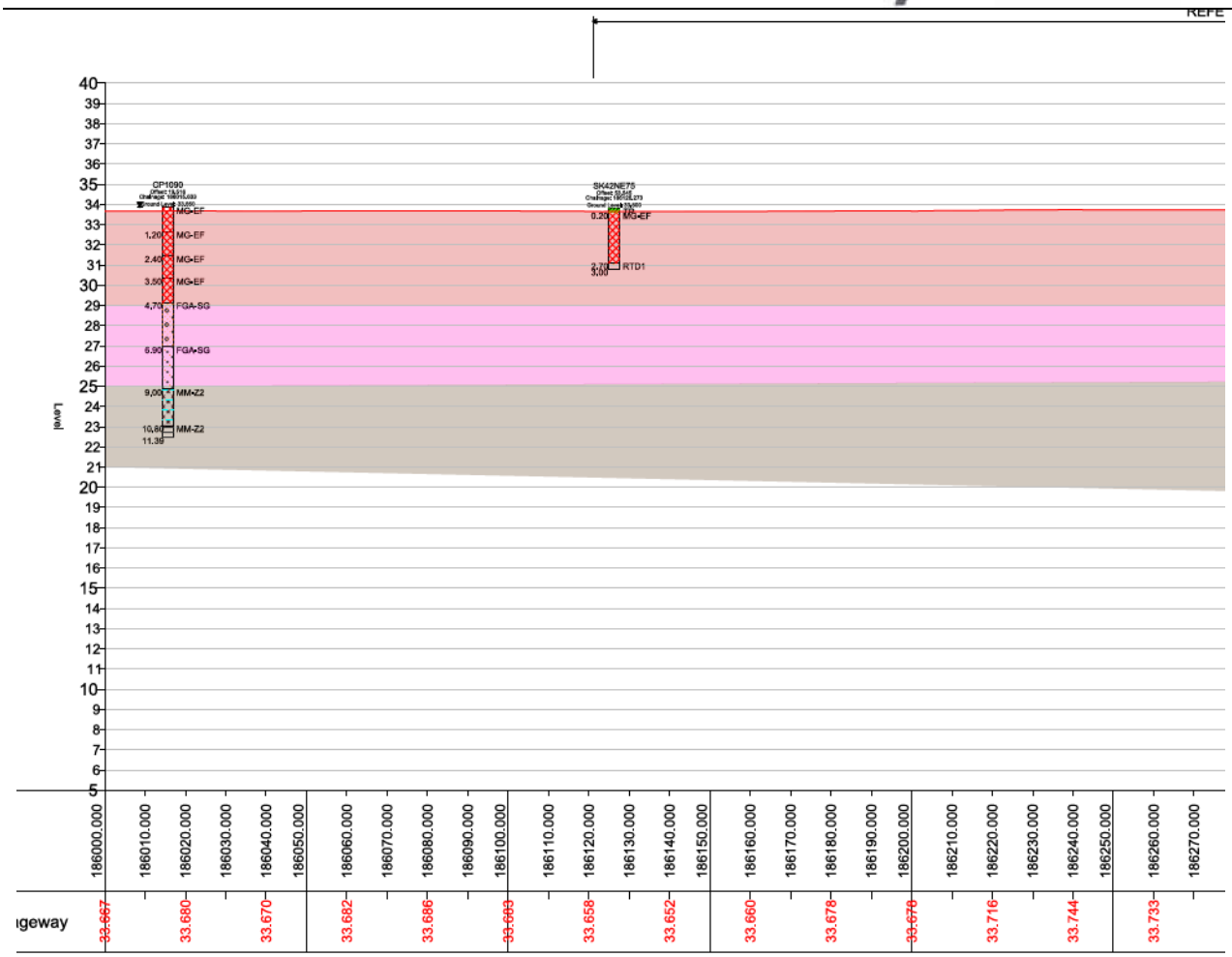


Figure 4.2: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
185870	186200	Granular Wedge at Embankment Crest (1:2.0)	4.5	45 (1V:1H)

Proposed Structural Solution:

N/A

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- L-CCD-13A and 13B, Chainage 186180, Southbound –CPT test to a maximum depth of 5mbgl.
- T-CCD-45A and 45B, Chainage 185905, Southbound –CPT test to a maximum depth of 5mbgl.
- T-CCD-18A and 18B, Chainage 186165, Southbound –CPT test to a maximum depth of 5mbgl.
- T-CCD-17A, Chainage 186057, Northbound –CPT test to a maximum depth of 5mbgl.
- T-CCD-17A, Chainage 186057, Southbound –CPT test to a maximum depth of 5mbgl.

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HISTORICAL EXPLORATORY HOLES

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Borehole Log

Borehole No.
SK42NE13
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447430.00 - 328260.00	Hole Type CP
Location:		Level: 30.40mbgl	Scale 1:50
Client: Highways England		Dates: 11/08/1961 - 12/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.76	624D						Firm brown silty clay FGA
		1.37	625			1.37	29.03		
			W						Gravel FGA-SG
		1.52	626D						
		2.29	627D						
						3.51	26.89		Firm red & grey silty clay MM-Z4
		3.96	628D						
		4.11 - 4.57	629U	32blows					
						4.80	25.60		Sand & siltstone MM-ST
		5.18	630D			5.18	25.22		Stiff red clay MM-Z4
		5.33 - 5.79	631U	52blows					
		5.79	632D						
						5.94	24.46		Grey sand (weakly cemented) MM-SS
		6.71 - 7.16	633U	85blows					
		7.16	634D						
						8.23	22.17		Grey sandstone MM-SS
		8.38	635D						
		9.14	636D			9.14	21.26		End of borehole at 9.14 m

Remarks

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Borehole Log

Borehole No. **CP1090** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447432.00 - 328391.00	Hole Type CP
Location:		Level: 33.85mbgl	Scale 1:50
Client: Highways England		Dates: 23/11/2006 - 23/11/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.50	101B						MADE GROUND. Light brown clayey very gravelly sand with occasional rootlets. Gravel is angular to subrounded fine to coarse of mudstone, sandstone and quartzite. Possible MG-EF
		1.00	102B						
						1.20	32.65		MADE GROUND. Stiff red brown locally grey green, occasionally gravelly clay. Gravel is fine to coarse angular to subangular of siltstone. MG-EF
		1.50 - 1.95	1U	50blows					
		2.00	2D						
		2.40	3D			2.40	31.45		MADE GROUND. Brown sandy gravel. Sand is medium. Gravel is medium to coarse, subrounded of quartz. MG-EF
		2.50	SPT (C)	N=28 (3,4/6,7,7,8)	Casing=2.50m Water=2.00m				
		2.50 - 3.00	4B						
		3.50	SPT (C)	50 (35 for 90mm/50 for 85mm)	Casing=3.50m Water=DRY	3.50	30.35		Possible MADE GROUND. Grey brown sand and gravel. Sand is coarse. Gravel is fine to coarse, angular to subangular of limestone and dolomite. MG-EF
		3.50 - 4.00	5B						*Between 3.50m and 4.70m; driller notes 'water running away'.*
		4.50	SPT (C)	50 (25 for 30mm/50 for 20mm)	Casing=4.50m Water=DRY	4.70	29.15		Brown SAND and GRAVEL. Sand is medium to coarse. Gravel is fine to coarse, subangular to rounded of sandstone, quartz and some coal. FGA-SG
		4.50 - 5.00	6B						
		5.50	SPT (C)	N=31 (3,5/6,7,9,9)	Casing=5.50m Water=4.20m				
		5.50 - 6.00	7B						
		6.50	SPT (C)	N=17 (4,4/4,5,4,4)	Casing=6.50m Water=3.00m				
		6.50 - 7.00	8B						
						6.90	26.95		Red brown sandy SILT to silty SAND with some gravel. Gravel is medium to coarse, subangular to subrounded of sandstone and quartz. FGA-SG
		7.50 - 7.95	U#B	30blows					
		7.50 - 8.00	9B						
		9.00	10D			9.00	24.85		Very stiff red brown locally grey green SILT/ CLAY with some mudstone lithorelics. Locally a grey green slightly silty fine grained sand. MM-Z2
		9.00	SPT (S)	N=40 (7,10/10,10,10,10)	Casing=9.00m Water=5.90m				
		9.00 - 9.50	11B						

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 3.50m to 4.70m (2.5 hours) and 10.80m to 11.30m (1 hour).;No visual or olfactory indication of contamination was observed.;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 2.50m.;

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Borehole Log

Borehole No. **CP1090** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447432.00 - 328391.00	Hole Type CP
Location:		Level: 33.85mbgl	Scale 1:50
Client: Highways England		Dates: 23/11/2006 - 23/11/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		10.50	12D						SILT/CLAY (as previous sheet)
		10.50	SPT (S)	50 (10,15/50 for 180mm)	Casing=10.50m Water=8.70m	10.80	23.05		
		10.50 - 11.00	13B						Very weak friable brown MUDSTONE recovered as sandy clay. With very thin (<0.5mm) white laminae. MM-Z2
		11.30	14D						
		11.30	SPT (S)	50 (25 for 50mm/50 for 40mm)	Casing=10.50m Water=9.00m	11.39	22.46		End of borehole at 11.39 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 3.50m to 4.70m (2.5 hours) and 10.80m to 11.30m (1 hour).;No visual or olfactory indication of contamination was observed.;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 2.50m.;

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Borehole Log

Borehole No. **SK42NE75**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447433.00 - 328508.00	Hole Type CP
Location:		Level: 33.80mbgl	Scale 1:50
Client: Highways England		Dates: 03/02/1988 - 03/02/1988	Logged By AAC

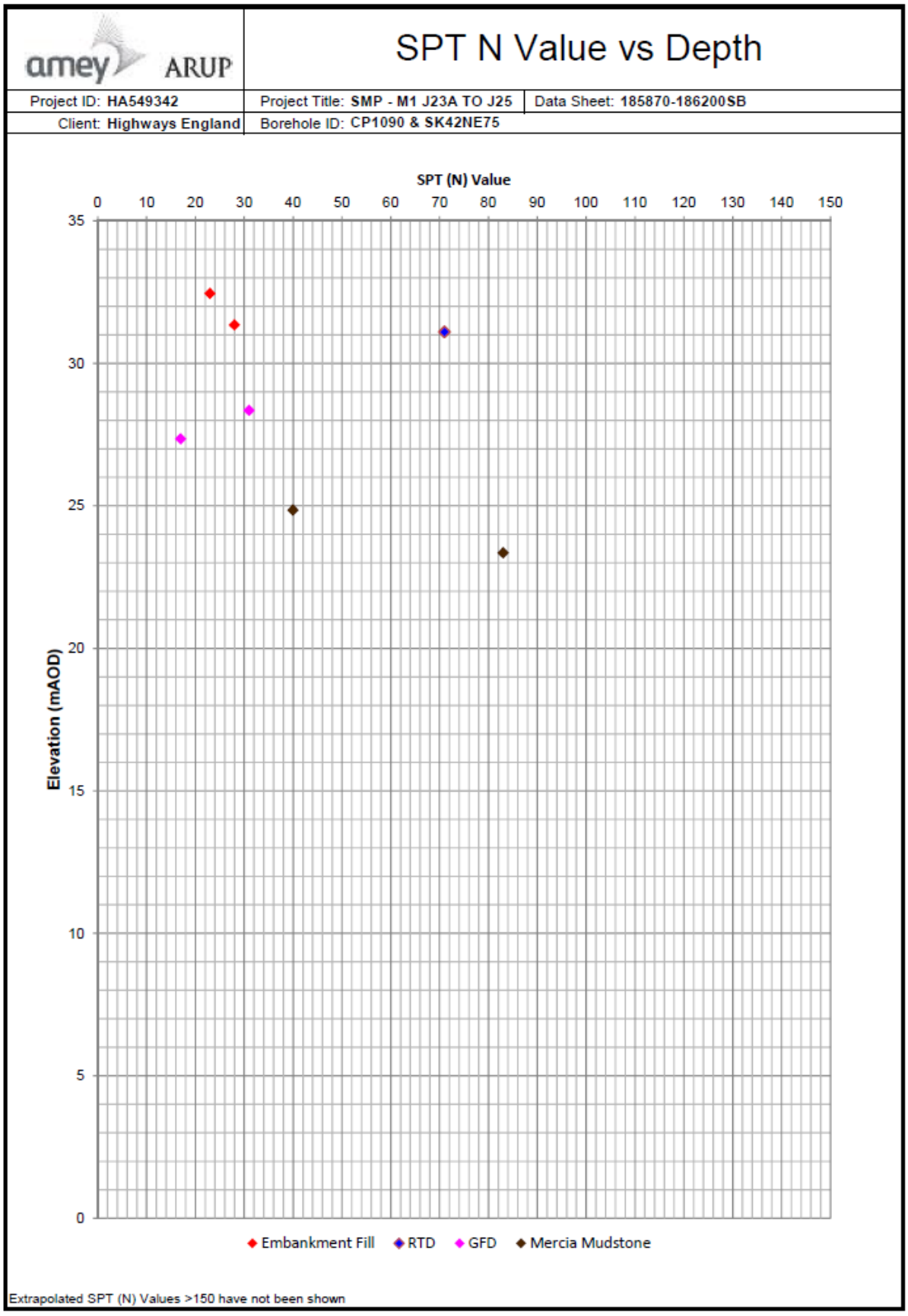
Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.20	33.60		TOPSOIL TP Very stiff red brown locally very silty CLAY with occasional fine to medium gravel sized lithorelics and a little subrounded to subangular fine to medium assorted gravel. (FILL) Below 1.35m becoming locally fine sandy with occasional pockets and lenses of light grey green silt.
		1.35	SPT (S)	N=23 (2,2/4,6,6,7)	Water=-				MG-EF *subangular coarse gravel and cobbles of LIMESTONE strong to very strong* *angular fine to coarse gravel and cobble sized fragments of light grey green SILTSTONE strong.*
		2.70	SPT (S)	71 (7,10/71 for 150mm)	Water=-	2.70	31.10		Brown fine to medium SAND with a little to some subrounded to subangular fine to medium occasionally coarse assorted gravel. (Probable TERRACE DEPOSITS)
						3.00	30.80		RTD1 End of borehole at 3.00 m

Remarks
Hand dug inspection pit from ground level to 1.00m

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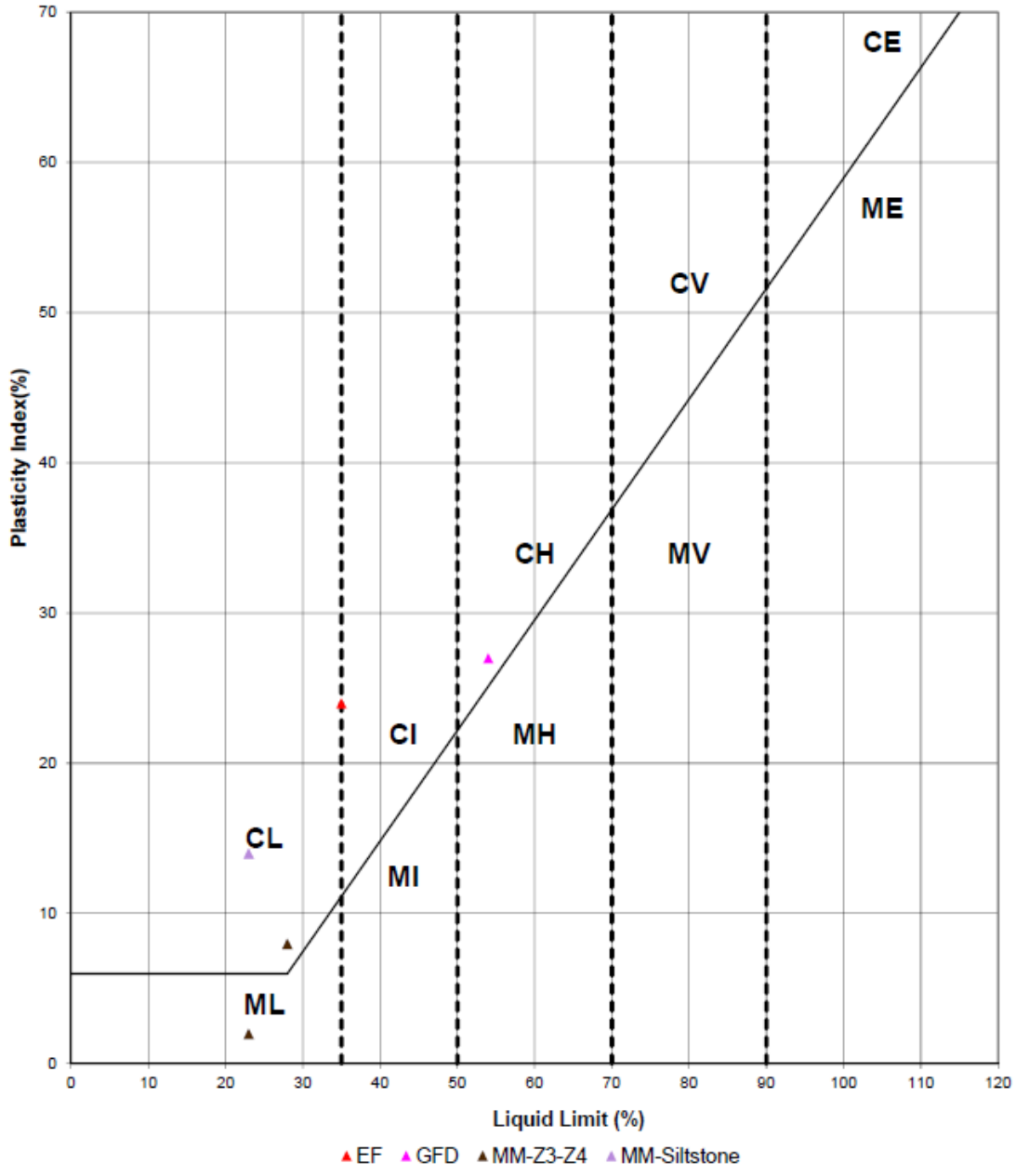
PLOTS



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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185870-186200SB**
Client: **Highways England**	Borehole ID: **SK42NE13 & CP1090**	



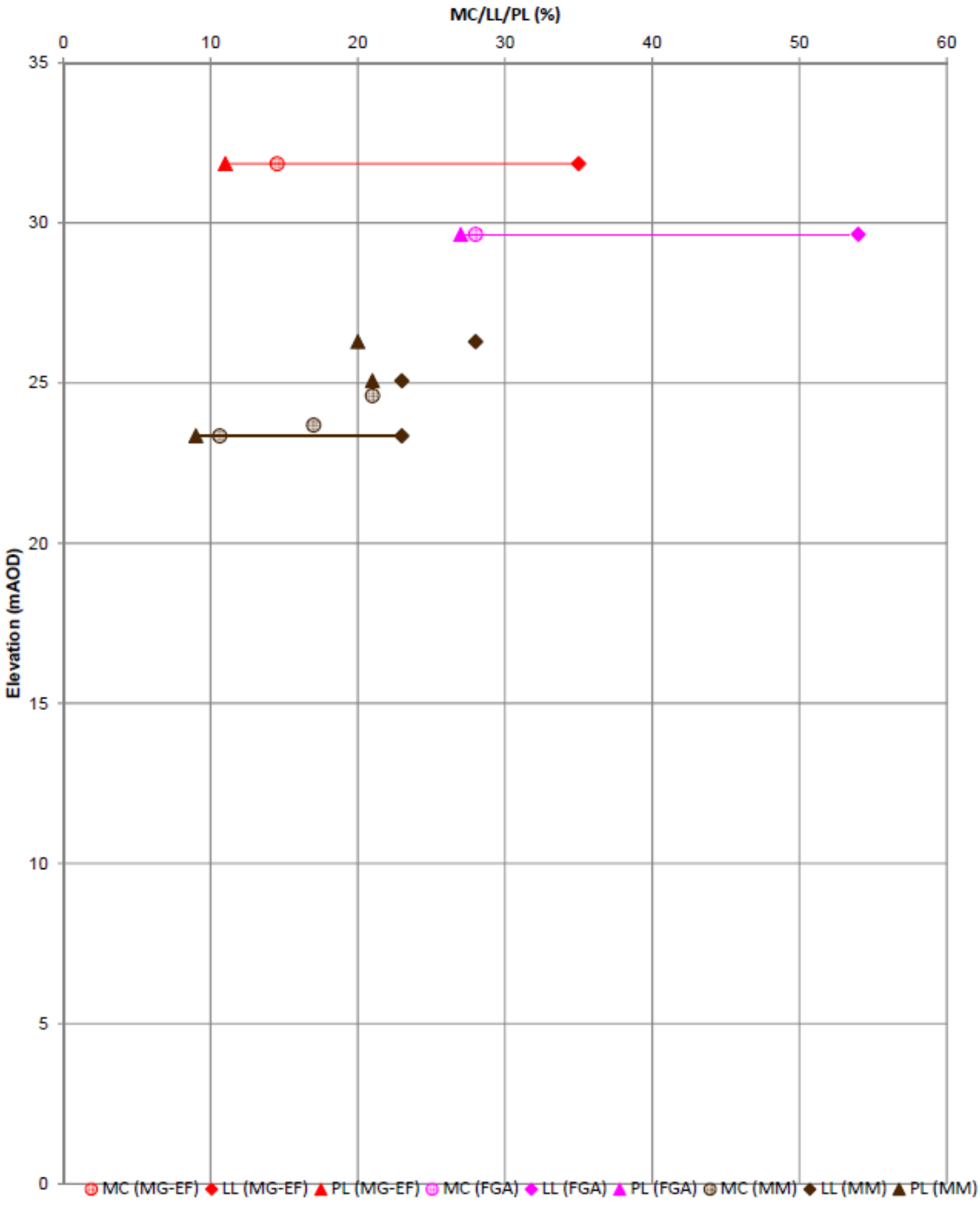
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185870-186200SB**
Client: **Highways England**	Borehole ID: **CP1090 and SK42NE13**	

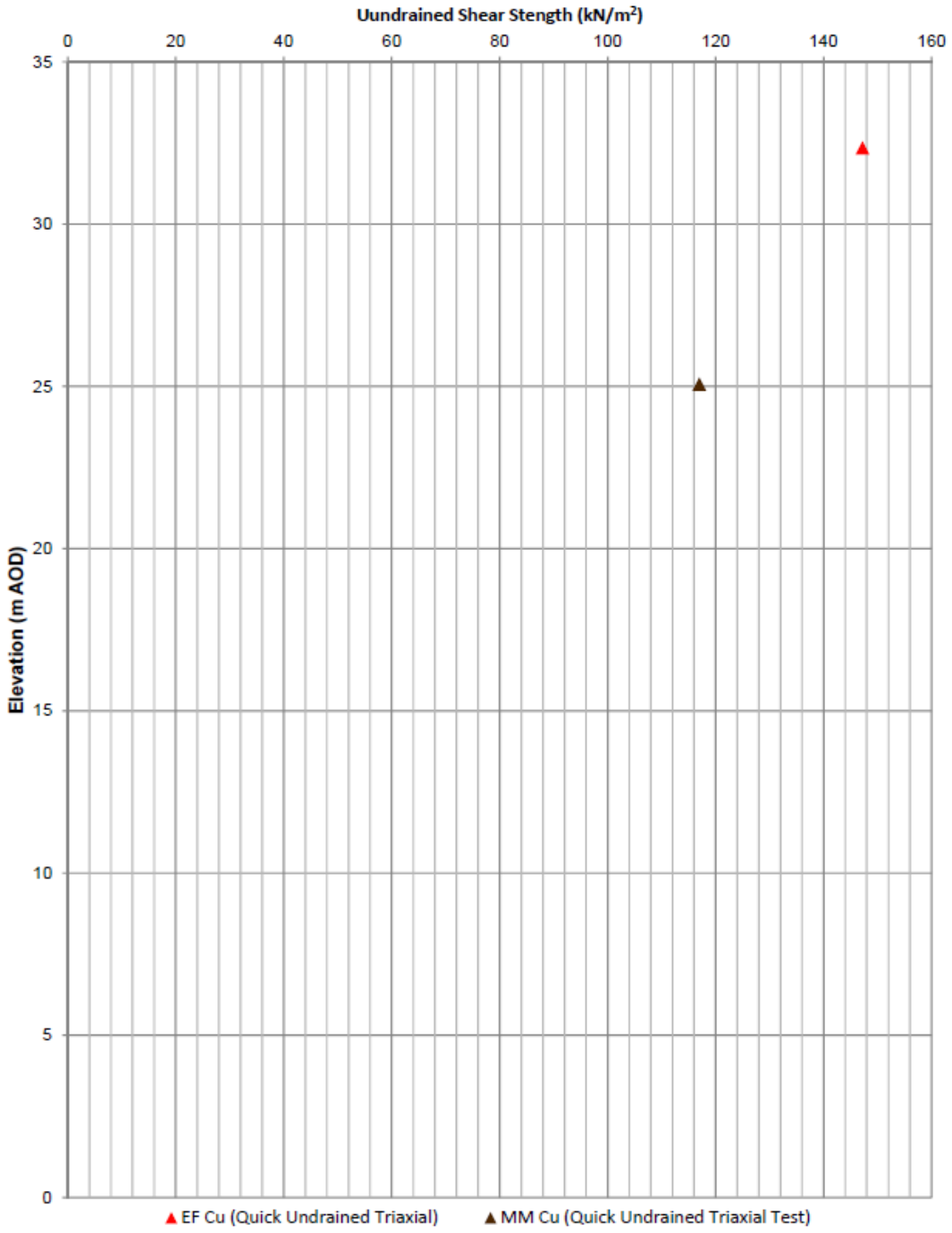


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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185870-186200SB**
Client: **Highways England**	Borehole ID: **CP1090**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-186210-186400SB-GSS-000001		
Earthwork Widening Solution	Full Height Embankment Widening 1:2.0		
Structure Number	Gantry 202 and Gantry 203		
Structure Type	Superspan Portal & ADS Cantilever		
Design Chainage	186210-186400		
Carriageway	Southbound		
Marker Post	MP186/2B+10 – MP186/4B+00		
National Grid Reference	E 447469, N 328252 – E 447379, N 328569		
Existing Ground Level at Location	Carriageway	33.70mAOD	
	Toe of embankment	30.63mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_24390 & 7_M1_24405	HAGDMS designation
Earthwork Height	NB: N/A	SB: 2.30m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 23°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	07/02/2017	[redacted]
Checked	Alice Bazen	15/02/2017	
Reviewed	Gary Summerfield	16/02/2017	
Approved	Tom Bulteel	23/02/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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DESK STUDY

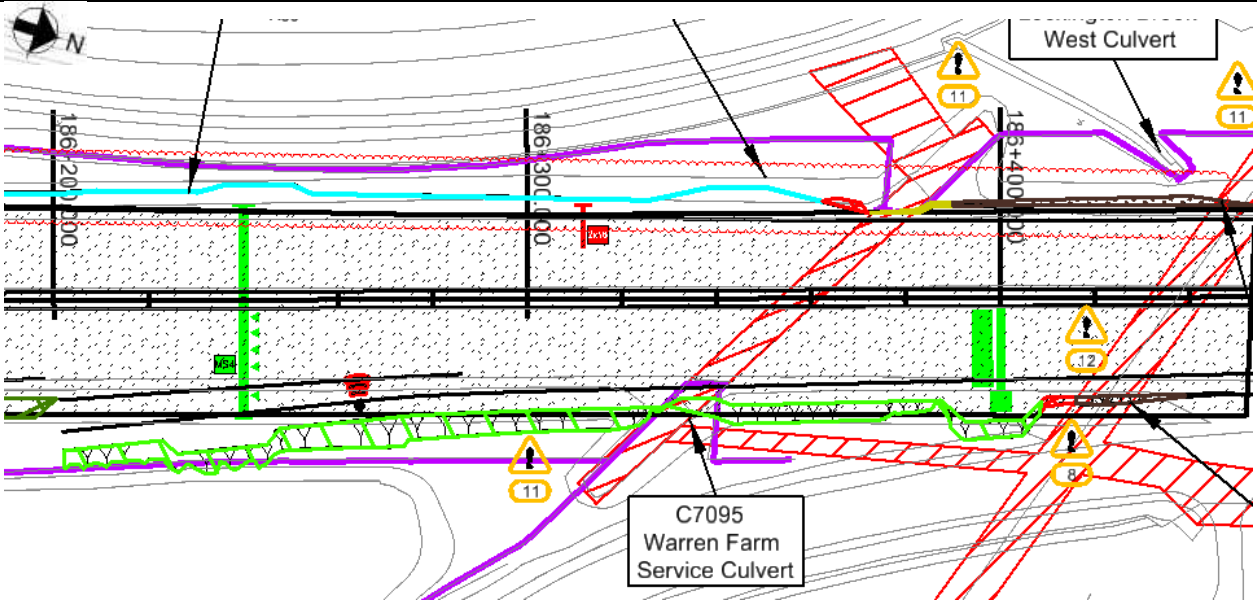


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Full Height Embankment Widening at 1 in 2 gradient.

Proposed Major Structures:

Superspan Cantilever (Gantry 202) and ADS Cantilever (Gantry 203) proposed at Ch.186240 and Ch.186400 respectively.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment ranging in height from 1.0m to 2.3m with a typical slope angle of 23 degrees.

The critical cross section with the greatest earthwork height and widening is Ch186210.

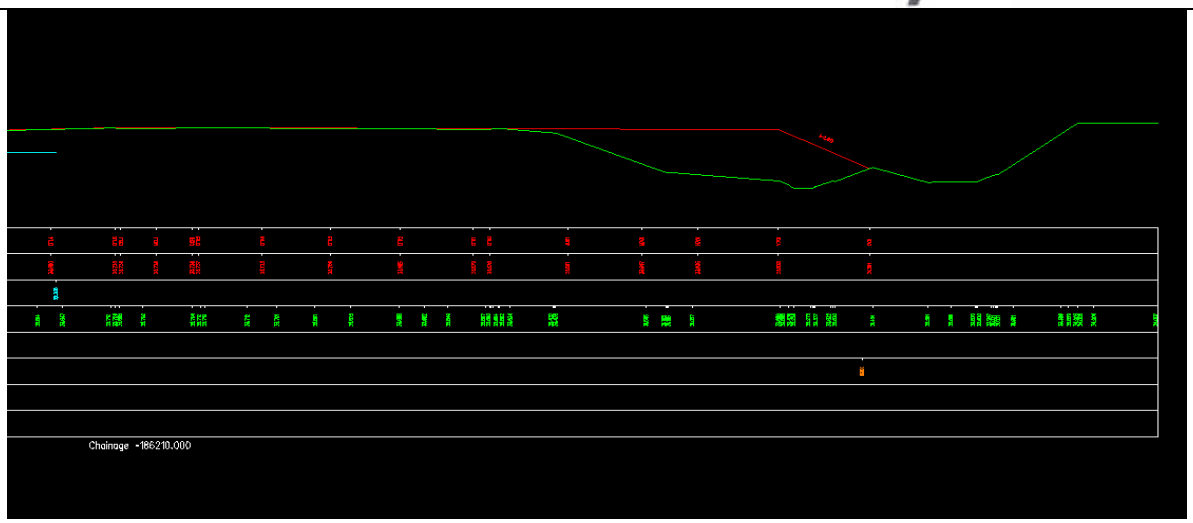


Figure 2: Topographic Critical Cross Section Chainage 186210

Utilities:

Severn Trent Water Supply Pipe running east to west between chainage 186340 and 186380.

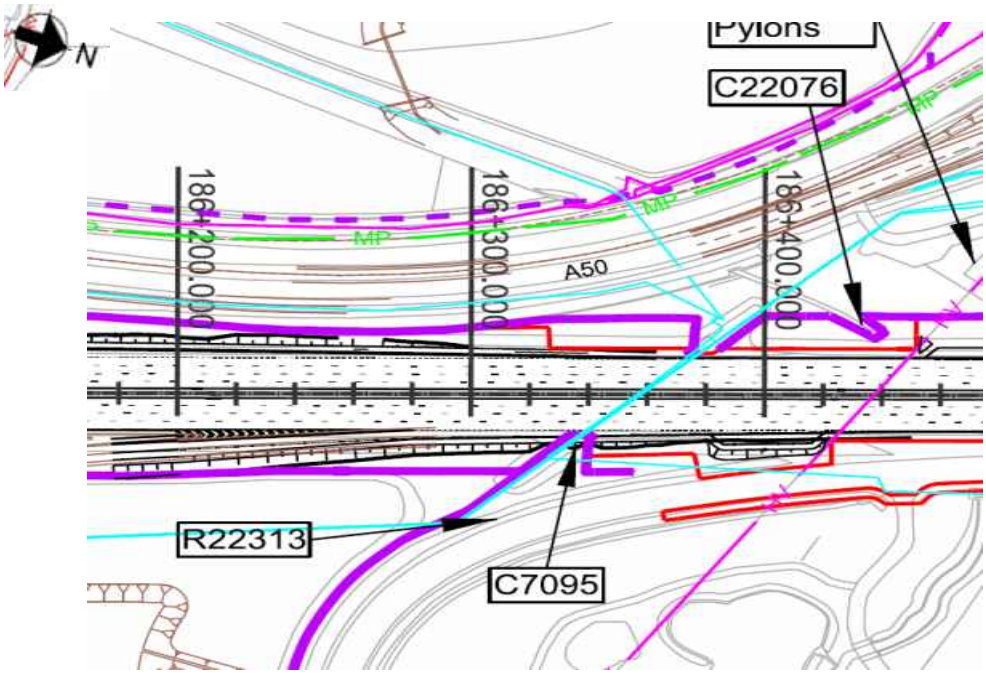


Figure 3: Utilities location plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Holme Pierrepont Sand and Gravel Member – Sand and Gravel (River Terrace Deposits)

Solid Deposits: Branscombe Mudstone Formation - Mudstone.

Ground Investigation:

There are 3 No. historical exploratory holes recorded within the design chainage, as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000028, Rev P01.

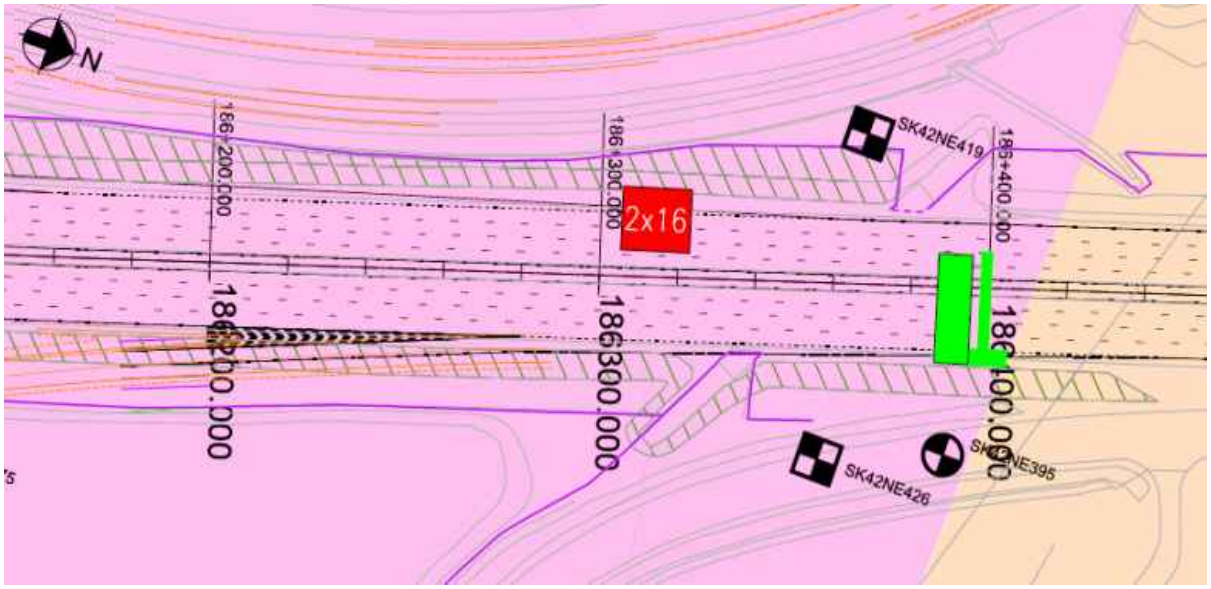


Figure 4: Borehole Location Plan

Flood Risk:

Gantry 202 is located within an area at risk from flooding. The estimated design flood level on both the NB and SB side of the gantry is 32.3mAOD, however Gantry 203 is not located in a flood risk zone.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04

Historical Boreholes:

Relevant Borehole Number	SK42NE395	SK42NE419	SK42NE426
Borehole Chainage	186390	186368	186357
Borehole Location	Southbound (J24A Off Slip)	Northbound	Southbound (J24A Off Slip)
National Grid Reference	E 447340, N 328755	E 447472, N 328710	E 447352, N 328725
Ground Level at Exploratory Hole	30.93mAOD	31.51mAOD	30.60mAOD

RAG Analysis	Green	Amber	Amber
Date Drilled	15/06/1992	22/06/1992	24/06/1992
Termination Depth	10.00 meters below ground level (mbgl)	4.00 metres below ground level (mbgl)	2.85 metres below ground level (mbgl)
Other suitable holes	None		

Existing Ground itions:

The following ground conditions are assumed based on previous GI and driven LiDAR Survey data.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*	Hand Vane Strength Range (kN/m^2)
Embankment Fill	4.70	29.00	20 (20)	188
River Terrace Deposits (coarse grained)	8.20	25.50	43-56 (43)	-
Mercia Mudstone – III/IV	>8.20	<25.50	>150	-

(1) Ground level is assumed to be at the carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

Geotechnical hazard plan HA549342-AMAR-HGT-SWI-DR-CE-000054 shows hazard 'E16' ("4m of refuse material and unsuitable material removed below formation level") in the vicinity of the southbound leg of the proposed new gantry.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken in exploratory hole SK42NE395 and 1 No. Hand Shear Vane was completed in borehole SK42NE419.

Groundwater:

Groundwater was encountered in the historical exploratory holes and is presented in the table below:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
SK42NE395	Embankment Fill	1.28	29.65	N/A	N/A	N/A
SK42NE419	Glaciofluvial Deposits	3.20	28.31	N/A	2.55	28.96
SK42NE426	Embankment Fill	1.05	29.55	N/A	N/A	N/A

Groundwater Design Level:

Groundwater level for design has been assumed as the flood risk level (32.30mAOD). Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

1 No. Atterberg Limit Tests and 4 No. Moisture content tests ere undertaken within Embankment Fill and River Terrace Deposits layers, with the results presented below:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	0.00	20.50	-	-	-	-
Embankment Fill	1.00	31.30	32	20	12	CL
Embankment Fill	2.00	10.20	-	-	-	-
River Terrace Deposits	3.00	7.40	-	-	-	-

Lab Test Data – BRE Classification:

No chemical test data is available for this earthwork.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment fill	0-4.70	33.70-29.00	4.70	21	27	0	100	7.8	6.2	-	0.50	0.20	-	2.6	0.45	1.0	6.2*		DS-2 AC-2
River Terrace Deposits (coarse grained)	4.70-8.20	29.00-25.50	3.50	20	39	-	-	-	58.8	-	-	0.25	-	23.5	-	1.0	-	50	DS-3 AC-3
Mercia Mudstone – III/IV (<10m bgl)	8.20-10.00	25.50-23.70	1.80	21	30	2	100	10.8	8.6	-	0.50	0.20	-	3.6	0.45	-	9	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10m bgl)	>10.00	<23.70	-	21	30	2	200	16.8	13.4	-	0.50	0.20	-	5.6	0.37	-	9	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical borehole SK42NE395.
(3) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) Due to the absence of local data for Embankment Fill, the generalised parameters derived in the AMAR GIR are used for Embankment Fill.
(5) The ϕ' for River Terrace Deposits (coarse grained) is based on a conservative SPT N value of 43, and compared to the correlation by Peck 1974.
(6) The ϕ' for Mercia Mudstone – III/IV 1-10m bgl is based on values from the AMAR GIR due to lack of PI data available.

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(7) c_u for Mercia Mudstone – III/IV is based on the AMAR GIR parameters due to a lack of local data.
(8) E' of River Terrace Deposits (coarse grained) can be determined using Bowles correlation E' = 1200 (N + 6) which (using conservative N value of 43) gives a value of 58.8MN/m^2.
(9) Due to the lack of local SPT N values for current ground conditions, E for Mercia Mudstone – III/IV >10m bgl is based on derivations in the AMAR GIR.
(10) Shear modulus is based on G = E/2(1+v).
(11) Adhesion factor for Embankment fill is based on BS8004 (equation 41).
(12) Nc is based on BS8004 for Embankment Fill, and on CIRIA C570 for Mercia Mudstone. * increases to '9' from 3.6m bgl.
(13) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).
(14) Nq is based on relationship with density as shown in Tomlinson (Table 7.1).

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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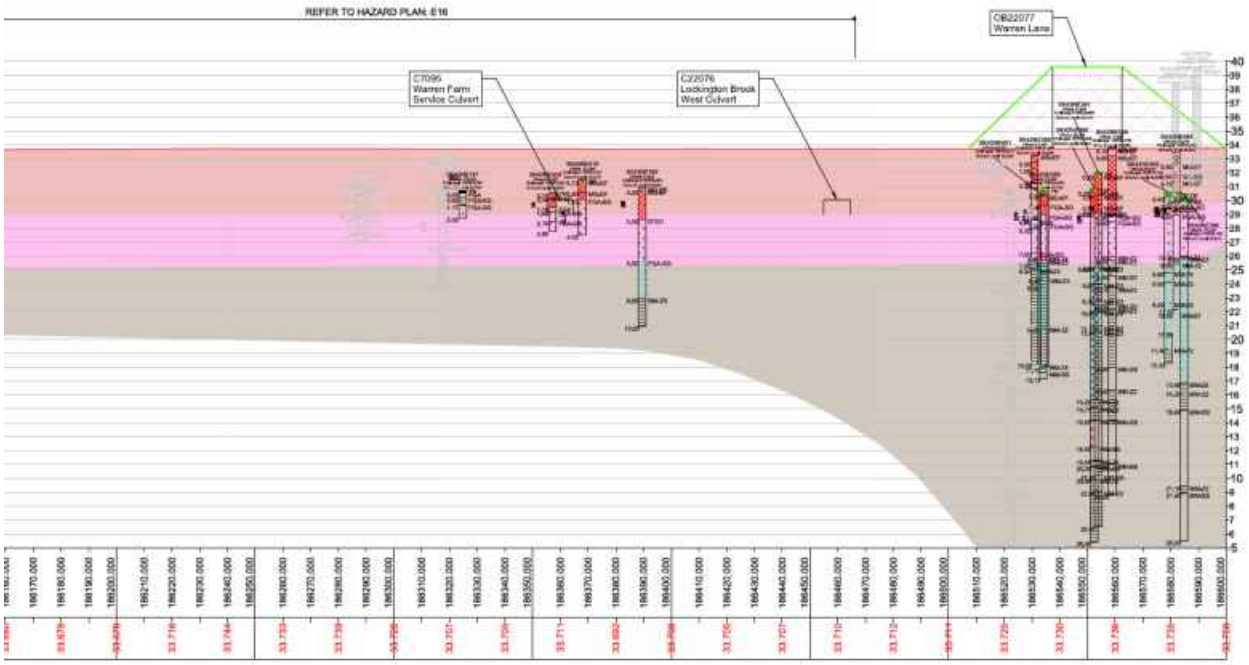


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
186210	186400	Full Height Embankment Widening (1:2.0)	10.32	26.6

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Structure Reference	Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
Gantry 202	3 (1x3)	900	15.5	2.70	11	805	677
Gantry 203	4 (2x2)	900	25.0	2.70	13	464	1137

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Further Ground Investigation

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH –G202B at chainage 186240, Southbound – Dynamic Sample with a Rotary Core follow on up to a minimum depth of 19.0m bgl.
- BH –G203 at chainage 186240, Southbound – Dynamic Sample with a Rotary Core follow on upto a minimum depth of 30.0m bgl.
- T – CCD – 19B, 186255, Northbound, CPT up to a minimum depth of 5.0mbgl.
- L – CCD – 14B, 186255, Southbound, CPT test up to a minimum depth of 5.0mbgl.

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LOGS

Borehole Log

Borehole No. **SK42NE395** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447340.00 - 328755.00	Hole Type CP
Location:		Level: 30.93mbgl	Scale 1:50
Client: Highways England		Dates: 15/06/1992 - 15/06/1992	Logged By M.Bryans

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 1.00	1B			0.20	30.73		CONCRETE MG-EF Black clayey fine to coarse sand of ash with much angular gravel and occasional cobbles, including brick and concrete fragments. Trace of glass (Made Ground) MG-EF
		1.00 - 1.45	2U	20blows					
		1.01 - 2.00	3B						
		1.50 - 1.95	4U	32blows					
		2.00	SPT (S)	20 (0 for 0mm/20,,,)	Water=-				
		2.00 - 2.45	1S			2.30	28.63		Dense and very dense brown fine to coarse SAND AND subrounded fine to coarse GRAVEL, predominantly of quartzite. (River Terrace Deposits) RTD1 *3.00-4.00m silty very sandy gravel*
		2.01 - 3.00	5B						
		3.00	2S						
		3.00	SPT (C)	47 (0 for 0mm/47,,,)	Water=-				
		3.01 - 4.00	7B						
		4.00	SPT (C)	56 (0 for 0mm/56,,,)	Water=-				
		4.01 - 5.00	8B						
		5.00	SPT (C)	43 (0 for 0mm/43,,,)	Water=-				
		5.01 - 6.00	9B			5.30	25.63		Very stiff red brown, slightly mottled grey green friable silty CLAY with many coarse sand sized lithorelicts of very weak and weak mudstone. (Highly weathered , GIVa/IVb, Mercia Mudstone Group) FGA
		6.50	SPT (C)	49 (0 for 0mm/49,,,)	Water=-				
		6.51 - 7.50	10B						
		8.00	SPT (S)	82 (0 for 0mm/82,,,)	Water=-	8.00	22.93		Very weak and weak red brown slightly mottledgrey green MUDSTONE, recovered as angular fine to medium gravel sized fragments with a little stiff clay matrix. (Mercia Mudstone Group) MM-Z3
		8.00 - 8.30	11B						
		8.01 - 9.00	12B						
		9.50	SPT (C)	80 (0 for 0mm/80,,,)	Water=-				
		9.51 - 10.00	13B						
						10.00	20.93		End of borehole at 10.00 m

Remarks

AGS

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Trial Pit Log

Trialpit No: **SK42NE419** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447272.00 - 328710.00 Level: 31.51mbgl	Date 22/06/1992
Location:		Dimensions: 2.95m x 1.00m Inclination: 90° Orientation: 174° Depth: 4.00m	Scale 1:50
Client: Highways England			Logged

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
	0.30 0.40 - 0.50	1J 2J			0.10	31.41		HUMUS and TOPSOIL TP
	0.95 1.00	3J HV			0.90	30.61		Loose* orange brown silty fine to medium SAND with some locally much subrounded fine to coarse gravel of quartzite, sandstone and siltstone. Occasional pockets of stiff red brown extremely closely fissured clay. (MADE GROUND) MG-EF
	1.55 - 1.65	4J			1.45	30.06		Very stiff brown to red brown extremely closely to closely fissured very silty slightly sandy CLAY with rare subrounded fine to medium gravel of quartzite and sandstone (MADE GROUND) MG-EF
▼	2.55 - 2.65	5B						Dense* brown clayey silty fine to medium SAND with some subrounded fine to coarse gravel of quartzite, sandstone and siltstone. In parts light grey mottled and orange brown. (RIVER TERRCE DEPOSITS) - locally becoming medium to coarse sand and gravel FGA-SG
▽	3.20	6W						
	3.55 - 3.65	7B						
					4.00	27.51		End of pit at 4.00 m

Shift Information				Backfill			Water Strike						Depth Related Remarks		
Date & Time	Depth	Water	Remarks	Top	Base	Description	Struck	Rose to	Date	Time	Sealed	Remarks	Top	Base	Remarks
							3.20	2.6	22-06-1992	12:00		Encountered as slight seepage at 2.60m. No rise. Water			

Remarks:
1. No significant lateral variation in soil types.
2. Photograph of Face D only.
3. Logged on excavated material below 1.20m.
4. *Engineer's visual assessment.
5. Hand vane result is an average of three tests.
6. No watercourse near to pit from which to obtain water sample.

Stability: No support. Spalling below 2.90m.

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Trial Pit Log

Trialpit No **SK42NE426**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447352.00 - 328725.00 Level: 30.60mbgl	Date 24/06/1992
Location:		Dimensions: Inclination: 90° Orientation: 162° Depth: 2.85m	Scale 1:50
Client: Highways England			Logged S.G.FLYNN



Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
	0.20 - 0.30	1J			0.10	30.50		TOPSOIL. TP
	0.45 - 0.55	2B			0.40	30.20		Dense* orange brown and brown silty very sandy subrounded fine to medium GRAVEL of flint, quartzite, sandstone, siltstone (MADE GROUND). MG-EF
▼	1.05	3W			1.10	29.50		Loose* grey brown ashy fine to coarse SAND, in parts becoming very soft black organic sandy clay. Some glass bottles, brick and brick fragments, metal fragments. Odorous. (MADE GROUND) MG-EF
	1.10	HV	164kPa					
	1.20 - 1.30	4J			1.40	29.20		
	1.40 - 1.50	5J						
	2.10 - 2.20	6J			2.10	28.50		Very stiff light grey and orange brown sandy CLAY with a little subrounded fine to coarse gravel of quartzite, sandstone and siltstone - by about 1.30m becoming clayey fine to coarse SAND with much subrounded fine to coarse gravel (ALLUVIUM) FGA
					2.85	27.75		Dense* grey medium to coarse SAND with some subrounded fine to coarse gravel predominantly of quartzite - becoming brown by 1.80m (RIVER TERRACE DEPOSITS) FGA-SG
								Dense* brown medium to coarse SAND AND subrounded to rounded fine to coarse GRAVEL predominantly of quartzite, sandstone. Grading to sandy GRAVEL by 2.50m. Occasional orange brown fine to coarse sand pockets. (RIVER TERRACE DEPOSITS) FGA-SG
								End of pit at 2.85 m

Shift Information				Backfill			Water Strike						Depth Related Remarks		
Date & Time	Depth	Water	Remarks	Top	Base	Description	Struck	Rose to	Date	Time	Sealed	Remarks	Top	Base	Remarks
							1.05	1.05	24-06-1992	12:00		Encountered as a strike at 1.05m. Rose from 1.20 to 1.05m in			

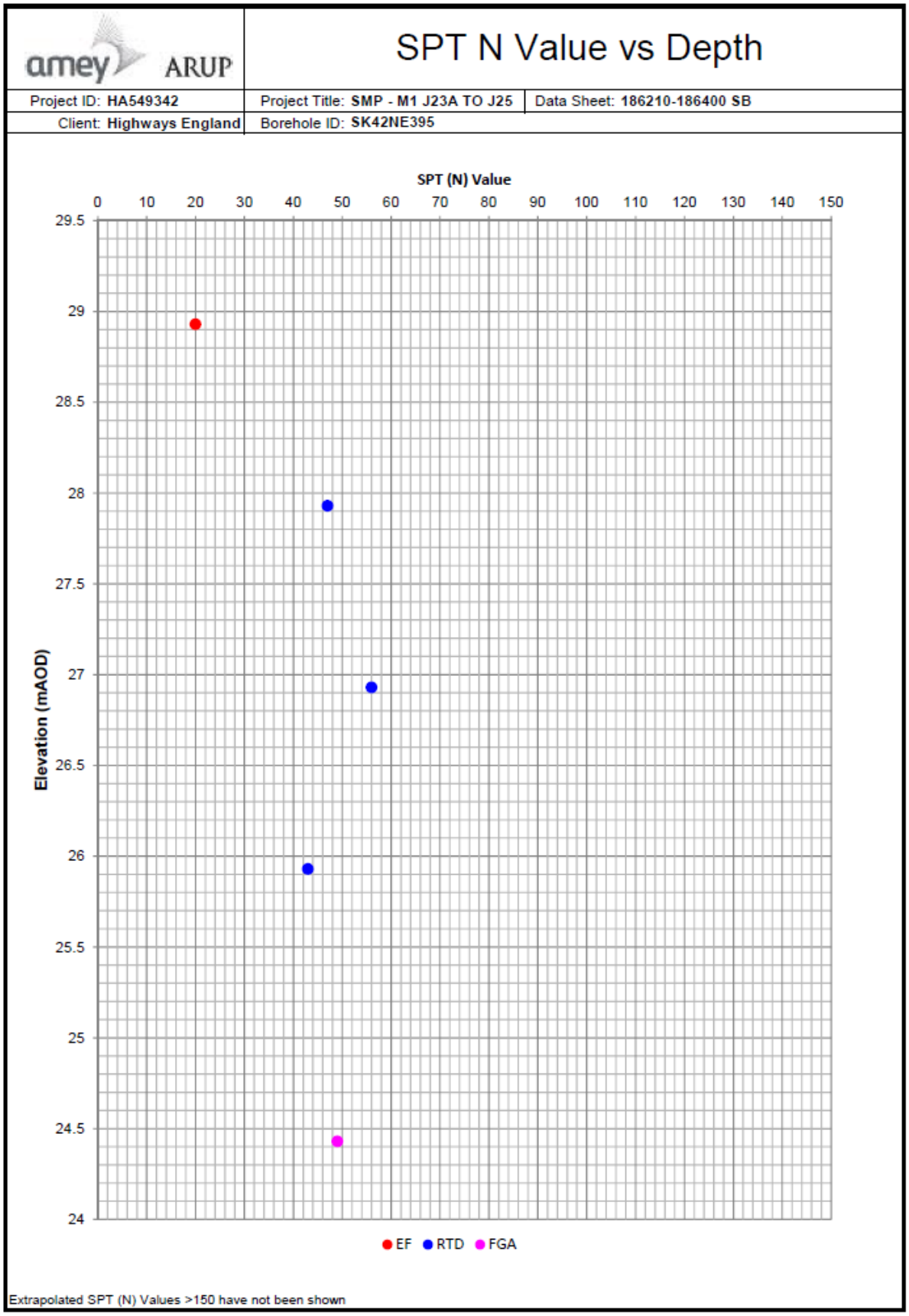
Remarks:

Stability: No support. Constant spalling below 1.50m

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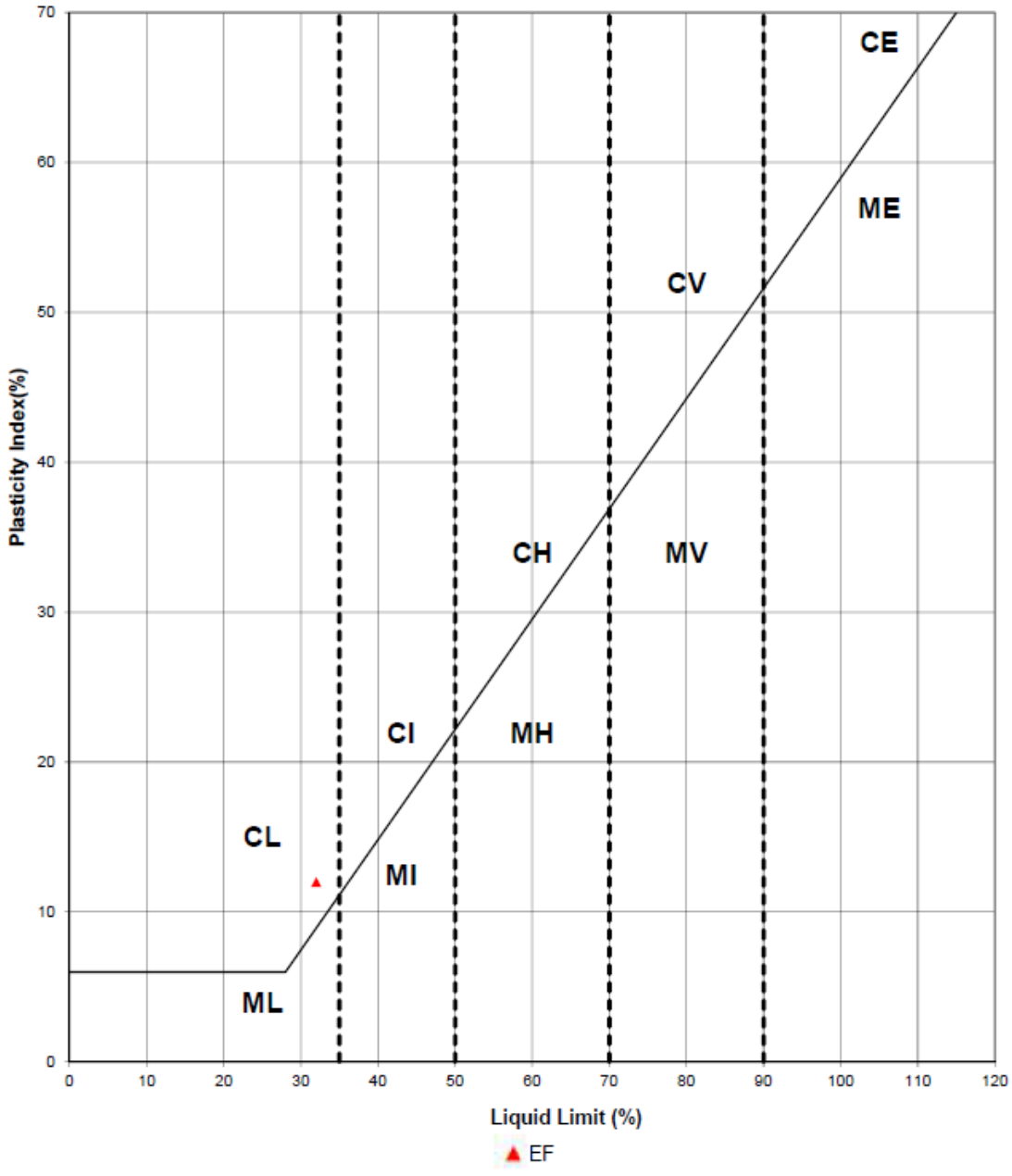
PLOTS



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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186210-186400 SB**
Client: **Highways England**	Borehole ID: **SK42NE395**	



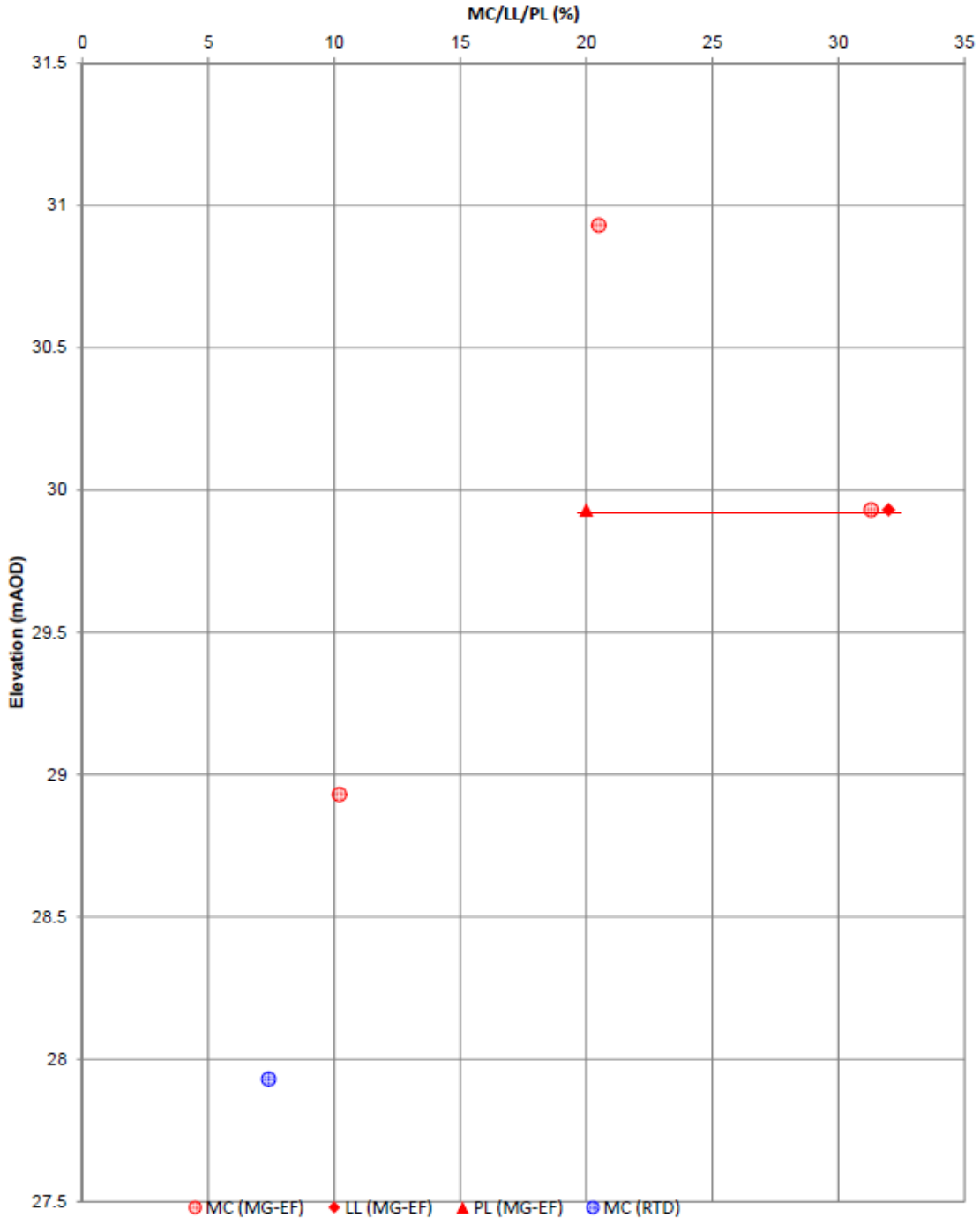
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

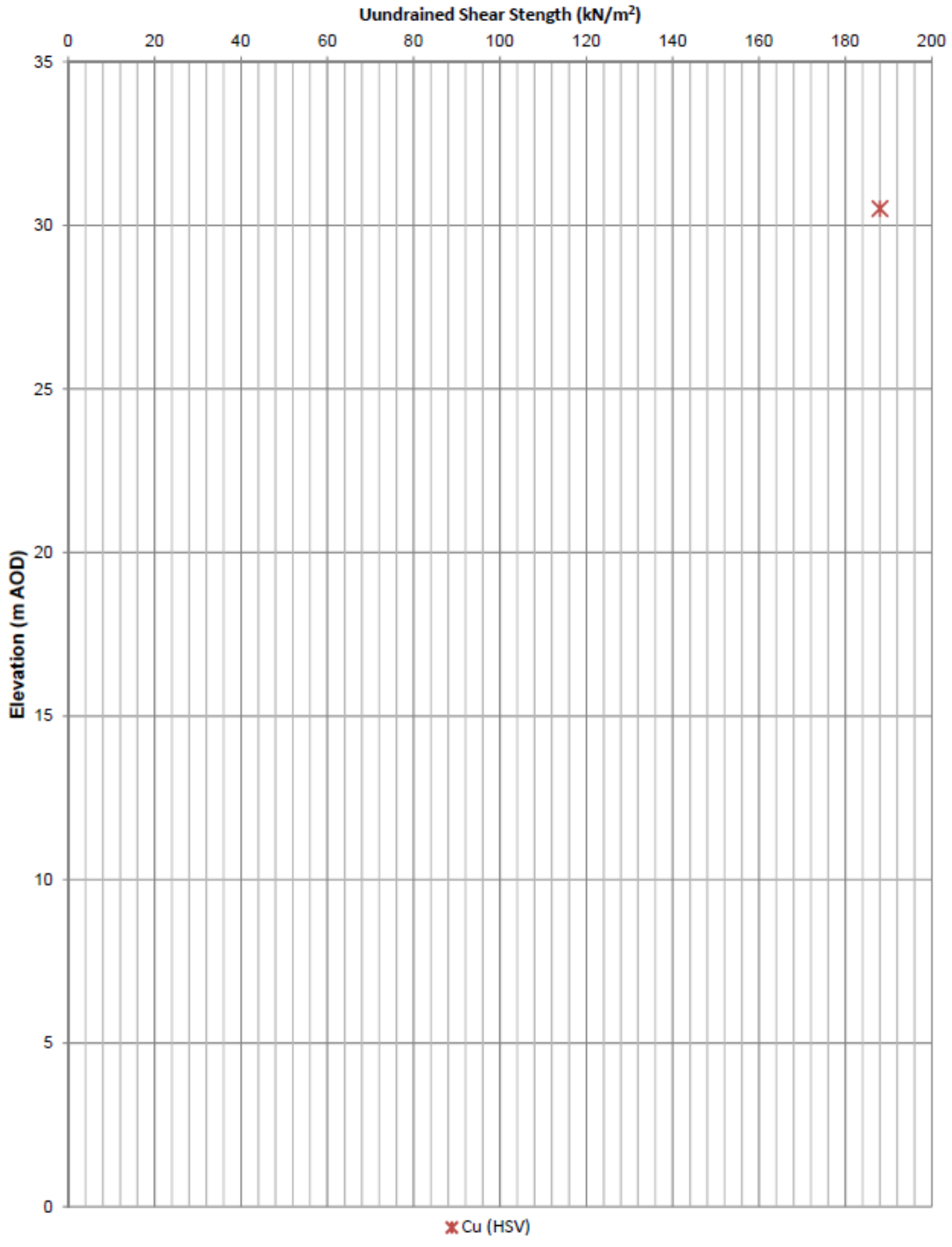
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186210-186400SB**
Client: **Highways England**	Borehole ID: **SK42NE395**	



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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186210-186400 SB**
Client: **Highways England**	Borehole ID: **SK42NE19**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-186800-186880SB-GSS-000001		
Earthworks Widening Solution	Full Height Embankment Widening (1:2.0), Granular Wedge at Embankment Crest (1:2.0)		
Structure Number	GANTRY_301 [1]		
Structure Type	Superspan Portal Gantry		
Design Chainage	186800-186880		
Carriageway	Southbound		
Marker Post	186/8A+00 – 186/8A+80		
National Grid Reference	E 447204, N 329142 – E 447174, N 329216		
Existing Ground Level at Structure Location	Carriageway	35.40-36.90mAOD	
	Toe of Embankment	30.10-30.70mAOD	
Earthwork Type	NB: N/A	SB: Embankment	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: N/A	SB: 7_M1_22028 & 7_M1_22192	HAGDMS designation
Earthwork Height	NB: N/A	SB: 4.7-6.8m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 27°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	17/02/2017	[redacted]
Checked	Alice Bazen	27/02/2017	
Reviewed	Gary Summerfield	28/02/2017	
Approved	Tom Bulteel	03/03/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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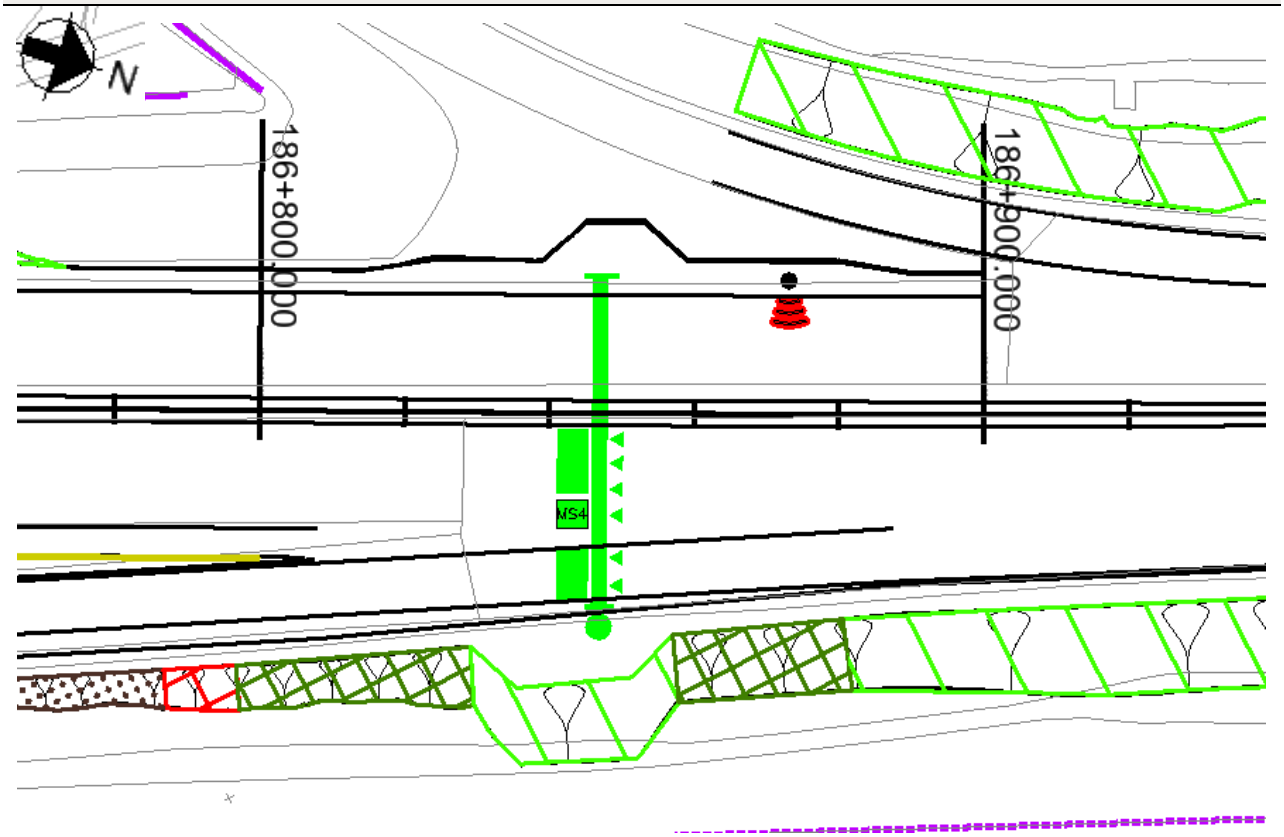


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch186800-186830, Granular Wedge at Embankment Crest (1:2.0);
- Ch186830-186860, Full Height Embankment Widening (1:2.0);
- Ch186860-186880, Granular Wedge at Embankment Crest (1:2.0).

Proposed Major Structure:

A new Superspan Portal Gantry structure (Gantry 301) has been proposed at chainage 186847.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that location comprises and embankment of 4.7-6.8m height (increasing in height from south to north) and a proposed slope gradient of 27°.

The critical cross sections (i.e. the cross section with the greatest earthwork height) used for design are as follows:

- Ch186850, Full Height Embankment Widening and Gantry 301;
- Ch186880, Granular Wedge at Embankment Crest.

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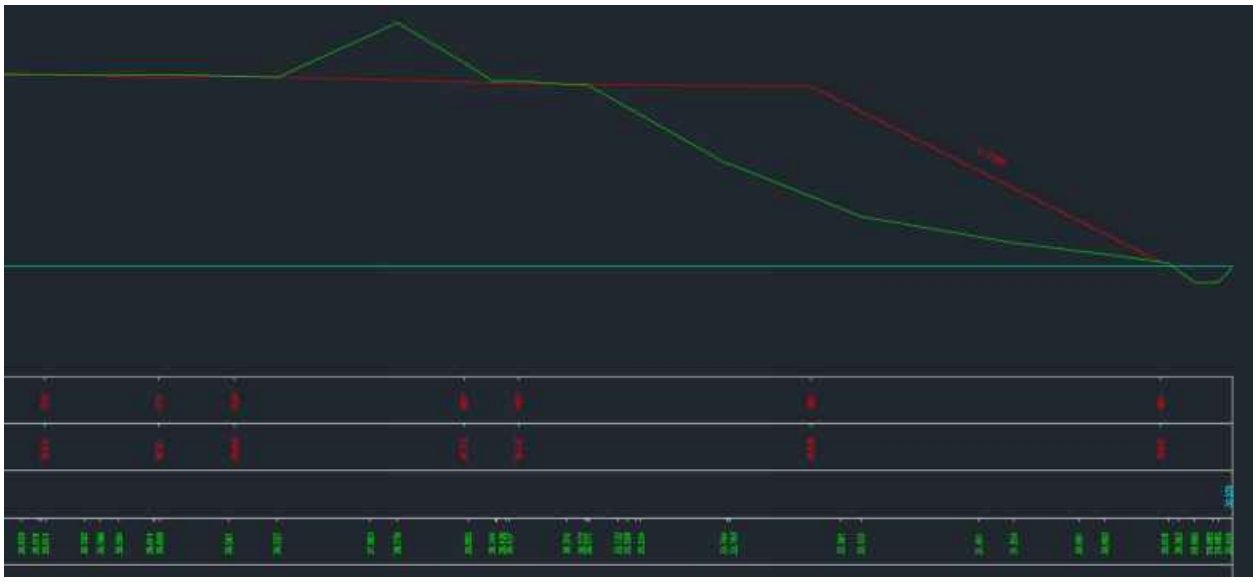


Figure 2.1 Topographic Critical Cross Section Chainage 186850

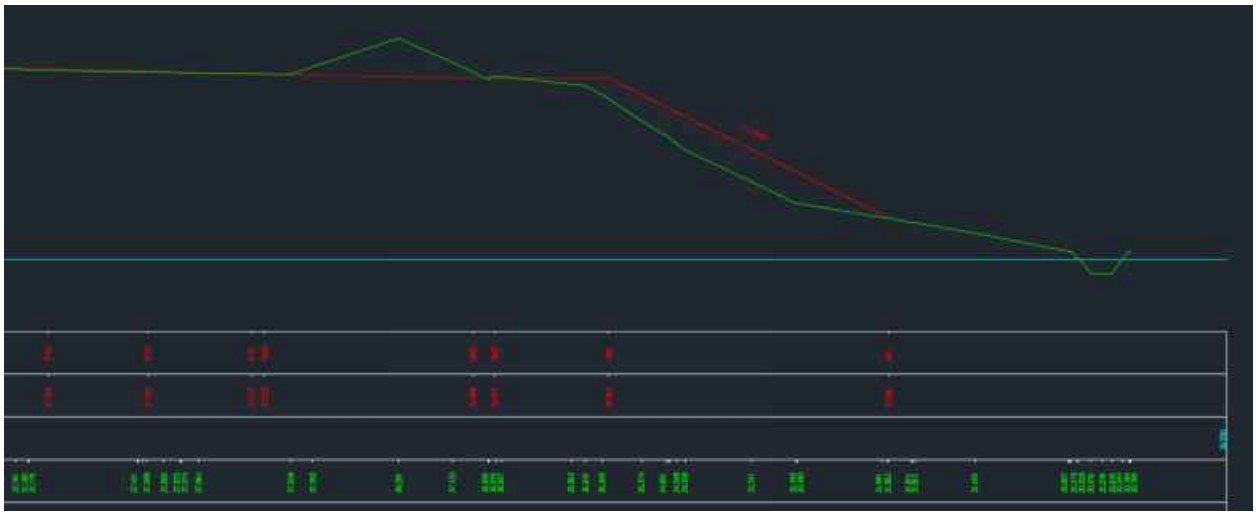


Figure 2.2 Topographic Critical Cross Section Chainage 186880

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough, indicates that the site is underlain by:

Superficial Deposits: Holme Pierrepont Sand and Gravel Member (Sand and Gravel)

Solid Deposits: Branscombe Mudstone Formation (Mudstone – Mercia Mudstone Group)

Ground Investigation:

There are 4 No. historical exploratory holes recorded within 100m of the chainage extents, as presented on the Geological Long Section, Drawing No. HA549342-AMAR-HCT-SWI-DR-CE-000028, Rev P01.

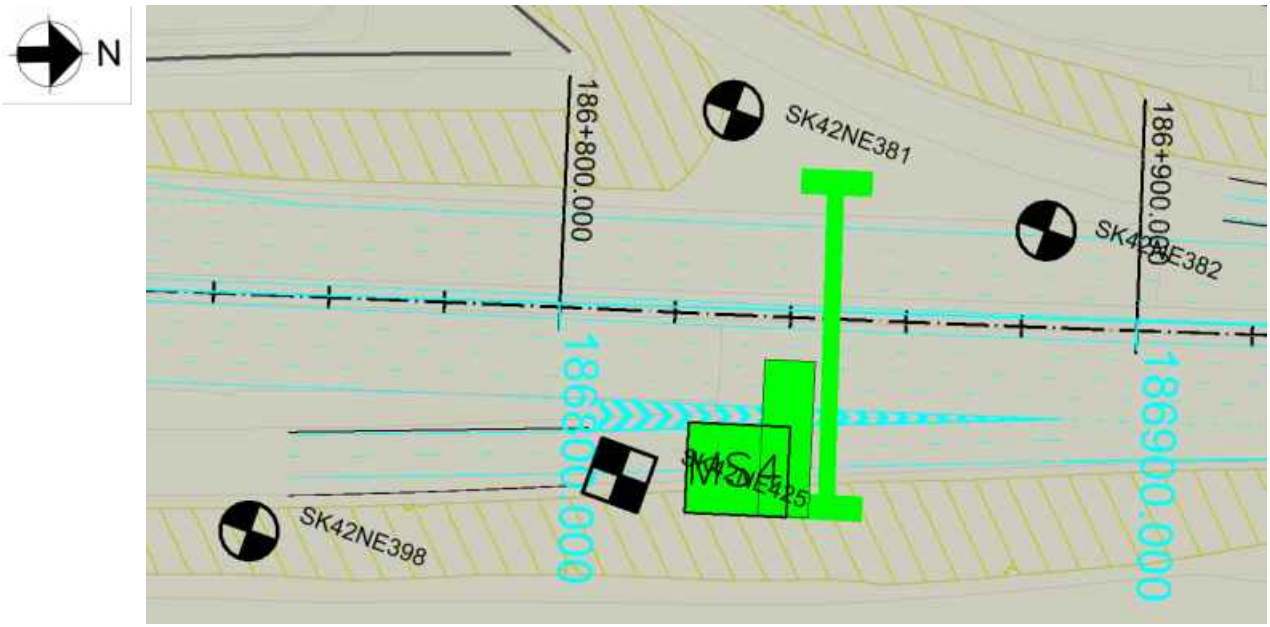


Figure 3: Borehole Location Plan

Flood Risk:

The design flood level is 30.52mAOD. Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Closest Borehole Number	SK42NE425
Borehole Chainage	189811
Borehole Location	Southbound
National Grid Reference	E 447197, N 329152
Ground Level at Exploratory Hole	32.27mAOD
RAG Analysis	Amber
Date Drilled	19/06/1992
Termination Depth	4.00m bgl
Distance from Structure	35.9m
Other suitable holes	SK42NE381, SK42NE382 & SK42NE398

Existing Ground Conditions:

The following ground conditions have been assumed based on the driven LiDAR survey and historical GI data.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*	Hand Vane Strength Range (kN/m^2)
Embankment Fill	6.9	30.0	17-21 (20)	-
River Terrace Deposits	12.1	24.8	5-107 (30)	140 and 148
Mercia Mudstone – III/IV	>12.1	<24.8	21-109 (23)	-

(1) Ground level is assumed to be at the carriageway level;
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within historical exploratory holes SK42NE381, SK42NE382 and SK42NE398.

2 No. hand vane strength tests have been undertaken within historical exploratory hole SK42NE425.

Groundwater:

Water strikes were encountered in SK42NE382 at 3.85mbgl (33.31mAOD) on the first day of drilling and at 9.45mbgl (27.17mAOD) on the second day of drilling.

No groundwater data was recorded for the other historical exploratory holes.

Groundwater Design Level:

Limited groundwater data is available therefore design groundwater level of 30.52mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

5 No. Atterberg Limit Test, 9 No. Natural Moisture Content tests and 3 No. Quick Undrained Triaxial tests were undertaken within the Embankment Fill and Mercia Mudstone with the following results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	0.80	22.0	-	-	-	-
Embankment Fill	1.00	16.0	-	-	-	-
Embankment Fill	1.20	17.0	36	16	20	CI
Embankment Fill	1.80	16.3	-	-	-	-
Embankment Fill	2.30	18.2	34	14	20	CL
Embankment Fill	2.79	14.9	-	-	-	-
Embankment Fill	2.80	12.6	32	17	15	CL
Embankment Fill	3.40	13.4	32	15	17	CL
Embankment Fill	4.40	14.7	34	14	20	CL
Mercia Mudstone	1.00	7.3	23	14	9	CL
Mercia Mudstone	6.60	19.3	-	-	-	-
Mercia Mudstone	8.00	16.6	-	-	-	-
Mercia Mudstone	9.00	16.0	-	-	-	-
Mercia Mudstone	9.50	8.0	-	-	-	-

3 No. Quick Undrained Traixial Tests were undertaken within the Embankment Fill with the following results

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	1.20	110
Embankment Fill	2.80	170
Embankment Fill	4.40	150

Lab Test Data – BRE Classification:

No chemical laboratory testing data is available for this structure location.

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Assumed Ground Model For Design:

Ground model is based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-000034, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01.

The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment Fill	0-6.9	36.9-30.0	6.9	21	26	0	120	6.9	5.5	-	0.50	0.20	-	2.30	0.40	-	6.9*	-	DS-2 AC-2
River Terrace Deposits	6.9-12.1	30.0-24.8	6.2	20	36	-	-	-	43.2	-	-	0.35	-	16.0	-	1.0		30	DS-3 AC-3
Mercia Mudstone – III/IV	>12.1	<24.8	-	21	27	2	115	8.7	7.0	-	0.50	0.20	-	2.90	0.40	-	9	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) c_u of Embankment Fill can be determined using SPT N values and the Stroud correlation; these results and those from hand shear vanes and triaxial tests are included as a plot of c_u versus elevation. Based on these values, it is considered that a cu of 120kN/m^2 is characteristic of the stratum.
(4) ϕ' of Embankment Fill can be determined using Table 2 in BS8002:2015 using a typical PI of 20% gives 26°.
(5) E' of Embankment Fill can be determined using Bowles relationship Eu = 300 (N + 6) = 300 (17 + 6) = 6.9MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 5.5MN/m^2.
(6) ϕ' of River Terrace Deposits can be determined using correlation with SPT (Peck 1974) N values (typical N value of 30) gives an angle of 36°.
(7) E' of River Terrace Deposits can be determined using Bowles correlation E' = 1200 (N + 6) which (using typical N value of 30) gives a value of 43.2MN/m^2.
(8) c_u of Mercia Mudstone – III/IV can be derived using the Stroud correlation. A characteristic PI of 14% was used to derive an f1 value of 5.0; combined with a conservative SPT N value of 23, this gives a cu of 115kN/m^2.
(9) ϕ' of Mercia Mudstone III/IV can be determined using Table 2 in BS8002:2015 using typical PI of 14% gives 27°.
(10) Eu for Mercia Mudstone – III/IV can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 23 gives Eu = 8.7MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 7.0MN/m^2.

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(11) Shear modulus is based on G = E/2(1+v).
(12) Adhesion Factor for Mercia Mudstone is based on BS8004 (equation 41).
(13) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl
(14) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).
(15) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1). For sandstone, Nq is derived based on a very dense siliceous cohesionless soil (Tomlinson Table 7.1).
(16) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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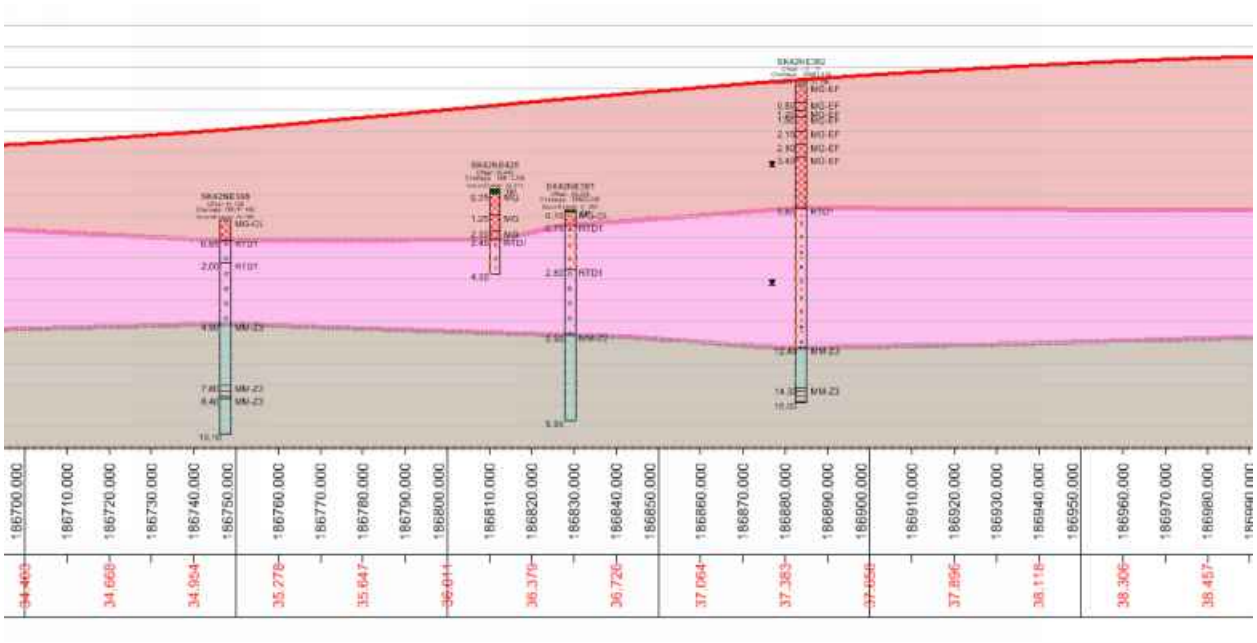


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
186800	186830	Granular Wedge at Embankment Crest (1:2.0)	9.00	45 (1V:11H)
186830	186860	Full Height Embankment Widening (1:2.0)	6.60	26.6 (1V:2H)
186860	186880	Granular Wedge at Embankment Crest (1:2.0)	9.00	45 (1V:11H)

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2 x 2)	900	13	2.70	10	1720	768

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BG-G301B at change 186847, southbound, 18m dynamic sample with rotary follow on exploratory hole.

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HISTORICAL EXPLORATORY HOLES

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Borehole Log

Borehole No. **SK42NE381**
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447131.00 - 329149.00	Hole Type CP
Location:		Level: 31.26mbgl	Scale 1:50
Client: Highways England		Dates: 09/06/1992 - 11/06/1992	Logged By C.S.Owens

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.10	31.16		TOPSOIL TP Stiff CLAY and MARL (Driller's Description) (Made Ground) MG-CL
						0.70	30.56		Very dense becoming dense brown SAND AND subrounded fine to coarse GRAVEL, predominantly of quartzite. (River Terrace Deposits) RTD1
		1.20	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		1.20 - 1.65	1B						
		1.90	2W						
		2.10	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		2.10 - 2.55	3B						
						2.80	28.46		Medium dense grey brown subrounded fine to coarse GRAVEL, predominantly of quartzite and sandstone. (River Terrace Deposits) RTD1
		3.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.00 - 3.45	4B						
		4.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				Increasing coarse sand content
		4.00 - 4.45	5B						
		5.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				Becoming very dense
		5.00 - 5.45	6B						
						5.90	25.36		Stiff dark red brown mottled grey green CLAY with many fine gravel sized lithorelicts of weak mudstone. (Mercia Mudstone Group) MM-Z2
		6.00 - 6.45	7U	60blows					
		6.50	8J						
		6.60	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
		6.60 - 7.05	1S						
		7.50 - 7.90	9U	100blows					
		7.90	10J						
		8.00	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				Becoming very stiff
		8.00 - 8.45	2S						
		9.00 - 9.24	11U	100blows					Hard
		9.50	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
		9.50 - 9.95	3S						
						9.95	21.31		End of borehole at 9.95 m

Remarks

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Borehole Log

Borehole No. **SK42NE382**
HISTORIC
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447132.00 - 329207.00	Hole Type CP
Location:		Level: 37.16mbgl	Scale 1:50
Client: Highways England		Dates: 09/06/1992 - 11/06/1992	Logged By M.Bryans

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									TARMACADAM AND CONCRETE (Drillers description) (Borehole predrilled to 0.80m using rotary coring techniques) MG-EF
		0.60	2W						
		0.80 - 1.20	3B			0.80	36.36		
		1.00	4J						Stiff brown and dark slightly sandy CLAY with some angular to rounded fine to coarse gravel, including quartzite, coal, siltstone. (MADE GROUND) MG-EF
		1.19	5J			1.20	35.96		
		1.20 - 1.65	6U	55blows					
						1.50	35.66		
		1.79	7J						Soft and firm red brown CLAY with many coarse sand sized lithorelicts of very weak mudstone and occasional angular gravel of quartzite. (MADE GROUND) MG-EF
		1.80	SPT (S)	17 (0 for 0mm/17...)	Water=-				
		1.80 - 2.25	8B			2.15	35.01		
		2.30 - 2.80	9B						Stiff red brown intermixed dark brown slightly sandy CLAY with occasional angular to rounded fine to coarse gravel including siltstone, quartzite, flint and mudstone. (MADE GROUND) MG-EF
		2.79	10J			2.80	34.36		
		2.80 - 3.25	11U	64blows					
		3.39	12J			3.40	33.76		Firm red brown silty CLAY. (MADE GROUND) MG-EF
		3.40	SPT (S)	20 (0 for 0mm/20...)	Water=-				
	▼	3.40 - 3.85	13B						Stiff red brown CLAY with some angular fine to medium gravel of hard clay and mudstone. (MADE GROUND) MG-EF
		4.00 - 4.40	14B						
		4.40 - 4.85	15U	70blows					Probably stiff, recovered firm, red brown CLAY with occasional angular fine to coarse gravel of grey green siltstone and fine grained sandstone. (MADE GROUND) MG-EF
		4.99	16J						
		5.00	SPT (S)	21 (0 for 0mm/21...)	Water=-				
		5.00 - 5.45	17B						
		5.50 - 6.00	18B						
						5.80	31.36		
		5.99	19J						Very dense and dense red brown fine to coarse SAND AND subangular to rounded fine to coarse GRAVEL, including quartzite, siltstone and occasional cobbles. (River Terrace Deposits) RTD1
		6.00	SPT (S)	50 (0 for 0mm/50...)	Water=-				
		6.01 - 6.45	20B						*Clayey in parts*
		6.50 - 7.00	21B						*driller records "boulder"*
		7.00	SPT (S)	40 (0 for 0mm/40...)	Water=-				
		7.00 - 7.45	22B						
		7.50 - 8.00	23B						
		8.00	SPT (S)	71 (0 for 0mm/71...)	Water=-				
		8.00 - 8.45	24B						
		8.10	25W						
		8.40	26W						*Below 8.50m SPT's probably affected by loosening as borehole being advanced dry*
		8.50 - 9.00	27B						
		9.00	SPT (S)	15 (0 for 0mm/15...)	Water=-				
	▼	9.00 - 9.45	28B						
		9.50 - 10.00	29B						
		10.00 - 10.55	30B						

Continued on next sheet

Remarks

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Borehole Log

Borehole No. **SK42NE382**
HISTORIC
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447132.00 - 329207.00	Hole Type CP
Location:		Level: 37.16mbgl	Scale 1:50
Client: Highways England		Dates: 09/06/1992 - 11/06/1992	Logged By M.Bryans

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		10.55	SPT (S)	5 (0 for 0mm/5,..)	Water=-				Slightly clayey. (SPT probably affected by loosening as borehole progressed dry)
		10.55 - 11.00	31B						Driller records "dense, large cobbles"
									Cobble
		12.00 - 12.40	32B						
		12.39	33J			12.40	24.76		
		12.40	SPT (S)	46 (0 for 0mm/46,..)	Water=-				Very stiff red brown slightly mottled light grey grenn, friable CLAY with many to 70% coarse sand sized to fine gravel lithorelicts of weak mudstone. (Mercia Mudstone Group) MM-Z3
		12.40 - 12.85	34B						Cobble or boulder
		13.50 - 14.00	35B						
		14.00	SPT (S)	109 (0 for 0mm/109,..)	Water=-				
		14.00 - 14.40	37B			14.30	22.86		Moderately weak red brown MUDSTONE (recovered as angular gravel sized fragments) with some firm red brown clay matrix. (Driller records "occasional soft bands") MM-Z3
		14.50 - 15.00	38B			15.00	22.16		End of borehole at 15.00 m

Remarks

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Borehole Log

Borehole No. **SK42NE398**
HISTORIC
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords:	447228.00 - 329095.00	Hole Type CP
Location:		Level:	30.78mbgl	Scale 1:50
Client: Highways England		Dates:	23/06/1992 - 24/06/1992	Logged By S.G.Flynn

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.00 - 1.00	1B						TOPSOIL over firm dark brownvary sandy clay with much subrounded fine to coarse gravel. (Possible Made Ground) MG-CL
		1.00	1S			0.95	29.83		
		1.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				Medium dense brown slightly clayey fine to coarse SAND AND subrounded fine to coarse GRAVEL with occasional cobbles. predominantly of quartzite. (River Terrace deposits) RTD1
		1.01 - 2.00	2B						1.80-1.95m cobble
		2.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	2.00	28.78		Dense brown fine to coarse SAND AND subrounded fine to coarse GRAVEL , predominantly quartzite, with occasional cobbles . (River Terrace Deposits) RTD1
		2.01 - 3.00	4B						
		3.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.01 - 4.00	5B						3.60-3.85m cobble
		4.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.01 - 4.90	6B						
		4.90	7J			4.90	25.88		Stiff becoming very stiff red brown slightly mottled grey green friable silty CLAY with some sand sized to fine gravel sized lithorelicts of very weak mudstone. (Mercia Mudstone Group) MM-Z3
		5.00	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.01 - 6.00	8B						
		6.50	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		6.51 - 8.00	9B						
		8.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	7.80	22.98		Weak and moderately weak red brown, spotted grey green, silty MUDSTONE recovered as angular fine to medium gravel sized fragments. (Moderately waethered, GIII, Mercia Mudstone Group) MM-Z3
		8.01 - 9.50	10B						
		8.40	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	8.40	22.38		Hard red brown, slightly mottled grey green ,friable silty CLAY with extremely closely spaced random irregular discontinuities. (Mercia Mudstone Group) MM-Z3
		9.50	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				9.50-10.00m much weak mudstone (GIII)
		9.50 - 9.95	11B						
									Continued on next sheet

Remarks

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Borehole Log

Borehole No.
SK42NE398
HISTORIC
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447228.00 - 329095.00	Hole Type CP
Location:		Level: 30.78mbgl	Scale 1:50
Client: Highways England		Dates: 23/06/1992 - 24/06/1992	Logged By S.G.Flynn

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
						10.10	20.68		End of borehole at 10.10 m

Remarks

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Trial Pit Log

Trialpit No: SK42NE425 HISTORIC Sheet 1 of 1

Project Name:	SMP - M1 J23A TO J25	Project No.: COCDFL1SMP01	Co-ords: 447197.00 - 329152.00
Location:			Level: 32.27mbgl
Client:	Highways England		Dimensions: 2.60m x 1.00m
			Inclination: 90°
			Orientation: 250°
			Depth: 4.00m
			Date: 19/06/1992
			Scale: 1:50
			Logged: S.G.FLYNN

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
	0.35 - 0.45	1J			0.25	32.02		TOPSOIL. TP
	0.50	HV	148kPa					Stiff red brown slightly sandy CLAY with occasional fine to medium gravel sized lithorelicts of very weak mudstone and occasional rounded fine to medium gravel of quartzite. Light grey in parts. (MADE GROUND) MG
	1.00	HV	140kPa					
	1.30 - 1.40	2J			1.25	31.02		Dense* orange brown medium to coarse SAND AND subrounded to rounded fine to coarse GRAVEL of quartzite, siltstone, sandstone. (MADE GROUND) MG
					2.00	30.27		Dense* angular to subangular COBBLES AND BOULDERS with a little matrix of orange brown medium to coarse sand and fine to coarse gravel. Boulders up to 0.45 by 0.35 by 0.25m. (MADE GROUND) MG
	2.50 - 2.60	3J			2.40	29.87		Dense* orange brown medium to coarse SAND AND subrounded to rounded fine to coarse GRAVEL of quartzite, siltstone, sandstone. Locally becoming very sandy gravel. (RIVER TERRACE DEPOSITS) RTD1
	3.30 - 3.40	4B						Groundwater not encountered. Soil wet below 3.30m
					4.00	28.27		End of pit at 4.00 m

Shift Information: Date & Time	Depth	Water	Remarks	Backfill: Top	Base	Description	Water Strike: Struck	Rose to	Date	Time	Sealed	Remarks	Depth Related Remarks: Top	Base	Remarks

Remarks:

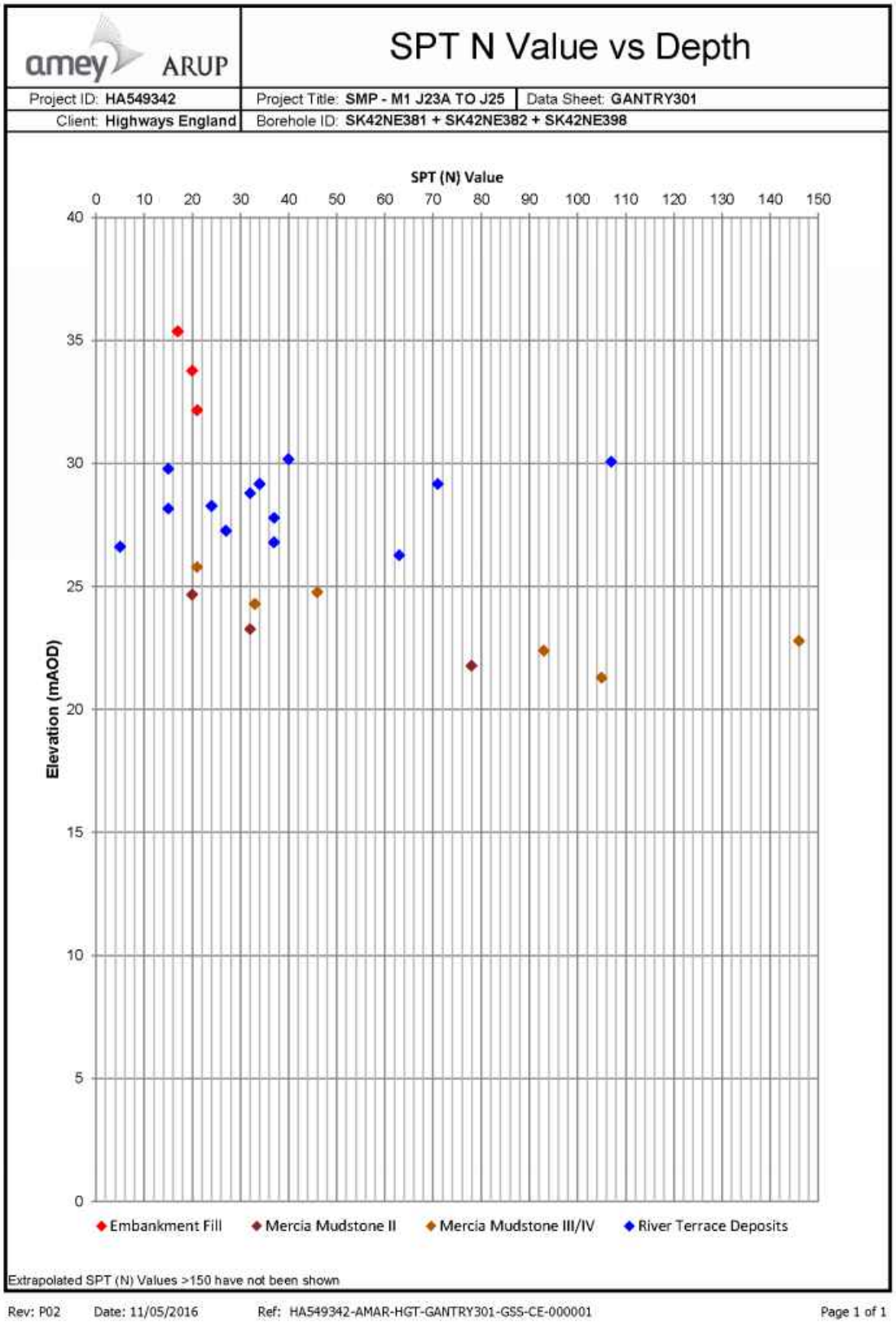
1. Trial pit excavated 90 to axis of M1 inclined embankment.
2. Strata description for Face B. Ground level at Face B is approximately 0.60m above ground level at Face D.
3. Photograph of Face B only.
4. Logged on exposed material below 1.20m.
5. *Engineer's visual assessment.
6. Hand vane results are an average of three tests at each depth.
7. Very difficult excavation below 1.20m.

Stability: No support. Pit remained stable throughout.

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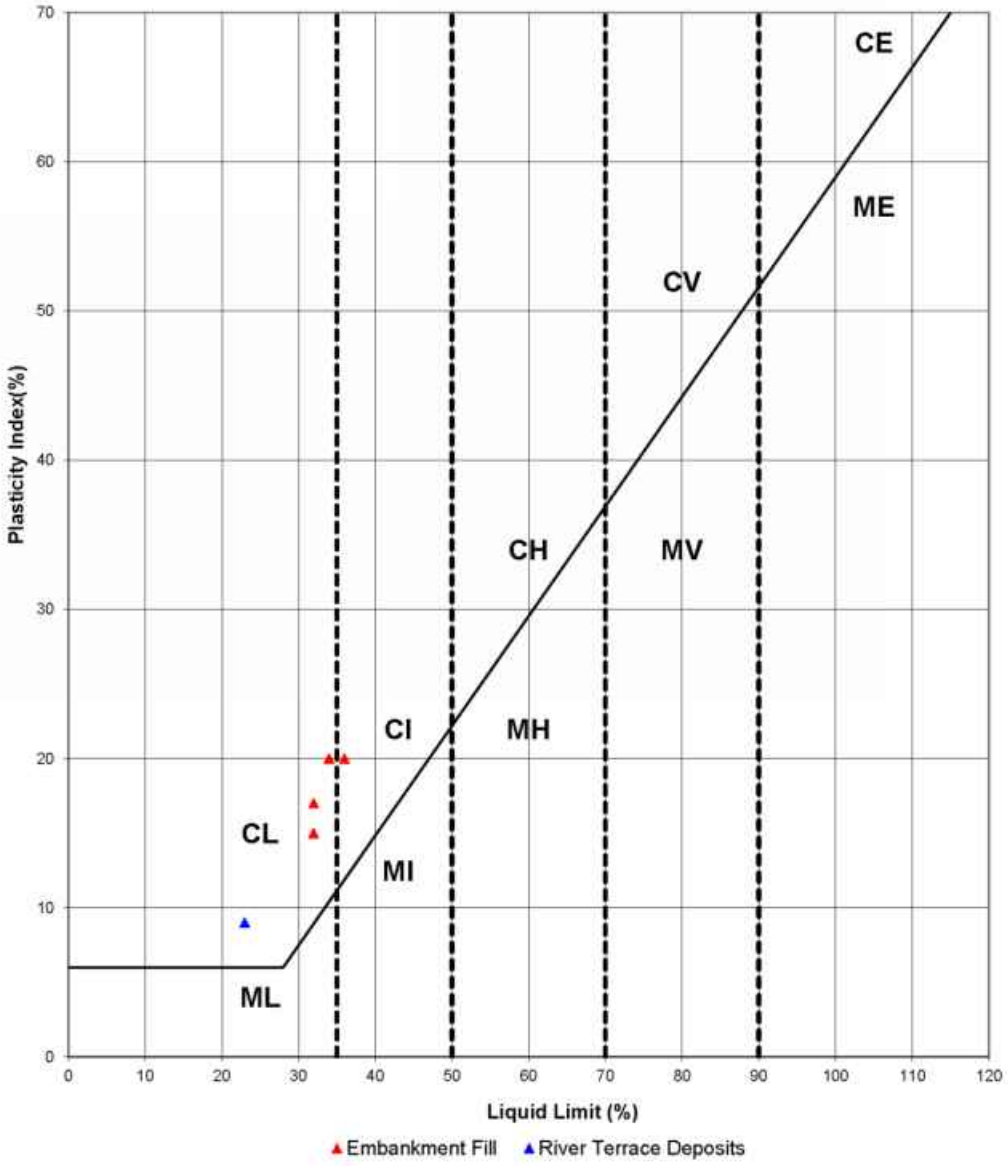
PLOTS



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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **GANTRY301**
Client: **Highways England**	Borehole ID: **SK42NE382**	



Key

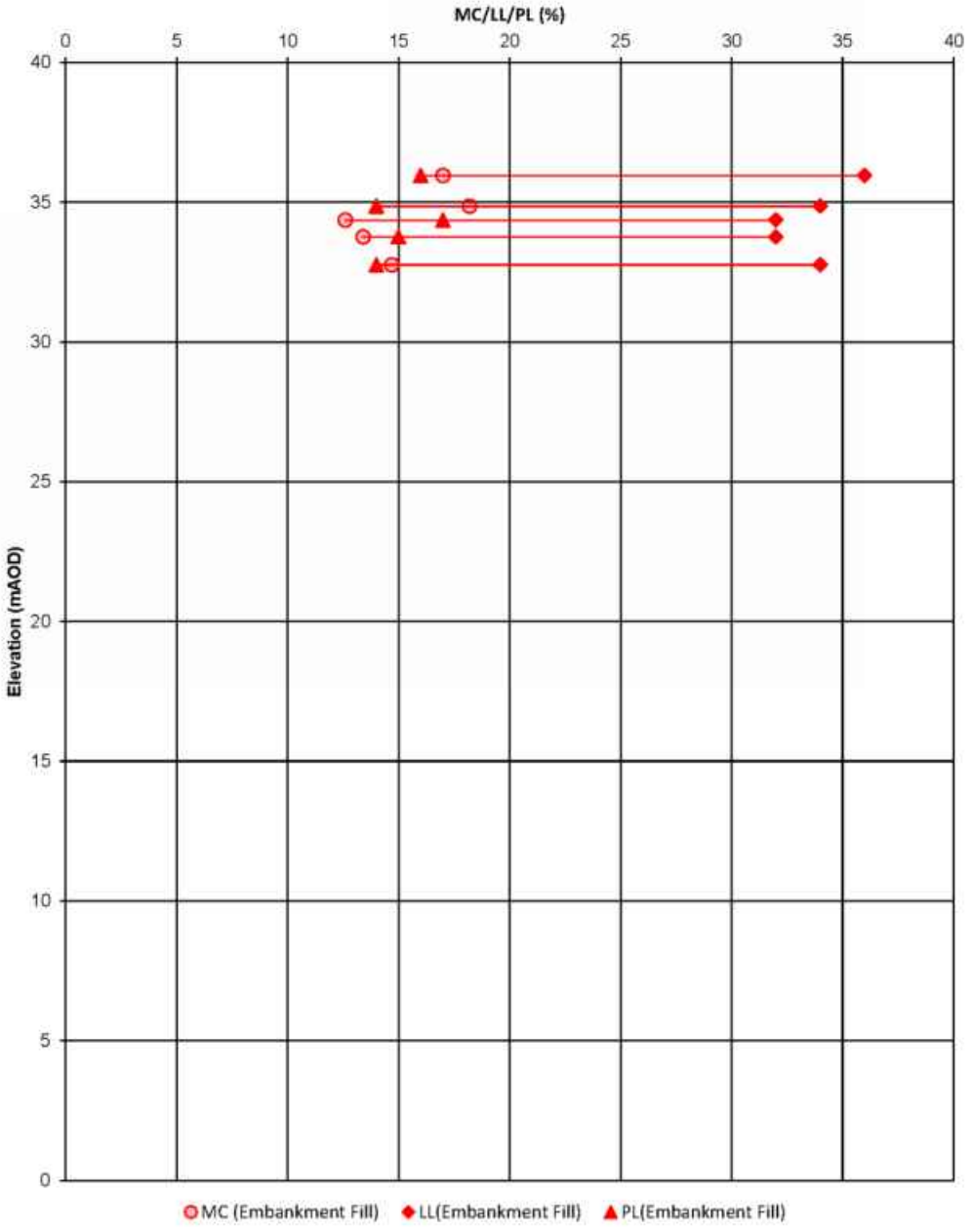
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 23/02/2016 Ref: HA549342-AMAR-HGT-GANTRY301-GSS-CE-000001 Page 1 of 1

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **GANTRY301**
Client: **Highways England**	Borehole ID: **SK42NE382**	

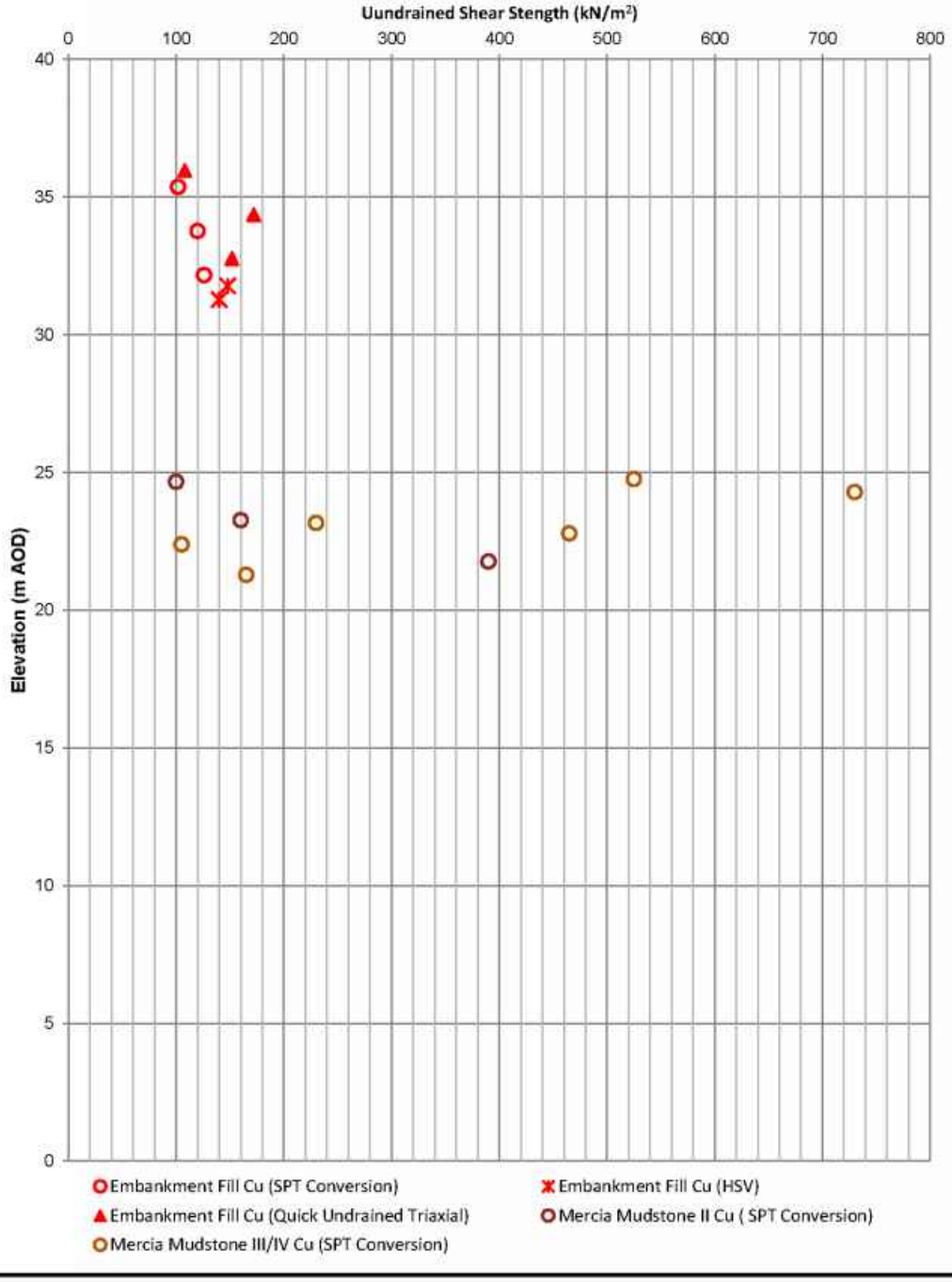


Rev: P02 Date: 12/05/2016 Ref: HA549342-AMAR-HGT-GANTRY301-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **GANTRY301**
Client: **Highways England**	Borehole ID: **SK42NE382 + SK42NE381 + SK42NE398**	



Rev: P02 Date: 12/05/2016 Ref: HA549342-AMAR-HGT-GANTRY301-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-186890-187070SB-GSS-000001		
Earthwork Widening Solution	Full Height Embankment Widening 1:2.0		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	186890-187070		
Carriageway	Southbound		
Structure Type & Reference	N/A		
Structure Chainage	N/A		
Marker Post	MP186/8B+90 – MP187/0B+70		
National Grid Reference	E 447169, N 329227 – E 447108, N 329392		
Existing Ground Level at Location	Carriageway	38.50mAOD	
	Toe of embankment	30.65mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_22028 & 7_M1_22029	HAGDMS designation
Earthwork Height	NB: N/A	SB: 7.9m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 25°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	08/02/2017	[redacted]
Checked	Alice Bazen	15/02/2017	
Reviewed	Gary Summerfield	01/03/2017	
Approved	Tom Bulteel	03/03/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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DESK STUDY

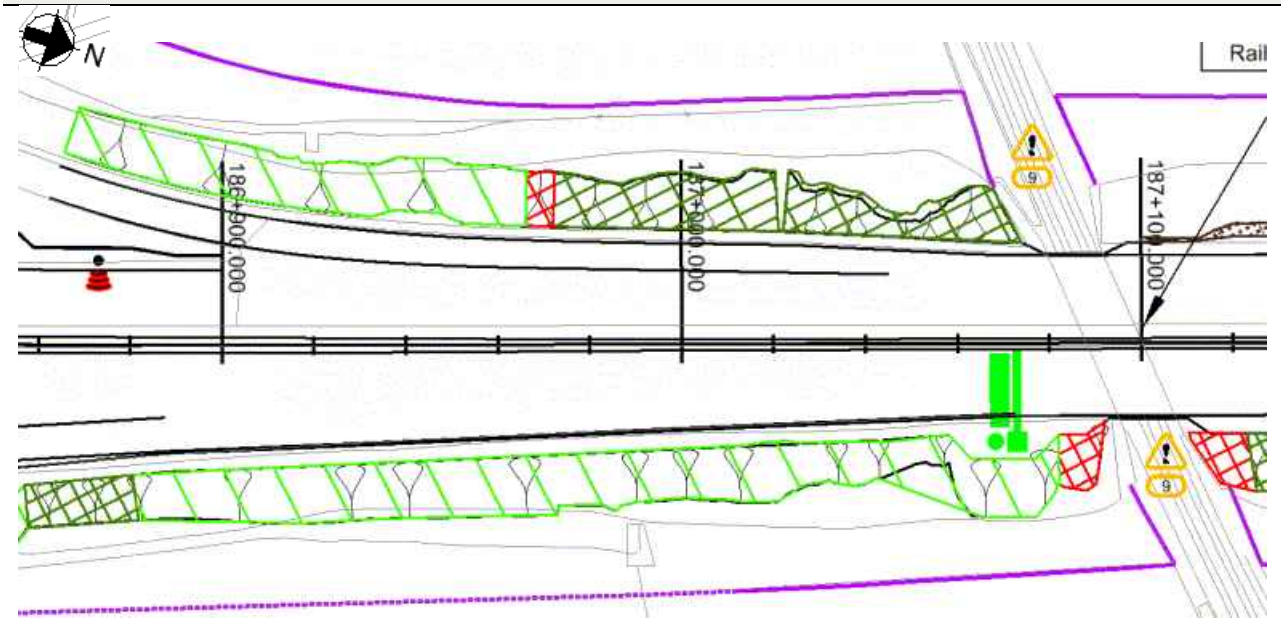


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed

- Full Height Embankment Widening (1:2.0)

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment ranging in height from 6.2m to 7.9m with a typical slope angle of 25 degrees.

The critical cross section at chainage 187020 is based on the section with the greatest earthwork height.

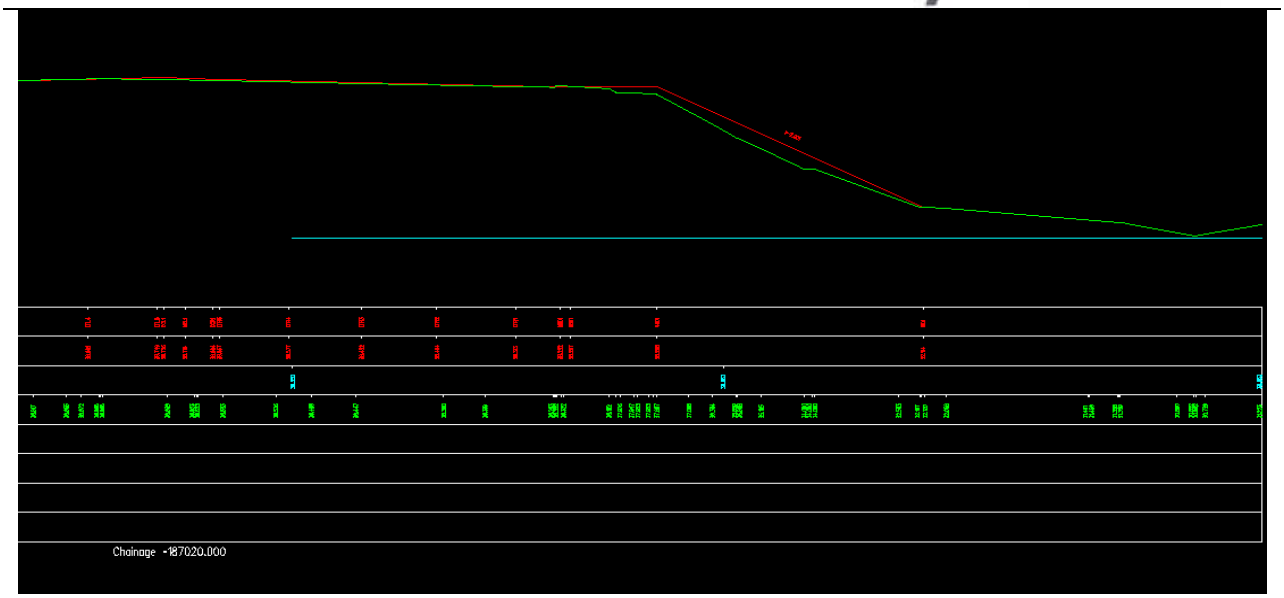


Figure 2: Topographic Critical Cross Section Chainage 187020

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Holme Pierrepont Sand and Gravel Member – Sand and Gravel

Solid Deposits: Branscombe Mudstone Formation - Mudstone.

Ground Investigation:

There is 1 No. historical exploratory holes recorded within the design chainage, with additional 4 no. relevant exploratory holes considered, as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000028, Rev P01.

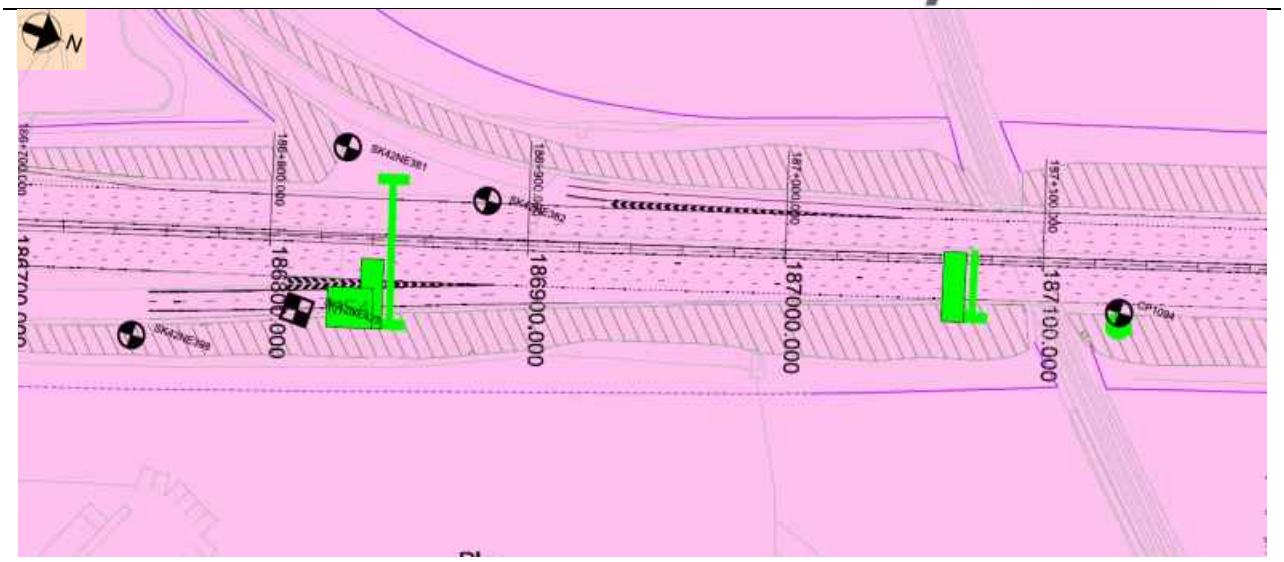


Figure 3: Borehole Location Plan

Flood Risk:

The design flood level is at 30.55mAOD. Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	SK42NE381	SK42NE382	SK42NE425
Borehole Chainage	186829	186884	186811
Borehole Location	Northbound	Northbound	Southbound
National Grid Reference	E 447131, N 329149	E 447132, N 329207	E 447197, N 329152
Ground Level at Exploratory Hole	31.26mAOD	37.16mAOD	32.27mAOD
RAG Analysis	Green	Green	Amber
Date Drilled	09/06/1992 – 11/06/1992	09/06/1992 – 11/06/1992	19/06/1992
Termination Depth	9.95 meters below ground level (mbgl)	15.00 metres below ground level (mbgl)	4.00 metres below ground level (mbgl)
Other suitable holes	SK42NE398 and CP1094		

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Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*	Hand Vane Strength Range (kN/m^2)
Embankment Fill	8.50	30.00	7 - 21 (17)	140-148
River Terrace Deposits (coarse grained)	12.5	26.00	5 - 107 (43)	-
Mercia Mudstone – III/IV	>12.5	<26.00	20->150 (38)	-

(1) Ground level is assumed to be at carriageway level;
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary;
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken in exploratory hole SK42NE398, SK42NE381, SK42NE382 and CP1094 and 2 No. Hand Shear Vane was completed in borehole SK42NE419.

Groundwater:

Groundwater was encountered in SK42NE382 at 3.40mbgl (33.76mAOD) and at 9.45mbgl (27.71mAOD).

Groundwater Design Level:

No Local groundwater is available therefore design groundwater level of 30.55mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

9 No. Atterberg Limit Tests and 17 No. Moisture content tests, 2 No. Hand Shear Vane Test and 4 No. Triaxial tests were undertaken within Embankment Fill and River Terrace Deposits and Mercia Mustone layers, with the results presented below:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	0.50	-	-	-	-	-
Embankment Fill	0.80	22.20	-	-	-	-
Embankment Fill	1.00	16.00	-	-	-	-
Embankment Fill	1.80	16.30	-	-	-	-
Embankment Fill	2.00	16.76	28	16	12	CL
Embankment Fill	2.30	18.20	34	14	20	CL
Embankment Fill	2.79	14.90	-	-	-	-
Embankment Fill	2.80	12.60	32	17	15	CL
Embankment Fill	3.40	13.40	32	15	17	CL
Embankment Fill	4.40	14.70	34	14	20	CL
Embankment Fill	1.20	17.00	36	16	20	CI
Embankment Fill	6.00	17.52	33	15	18	CL
River Terrace Deposits	1.00	7.30	23	14	9	CL
Mercia Mudstone-III/IV	6.60	19.30	-	-	-	-
Mercia Mudstone-III/IV	8.00	16.60	-	-	-	-
Mercia Mudstone-III/IV	9.00	16.00	-	-	-	-
Mercia Mudstone-III/IV	9.50	8.00	-	-	-	-
Mercia Mudstone-III/IV	15.00	24.24	35	14	21	CI

4 No. Triaxial Tests were undertaken within the Embankment Fill with the following results

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	1.20	108
Embankment Fill	2.80	172
Embankment Fill	3.50	107
Embankment Fill	4.40	152

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Lab Test Data – BRE Classification:

No chemical test data is available for this earthwork.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0.00-8.50	38.50-30.00	8.50	21	27	0	111	6.9	5.5	-	0.50	0.20	-	DS-2 AC-2
River Terrace Deposits (coarse grained)	8.50-12.50	30.00-26.00	4.00	20	39	-	-	-	58.8	-	-	0.35	-	DS-3 AC-3
Mercia Mudstone – III/IV (>10m bgl)	>12.50	<26.00	-	21	30	2	200	13.2	10.6	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical borehole SK42NE395.
(3) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) ϕ' for Embankment Fill is derived using plasticity index (based on Table 2 in BS8002:2015). For an average PI of 15, ϕ' is 27^0.
(5) cu of Embankment Fill was derived using the Stroud correlation. A typical PI of 15% gives an f1 value of 6.5, combined with a typical SPT 'N' value of 17, this gives a typical cu of 111kN/m^2.
(6) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using typical SPT 'N' value of 17, Eu = 6.9MN/m^2. Therefore E' = 5.5MN/m^2.
(7) ϕ' for River Terrace Deposits (coarse grained) is based on a conservative SPT N value of 43, and compared to the correlation by Peck 1974. Using a typical 'N' value of 43 gives an angle of 39°.
(8) E' of River Terrace Deposits (coarse grained) was determined using Bowles correlation E' = 1200 (N + 6) which (using typical 'N' value of 43) gives a value of 58.8MN/m^2.

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(9) The ϕ' for Mercia Mudstone – III/IV >10m bgl is based on values in the AMAR GIR due to lack of PI data available at this location.
(10) c_u for Mercia Mudstone – III/IV is based on the AMAR GIR parameters due to a lack of local data.
(11) E' of Mercia Mudstone >10mbgl was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using typical SPT 'N' value of 38, Eu = 13.2MN/m2. Therefore E' = 10.6MN/m2.
(12) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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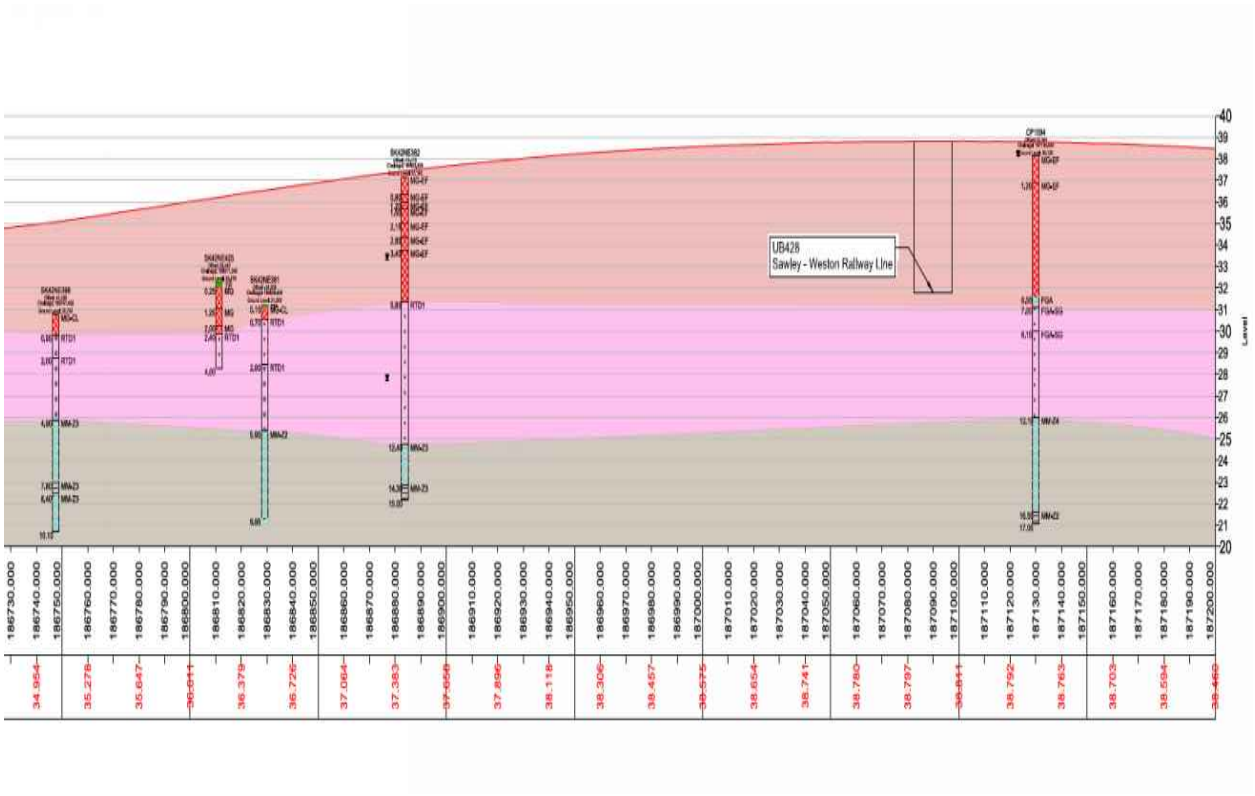


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
186890	187070	Full Height Embankment Widening (1:2.0)	6.1	26.6 (1V:2H)

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH –G302 at chainage 187073, Southbound – Dynamic Sample with a Rotary Core follow on up to a minimum depth of 25.0m bgl.

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LOGS

Borehole Log

Borehole No. **SK42NE381** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447131.00 - 329149.00	Hole Type CP
Location:		Level: 31.26mbgl	Scale 1:50
Client: Highways England		Dates: 09/06/1992 - 11/06/1992	Logged By C.S.Owens

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.10	31.16		TOPSOIL TP
						0.70	30.56		Stiff CLAY and MARL (Driller's Description) (Made Ground) MG-CL
		1.20	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				Very dense becoming dense brown SAND AND subrounded fine to coarse GRAVEL, predominantly of quartzite. (River Terrace Deposits) RTD1
		1.20 - 1.65	1B						
		1.90	2W						
		2.10	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		2.10 - 2.55	3B						
						2.80	28.46		
		3.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				Medium dense grey brown subrounded fine to coarse GRAVEL, predominantly of quartzite and sandstone. (River Terrace Deposits) RTD1
		3.00 - 3.45	4B						
		4.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				*Increasing coarse sand content.*
		4.00 - 4.45	5B						
		5.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				*Becoming very dense.*
		5.00 - 5.45	6B						
						5.90	25.36		
		6.00 - 6.45	7U	60blows					Stiff dark red brown mottled grey green CLAY with many fine gravel sized lithorelicts of weak mudstone. (Mercia Mudstone Group) MM-Z2
		6.50	8J						
		6.60	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
		6.60 - 7.05	1S						
		7.50 - 7.90	9U	100blows					
		7.90	10J						
		8.00	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				*Becoming very stiff.*
		8.00 - 8.45	2S						
		9.00 - 9.24	11U	100blows					*Hard*
		9.50	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
		9.50 - 9.95	3S						
						9.95	21.31		End of borehole at 9.95 m

Remarks

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Borehole Log

Borehole No. **SK42NE382**
HISTORIC
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447132.00 - 329207.00	Hole Type CP
Location:		Level: 37.16mbgl	Scale 1:50
Client: Highways England		Dates: 09/06/1992 - 11/06/1992	Logged By M.Bryans

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									TARMACADAM AND CONCRETE (Drillers description) (Borehole predrilled to 0.80m using rotary coring techniques) MG-EF
		0.60	2W						
		0.80 - 1.20	3B			0.80	36.36		
		1.00	4J						Stiff brown and dark slightly sandy CLAY with some angular to rounded fine to coarse gravel, including quartzite, coal, siltstone. (MADE GROUND) MG-EF
		1.19	5J			1.20	35.96		
		1.20 - 1.65	6U	55blows					
						1.50	35.66		
		1.79	7J						Soft and firm red brown CLAY with many coarse sand sized lithorelicts of very weak mudstone and occasional angular gravel of quartzite. (MADE GROUND) MG-EF
		1.80	SPT (S)	17 (0 for 0mm/17,..)	Water=-				
		1.80 - 2.25	8B			2.15	35.01		
		2.30 - 2.80	9B						Stiff red brown intermixed dark brown slightly sandy CLAY with occasional angular to rounded fine to coarse gravel including siltstone, quartzite, flint and mudstone. (MADE GROUND) MG-EF
		2.79	10J			2.80	34.36		
		2.80 - 3.25	11U	64blows					
		3.39	12J			3.40	33.76		Firm red brown silty CLAY. (MADE GROUND) MG-EF
		3.40	SPT (S)	20 (0 for 0mm/20,..)	Water=-				
	▼	3.40 - 3.85	13B						Stiff red brown CLAY with some angular fine to medium gravel of hard clay and mudstone. (MADE GROUND) MG-EF
		4.00 - 4.40	14B						
		4.40 - 4.85	15U	70blows					Probably stiff, recovered firm, red brown CLAY with occasional angular fine to coarse gravel of grey green siltstone and fine grained sandstone. (MADE GROUND) MG-EF
		4.99	16J						
		5.00	SPT (S)	21 (0 for 0mm/21,..)	Water=-				
		5.00 - 5.45	17B						
		5.50 - 6.00	18B						
						5.80	31.36		
		5.99	19J						Very dense and dense red brown fine to coarse SAND AND subangular to rounded fine to coarse GRAVEL, including quartzite, siltstone and occasional cobbles. (River Terrace Deposits) RTD1
		6.00	SPT (S)	50 (0 for 0mm/50,..)	Water=-				
		6.01 - 6.45	20B						*Clayey in parts.*
		6.50 - 7.00	21B						*driller records "boulder"*
		7.00	SPT (S)	40 (0 for 0mm/40,..)	Water=-				
		7.00 - 7.45	22B						
		7.50 - 8.00	23B						
		8.00	SPT (S)	71 (0 for 0mm/71,..)	Water=-				
		8.00 - 8.45	24B						
		8.10	25W						
		8.40	26W						*Below 8.50m SPT's probably affected by loosening as borehole being advanced dry.*
		8.50 - 9.00	27B						
		9.00	SPT (S)	15 (0 for 0mm/15,..)	Water=-				
	▼	9.00 - 9.45	28B						
		9.50 - 10.00	29B						
		10.00 - 10.55	30B						

Continued on next sheet

Remarks

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Borehole Log

Borehole No. **SK42NE382**
HISTORIC
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447132.00 - 329207.00	Hole Type CP
Location:		Level: 37.16mbgl	Scale 1:50
Client: Highways England		Dates: 09/06/1992 - 11/06/1992	Logged By M.Bryans

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		10.55	SPT (S)	5 (0 for 0mm/5,...)	Water=-				*Slightly clayey. (SPT probably affected by loosening as borehole progressed dry)*
		10.55 - 11.00	31B						*Driller records "dense, large cobbles"*
									Cobble
		12.00 - 12.40	32B						
		12.39	33J			12.40	24.76		
		12.40	SPT (S)	46 (0 for 0mm/46,...)	Water=-				Very stiff red brown slightly mottled light grey grenn, friable CLAY with many to 70% coarse sand sized to fine gravel lithorelicts of weak mudstone. (Mercia Mudstone Group) MM-Z3
		12.40 - 12.85	34B						*Cobble or boulder.*
		13.50 - 14.00	35B						
		14.00	SPT (S)	109 (0 for 0mm/109,...)	Water=-				
		14.00 - 14.40	37B			14.30	22.86		Moderately weak red brown MUDSTONE (recovered as angular gravel sized fragments) with some firm red brown clay matrix. (Driller records "occasional soft bands") MM-Z3
		14.50 - 15.00	38B			15.00	22.16		End of borehole at 15.00 m

Remarks

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Trial Pit Log

Trialpit No **SK42NE425** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447197.00 - 329152.00 Level: 32.27mbgl	Date 19/06/1992
Location:		Dimensions: 2.60m x 1.00m Inclination: 90° Orientation: 250° Depth: 4.00m	Scale 1:50
Client: Highways England			Logged S.G.FLYNN

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
	0.35 - 0.45 0.50	1J HV	148kPa		0.25	32.02		TOPSOIL. TP
	1.00	HV	140kPa					Stiff red brown slightly sandy CLAY with occasional fine to medium gravel sized lithorelicts of very weak mudstone and occasional rounded fine to medium gravel of quartzite. Light grey in parts. (MADE GROUND) MG
	1.30 - 1.40	2J			1.25	31.02		Dense* orange brown medium to coarse SAND AND subrounded to rounded fine to coarse GRAVEL of quartzite, siltstone, sandstone. (MADE GROUND) MG
					2.00	30.27		Dense* angular to subangular COBBLES AND BOULDERS with a little matrix of orange brown medium to coarse sand and fine to coarse gravel. Boulders up to 0.45 by 0.35 by 0.25m. (MADE GROUND) MG
	2.50 - 2.60	3J			2.40	29.87		Dense* orange brown medium to coarse SAND AND subrounded to rounded fine to coarse GRAVEL of quartzite, siltstone, sandstone. Locally becoming very sandy gravel. (RIVER TERRACE DEPOSITS) RTD1
	3.30 - 3.40	4B						*Groundwater not encountered. Soil wet below 3.30m.*
					4.00	28.27		End of pit at 4.00 m

Shift Information				Backfill			Water Strike						Depth Related Remarks		
Date & Time	Depth	Water	Remarks	Top	Base	Description	Struck	Rose to	Date	Time	Sealed	Remarks	Top	Base	Remarks

Remarks:
1. Trial pit excavated into toe of M1 motorway embankment.
2. Strata description for Face B. Ground level at Face B is approximately 0.50m above ground level at Face D.
3. Photograph of Face B only.
4. Logged on excavated material below 1.20m.
5. *Engineer's visual assessment.
6. Hand vane results are an average of three tests at each depth.
7. Very difficult excavation below 1.20m.

Stability: No support. Pit remained stable throughout.

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Borehole Log

Borehole No. **CP1094** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447089.00 - 329452.00	Hole Type CP
Location:		Level: 38.10mbgl	Scale 1:50
Client: Highways England		Dates: 22/11/2006 - 22/11/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.50	101B						MADE GROUND. Light brown slightly clayey very gravelly sand with occasional rootlets. Gravel is angular to subrounded fine to coarse of sandstone, mudstone, limestone and quartzite. With occasional angular cobbles of grey fine grained sandstone. MG-EF
		1.20	102B			1.20	36.90		
		1.50 - 1.95	1U	30blows					MADE GROUND. Firm red brown, locally grey green, slightly sandy slightly gravelly clay, locally slightly silty. Gravel is angular to subangular fine to coarse, of mudstone and siltstone. MG-EF
		2.00	2D						
		2.50	3D						
		2.50	SPT (S)	N=7 (1,2/1,2,2,2)	Casing=1.50m Water=DRY				
		2.50 - 3.00	4B						
		3.50 - 3.95	5U	30blows					At 3.50m: stiff.
		4.00	6D						
		4.50	7D						
		4.50	SPT (S)	N=14 (2,2/3,4,3,4)	Casing=1.50m Water=DRY				
		4.50 - 5.00	8B						
		5.50 - 5.95	9U	40blows					
		6.00	10D						
		6.50	11D			6.50	31.60		
		6.50	SPT (S)	N=13 (3,4/3,3,3,4)	Casing=1.50m Water=DRY				Brown slightly sandy, locally sandy, occasionally gravelly to gravelly CLAY locally a clay/silt. Gravel is subangular to subrounded fine to coarse, of quartz and sandstone. FGA
		6.50 - 7.00	12B			7.00	31.10		
		7.50	SPT (C)	50 (10,15/50 for 135mm)	Casing=7.50m Water=4.10m				Brown SAND and GRAVEL. Sand is medium to coarse grained. Gravel is angular to subrounded fine to coarse, of quartz, dolomite, sandstone and rare (possible) slag, with some angular dolomite cobbles. FGA-SG
		7.50 - 8.00	13B						
						8.10	30.00		
		9.00	SPT (C)	N=44 (7,9/10,9,11,14)	Casing=9.00m Water=3.20m				Brown SAND and GRAVEL. Sand is medium to coarse grained. Gravel is subangular to rounded fine to coarse, of quartz, sandstone, carbonaceous mudstone and some subrounded quartz cobbles. FGA-SG
		9.00 - 9.50	14B						
									Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 7.00m.;The borehole was advanced by chiselling methods from 16.50m to 17.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **CP1094** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447089.00 - 329452.00	Hole Type CP
Location:		Level: 38.10mbgl	Scale 1:50
Client: Highways England		Dates: 22/11/2006 - 22/11/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		10.50	SPT (C)	50 (3,6/50 for 210mm)	Casing=10.50m Water=4.20m				*SAND and GRAVEL (as previous sheet)*
		10.50 - 11.00	15B						*Below 10.50m: medium to coarse GRAVEL.*
		12.00	SPT (C)	N=13 (2,2/3,3,3,4)	Casing=12.00m Water=4.80m	12.10	26.00		Friable red brown, locally grey green CLAY with angular, fine lithorelics of mudstone and occasional siltstone. MM-Z4
		12.00 - 12.50	16B						
		13.50 - 14.00	17U# B	30blows					
		15.00	18D						
		15.00	SPT (S)	N=38 (5,7/6,8,10,14)	Casing=15.00m Water=7.60m				
		15.00 - 15.50	19B						
		16.50	20D			16.50	21.60		
		16.50	SPT (S)	50 (25 for 30mm/50 for 20mm)	Casing=16.50m Water=7.90m				Very weak red brown locally grey green MUDSTONE and SILTSTONE recovered as angular to subangular fine and medium gravel sized fragments. MM-Z2
		16.50 - 17.00	21B			17.05	21.05		*At 17.00m: red brown friable sandy siltstone with some thin (<1mm) laminations of white gypsum.*
		17.00	22D						End of borehole at 17.05 m
		17.00	SPT (S)	50 (25 for 8mm/50 for 5mm)	Casing=16.50m Water=8.80m				

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 7.00m.;The borehole was advanced by chiselling methods from 16.50m to 17.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **SK42NE398** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447228.00 - 329095.00	Hole Type CP
Location:		Level: 30.78mbgl	Scale 1:50
Client: Highways England		Dates: 23/06/1992 - 24/06/1992	Logged By S.G.Flynn

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 1.00	1B						TOPSOIL over firm dark brownvary sandy clay with much subrounded fine to coarse gravel. (Possible Made Ground) MG-CL
		1.00	1S			0.95	29.83		
		1.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				Medium dense brown slightly clayey fine to coarse SAND AND subrounded fine to coarse GRAVEL with occasional cobbles, predominantly of quartzite. (River Terrace deposits) RTD1
		1.01 - 2.00	2B						1.80-1.95m cobble
		2.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	2.00	28.78		Dense brown fine to coarse SAND AND subrounded fine to coarse GRAVEL , predominantly quartzite, with occasional cobbles . (River Terrace Deposits) RTD1
		2.01 - 3.00	4B						
		3.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.01 - 4.00	5B						3.60-3.85m cobble
		4.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.01 - 4.90	6B						
		4.90	7J			4.90	25.88		
		5.00	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				Stiff becoming very stiff red brown slightly mottled grey green friable silty CLAY with some sand sized to fine gravel sized lithorelicts of very weak mudstone. (Mercia Mudstone Group) MM-Z3
		5.01 - 6.00	8B						
		6.50	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		6.51 - 8.00	9B						
						7.80	22.98		
		8.00	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				Weak and moderately weak red brown, spotted grey green, silty MUDSTONE recovered as angular fine to medium gravel sized fragments. (Moderately waethered, GIII, Mercia Mudstone Group) MM-Z3
		8.01 - 9.50	10B						
		8.40	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	8.40	22.38		Hard red brown, slightly mottled grey green ,friable silty CLAY with extremely closely spaced random irregular discontinuities. (Mercia Mudstone Group) MM-Z3
		9.50	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				9.50-10.00m much weak mudstone (GIII)
		9.50 - 9.95	11B						
									Continued on next sheet

Remarks

AGS

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Borehole Log

Borehole No.
SK42NE398
HISTORIC
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447228.00 - 329095.00	Hole Type CP
Location:		Level: 30.78mbgl	Scale 1:50
Client: Highways England		Dates: 23/06/1992 - 24/06/1992	Logged By S.G.Flynn

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
						10.10	20.68		End of borehole at 10.10 m

Remarks

AGS

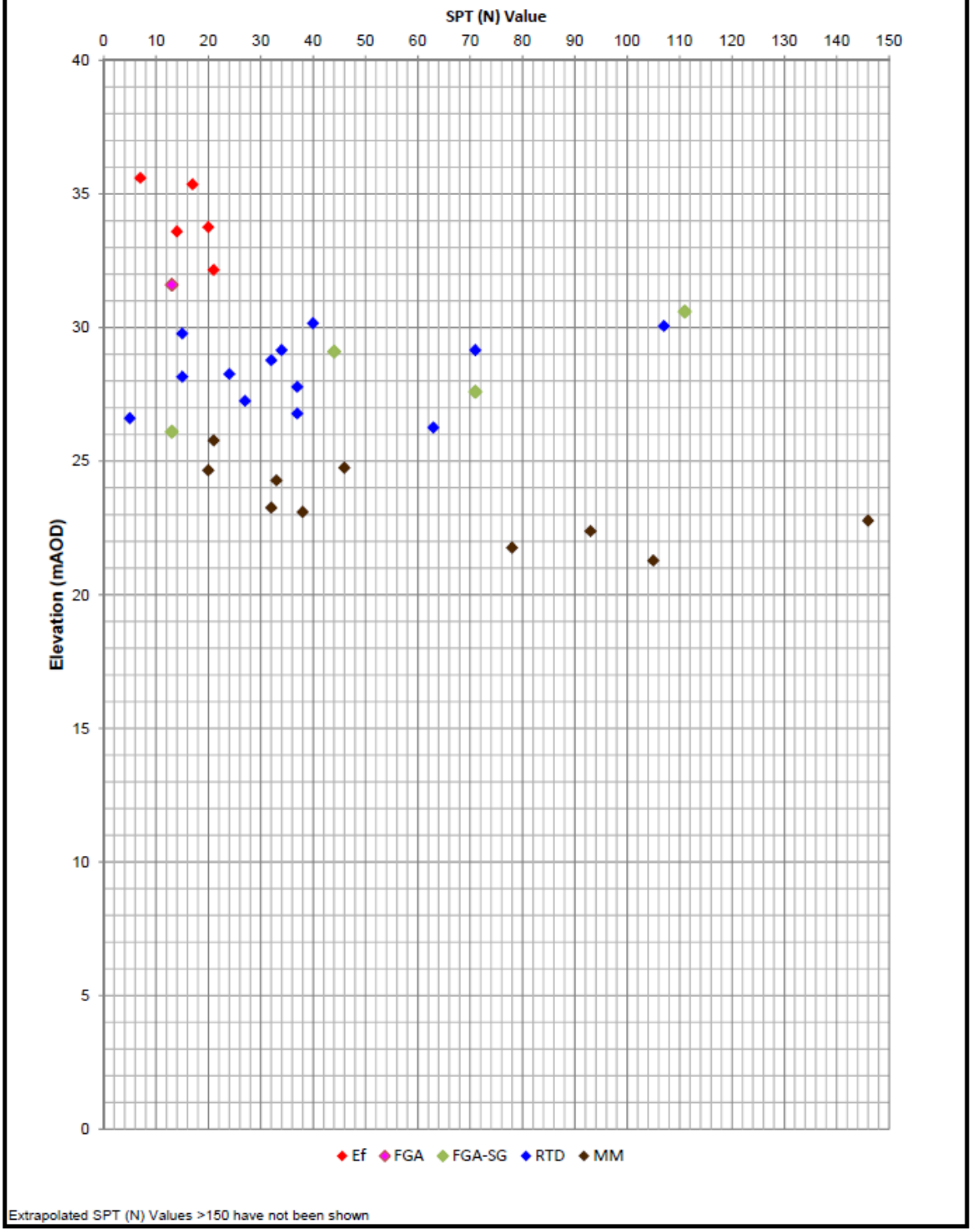
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PLOTS

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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186890-187070SB**
Client: **Highways England**	Borehole ID: **CP1094, SK42NE381, SK42NE382 and SK42EN398**	

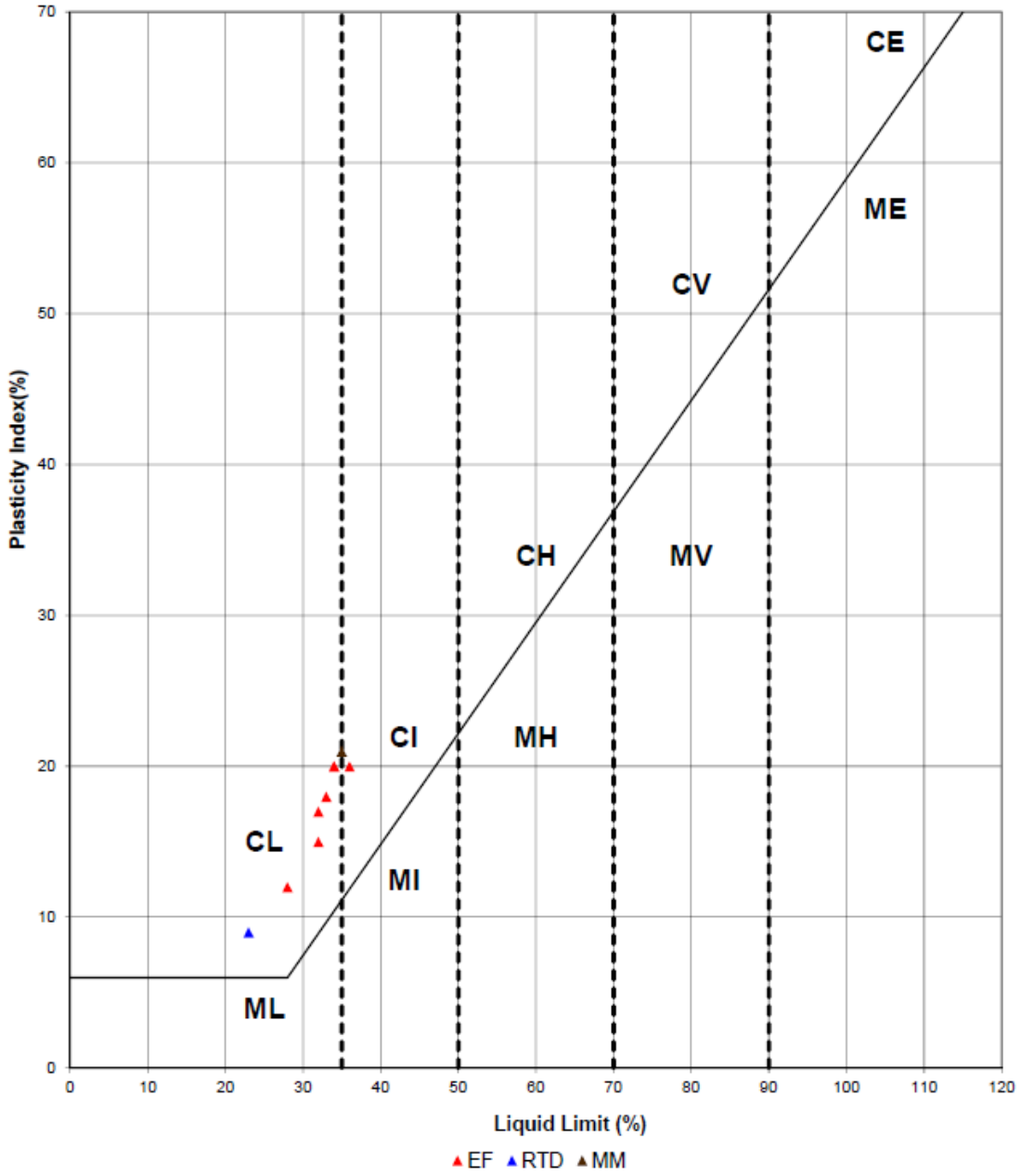


Extrapolated SPT (N) Values >150 have not been shown

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186890-187070SB**
Client: **Highways England**	Borehole ID: **CP1094, SK42NE381, SK42NE382 and SK42NE425**	



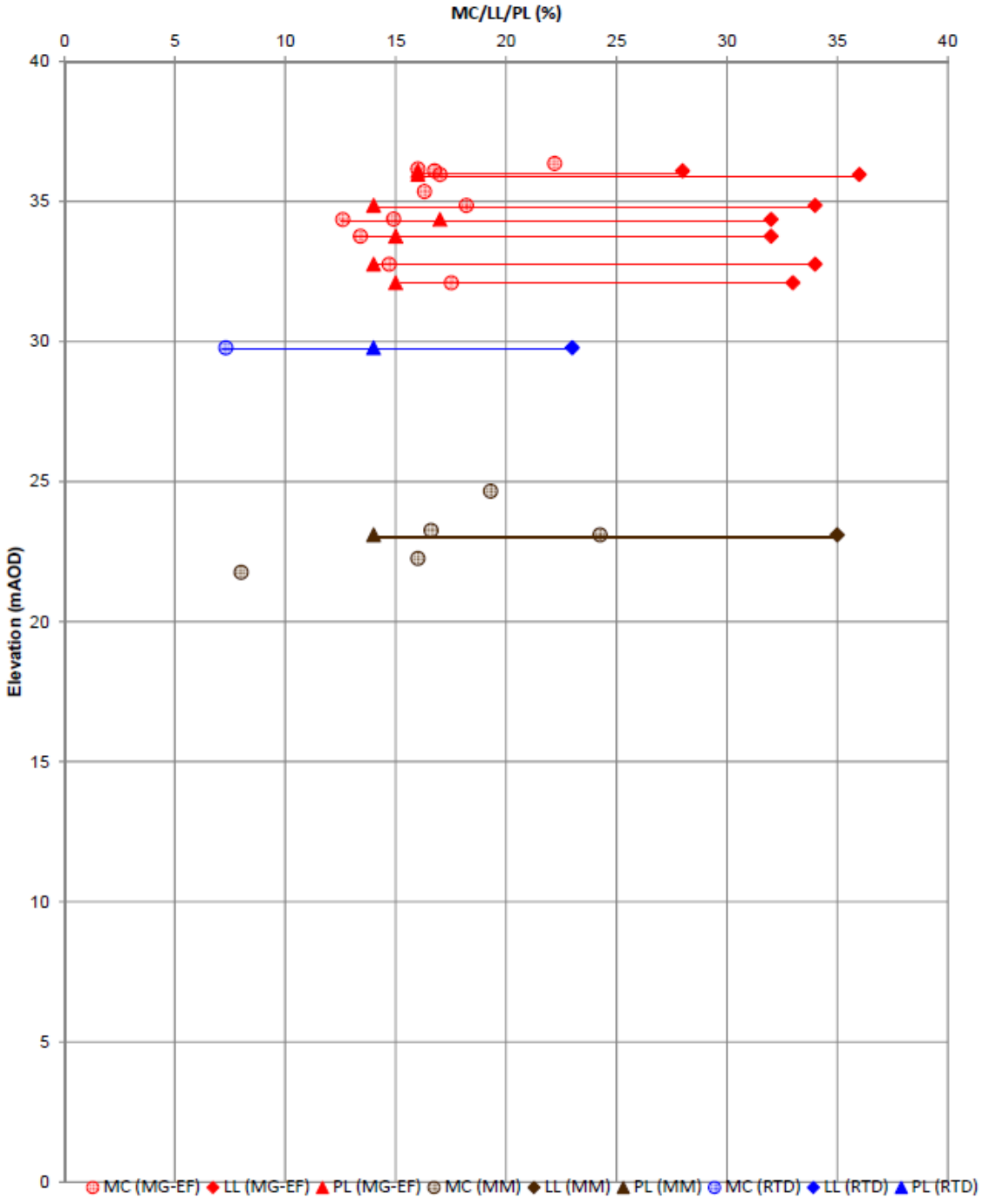
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186890-187070SB**
Client: **Highways England**	Borehole ID: **CP1094, SK42NE398 and SK42NE382**	

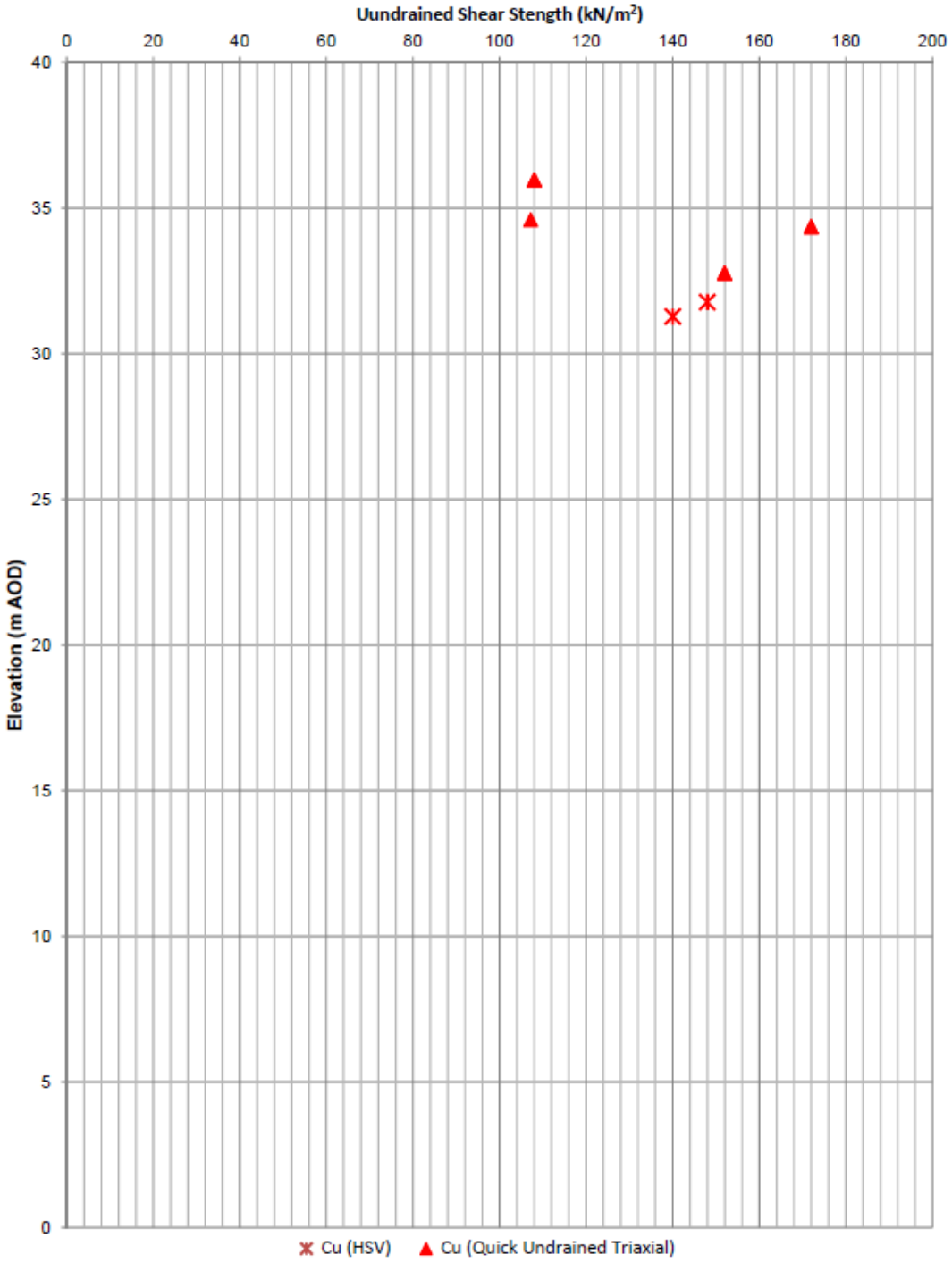


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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186890-187070SB**
Client: **Highways England**	Borehole ID: **SK42NE382 and CP1094**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-187120-187620SB-GSS-000001		
Earthwork Widening Solution	Full Height Embankment Widening 1:2.0 and Granular Wedge at Embankment Crest 1:2.0		
Structure Number	Gantry 326 and Gantry 303		
Structure Type	MS4 Cantilever and ADS Cantilever		
Design Chainage	187120-187620		
Carriageway	Southbound		
Marker Post	MP187/1B+20 – MP187/6B+20		
National Grid Reference	E 447092, N 329443 – E 446933, N 329915		
Existing Ground Level at Location	Carriageway	38.50 – 33.40mAOD	
	Toe of embankment	31.00 – 31.30mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_21152 & 7_M1_22215	HAGDMS designation
Earthwork Height	NB: N/A	SB: 2.1 – 7.5m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 23°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	08/02/2017	[redacted]
Checked	Alice Bazen	18/02/2017	
Reviewed	Gary Summerfield	28/02/2017	
Approved	Tom Bulteel	03/03/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR

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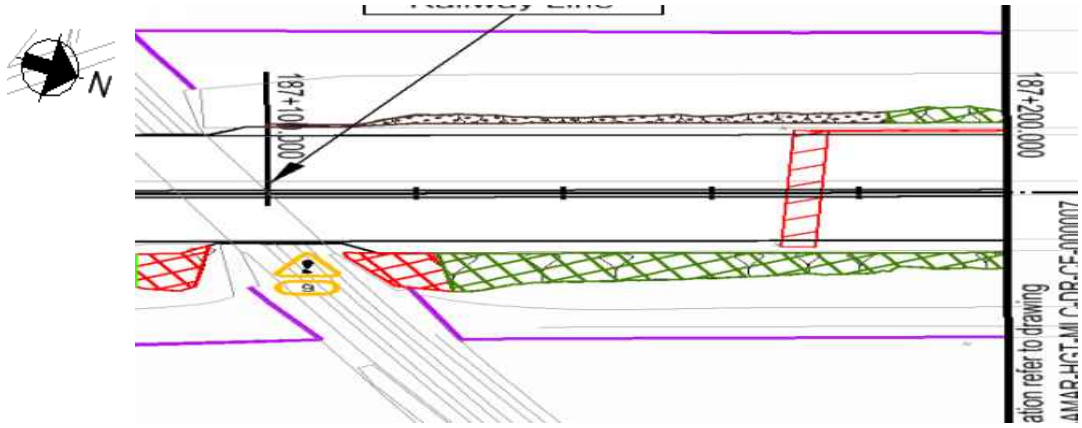


Figure 1.1: Location Plan – 187100 – 187200

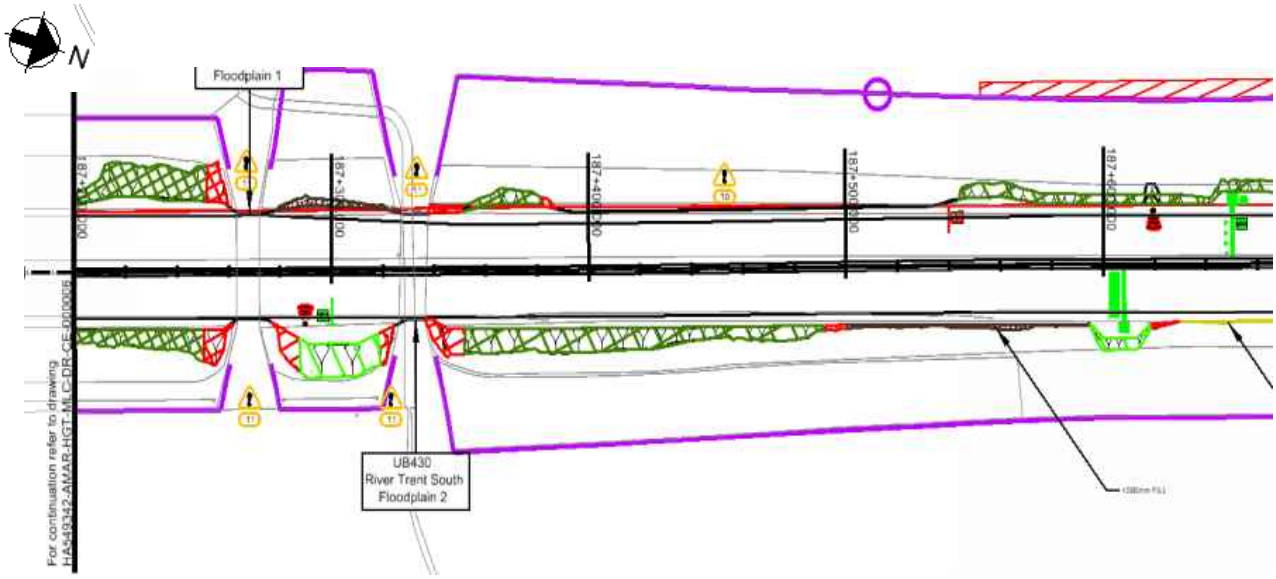


Figure 1.2: Location Plan – 187200 – 187620

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- 187120-187250 – granular wedge at embankment crest (1:2.0)
- 187280-187320 – full height embankment widening (1:2.0)
- 187350-187490 – granular wedge at embankment crest (1:2.0)
- 187600-187620 – full height embankment widening (1:2.0)

Proposed Major Structures:

The following structures have been proposed between chainage 187120 and 187620 and will require foundation design:

- MS4 Cantilever Gantry 326
- ADS Cantilever Gantry 303

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment ranging in height from 2.1m to 7.5m with a typical slope angle of 23 degrees.

The critical cross sections for both solutions at chainages 187130 and 187290 were based on sections with the greatest earthwork height.

1:2.0 Granular Wedge at Embankment Crest

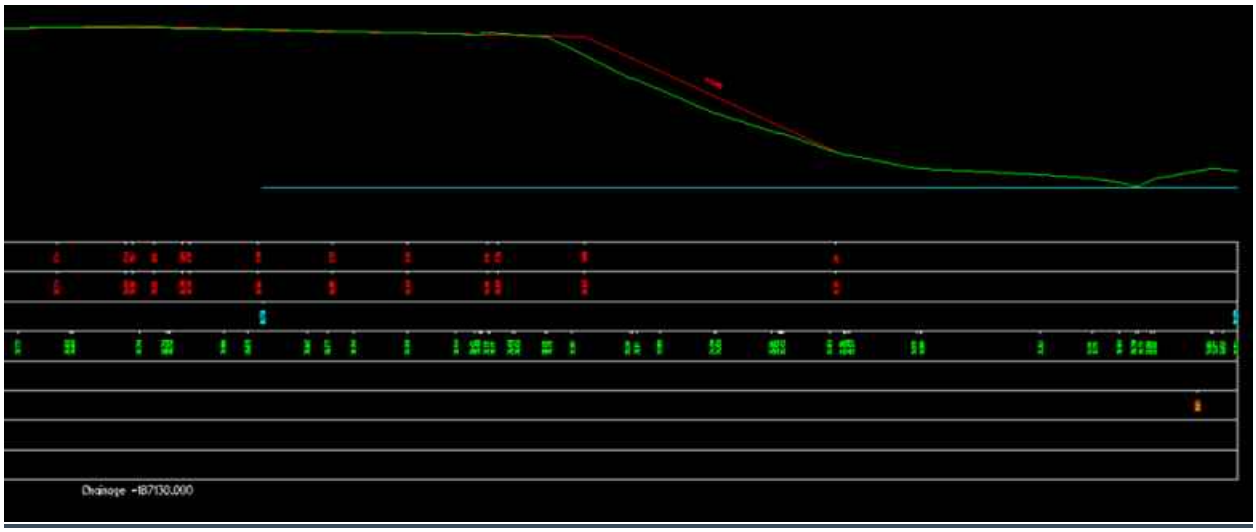


Figure 2.1: Topographic Critical Cross Section Chainage 187130

1:2.0 Full Height Embankment Widening

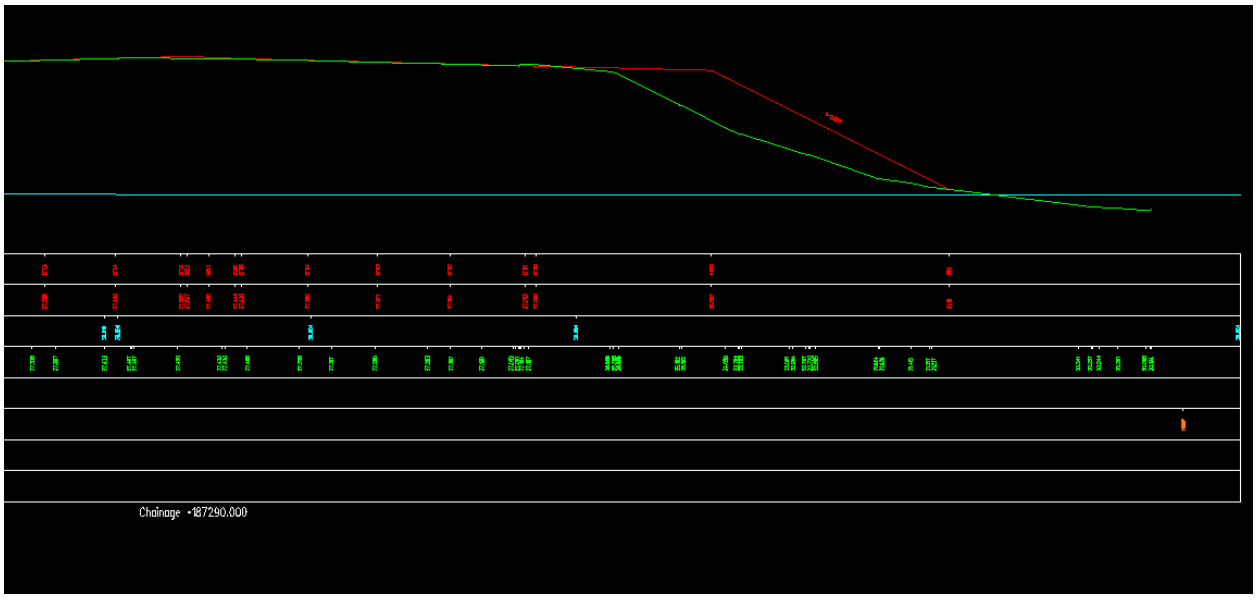


Figure 2.2: Topographic Critical Cross Section Chainage 187290

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Utilities:

British Telecoms Communication cable running from southbound verge to northbound at ch 187170



Figure 3: Utilities location plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Holme Pierrepont Sand and Gravel Member – Sand and Gravel / Hemington Member - Silt And Gravel

Solid Deposits: Branscombe Mudstone Formation – Mudstone / Edwalton Member - Mudstone

Ground Investigation:

There are 3 No. historical exploratory holes recorded within the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000029, Rev P01.

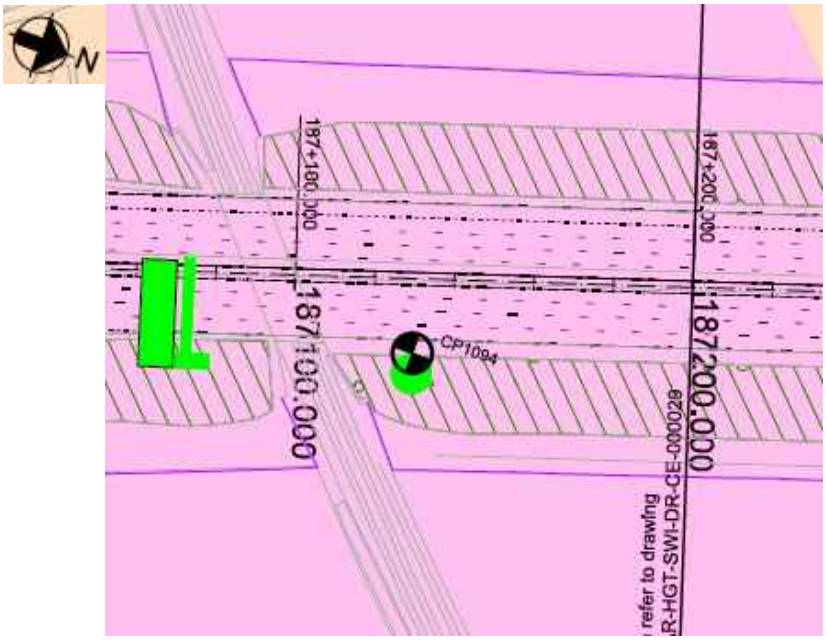


Figure 4.1: Borehole Location Plan – 187100-187200



Figure 4.2: Borehole Location Plan - 187200-187620

Flood Risk:

The desgin flood level varies between 30.72mAOD and 30.90mAOD. Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	CP1094	CP1096	NWHM1
Borehole Chainage	187130	187290	187526
Borehole Location	Southbound	Northbound	Northbound
National Grid Reference	E 447089, N 329452	E 447000, N 329591	E 446930, N 329816
Ground Level at Exploratory Hole	38.10mAOD	36.70mAOD	34.20mAOD
Date Drilled	22/11/2006	17/10/2006 – 18/10/2006	16/09/1999 - 19/09/1999
Termination Depth	17.05 meters below ground level (mbgl)	17.21 metres below ground level (mbgl)	6.00 metres below ground level (mbgl)
Other suitable holes	TP1095		

Existing Ground itions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Embankment Fill	7.50	31.00	7-16 (9)
Glaciofluvial Deposits (Coarse Grained)	15.0	23.5	13 - 136 (50)
Mercia Mudstone – Siltstone	>15.0	<23.5	38-150 (50)

(1) Ground level is assumed to be at carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken in exploratory hole CP1094, CP1096 and NWHM1.

Groundwater:

No Groundwater was encountered within any of the historical exploratory hole.

Groundwater Design Level:

No Local groundwater is available therefore design groundwater level of 30.90mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

4 No. Atterberg Limit Tests and 4 No. Moisture content tests were undertaken within Embankment Fill and Mercia Mudstone layers, with the results presented below:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class	Cu (kN/m^2)
Embankment Fill	2.00	16.76	28	16	12	CL	-
Embankment Fill	3.70	17.15	36	18	18	CL	-
Embankment Fill	6.00	17.52	33	15	18	CL	-
Mercia Mudstone	15.00	24.24	35	14	21	CI	-

3 No. Quick Undrained Traixial Tests were undertaken within the Embankment Fill with the following results:

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	1.20	110
Embankment Fill	3.20	44
Embankment Fill	3.50	107

Lab Test Data - BRE Classification:

No chemical test data is available for this earthwork.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γ_b (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment Fill	0.00-7.50	38.50-31.00	7.5	21	26	0	50	4.5	3.6	-	0.50	0.20	-	1.50	0.45	-	6.9*	-	DS-2 AC-2
Glaciofluvial Deposits (coarse grained)	7.50 – 15.00	31.0-23.50	7.50	21	41	-	-	-	55.2	-	-	0.25	-	22.08	-	1.0	-	50	DS-3 AC-3
Mercia Mudstone – Siltstone	>15.00	<23.50	>3.90	22	-	-	250	-	-	75	-	-	0.20	31.25	0.4	-	9.0	-	DS-1 AC-1s

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded in historical boreholes CP1096.
(3) Typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) c_u of Embankment Fill can be derived using the Stroud correlation. The recorded PI of 18% gives an f1 value of 5.5, combined with a SPT N value of 9, this gives a typical c_u of 50kN/m^2.
(5) ϕ' of Embankment Fill can be determined using Table 2 in BS8002:2015 using the recorded PI of 18% gives 26°.
(6) E' of Embankment Fill is based relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the conservative SPT N value of 9, Eu = 4.5MN/m^2. Therefore E' = 3.6MN/m^2.
(7) ϕ' of Glaciofluvial Deposits can be determined using correlation with SPT (Peck 1974) N values. Using a typical N value of 50 gives an angle of 41°.
(8) E' of Glaciofluvial Deposits can be determined using Bowles correlation E' = 1200 (N + 6) which (using typical N value of 50) gives a value of 67.2MN/m^2. This value is above the range given in the AMAR GIR and is considered to be unrepresentatively high for the stratum; therefore the upper bound of the range given in the AMAR GIR is considered more appropriate.

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(9) c_u of Mercia Mudstone – Siltstone can be derived using the Stroud correlation. A typical f1 value of 5.0 for Mercia Mudstone (CIRIA C570) is adopted; combined with a typical SPT N value of 50, this gives a c_u of 250kN/m^2.
(10) Due to a lack of local test data to derive E for Mercia Mudstone – Siltstone, the value derived in the AMAR GIR is adopted.
(11) Due to a lack of local test data for Mercia Mudstone – Siltstone, the characteristic UCS and E values derived in the AMAR GIR are used.
(12) Shear modulus is based on G = E/2(1+v).
(13) Adhesion factor is based on BS8004 (equation 41).
(14) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl. Embankment Fill is assumed to comprise reworked Mercia Mudstone.
(15) Ks/K0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).
(16) Nq is based on relationship with density as shown in Tomlinson (Table 7.1).

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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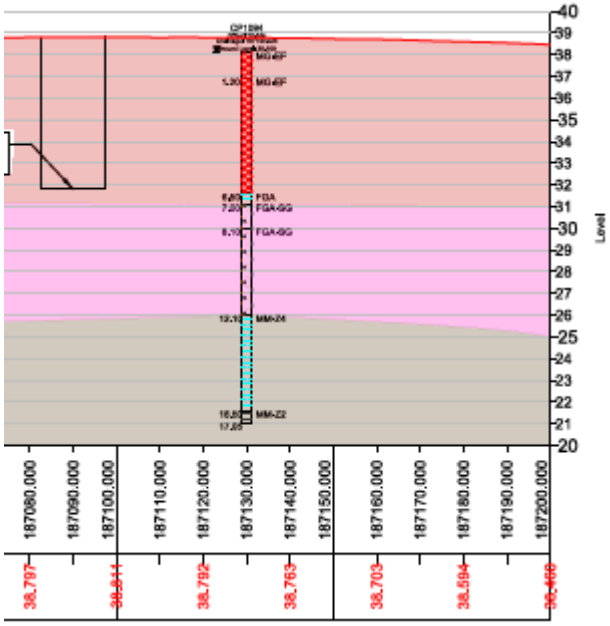


Figure 5.1: Geological Long Section – 187100-187200

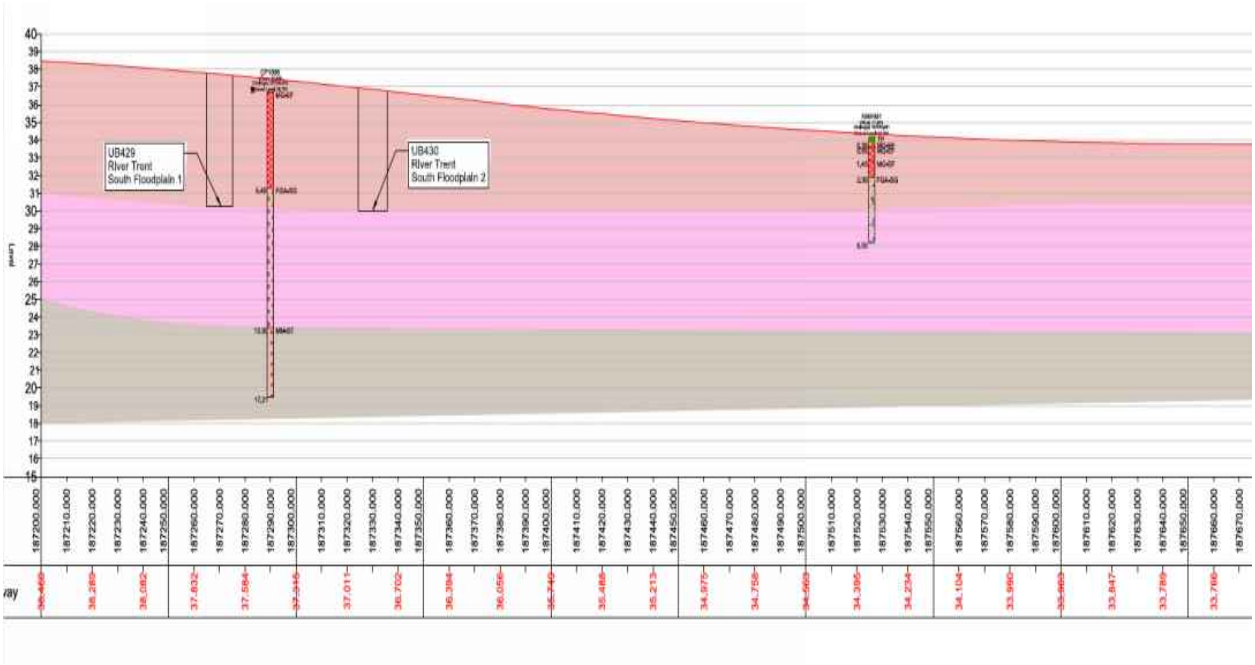


Figure 5.2: Geological Long Section – 187200-187620

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
187120	187250	Granular Wedge at Embankment Crest (1:2.0)	6.5	26.6 (1V:2H)
187280	187320	Full Height Embankment Widening (1:2.0)	4	26.6 (1V:2H)
187350	187490	Granular Wedge at Embankment Crest (1:2.0	6.5	26.6 (1V:2H)
187600	187620	Full Height Embankment Widening (1:2.0)	4	26.6 (1V:2H)

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Structure Reference	Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
Gantry 326	4 (2x2)	750	9	2.25	12	227	741
Gantry 303	4 (2x2)	900	20	2.70	11	481	1143

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

:

- BH –G326 at chainage 187300, Southbound – Dynamic Sample with a Rotary Core follow on up to a depth of 14.0m bgl.
- BH –G303 at chainage 187608, Southbound – Dynamic Sample with a Rotary Core follow on up to a depth of 25.0m bgl.
- T-CCD-24B at chainage 187499, Southbound – CPT up to a depth of 5.0mbgl.

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LOGS

Borehole Log

Borehole No. **CP1094** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447089.00 - 329452.00	Hole Type CP
Location:		Level: 38.10mbgl	Scale 1:50
Client: Highways England		Dates: 22/11/2006 - 22/11/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.50	101B						MADE GROUND. Light brown slightly clayey very gravelly sand with occasional rootlets. Gravel is angular to subrounded fine to coarse of sandstone, mudstone, limestone and quartzite. With occasional angular cobbles of grey fine grained sandstone. MG-EF
		1.20	102B			1.20	36.90		MADE GROUND. Firm red brown, locally grey green, slightly sandy slightly gravelly clay, locally slightly silty. Gravel is angular to subangular fine to coarse, of mudstone and siltstone. MG-EF
		1.50 - 1.95	1U	30blows					
		2.00	2D						
		2.50	3D						
		2.50	SPT (S)	N=7 (1,2/1,2,2,2)	Casing=1.50m Water=DRY				
		2.50 - 3.00	4B						
		3.50 - 3.95	5U	30blows					*At 3.50m; stiff.*
		4.00	6D						
		4.50	7D						
		4.50	SPT (S)	N=14 (2,2/3,4,3,4)	Casing=1.50m Water=DRY				
		4.50 - 5.00	8B						
		5.50 - 5.95	9U	40blows					
		6.00	10D						
		6.50	11D			6.50	31.60		
		6.50	SPT (S)	N=13 (3,4/3,3,3,4)	Casing=1.50m Water=DRY				Brown slightly sandy, locally sandy, occasionally gravelly to gravelly CLAY locally a clay/silt. Gravel is subangular to subrounded fine to coarse, of quartz and sandstone. FGA
		6.50 - 7.00	12B			7.00	31.10		
		7.50	SPT (C)	50 (10,15/50 for 135mm)	Casing=7.50m Water=4.10m				Brown SAND and GRAVEL. Sand is medium to coarse grained. Gravel is angular to subrounded fine to coarse, of quartz, dolomite, sandstone and rare (possible) slag, with some angular dolomite cobbles. FGA-SG
		7.50 - 8.00	13B						
						8.10	30.00		Brown SAND and GRAVEL. Sand is medium to coarse grained. Gravel is subangular to rounded fine to coarse, of quartz, sandstone, carbonaceous mudstone and some subrounded quartz cobbles. FGA-SG
		9.00	SPT (C)	N=44 (7,9/10,9,11,14)	Casing=9.00m Water=3.20m				
		9.00 - 9.50	14B						

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 7.00m.;The borehole was advanced by chiselling methods from 16.50m to 17.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **CP1094** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447089.00 - 329452.00	Hole Type CP
Location:		Level: 38.10mbgl	Scale 1:50
Client: Highways England		Dates: 22/11/2006 - 22/11/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		10.50	SPT (C)	50 (3,6/50 for 210mm)	Casing=10.50m Water=4.20m				*SAND and GRAVEL (as previous sheet)*
		10.50 - 11.00	15B						*Below 10.50m; medium to coarse GRAVEL.*
		12.00	SPT (C)	N=13 (2,2/3,3,3,4)	Casing=12.00m Water=4.80m	12.10	26.00		Friable red brown, locally grey green CLAY with angular, fine lithorelics of mudstone and occasional siltstone. MM-Z4
		12.00 - 12.50	16B						
		13.50 - 14.00	17U# B	30blows					
		15.00	18D						
		15.00	SPT (S)	N=38 (5,7/6,8,10,14)	Casing=15.00m Water=7.60m				
		15.00 - 15.50	19B						
		16.50	20D			16.50	21.60		Very weak red brown locally grey green MUDSTONE and SILTSTONE recovered as angular to subangular fine and medium gravel sized fragments. MM-Z2
		16.50	SPT (S)	50 (25 for 30mm/50 for 20mm)	Casing=16.50m Water=7.90m				
		16.50 - 17.00	21B			17.05	21.05		*At 17.00m; red brown friable sandy siltstone with some thin (<1mm) laminations of white gypsum.* End of borehole at 17.05 m
		17.00	22D						
		17.00	SPT (S)	50 (25 for 8mm/50 for 5mm)	Casing=16.50m Water=8.80m				

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 7.00m.;The borehole was advanced by chiselling methods from 16.50m to 17.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **CP1096** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 329591.00	Hole Type CP
Location:		Level: 36.70mbgl	Scale 1:50
Client: Highways England		Dates: 17/10/2006 - 18/10/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									MADE GROUND. Grass over firm brown locally green grey sandy gravelly silt, locally clay/silt. Gravel is subangular medium to coarse of siltstone with occasional subangular cobbles of siltstone. MG-EF
		1.20 - 1.65	2U	49blows					*At 1.20m; stiff*
		1.70	3D						
		1.80	4CD						
		2.20	5D						
		2.20	PID	0ppmv					*Below 2.20m; slightly friable slightly sandy gravelly clay. Gravel is fine to coarse subangular of quartz and siltstone.*
		2.20	SPT (S)	N=16 (1,2/2,5,4,5)	Casing=1.50m Water=DRY				
		2.20 - 2.70	6B						
		2.80	7CD						
		3.20 - 3.65	8U	31blows					
		3.70	9D						
		3.80	10CD						
		4.20	11D						
		4.20	PID	0ppmv					*At 4.20m; silt/clay.*
		4.20	SPT (S)	N=9 (1,1/2,2,2,3)	Casing=2.50m Water=DRY				
		4.20 - 4.70	12B						
		4.80	13CD						
		5.20 - 5.65	14U	100blows					
						5.40	31.30		Very dense becoming dense brown slightly sandy to sandy GRAVEL. Gravel is fine to coarse subangular to rounded of quartz, sandstone, siltstone and coal with subrounded cobbles of quartz. FGA-SG
		5.70	15D						
		5.80	16CD						
		5.80	SPT (C)	50 (25 for 125mm/50 for 125mm)	Casing=2.50m Water=DRY				
		5.80 - 6.30	17B						
		6.80	18CD						
		6.80	SPT (C)	50 (2,8/50 for 190mm)	Casing=6.80m Water=ADDED				
		6.80 - 7.30	19B						
		7.60	401 W						
		7.70	1L						
		7.70	32W						
		7.80	SPT (C)	50 (4,8/50 for 255mm)	Casing=7.80m Water=ADDED				
		7.80 - 8.30	20B						
		7.90	201 W						
		7.90	26W						
		8.80	SPT (C)	N=33 (3,6/7,9,8,9)	Casing=8.80m Water=ADDED				
		8.80 - 9.30	21B						

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 6.20m.;The borehole was advanced by chiselling methods from 6.00m and 6.20m (0.75 hours) and 16.60m and 17.00m (1 hour).;A hand held Photo-Ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.;

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Borehole Log

Borehole No. **CP1096** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 329591.00	Hole Type CP
Location:		Level: 36.70mbgl	Scale 1:50
Client: Highways England		Dates: 17/10/2006 - 18/10/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		10.30	SPT (C)	N=49 (2,5/9,10,14,16)	Casing=10.30m Water=ADDED				GRAVEL (as previous sheet)
		10.30 - 10.80	22B						
		11.80	SPT (C)	N=37 (4,6/7,9,9,12)	Casing=11.80m Water=ADDED				
		11.80 - 12.30	23B						
		13.30	SPT (S)	N=39 (7,8/8,10,11,10)	Casing=13.30m Water=ADDED	13.30	23.40		Brown and grey green SILTSTONE recovered as very weak to weak fine to medium subangular to angular gravel size fragments. MM-ST
		13.30 - 13.75	24D						
		13.30 - 13.80	25B						
		14.80 - 15.25	27U	69blows					
		15.30	28D						At 15.30m; rare coarse subrounded gravel of quartz.
		16.30	29D						
		16.30	SPT (S)	50 (6,8/50 for 210mm)	Casing=16.30m Water=9.40m				
		16.60 - 17.00	30B						
		17.00	31D						
		17.00	SPT (S)	50 (25 for 105mm/50 for 105mm)	Casing=16.50m Water=9.50m	17.21	19.49		At 17.00m; laminated, with occasional laminae of gypsum. End of borehole at 17.21 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 6.20m.;The borehole was advanced by chiselling methods from 6.00m and 6.20m (0.75 hours) and 16.60m and 17.00m (1 hour).;A hand held Photo-Ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.;

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Borehole No. NWHM1 HISTORIC Sheet 1 of 1
Location:	Co-ords: 446929.60 - 329816.11	Hole Type RC
	Level: 34.20mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England	Dates: 16/09/1999 - 19/09/1999	Logged By NBR

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.35	01D					0.35	33.85		TOPSOIL. TP
		0.35 - 0.65	D								
		0.65 - 0.70	02D					0.65	33.55		MADE GROUND: Reddish brown very silty clay with some fine to medium subangular gravel sized fragments of mudstone. (Reworked Mercia Mudstone) MG-EF
		0.65 - 0.70	D								
		0.70 - 1.50	98	27	0	0					
								1.40	32.80		MADE GROUND: Brown sandy clay with much fine to coarse angular gravel sized fragments of limestone. MG-EF
		1.50 - 2.30	98	50	0	0					Very stiff brown mottled reddish brown very sandy CLAY with much fine to coarse angular to subrounded gravel sized fragments of sandstone, siltstone, mudstone, quartz and coal. MG-EF
		~~2.30~~	~~SPT(S)~~				102 (10,18/102 for 225mm)	2.30	31.90		
		2.67 - 3.30	97	0	0	0					Very dense brown clayey sandy fine to coarse subangular to rounded GRAVEL of quartz, sandstone and siltstone. (River Terrace Deposits) FGA-SG
		~~3.30~~	~~SPT(S)~~				78 (18,29/78 for 150mm)				
		3.60 - 4.30	97	0	0	0					
		~~4.30~~	~~SPT(S)~~				83 (12,25/83 for 150mm)				
		4.60 - 5.00	98	100	0	0					
		5.00 - 6.00		0	0	0					
								6.00	28.20		End of borehole at 6.00 m

1 2 3 4 5 6 7

Shift Information

Date & Time	Depth	Water	Casing	Remarks
16/09/1999 17:30	1.50	0.00	1.50	
17/09/1999 07:30	1.50	0.00	1.50	
17/09/1999 17:30	5.00	0.00	5.00	
19/09/1999 07:30	5.00	0.00	6.00	
19/09/1999 17:30	6.00	0.00	6.00	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

1. Inspection pit excavated to 0.70m. 2. H40 rig replaced by Hands England at 5.00m. 3. Openhole from 5.00m to 6.00m. 4. Borehole collapsing from 6.00mto 5.00m. 5. Borehole M1 terminated at 6.00m. Position grouted up to 0.50mbgl. Topsoil replaced. 6. Marker Post Ref 187/5 +50N.

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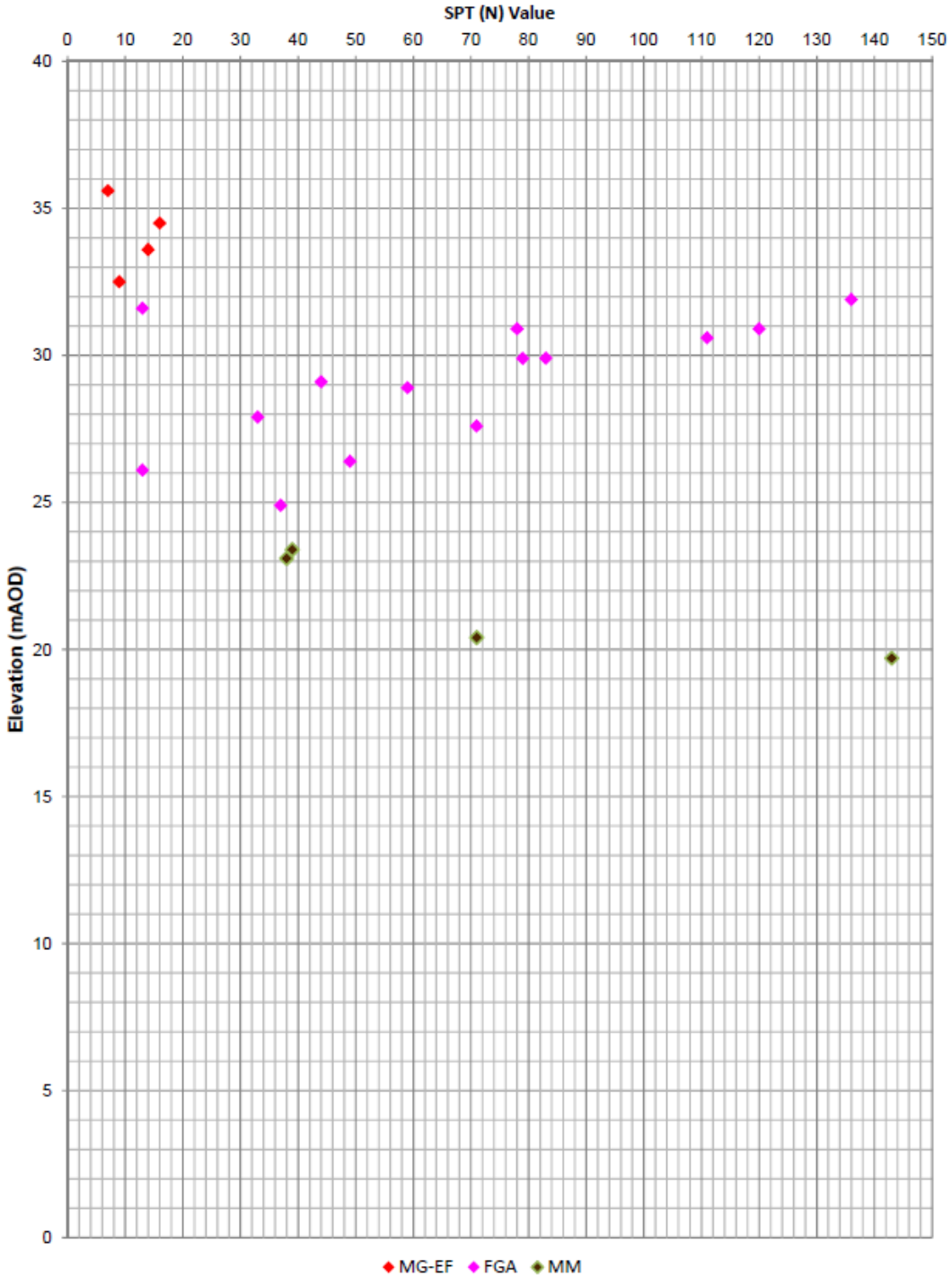
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PLOTS

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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **187120-187620SB**
Client: **Highways England**	Borehole ID: **CP1094, CP1096 and NMWHM1**	

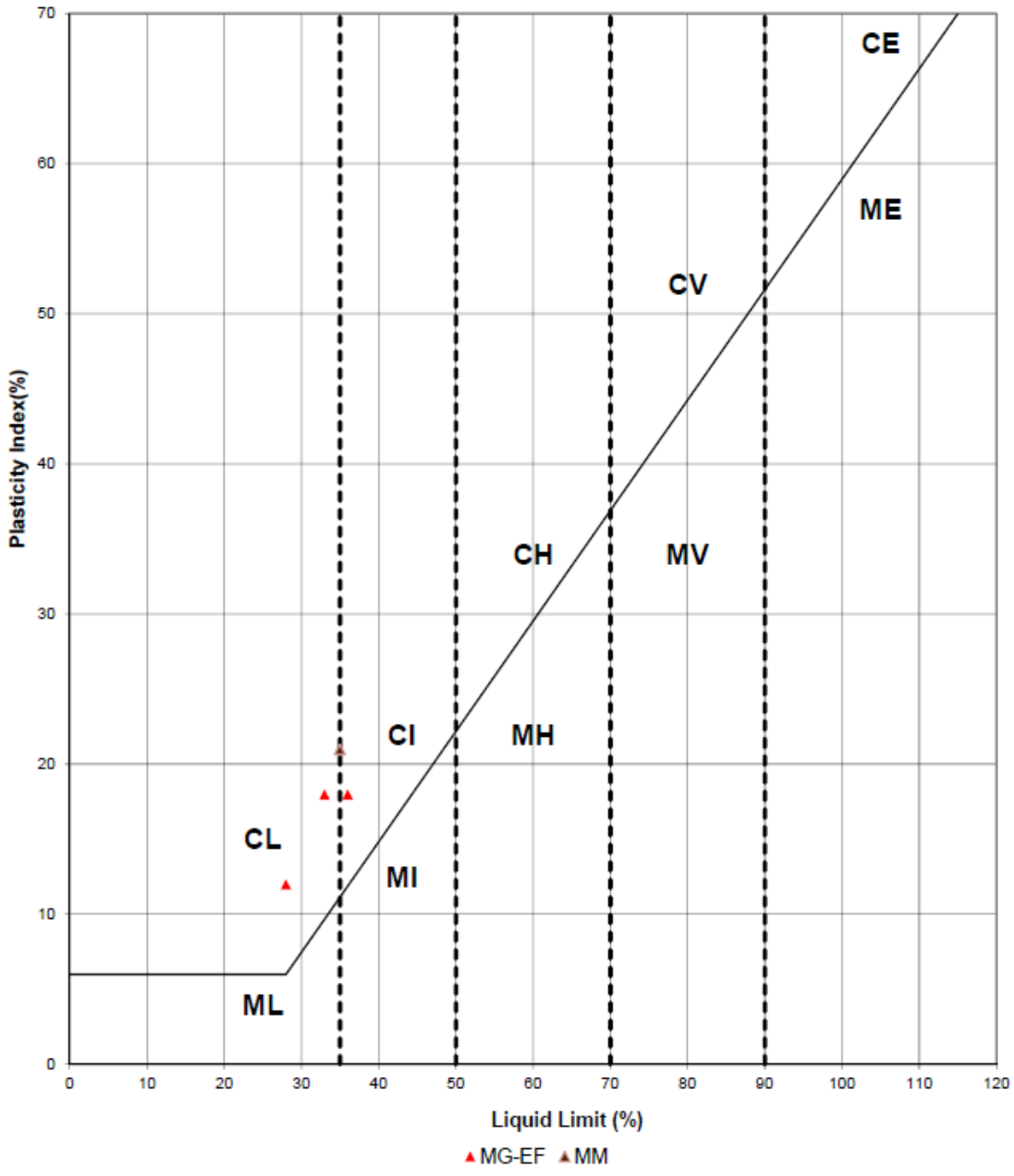


Extrapolated SPT (N) Values >150 have not been shown

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **187120-187620SB**
Client: **Highways England**	Borehole ID: **TP1095, CP1094 & CP1096**	



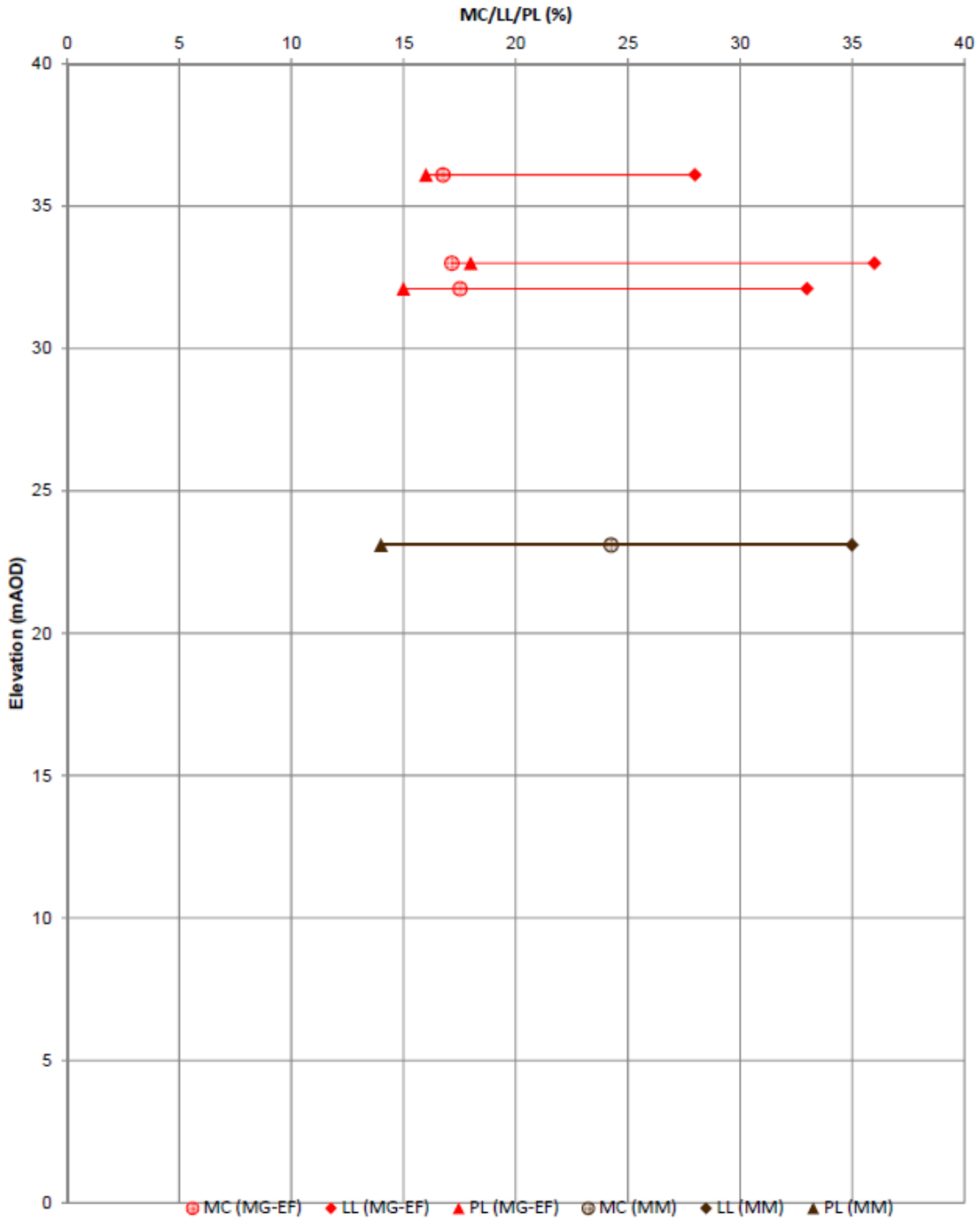
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

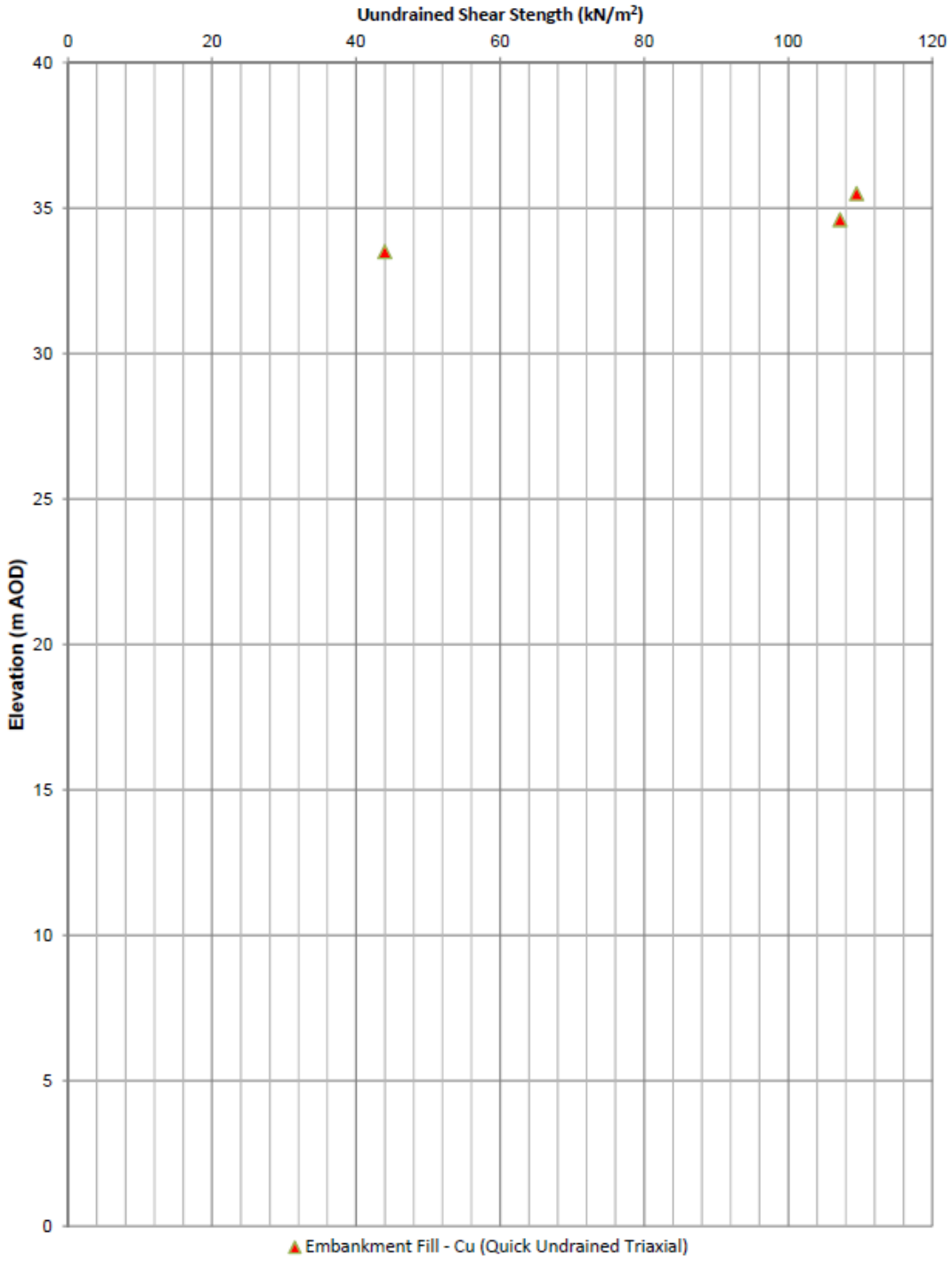
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **187120-187620SB**
Client: **Highways England**	Borehole ID: **CP1094 and CP1096**	



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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **187120-187620SB**
Client: **Highways England**	Borehole ID: **CP1094 and CP1096**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-187800-187830SB-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	Gantry 305		
Structure Type	MS4 Cantilever Gantry + CCTV		
Design Chainage	187800-187830		
Carriageway	Southbound		
Marker Post	MP187/8B+00 – MP187/8B+30		
National Grid Reference	E 446880, N 330085 – E 446871, N 330113		
Existing Ground Level at Location	Carriageway	33.71 mAOD	
	Toe of embankment	30.51 mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_24555	HAGDMS designation
Earthwork Height	NB: N/A	SB: 3.20	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 15°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Simon Arinze	05/01/2017	[redacted]
Checked	Alice Bazen	15/02/2017	
Reviewed	Gary Summerfield	15/02/2017	
Approved	Tom Bulteel	22/02/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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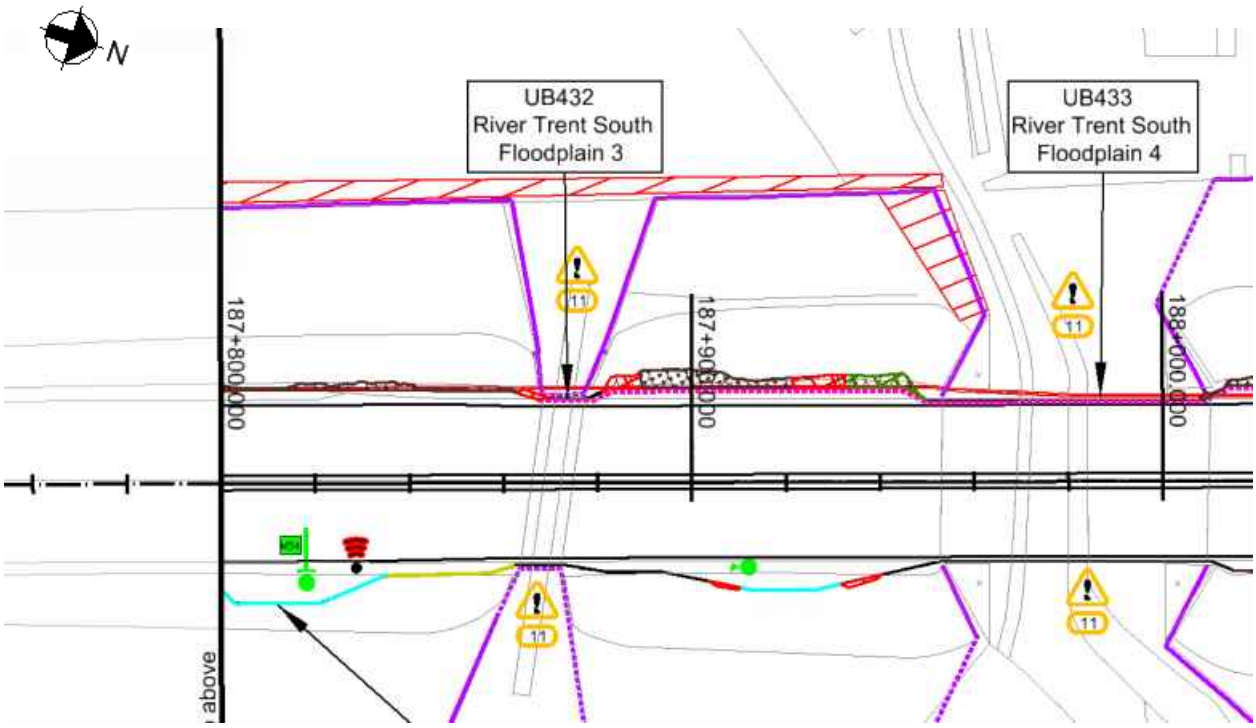


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- King sheet pile retaining wall to facilitate the base for Gantry 305.

Proposed Major Structures:

MS4 Cantilever Gantry with CCTV (Gantry 305) proposed at chainage 187818

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a cutting. However HAGDMS classifies this earthwork as an Embankment with a maximum height of 3.2m and a typical slope angle of 15 degrees.

The critical cross section at chainage 187820 was based on the section with the greatest retained height.

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Figure 2: Topographic Critical Cross Section Chainage 187820

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Heamington Member (Silt & Gravel)

Solid Deposits: Edwalton Member (Mercia Mudstone Group), Mudstone

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however 3 no. relevant exploratory holes are considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000030, Rev P01.

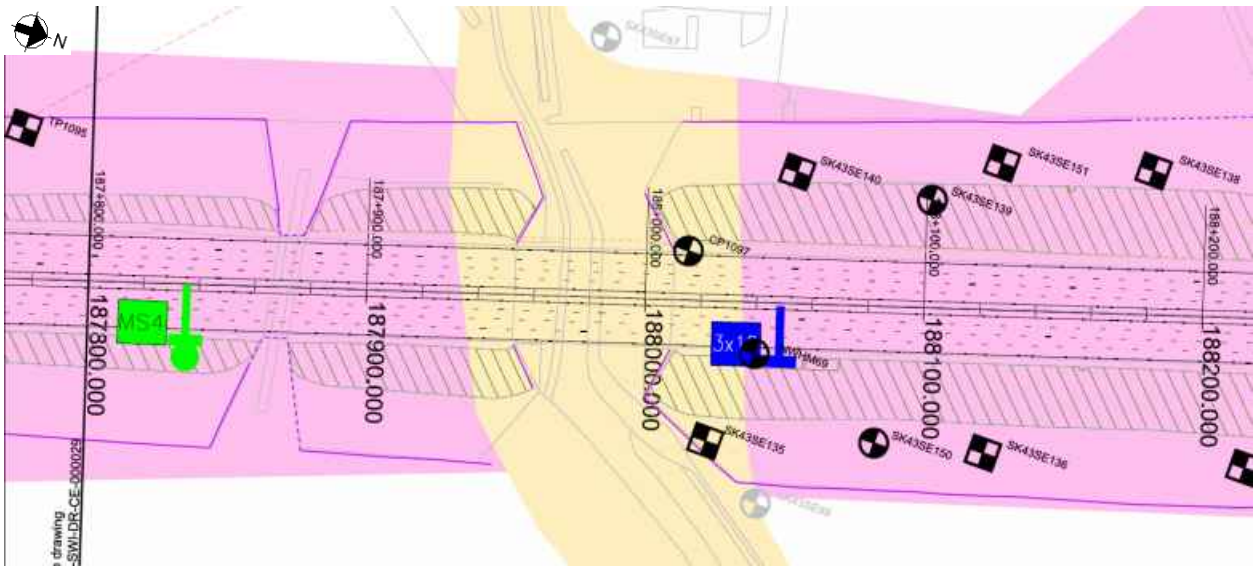


Figure 3: Borehole Location Plan

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Flood Risk:

The design flood level has been recorded as 30.95mAOD. Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	CP1097
Borehole Chainage	188015
Borehole Location	Southbound
National Grid Reference	E 446777, N 330281
Ground Level at Exploratory Hole	35.95mAOD
RAG Analysis	Green
Date Drilled	19/10/2006
Termination Depth	14.22 metres below ground level (mbgl)
Other suitable holes	NWHM1 & NWHM69

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Made Ground – Embankment Fill	6.60	29.35	12->150 (12)
Glaciofluvial Deposits	12.90	23.05	15-136
Mercia Mudstone – III/IV	>14.22	<21.73	83-130

(1) Ground level is assumed to be at carriageway level;
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes CP1097, NWHM1 & NWHM69.

Groundwater:

No groundwater data is available for any of the boreholes mentioned above.

Groundwater Design Level:

No local groundwater data is available. Therefore a groundwater level of 30.95mAOD (flood level) has been assumed for WALLAP analysis of the king sheet pile. When checking the global stability check of the earthwork and king sheet pile (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

3 No Atterberg Limit Tests and 3 No Natural Moisture Content tests were undertaken within the Mercia Mudstone – III/IV, Alluvium and Made Ground - Embankment Fill with the following results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Made Ground – Embankment Fill	3.70	19	37	20	17	CI
Alluvium	7.20	41	58	37	21	MH
Mercia Mudstone – III/IV	13.50	34.18	39	31	8	MI

Lab Test Data – BRE Classification:

The chemical tests completed in the historical exploratory holes are summarised in the table below:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Sulphate (Total) as SO4	Solid	2	0.06-0.07	%SO4
Embankment Fill	Water Soluble Sulphate as SO4	Water	3	0.09-0.81	g/l SO4
Embankment Fill	pH	Solid	4	7.14-8.31	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Validation Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Made Ground – Embankment Fill	0.00-3.71	33.71-30.00	3.71	21	27	0	60	5.40	4.32	-	0.50	0.20	-	1.80	0.68	-	6.2*	-	DS-2 AC-2
Glaciofluvial Deposits (Coarse Grained)	3.71-10.71	30.00-23.00	7.00	21	38	-	-	-	19.20	-	-	0.25	-	7.70	-	1.0	-	50	DS-3 AC-3
Mercia Mudstone – III/IV	>10.71	<23.00	-	21	30	2	50	10.80	8.60	-	0.50	0.20	-	3.60	0.76	-	9.0	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical borehole CP1097.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) A conservative SPT N value of 12 has been used for the Made Ground – Embankment Fill, combined with an f1 value of 5, give a C_u of 60kN/m^2.
(5) Eu for Made Ground – Embankment Fill can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 12 gives Eu = 5.4MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 4.32MN/m^2.
(6) Adhesion Factor for Made Ground – Embankment Fill is based on BS8004 (equation 41).
(7) Due to lack of near-by reliable GI data, parameters derived from the AMAR GIR have been used for the Glaciofluvial Deposits.
(8) Due to lack of near-by reliable GI data, parameters derived from the AMAR GIR have been used for the Mercia Mudstone – III/IV
(9) Shear modulus is based on G = E/2(1+v).
(10) Adhesion Factor for Mercia Mudstone is based on BS8004 (equation 41).
(11) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl
(12) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).

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(13) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1). For sandstone, Nq is derived based on a very dense siliceous cohesionless soil (Tomlinson Table 7.1).
(14) BRE Classification is determined using criteria set out in BRE Special Digest 1. Due to the lack or reliable of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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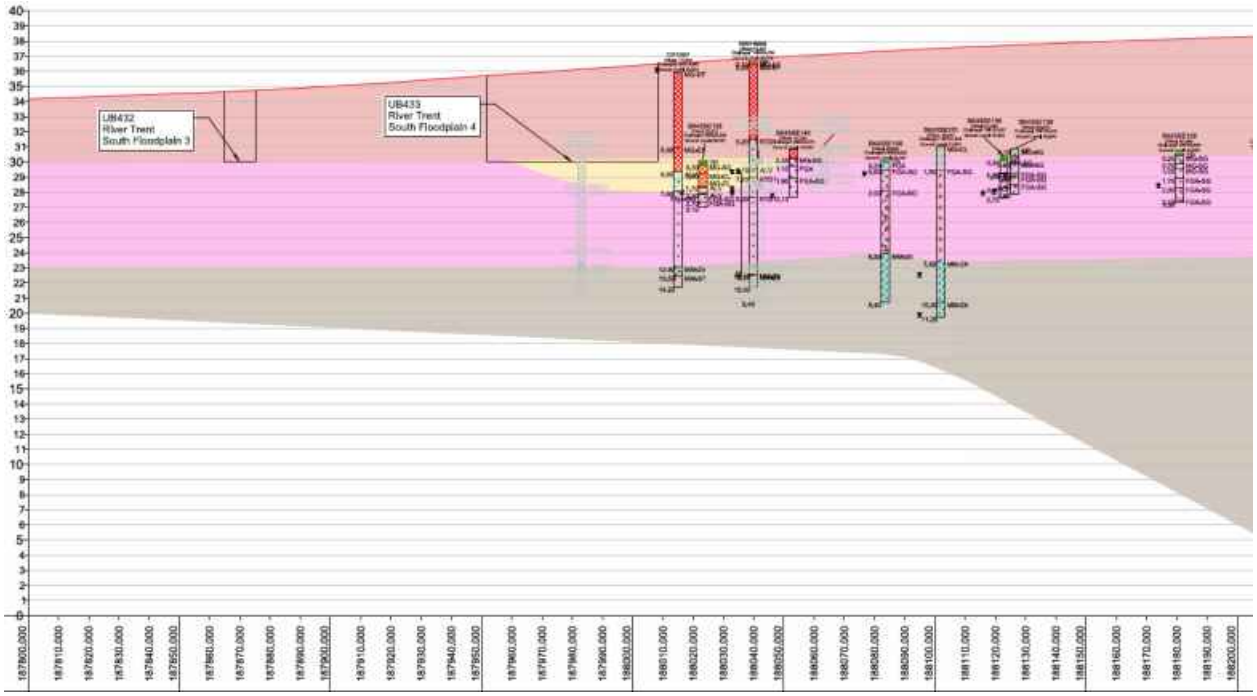


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to the flood plain, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	King Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
187800	187880	AZ-24 S 390 GP	2.3	4.2	6.5	80	35	26	67.1

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	750	9	2.25	10	235	434

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-G305 at chainage 187818, Southbound – Dynamic Sample with Rotary Core Follow on to a scheduled depth of 14m bgl.

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LOGS

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Rotary Core Log

Borehole No. **CP1097** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446777.00 - 330281.00	Hole Type CP
Location:		Level: 35.95	Scale 1:50
Client: Highways England		Dates: 19/10/2006 - 19/10/2006	Logged By MW

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										MADE GROUND. Soft to firm red brown and green clay/silt with occasional fine to coarse angular to subangular siltstone gravel sized fragments of siltstone. MG-EF
		1.20 - 1.65	U							
		1.70	D							
		1.80	CD							
		2.20 - 2.65	D							
		2.20 - 2.70	B							
		2.80	CD							
		3.20 - 3.65	U							
		3.70	D							Below 3.70m, occasionally grey blue
		3.80	CD							
		4.20 - 4.65	D							
		4.20 - 4.70	B							
		4.80	CD							
		5.00 - 5.50	B				5.00	30.95		MADE GROUND. Dense to very dense brown sand and gravel. Sand is coarse, gravel is fine to coarse angular to subrounded of quartz and siltstone with occasional subangular to subrounded cobbles. With rare cobble sized pockets of blue grey clay. MG-EF
		5.80	CD							
		6.00 - 6.50	B							
		6.17	W							
		6.21	W							
		6.50	W							
		6.50	W				6.60	29.35		
		6.60	CD							Firm to stiff brown and blue grey locally mottled orange brown gravelly CLAY, locally clay/silt. ALV
		6.60	D							
		6.70 - 7.15	U							
		7.20	D							
		7.70 - 8.15	D							
		7.70 - 8.20	B				7.90	28.05		
		9.20 - 9.70	B							Dense brown coarse SAND and GRAVEL locally gravelly sand. Sand is mainly coarse, gravel is fine to coarse subangular to rounded of quartz, sandstone and siltstone with occasional flint. FGA-SG
										Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 6.00m.;The borehole was advanced by chiselling methods from 6.00m to 6.30m (0.75 hours) and 13.70m to 14.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1097 Sheet 2 of 2

Project Name:	SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446777.00 - 330281.00
Location:			Level: 35.95
Client:	Highways England		Dates: 19/10/2006 - 19/10/2006

Hole Type CP | Scale 1:50 | Logged By MW

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.70 - 11.20	B							SAND and GRAVEL (as previous sheet) At 10.70m, sandy gravel
		12.20 - 12.70	B							
		12.90	D				12.90	23.05		
		13.00 - 13.45	U							Stiff to very stiff red brown locally grey green slightly sandy SILT/CLAY with occasional medium subrounded lithorelics of siltstone. With subrounded medium quartz gravel. MM-Z4
		13.50	D				13.50	22.45		
		13.60 - 13.88	D							Recovered as grey green fine and medium angular gravel size fragments of SILTSTONE with frequent laminae <1mm of gypsum. MM-ST
		13.60 - 14.00	B							
		14.00 - 14.21	D							
							14.22	21.73		End of borehole at 14.22 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 6.00m.;The borehole was advanced by chiselling methods from 6.00m to 6.30m (0.75 hours) and 13.70m to 14.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. NWHM1
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446929.60 - 329816.11	Hole Type RC
Location:		Level: 34.20	Scale 1:50
Client: Highways England		Dates: 16/09/1999 - 19/09/1999	Logged By NBR

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.35	D				0.35	33.85		TOPSOIL. TP
		0.35 - 0.65	D							MADE GROUND: Reddish brown very silty clay with some fine to medium subangular gravel sized fragments of mudstone. (Reworked Mercia Mudstone) MG-EF
		0.65 - 0.70	D				0.65	33.55		
		0.70 - 1.50	98	27	0	0				MADE GROUND: Brown sandy clay with much fine to coarse angular gravel sized fragments of limestone. MG-EF
							1.40	32.80		
		1.50 - 2.30	98	50	0	0				Very stiff brown mottled reddish brown very sandy CLAY with much fine to coarse angular to subrounded gravel sized fragments of sandstone, siltstone, mudstone, quartz and coal. MG-EF
							2.30	31.90		
		2.67 - 3.30	97	0	0	0				Very dense brown clayey sandy fine to coarse subangular to rounded GRAVEL of quartz, sandstone and siltstone. (River Terrace Deposits) FGA-SG
		3.60 - 4.30	97	0	0	0				
		4.60 - 5.00	98	100	0	0				
		5.00 - 6.00		0	0	0				
							6.00	28.20		End of borehole at 6.00 m

Remarks
1. Inspection pit excavated to 0.70m. 2. H40 rig replaced by Hands England at 5.00m. 3. Openhole from 5.00m to 6.00m. 4. Borehole collapsing from 6.00mto 5.00m. 5. Borehole M1 terminated at 6.00m. Position grouted up to 0.50mbgl. Topsoil replaced. 6. Marker Post Ref 187/5 +50N.

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Rotary Core Log

Borehole No. NWHM69
Sheet 1 of 2

Project Name:	SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446803.54 - 330315.82
Location:			Level: 36.70
Client:	Highways England		Dates: 20/09/1999 - 22/09/1999

Hole Type CP
Scale 1:50
Logged By BS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.10	36.60		TOPSOIL. TP
		0.50	D				0.30	36.40		MADE GROUND: Grey medium and coarse gravel sized fragments of limestone. (Hardcore) MG-EF
		1.20	D							MADE GROUND: Very stiff (desiccated) red brown locally mottled grey slightly sandy clay with some fine to coarse gravel of mudstone. Rare sandstone noted. MG-EF
							5.20	31.50		Dense brown and red brown slightly clayey coarse SAND with much fine to coarse subangular to rounded assorted gravel of quartz, limestone and sandstone. (River Terrace Deposits) RTD1
	▼						7.10	29.60		Stiff red brown mottled blue grey slightly sandy CLAY with some fine and medium subangular gravel of sandstone and coal. (Glacial Till) ALV
							7.70	29.00		Medium dense grey silty coarse SAND and GRAVEL: Gravel content fine to coarse subangular to rounded of quartz, sandstone and limestone. (River Terrace Deposits) RTD1
	▼									
	▼						9.00	27.70		Dense yellow brown coarse SAND and GRAVEL: Gravel content fine to coarse subangular to rounded of quartz, sandstone and limestone. (River Terrace Deposits) RTD1
										Continued on next sheet

Remarks
1. M69 commenced with a hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. Borehole completed at 15.00m. Upon completiona slotted standpipe was installed to 15.00m bgl. 3. Marker Post Ref 188/1-50S.

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Rotary Core Log

Borehole No. NWHM69
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446803.54 - 330315.82	Hole Type CP
Location:		Level: 36.70	Scale 1:50
Client: Highways England		Dates: 20/09/1999 - 22/09/1999	Logged By BS

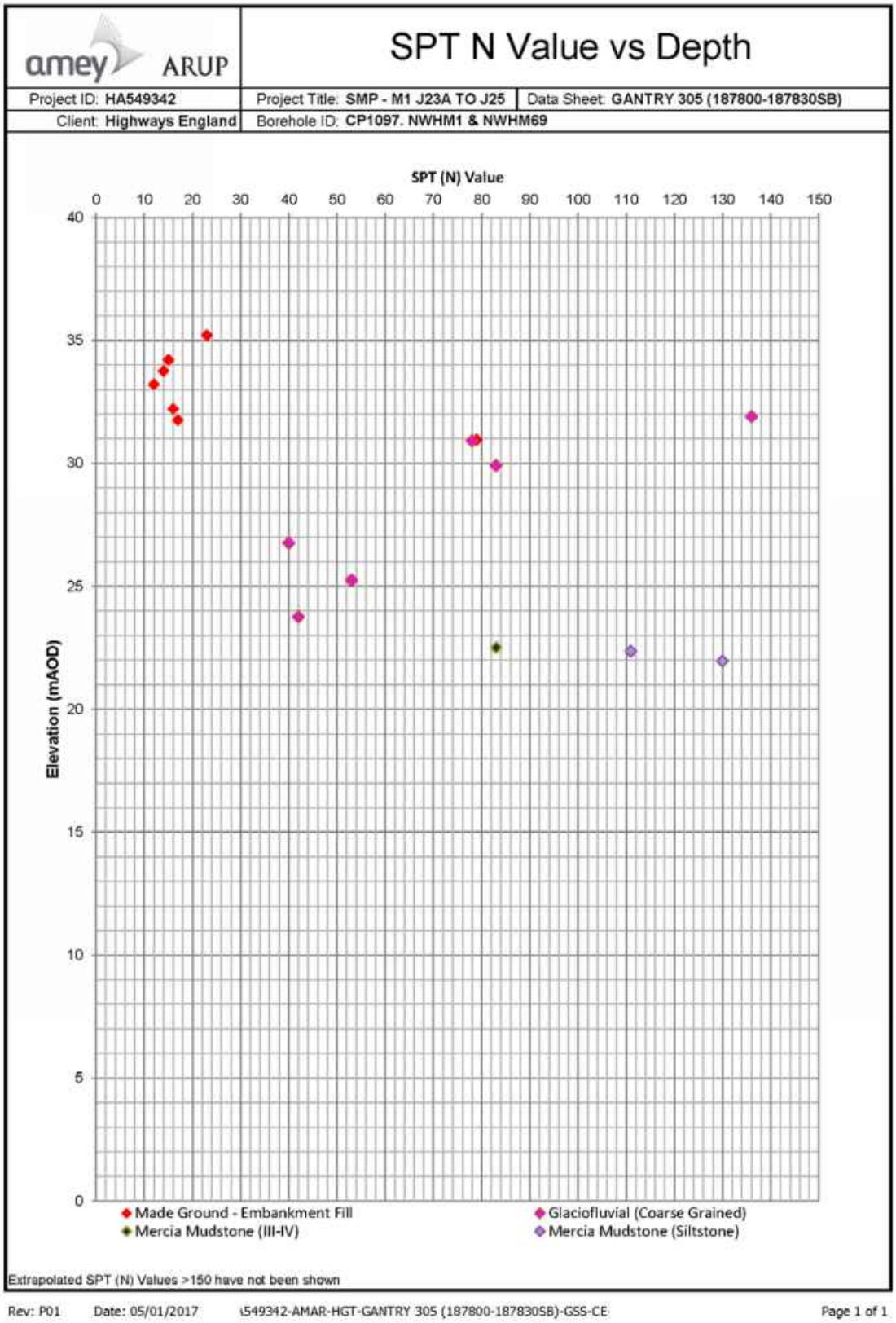
Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							14.10	22.60		Soft? red brown and grey sandy CLAY. MM-Z4
							14.20	22.50		Stiff red brown dappled blue grey slightly sandy CLAY with some to many fine and medium subangular mudstone lithorelicts. (Mercia Mudstone - Grade II/III?) MM-Z3
⑦							15.00	21.70		End of borehole at 15.00 m

Remarks
1. M69 commenced with a hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. Borehole completed at 15.00m. Upon completiona slotted standpipe was installed to 15.00m bgl. 3. Marker Post Ref 188/1-50S.

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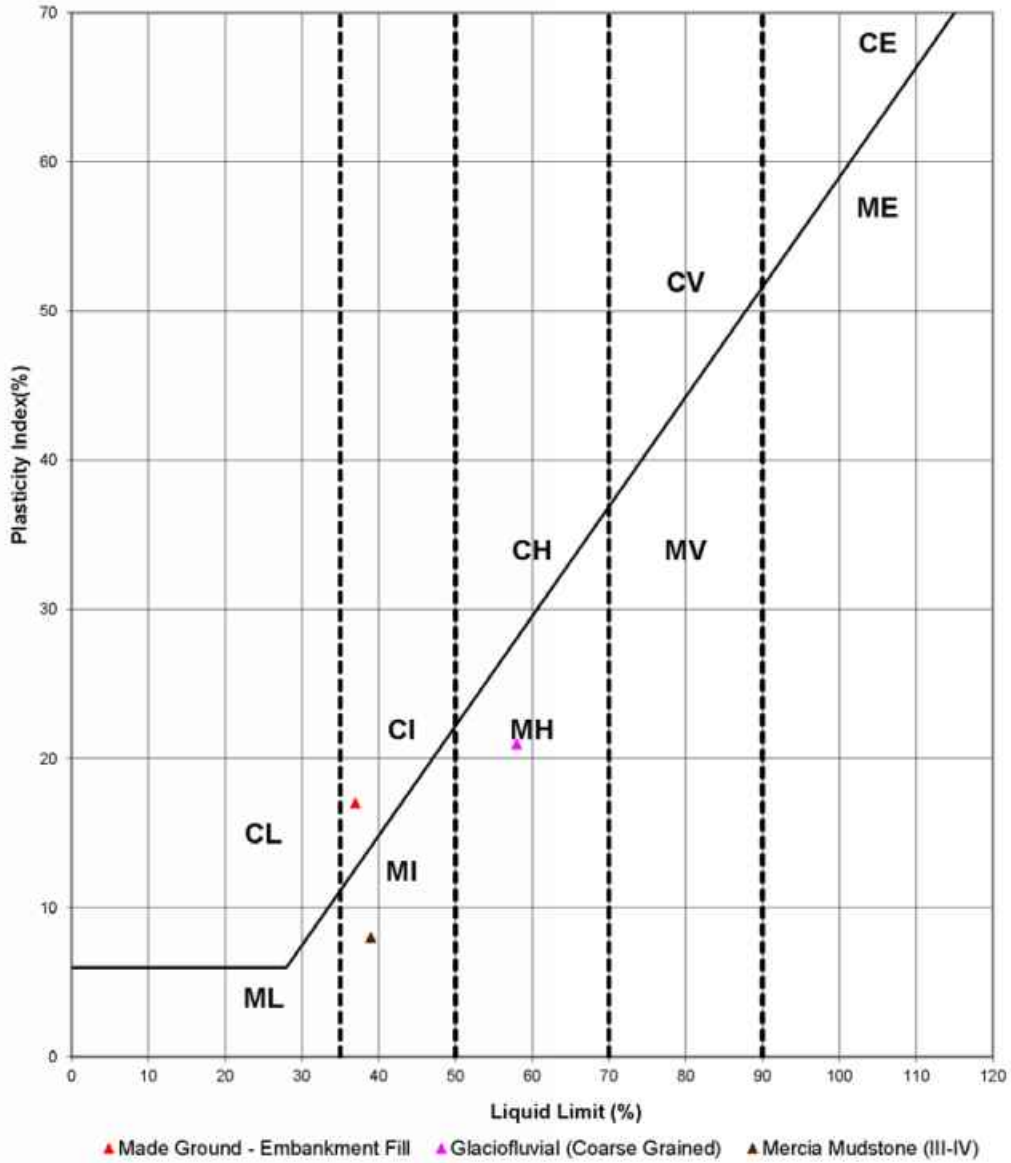
PLOTS



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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **GANTRY305 (187800-187830SB)**
Client: **Highways England**	Borehole ID: **CP1097**	



Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

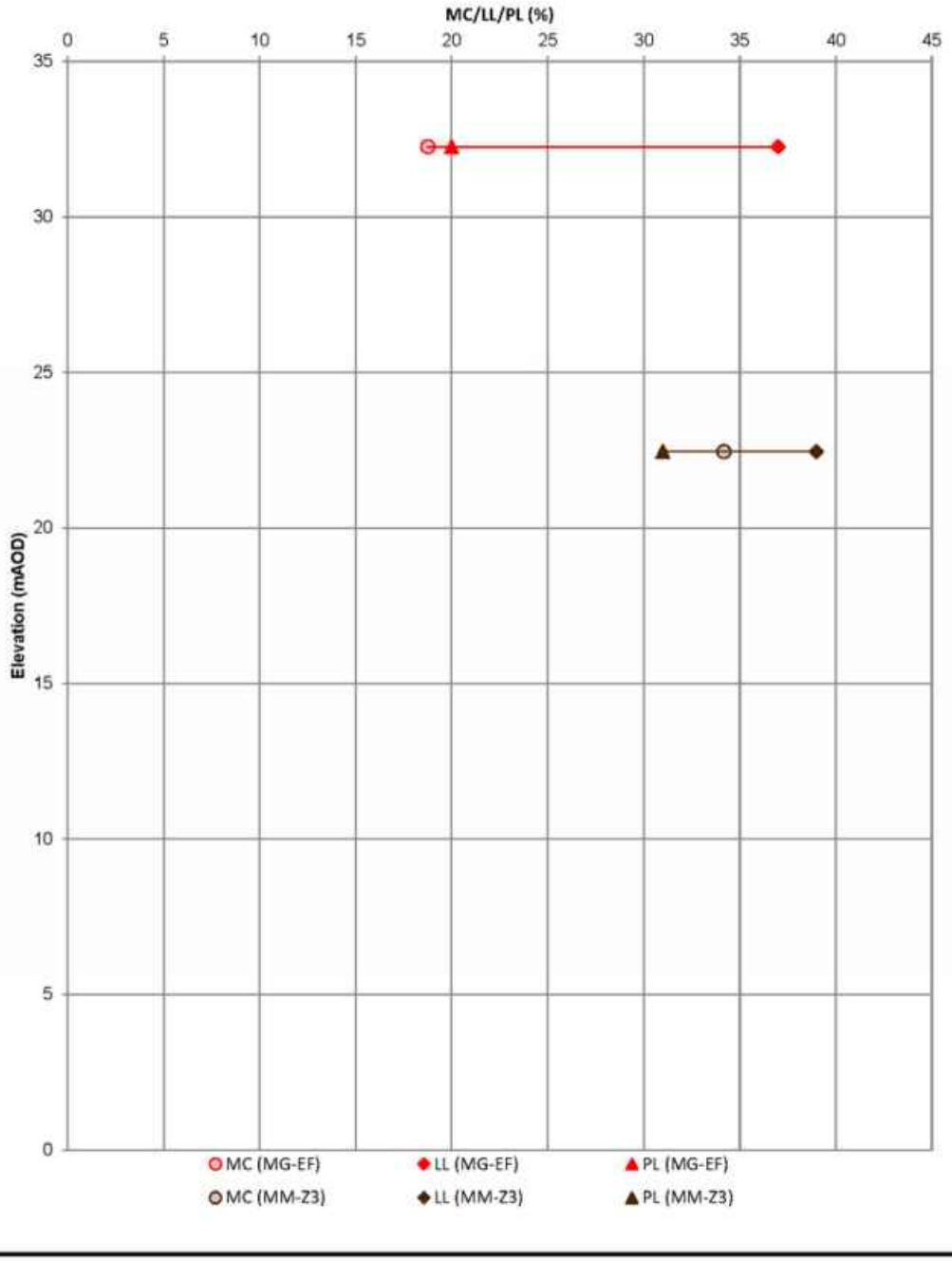
Rev: P01 Date: 05/01/2017 \549342-AMAR-HGT-GANTRY305 (187800-187830SB)-GSS-CE- Page 1 of 1

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **GANTRY305**
Client: **Highways England**	Borehole ID: **CP1097**	

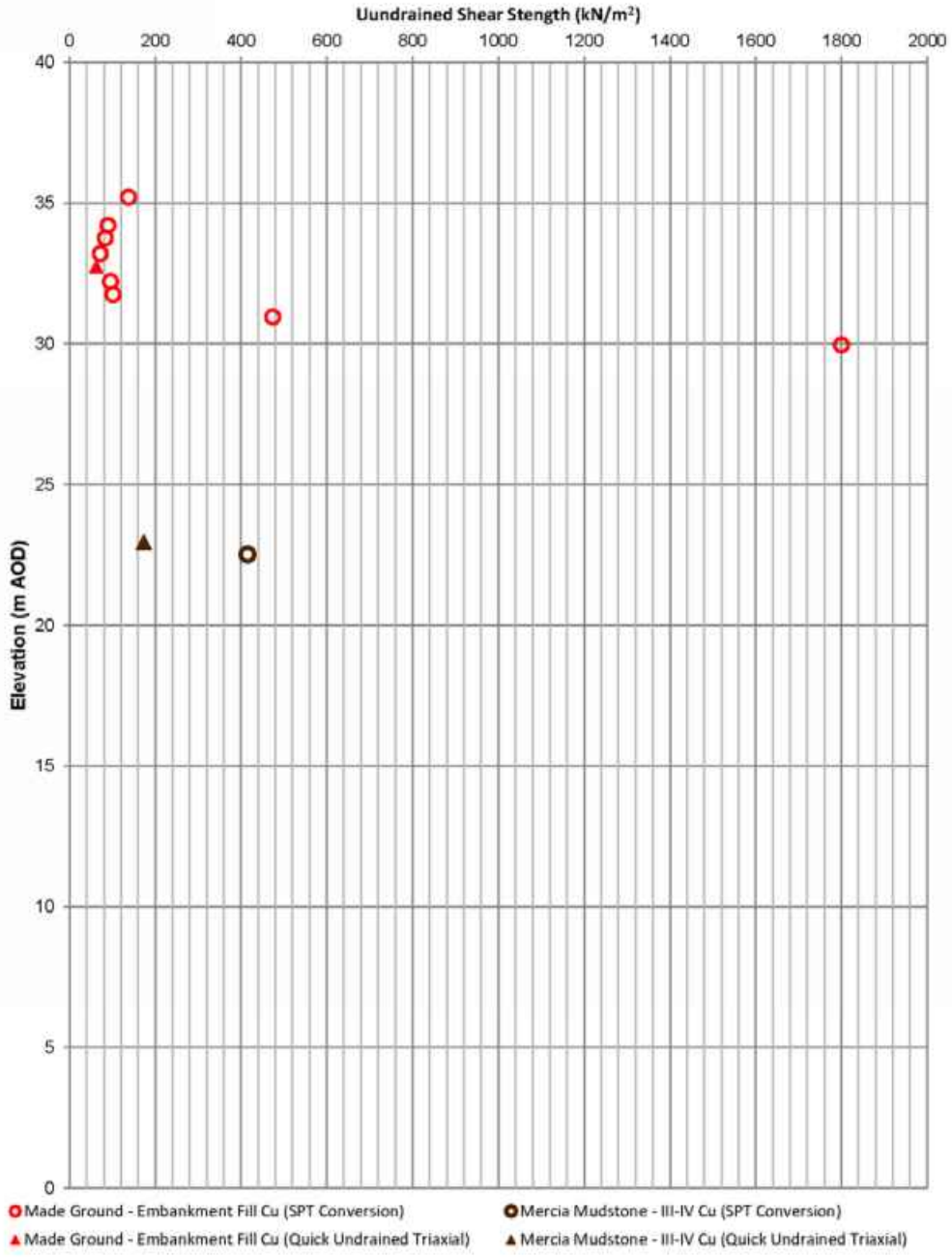


Rev: P01 Date: 05/01/2017 Ref: HA549342-AMAR-HGT-GANTRY305-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **GANTRY305**
Client: **Highways England**	Borehole ID: **CP1097, NWHM1 & NWHM69**	



Rev: P01 Date: 05/01/2017 Ref: HA549342-AMAR-HGT-GANTRY305-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-187800_187890SB-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	187910-187930		
Carriageway	Southbound		
Marker Post	MP187/9B+10 – MP187/9B+30		
National Grid Reference	E 446847, N 330192 – E 446836, N 330220		
Existing Ground Level at Location	Carriageway	35.30 mAOD	
	Toe of embankment	29.70 mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_22186	HAGDMS designation
Earthwork Height	NB: N/A	SB: 5.05	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 36°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Simon Arinze	20/01/2017	[redacted]
Checked	Alice Bazen	15/02/2017	
Reviewed	Gary Summerfield	15/02/2017	
Approved	Tom Bulteel	22/02/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this Earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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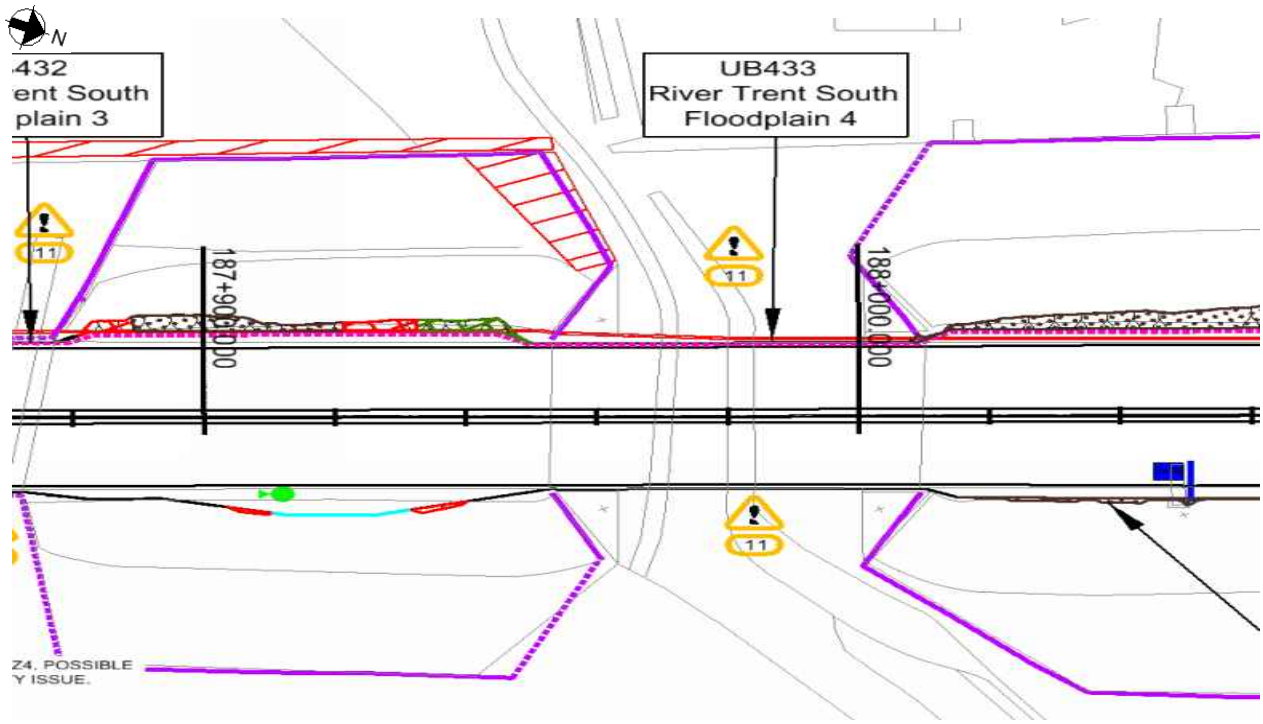


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- King Sheet Pile Retaining Wall

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment with a maximum height of 5.5m and with a typical slope angle of 36 degrees.

The critical cross section at Ch.187920 is based on the section with the greatest retained height.

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Figure 2: Topographic Critical Cross Section Chainage 187920

Utilities:

There are no known utilities in close proximity to the widening location. However the culvert (UB432) is situated approximately 30m to the south.

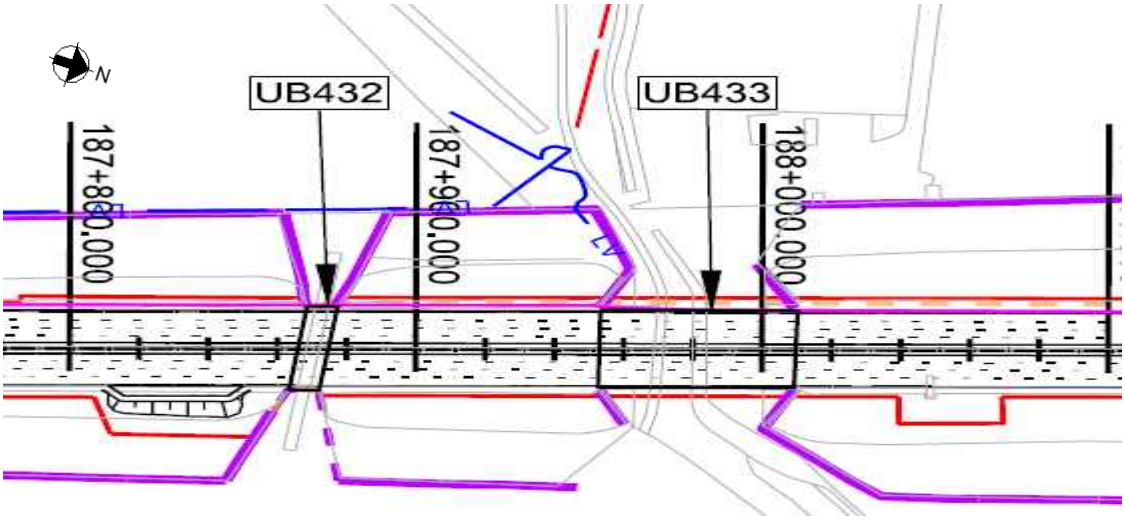


Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Heamington member (Silt & Gravel)

Solid Deposits: Edwalton Member (Mercia Mudstone Group), Mudstone

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however 2 no. relevant exploratory holes are considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000030, Rev P01.

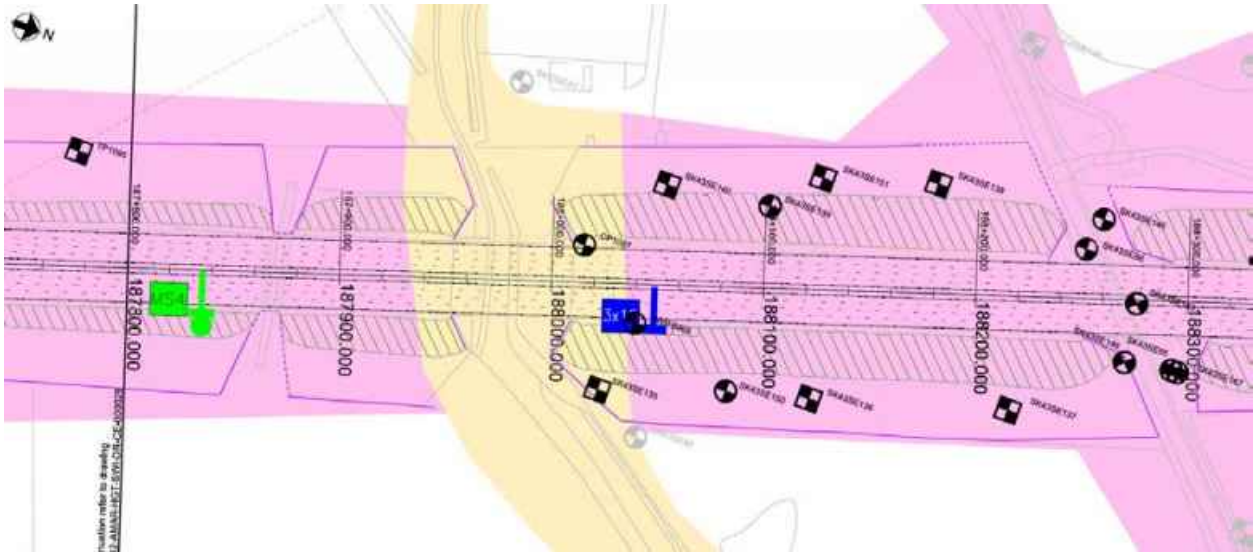


Figure 3: Borehole Location Plan

Flood Risk:

The design flood level has been recorded as 30.96mAOD. Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	CP1097
Borehole Chainage	188015
Borehole Location	Southbound
National Grid Reference	E 446777, N 330281
Ground Level at Exploratory Hole	35.95mAOD
RAG Analysis	Green
Date Drilled	19/10/2006
Termination Depth	14.22 metres below ground level (mbgl)
Other suitable holes	NWHM69

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR Survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Made Ground – Embankment Fill	6.60	29.35	12 - >150 (12)
Glaciofluvial Deposits	12.90	23.05	15 - 112
Mercia Mudstone – III/IV	<14.22	>21.73	83 - 130

(1) Ground level is assumed to be at carriageway level;
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary;
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes CP1097, NWHM69.

Groundwater:

No groundwater data is available for any of the boreholes mentioned above.

Groundwater Design Level:

No local groundwater data is available. Therefore a groundwater level of 30.96mAOD (flood level) has been assumed for WALLAP analysis of the king and intermediate sheet piles. When checking the global stability check of the earthwork and king and intermediate sheet piles (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

3 No Atterberg Limit Tests and 3 No Natural Moisture Content tests were undertaken within the Mercia Mudstone – III/IV within SK42NE6 with the following results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Made Ground – Embankment Fill	3.70	19	37	20	17	CI
Alluvium	7.20	41	58	37	21	MH
Mercia Mudstone – III/IV	13.50	34.00	39	31	8	MI

Lab Test Data - Chemical:

The chemical tests completed in the historical exploratory holes are summarised in the table below:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Sulphate (Total) as SO4	Solid	1	0.06-0.07	%SO4
Embankment Fill	Water Soluble Sulphate as SO4	Water	3	0.09-0.81	g/l SO4
Embankment Fill	pH	Solid	4	7.14-8.31	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Validation Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Made Ground – Embankment Fill	0.00-5.30	35.30-30.00	5.30	21	27	0	60	5.40	4.32	-	0.50	0.20	-	DS-2 AC-2
Glaciofluvial Deposits (Coarse Grained)	5.30-12.30	30.00-23.00	7.00	21	38	-	-	-	19.20	-	-	0.25	-	DS-3 AC-3
Mercia Mudstone – III/IV	>12.30	<23.00	-	21	30	2	50	10.80	8.60	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical borehole CP1097.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) A conservative SPT N value of 12 has been used for the Made Ground – Embankment Fill, combined with an f1 value of 5, give a C_u of 60kN/m^2.
(5) Eu for Made Ground – Embankment Fill can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 12 gives Eu = 5.4MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 4.32MN/m^2.
(6) Adhesion Factor for Made Ground – Embankment Fill is based on BS8004 (equation 41).
(7) Due to lack of near-by reliable GI data, parameters derived from the AMAR GIR have been used for the Glaciofluvial Deposits.
(8) Due to lack of near-by reliable GI data, parameters derived from the AMAR GIR have been used for the Mercia Mudstone – III/IV
(9) BRE Classification is determined using criteria set out in BRE Special Digest 1. Due to the lack of reliable of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

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Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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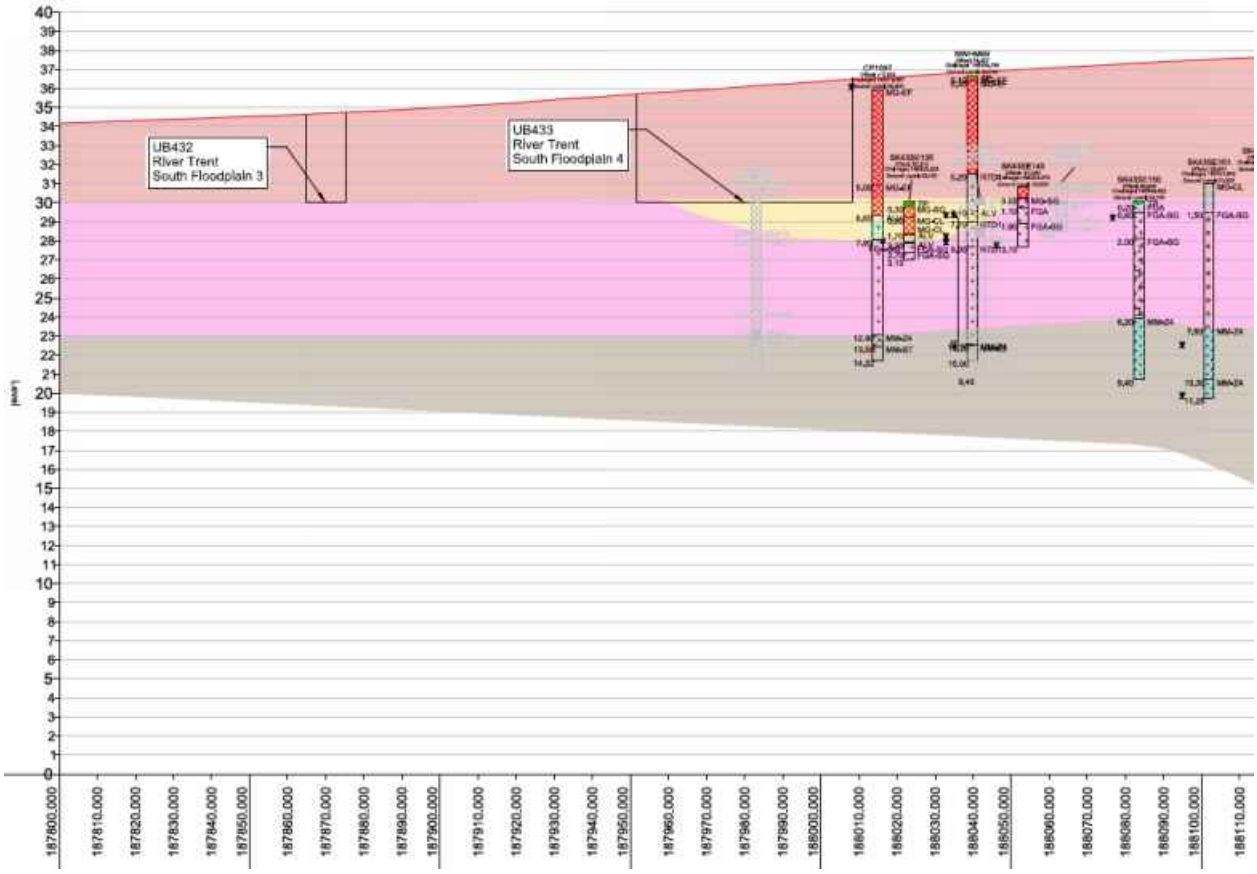


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Earthwork regrade was considered at this location, however due to a flood plain, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	King Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
187910	187930	AZ-12 S 390 GP	2.3	6.4	7.5	86	48	22.0	70.5

Intermediate sheet piles to be a pair of AZ-12 770 grade S 270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-R-FTPSB4_200y at chainage 187923, Southbound - Dynamic Sample with a Rotary Core Follow on to a scheduled depth of 13.0mbgl

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LOGS

Rotary Core Log

Borehole No. CP1097 Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446777.00 - 330281.00	Hole Type CP
Location:		Level: 35.95	Scale 1:50
Client: Highways England		Dates: 19/10/2006 - 19/10/2006	Logged By MW

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										MADE GROUND. Soft to firm red brown and green clay/silt with occasional fine to coarse angular to subangular siltstone gravel sized fragments of siltstone. MG-EF
		1.20 - 1.65	U							
		1.70	D							
		1.80	CD							
		2.20 - 2.65	D							
		2.20 - 2.70	B							
		2.80	CD							
		3.20 - 3.65	U							
		3.70	D							Below 3.70m, occasionally grey blue
		3.80	CD							
		4.20 - 4.65	D							
		4.20 - 4.70	B							
		4.80	CD							
		5.00 - 5.50	B				5.00	30.95		MADE GROUND. Dense to very dense brown sand and gravel. Sand is coarse, gravel is fine to coarse angular to subrounded of quartz and siltstone with occasional subangular to subrounded cobbles. With rare cobble sized pockets of blue grey clay. MG-EF
		5.80	CD							
		6.00 - 6.50	B							
		6.17	W							
		6.21	W							
		6.50	W							
		6.50	W				6.60	29.35		
		6.60	CD							Firm to stiff brown and blue grey locally mottled orange brown gravelly CLAY, locally clay/silt. ALV
		6.60	D							
		6.70 - 7.15	U							
		7.20	D							
		7.70 - 8.15	D							
		7.70 - 8.20	B				7.90	28.05		
		9.20 - 9.70	B							Dense brown coarse SAND and GRAVEL locally gravelly sand. Sand is mainly coarse, gravel is fine to coarse subangular to rounded of quartz, sandstone and siltstone with occasional flint. FGA-SG
										Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 6.00m.;The borehole was advanced by chiselling methods from 6.00m to 6.30m (0.75 hours) and 13.70m to 14.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

AGS

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Rotary Core Log

Borehole No. CP1097 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446777.00 - 330281.00	Hole Type CP
Location:		Level: 35.95	Scale 1:50
Client: Highways England		Dates: 19/10/2006 - 19/10/2006	Logged By MW

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.70 - 11.20	B							SAND and GRAVEL (as previous sheet) At 10.70m, sandy gravel
		12.20 - 12.70	B							
		12.90	D				12.90	23.05		Stiff to very stiff red brown locally grey green slightly sandy SILT/CLAY with occasional medium subrounded lithorelics of siltstone. With subrounded medium quartz gravel. MM-Z4
		13.00 - 13.45	U							
		13.50	D				13.50	22.45		Recovered as grey green fine and medium angular gravel size fragments of SILTSTONE with frequent laminae <1mm of gypsum. MM-ST
		13.60 - 13.88	D							
		13.60 - 14.00	B							
		14.00 - 14.21	D							
							14.22	21.73		End of borehole at 14.22 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 6.00m.;The borehole was advanced by chiselling methods from 6.00m to 6.30m (0.75 hours) and 13.70m to 14.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. NWHM69
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446803.54 - 330315.82	Hole Type CP
Location:		Level: 36.70	Scale 1:50
Client: Highways England		Dates: 20/09/1999 - 22/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.10	36.60		TOPSOIL. TP
		0.50	D				0.30	36.40		MADE GROUND: Grey medium and coarse gravel sized fragments of limestone. (Hardcore) MG-EF
		1.20	D							MADE GROUND: Very stiff (desiccated) red brown locally mottled grey slightly sandy clay with some fine to coarse gravel of mudstone. Rare sandstone noted. MG-EF
							5.20	31.50		Dense brown and red brown slightly clayey coarse SAND with much fine to coarse subangular to rounded assorted gravel of quartz, limestone and sandstone. (River Terrace Deposits) RTD1
	▼						7.10	29.60		Stiff red brown mottled blue grey slightly sandy CLAY with some fine and medium subangular gravel of sandstone and coal. (Glacial Till) ALV
							7.70	29.00		Medium dense grey silty coarse SAND and GRAVEL: Gravel content fine to coarse subangular to rounded of quartz, sandstone and limestone. (River Terrace Deposits) RTD1
	▼									
	▼						9.00	27.70		Dense yellow brown coarse SAND and GRAVEL: Gravel content fine to coarse subangular to rounded of quartz, sandstone and limestone. (River Terrace Deposits) RTD1
										Continued on next sheet

Remarks
1. M69 commenced with a hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. Borehole completed at 15.00m. Upon completiona slotted standpipe was installed to 15.00m bgl. 3. Marker Post Ref 188/1-50S.

AGS

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Rotary Core Log

Borehole No. NWHM69
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446803.54 - 330315.82	Hole Type CP
Location:		Level: 36.70	Scale 1:50
Client: Highways England		Dates: 20/09/1999 - 22/09/1999	Logged By BS

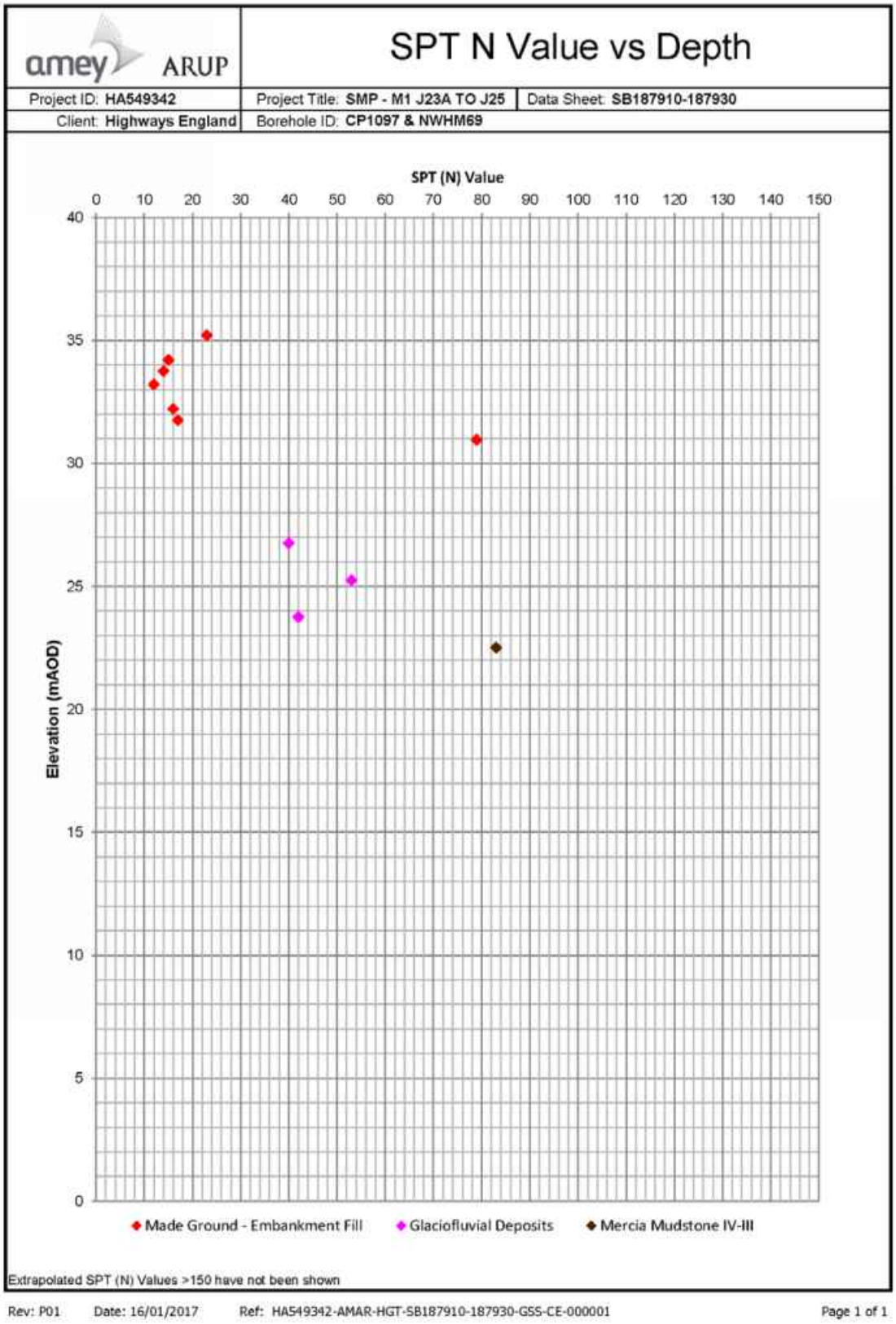
Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							14.10	22.60		Soft? red brown and grey sandy CLAY. MM-Z4
							14.20	22.50		Stiff red brown dappled blue grey slightly sandy CLAY with some to many fine and medium subangular mudstone lithorelicts. (Mercia Mudstone - Grade II/III?) MM-Z3
⑦							15.00	21.70		End of borehole at 15.00 m

Remarks
1. M69 commenced with a hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. Borehole completed at 15.00m. Upon completiona slotted standpipe was installed to 15.00m bgl. 3. Marker Post Ref 188/1-50S.

AGS

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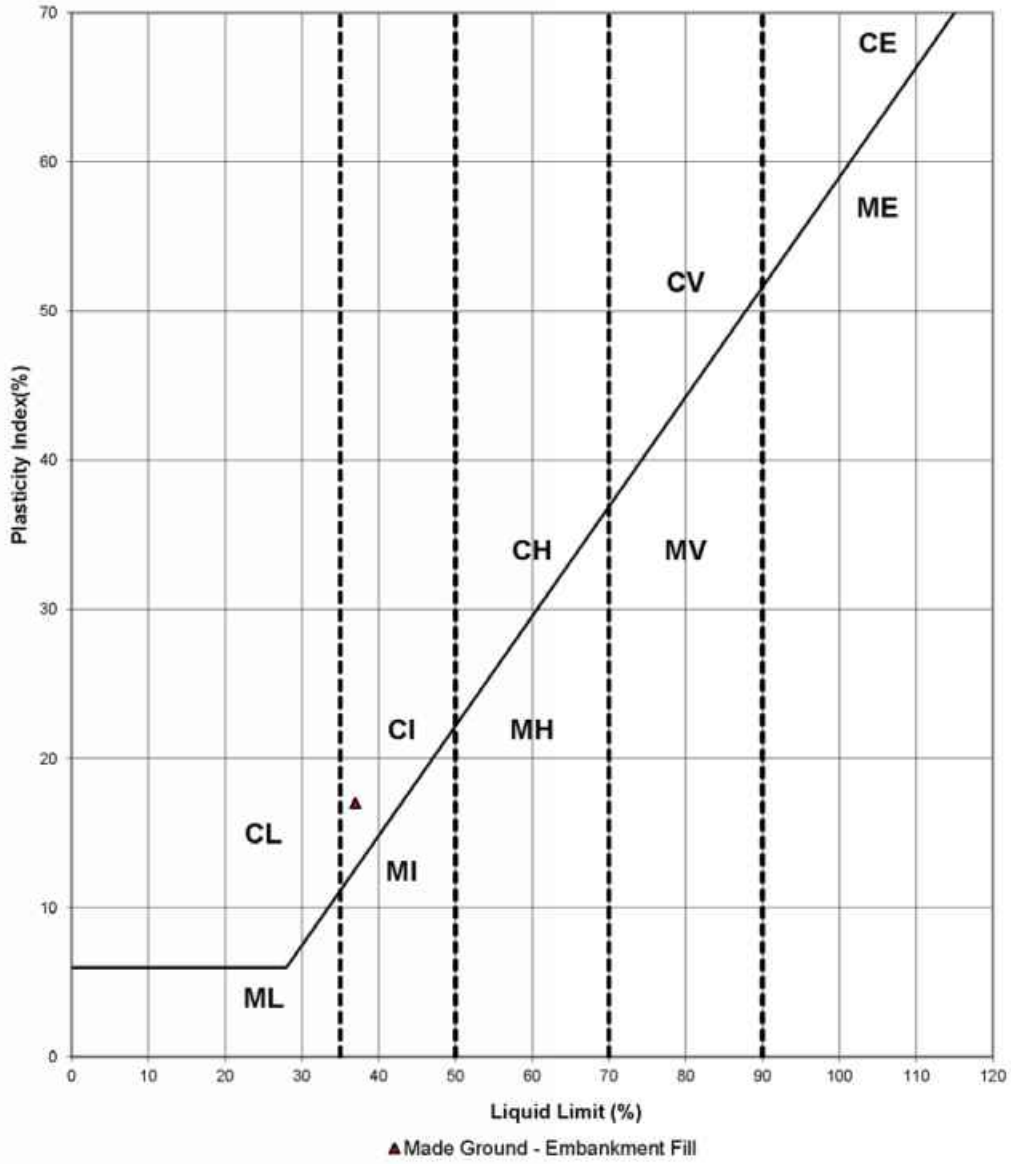
PLOTS



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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **SB187910-187930**
Client: **Highways England**	Borehole ID: **CP1097**	



Key

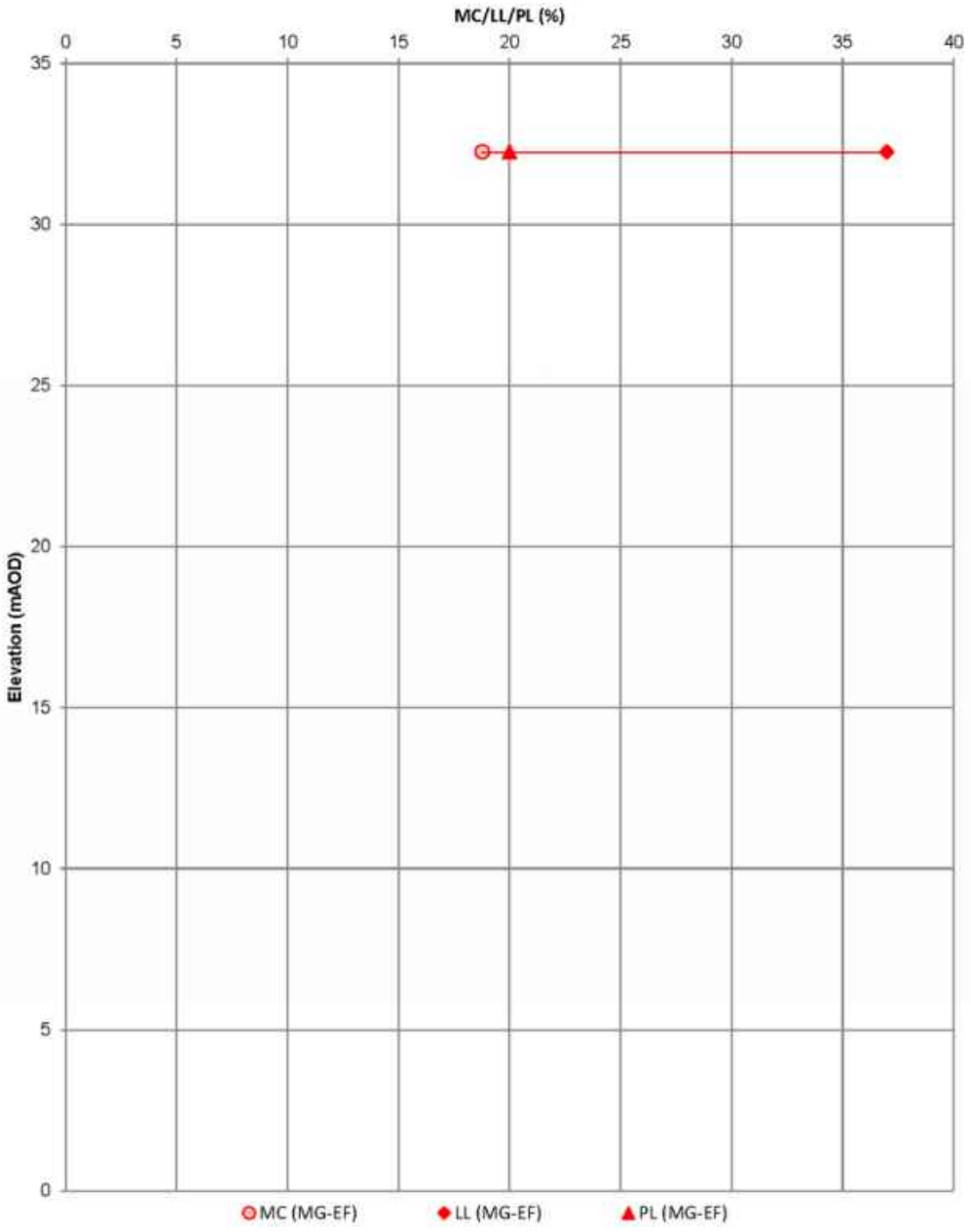
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 16/01/2017 Ref: HA549342-AMAR-HGT-SB187910-187930-GSS-CE-000001 Page 1 of 1

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **SB187910-187930**
Client: **Highways England**	Borehole ID: **CP1097**	

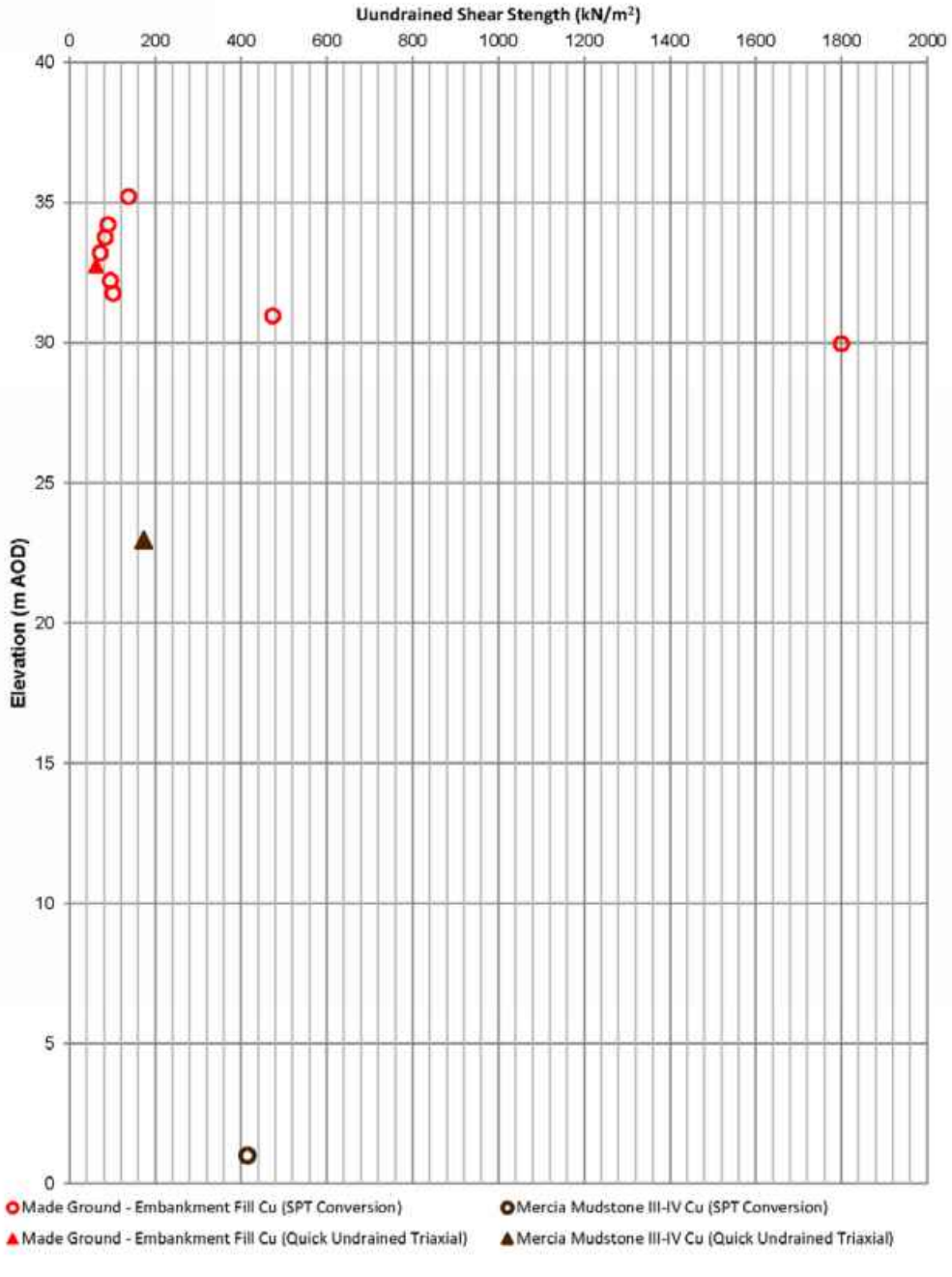


Rev: P01 Date: 16/01/2017 Ref: HA549342-AMAR-HGT-SB187910-187930-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **SB187910-187930**
Client: **Highways England**	Borehole ID: **CP1097 & NWHM69**	



Rev: P01 Date: 16/01/2017 Ref: HA549342-AMAR-HGT-SB187910-187930-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-188100_187890SB-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	188100-188130		
Carriageway	Southbound		
Marker Post	MP188/1B+00 – MP188/1B+30		
National Grid Reference	E 446788, N 330374 – E 446778, N 330401		
Existing Ground Level at Location	Carriageway	37.70 mAOD	
	Toe of embankment	30.25 mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_22191	HAGDMS designation
Earthwork Height	NB: N/A	SB: 6.90	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 23°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Simon Arinze	18/01/2017	[redacted]
Checked	Alice Bazen	15/02/2017	
Reviewed	Gary Summerfield	15/02/2017	
Approved	Tom Bulteel	22/02/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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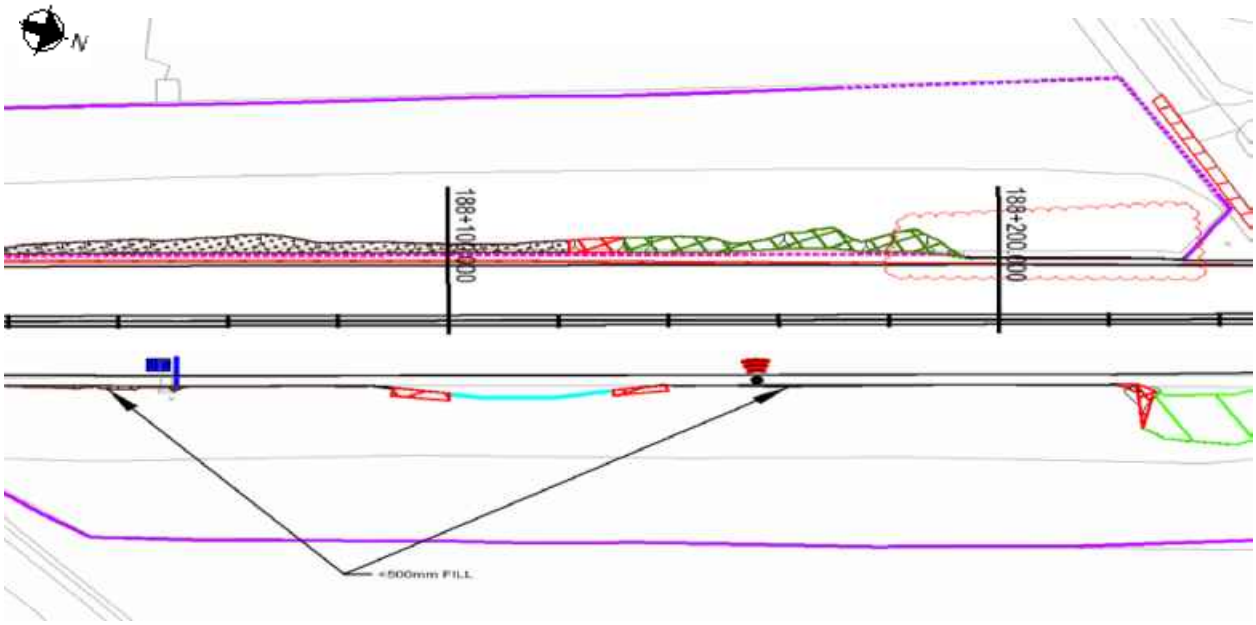


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- King Sheet Pile Retaining Wall

.

Proposed Major Structures:

N/A.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment with a maximum height of 6.9m and a typical slope angle of 23 degrees.

The critical cross section at chainage 188120 is based on the section with the greatest retained height.



Figure 2: Topographic Critical Cross Section Chainage 188120

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Hemington Member (Silt & Gravel)

Solid Deposits: Edwalton Member (Mercia Mudstone Group), Mudstone

Ground Investigation:

There are 2 No. historical exploratory holes recorded within the design chainage, with additional 1 no. relevant exploratory holes considered as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000030, Rev P01.

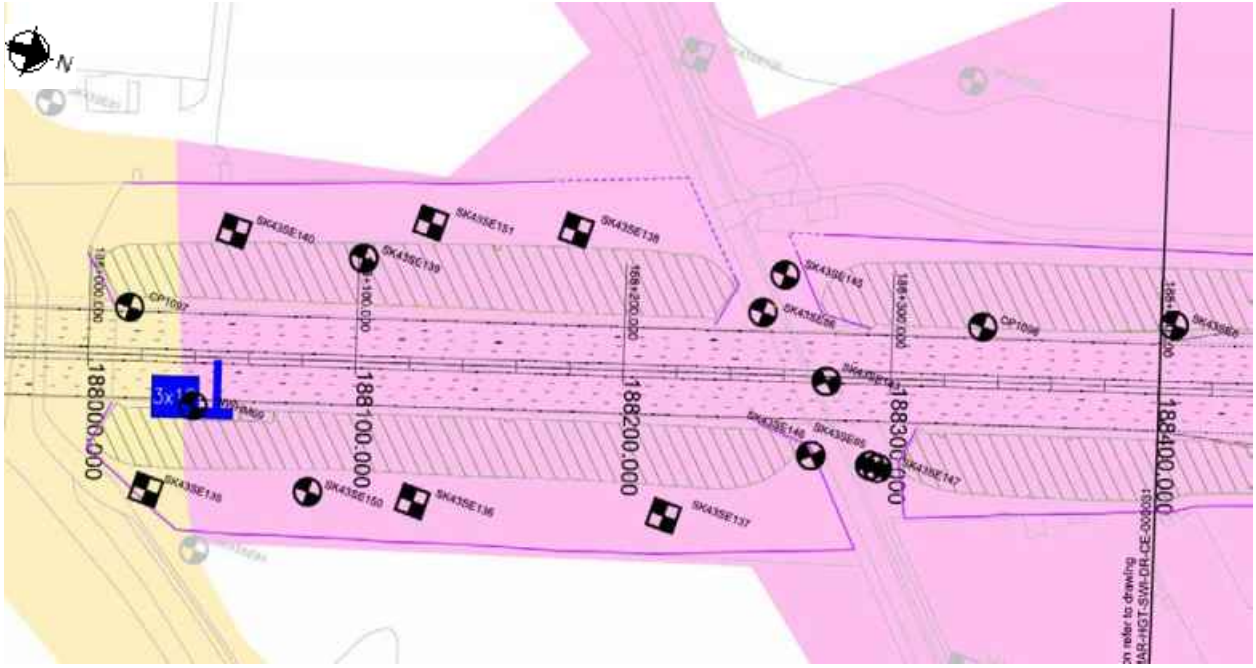


Figure 3: Borehole Location Plan

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Flood Risk:

The design flood level has been recorded as 31.00mAOD. Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Closest Borehole Number	SK43SE139
Borehole Chainage	188100
Borehole Location	Southbound
National Grid Reference	E 446709, N 330376
Ground Level at Exploratory Hole	30.90mAOD
RAG Analysis	Amber
Date Drilled	09/08/1990
Termination Depth	3.00 metres below ground level (mbgl)
Other suitable holes	NWHM69 & SK43SE150

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Made Ground – Embankment Fill	8.35	29.35	12-23
Glaciofluvial Deposits	14.67	23.05	15-71
Mercia Mudstone – III/IV	<15.97	>21.73	16->150

(1) Ground level is assumed to be at carriageway level;
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary;
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes SK43SE150, NWHM69.

Groundwater:

No groundwater data is available for any of the boreholes mentioned above.

Groundwater Design Level:

No local groundwater data is available. Therefore a groundwater level of 31.00mAOD (flood level) has been assumed for WALLAP analysis of the sheet pile. When checking the global stability check of the earthwork and king and intermediate sheet pile (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

No geotechnical lab testing data is available for this area.

Lab Test Data - Chemical:

1No pH test was undertaken within the Made Ground in borehole NWHM69 with the following result.

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	pH	Solid	1	8.40	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that the embankment is constructed of cohesive fill. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γ_b (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Made Ground – Embankment Fill	0.00-7.30	37.70-30.40	5.30	21	27	0	60	5.40	4.32	-	0.50	0.20	-	DS-2 AC-2
Glaciofluvial Deposits (Coarse Grained)	7.30-14.20	30.40-23.50	7.00	21	38	-	-	-	19.20	-	-	0.25	-	DS-3 AC-3
Mercia Mudstone – III/IV	>14.20	<23.50	-	21	30	2	50	10.80	8.60	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical borehole CP1097.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) A conservative SPT N value of 12 has been used for the Made Ground – Embankment Fill, combined with an f1 value of 5.
(5) Eu for Made Ground – Embankment Fill can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 12 gives Eu = 5.4MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 4.32MN/m^2.
(6) Adhesion Factor for Made Ground – Embankment Fill is based on BS8004 (equation 41).
(7) Due to lack of near-by reliable GI data, parameters derived from the AMAR GIR have been used for the Glaciofluvial Deposits.
(8) Due to lack of near-by reliable GI data, parameters derived from the AMAR GIR have been used for the Mercia Mudstone – III/IV
(9) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

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:

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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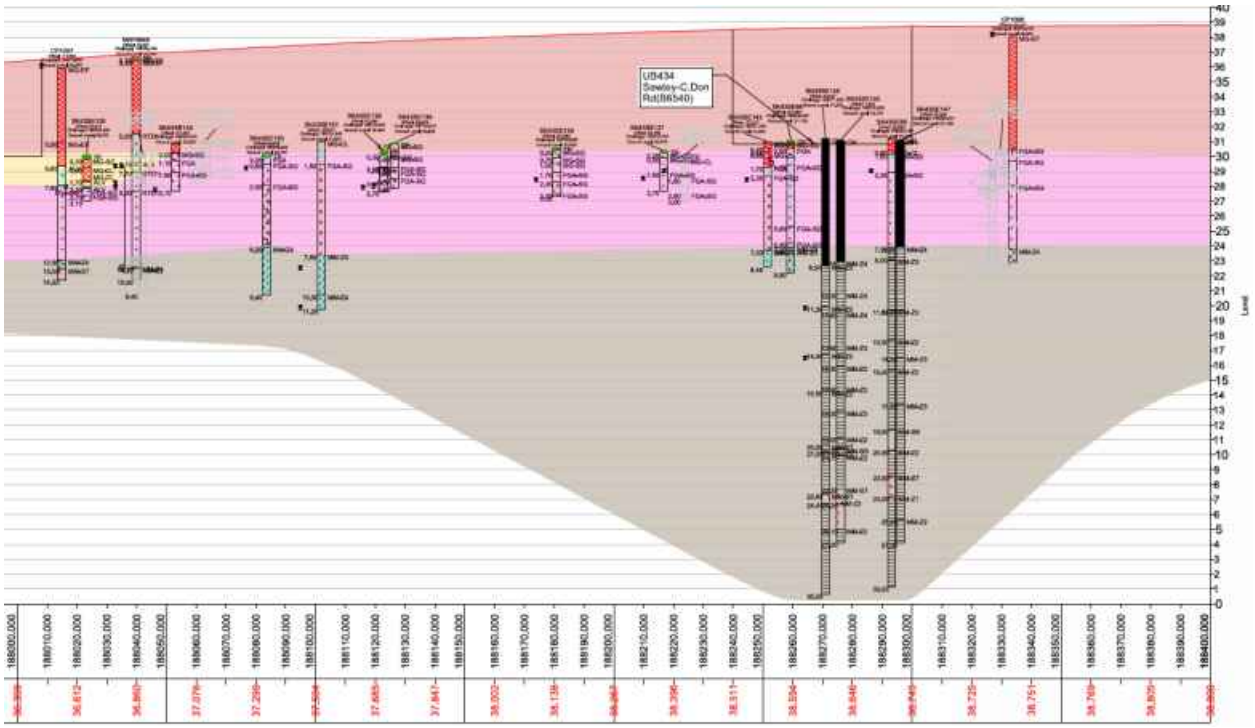


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to the flood plain, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
188100	188130	AZ-12 S 390 GP	1.4	5.6	7.0	84	53	13.0	24.4

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

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FURTHER GROUND INVESTIGATION

No further ground investigation is proposed at this location.

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LOGS

amey

Rotary Core Log

Borehole No. **NWHM69** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446803.54 - 330315.82	Hole Type CP
Location:		Level: 36.70	Scale 1:50
Client: Highways England		Dates: 20/09/1999 - 22/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.10	36.60		TOPSOIL. TP
		0.50	D				0.30	36.40		MADE GROUND: Grey medium and coarse gravel sized fragments of limestone. (Hardcore) MG-EF
		1.20	D							MADE GROUND: Very stiff (desiccated) red brown locally mottled grey slightly sandy clay with some fine to coarse gravel of mudstone. Rare sandstone noted. MG-EF
							5.20	31.50		Dense brown and red brown slightly clayey coarse SAND with much fine to coarse subangular to rounded assorted gravel of quartz, limestone and sandstone. (River Terrace Deposits) RTD1
	▼						7.10	29.60		Stiff red brown mottled blue grey slightly sandy CLAY with some fine and medium subangular gravel of sandstone and coal. (Glacial Till) ALV
							7.70	29.00		Medium dense grey silty coarse SAND and GRAVEL: Gravel content fine to coarse subangular to rounded of quartz, sandstone and limestone. (River Terrace Deposits) RTD1
	▼									
	▼									
							9.00	27.70		Dense yellow brown coarse SAND and GRAVEL: Gravel content fine to coarse subangular to rounded of quartz, sandstone and limestone. (River Terrace Deposits) RTD1
										Continued on next sheet

Remarks
1. M69 commenced with a hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. Borehole completed at 15.00m. Upon completiona slotted standpipe was installed to 15.00m bgl. 3. Marker Post Ref 188/1-50S.

AGS

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Rotary Core Log

Borehole No. NWHM69
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446803.54 - 330315.82	Hole Type CP
Location:		Level: 36.70	Scale 1:50
Client: Highways England		Dates: 20/09/1999 - 22/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							14.10	22.60		Soft? red brown and grey sandy CLAY. MM-Z4
							14.20	22.50		Stiff red brown dappled blue grey slightly sandy CLAY with some to many fine and medium subangular mudstone lithorelicts. (Mercia Mudstone - Grade II/III?) MM-Z3
⑦							15.00	21.70		End of borehole at 15.00 m

Remarks
1. M69 commenced with a hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. Borehole completed at 15.00m. Upon completiona slotted standpipe was installed to 15.00m bgl. 3. Marker Post Ref 188/1-50S.

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Trial Pit Log

Trialpit No: SK43SE139
Sheet 1 of 1

Project Name:	SMP - M1 J23A TO J25	Project No.: COCDFL1SMP01	Co-ords: 446709.00 - 330376.00
Location:			Level: 30.90
Client:	Highways England		Dimensions (m): Depth 3.00, 1.1, 3.5
Date:	09/08/1990		
Scale:	1:25		
Logged:			

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
				0.10	30.80		TOPSOIL TP
	0.35 0.35	B J					Dense reddish brown silty fine to coarse SAND with some angular to subrounded gravel and cobbles of concrete, quartzite and limestone and with occasional pieces of metal. (MADE GROUND) MG-SG
							concrete
							layer of broken bricks
				0.95	29.95		Dense brown fine to coarse SAND with angular to subrounded fine to coarse gravel of concrete and brick and occasional black organic remains (MAKE GROUND) MG-SG
	1.50 1.50	B J					
				1.60	29.30		Loose brown mottled yellow brown fine to coarse SAND (FLUVIAL DEPOSITS) FGA-SG
				1.80	29.10		Dense reddish brown mottled yellow sandy subangular to subrounded fine to coarse GRAVEL of predominantly quartzite with occasional cobbles (FLUVIAL DEPOSITS) FGA-SG
				1.90	29.00		Dense yellow brown very sandy subangular to subrounded fine to coarse GRAVEL of predominantly quartzite with occasional cobbles. (FLUVIAL DEPOSITS) FGA-SG
				2.40	28.50		Dense yellow brown fine to coarse SAND with much subangular to subrounded fine to coarse gravel and occasional cobbles. Below 2.70m, light brown with decreasing sand content. (FLUVIAL DEPOSITS) FGA-SG
▼				3.00	27.90		End of pit at 3.00 m

Remarks:

Stability:

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Rotary Core Log

Borehole No. SK43SE150
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446819.00 - 330367.00	Hole Type CP
Location:		Level: 30.10	Scale 1:50
Client: Highways England		Dates: 09/08/1990 - 10/08/1990	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.80	B				0.20	29.90		TOPSOIL TP
		0.50 - 0.95	J				0.60	29.50		Firm to stiff brown and grey mottled orange CLAY with occasional rootlets and dark silt nodules. (ALLUVIUM) FGA
	▼	0.95	B							Medium dense orangish brown very silty fine to coarse SAND with occasional subangular to subrounded fine to coarse gravel (FLUVIAL DEPOSITS) FGA-SG
		1.50 - 1.95	J							
		1.95	B				2.00	28.10		Medium dense brown slightly sandy subrounded to rounded fine to coarse GRAVEL of predominantly quartzite with occasional subrounded cobbles (FLUVIAL DEPOSITS) FGA-SG
		2.60 - 3.05 2.61	B K							
		3.60 - 4.05	B							
		4.60 - 5.05	B							
		5.60 - 6.05	B							with much sand
							6.20	23.90		Firm reddish brown slightly sandy CLAY with occasional angular up to fine gravel sized mudstone lithorelicts, occasional grey green alteration spots and extremely closely spaced sub-horizontal gypsum veins (up to 1mm). (MERCIA MUDSTONE GROUP) MM-Z4
		6.60 - 6.96	J							
		6.95	B							
		7.60 - 8.05	J							
		8.06	B							
		8.60 - 8.81	J							
		8.90	B							
		9.10 - 9.37	J							
							9.40	20.70		End of borehole at 9.40 m

Remarks
Permeability test carried out at 2.60m

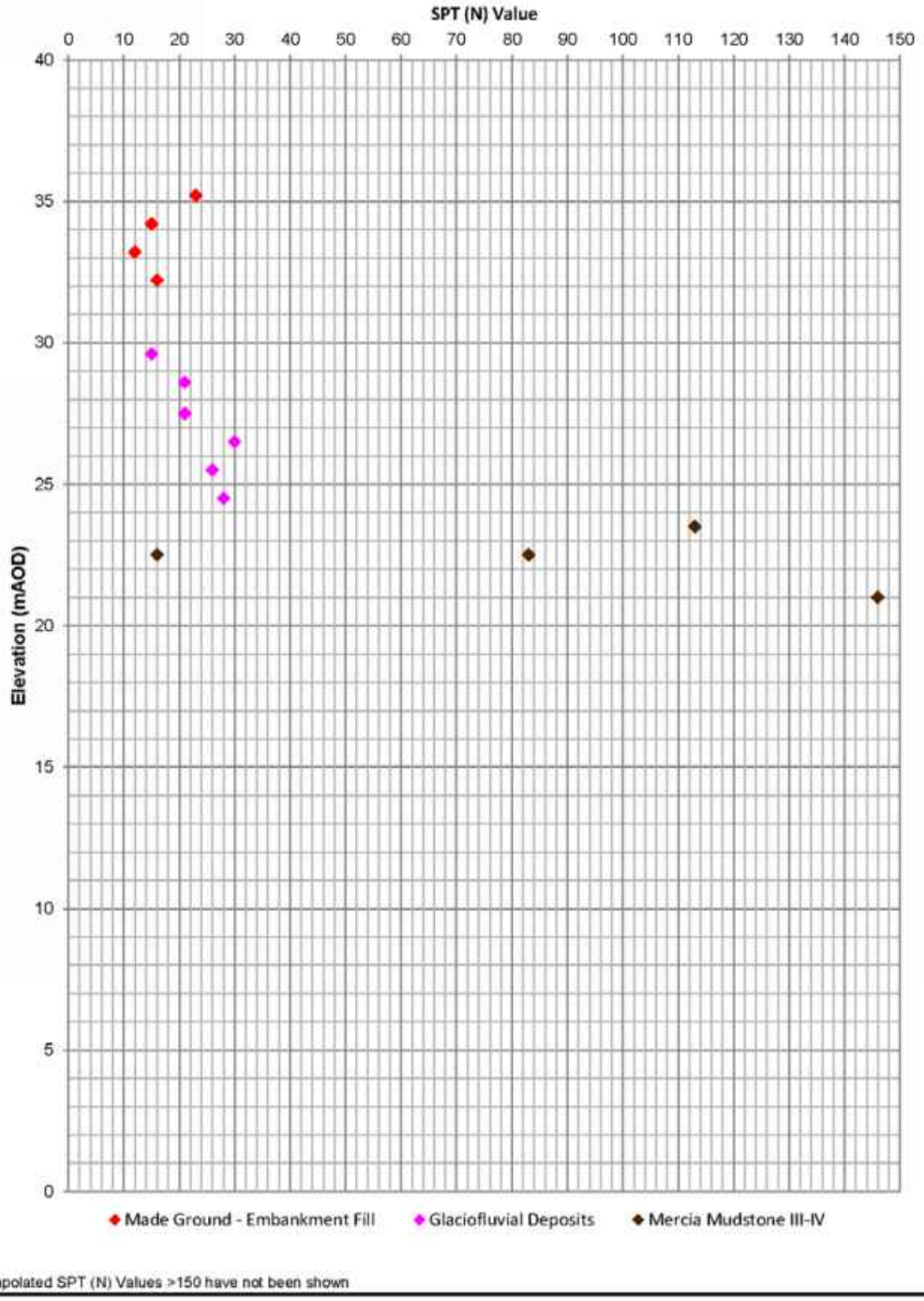
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PLOTS

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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **SB188100-188130**
Client: **Highways England**	Borehole ID: **NWHM69 & SK43SE150**	



Extrapolated SPT (N) Values >150 have not been shown

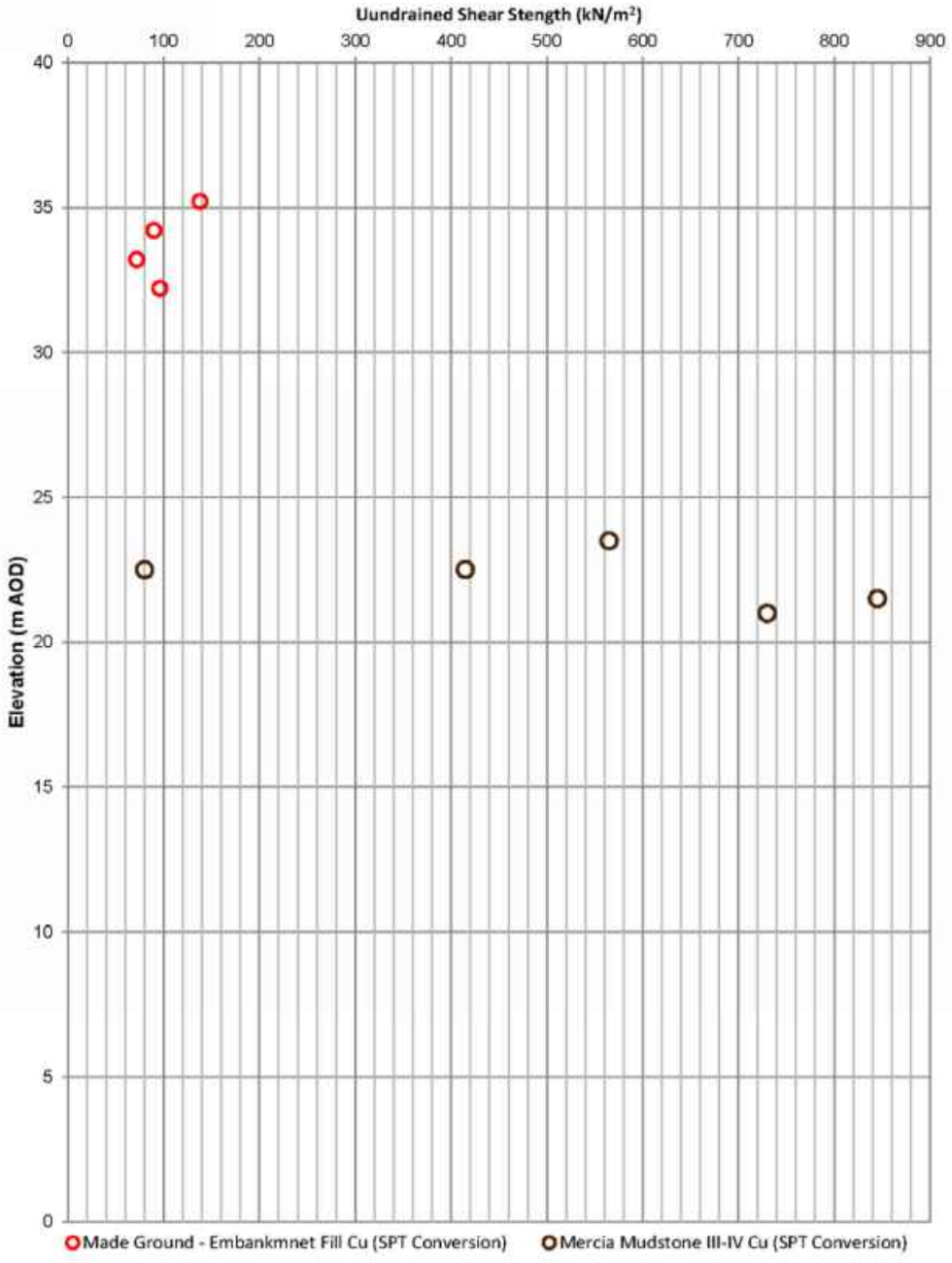
Rev: P01 Date: 17/01/2017 Ref: HA549342-AMAR-HGT-SB188100-188130-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **SB188100-188130**
Client: **Highways England**	Borehole ID: **NWHM69 & SK43SE150**	



Rev: P01 Date: 17/01/2017 Ref: HA549342-AMAR-HGT-SB188100-188130-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-188230-188400SB-GSS-000001		
Earthwork Widening Solution	Full Height Embankment Widening 1:2.0 & Granular Wedge at Embankment Crest 1:2.0		
Structure	N/A		
Structure Chainage	N/A		
Design Chainage	188230-188400		
Carriageway	Southbound		
Marker Post	MP188/2B+30 – MP188/4B+00		
National Grid Reference	E 447674, N 330500 – E 446689, N 330658		
Existing Ground Level at Location	Carriageway	38.6mAOD	
	Toe of Embankment	31.2mAOD	
Earthwork Type	NB: N/A	SB: Cutting	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_22191 & 7_M1_21871	HAGDMS designation
Earthwork Height	NB: N/A	SB: 7.4m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 27°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	09/02/2017	[redacted]
Checked	Alice Bazen	15/02/2017	
Reviewed	Gary Summerfield	16/02/2017	
Approved	Tom Bulteel	23/02/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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DESK STUDY

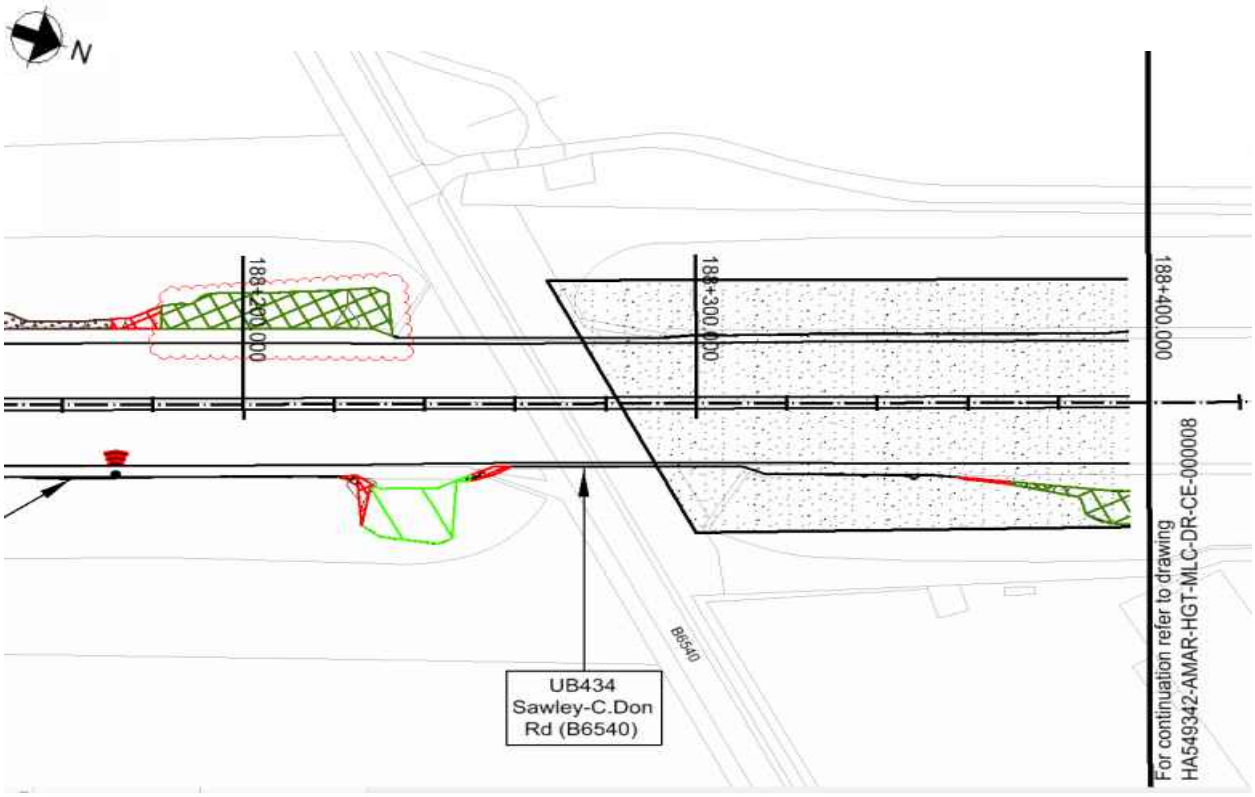


Figure 1: Location Plan

Proposed Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- 188230-188250 – Full Height Embankment Widneing 1:2.0
- 188380-188400 – Granular Wedge at Embankment Crest 1:2.0

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment ranging in height from 6.5m to 7.4m with a typical slope angle of 26-27 degrees.

Two critical sections were used to complete design for the widening solutions proposed above. The critical cross section with the greatest earthwork height is used at Ch188840 for the full height widening and Ch188400 for the Granular Wedge at Embankment Crest (1:2.0).

188230-188250 – Full Height Embankment Widening 1:2.0

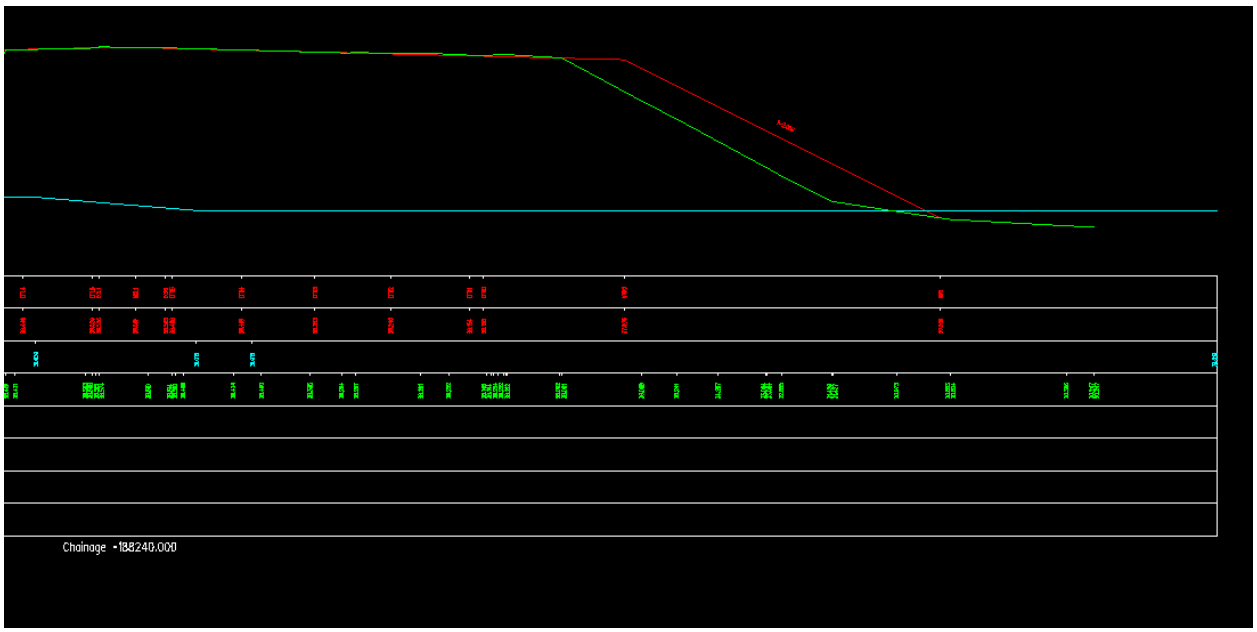


Figure 2.1: Topographic Critical Cross Section Chainage 188840

188380-188400 – Granular Wedge at Embankment Crest 1:2.0

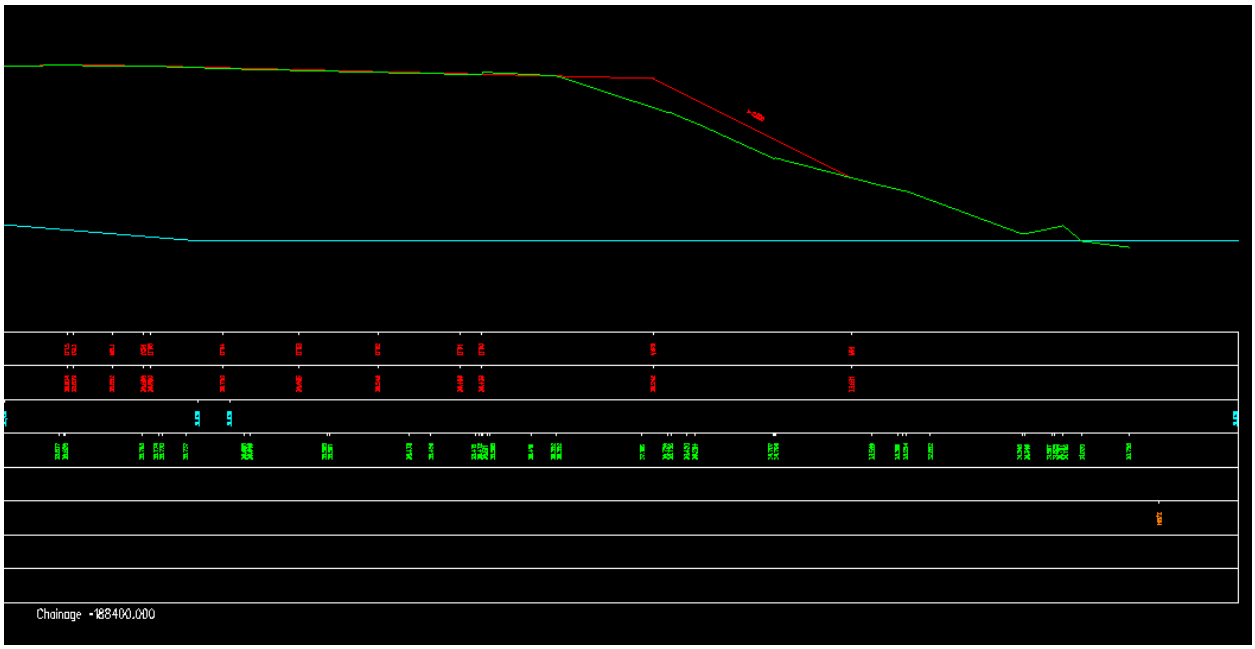


Figure 2.2: Topographic Critical Cross Section Chainage 188400

Utilities:

Western Power High Voltage and Low Voltage cables located at the underbridge UB434. See Figure 3 for details:

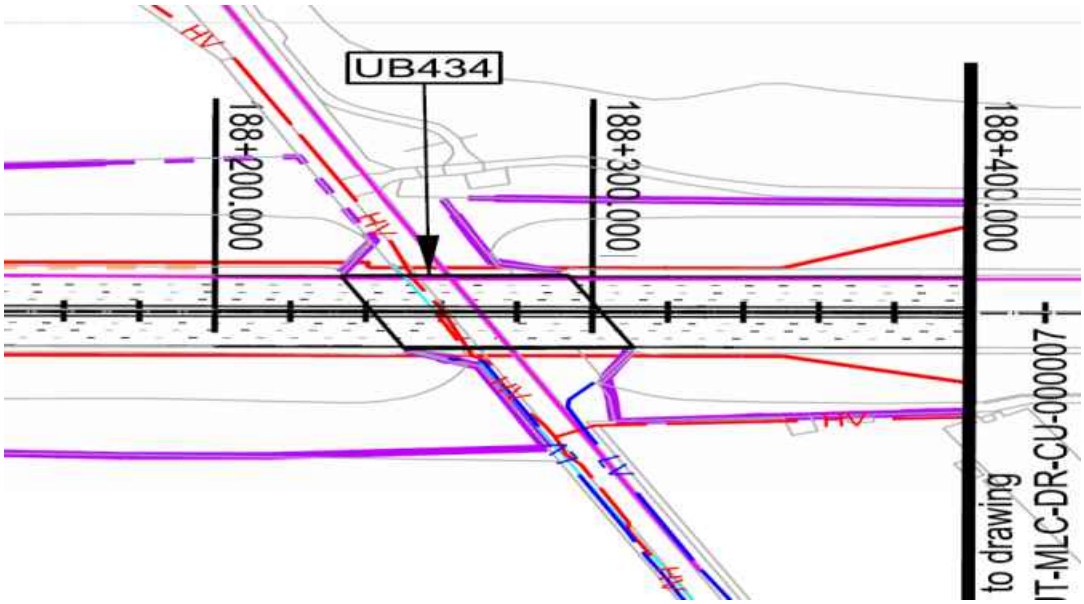


Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Hemington Member - Silt And Gravel

Solid Deposits: Edwalton Member – Mudstone

Ground Investigation:

There are 7 No. historical exploratory holes recorded within the design chainage, with additional 3 no. relevant exploratory holes considered outside the design chainage, as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000030, Rev P01.

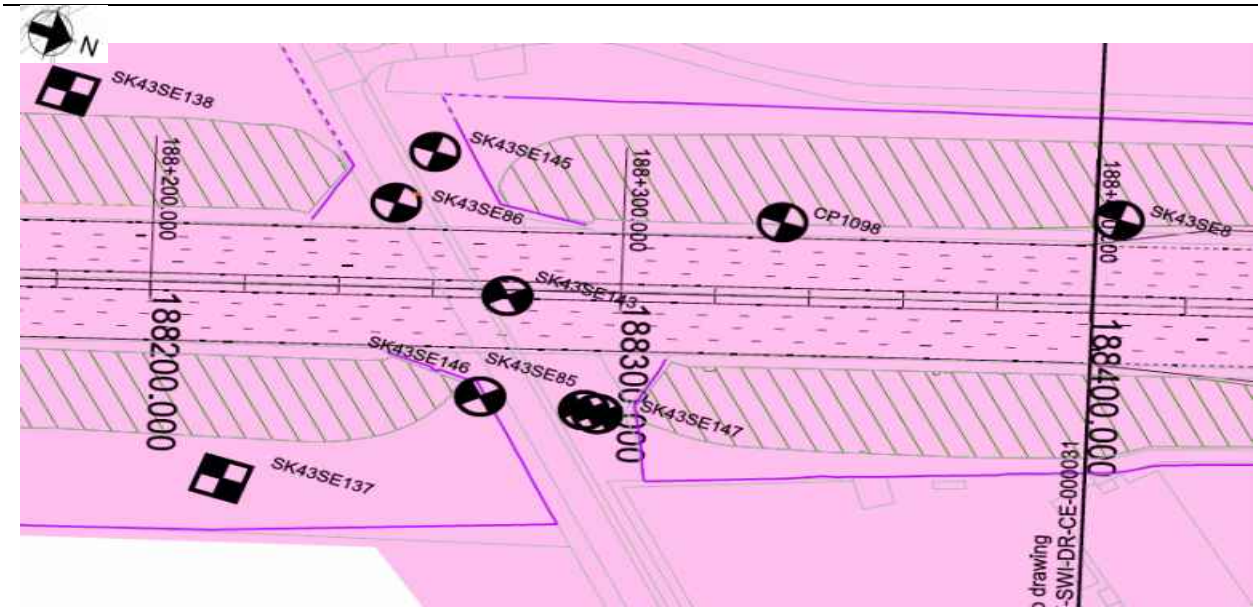


Figure 4: Borehole Location Plan

Flood Risk:

The earthworks are located within a flood risk zone. The flood risk levels are presented below:

- 188230-188250 – Flood Level is 31.01mAOD
- 188380-188400 - Flood Level is 31.04mAOD

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04

Historical Boreholes:

Relevant Borehole Number	SK43SE143	SK43SE85	CP1098
Borehole Chainage	188251	188293	188334
Borehole Location	Southbound	Southbound	Northbound
National Grid Reference	E 446698, N 330504	E 446738, N 330561	E 447675, N 330583
RAG Analysis	Green	Amber	Green
Ground Level at Exploratory Hole	31.00mAOD	31.19mAOD	38.05mAOD
Date Drilled	09/09/1990 – 10/09/1990	21/04/1988 – 28/04/1988	20/10/2006 – 23/10/2006
Termination Depth	8.45 metres below ground level (mbgl)	30.05 metres below ground level (mbgl)	15.19 metres below ground level (mbgl)
Other suitable holes	SK43SE8, SK43SE86, SK43SE137, SK43SE138 SK43SE145, SK43SE146 and SK43SE147		

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Embankment Fill	8.10	30.50	19-41 (19)
Glaciofluvial Deposits (coarse grained)	14.60	24.00	7-130 (28)
Mercia Mudstone – III-IV	>14.60	<24.0	94->150(94)

(1) Ground level is assumed to be at the carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Mercia Mudstone-I/II was encountered in the borehole logs, however given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model for a conservative design.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken in exploratory holes CP1098, SK43SE143, SK43SE8, SK43SE85, SK43SE145, SK43SE146, SK43SE147 and SK43SE86

Groundwater:

Groundwater strike are presented in the table below:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
SK43SE85	Glaciofluvial Deposits	2.10	29.09	-	-	-
SK43SE143	Glaciofluvial Deposits	2.20	28.80	-	-	-
SK43SE8	Glaciofluvial Deposits	1.37	29.23	-	0.15	30.45
SK43SE86	Glaciofluvial Deposits	1.70	29.40	-	1.40	29.70
SK43SE137	Glaciofluvial Deposits	2.00	28.40	-	-	-
SK43SE138	Glaciofluvial Deposits	2.30	28.3	-	-	-
SK43SE146	Mercia Mudstone	11.50	19.70	-	-	-
SK43SE146	Mercia Mudstone	14.85	16.35			

Groundwater Design Level:

A design groundwater level at the Flood Risk Level has been assumed within the embankment as presented below, with the piezometric line drawing down to ground level at the toe of the embankment.

- 188230-188250 – Flood Level is 31.01mAOD
- 188380-188400 - Flood Level is 31.04mAOD

GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

5 No Atterberg limit tests, 5 No. Moisture Content Tests and 1 quick undrained triaxial test was completed, with the results presented in the table below:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	3.70	14	26	12	14	CL
Embankment Fill	5.70	12	27	10	17	CL
Embankment Fill	7.50	15	28	14	14	CL
Glaciofluvial Deposits	8.80	18	21	16	5	ML
Mercia Mudstone	150	24	37	36	11	ML

1 No. quick undrained triaxial test was completed within the Embankment Fill with the following results:

Stratum	Depth to Top of Test (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	3.20	73.0

Lab Test Data - BRE Classification:

No chemical laboratory testing data is available between 188230 and 188400.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	00.00-8.10	38.60-30.50	8.10	21	27	0	100	7.5	6.0	-	0.5	0.2	-	DS-2 AC-2
Glaciofluvial Deposits (coarse grained)	8.10-14.60	30.50-24.00	6.50	21	35	-	-	-	40.8	-	-	0.25	-	DS-3 AC-3
Mercia Mudstone III/IV >10.0mbgl	>14.60	<24.00	6.5	21	30	2	200	30	24	-	0.5	0.2	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from the interpreted geological long section.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion, and Poisson's ratio derived in the AMAR GIR are used.
(4) ϕ' of Embankment Fill was based on PI value from Table 2 (BS8002:2015). For an average PI value of 14, ϕ' is 27^0.
(5) C_u of Embankment Fill was derived using the Stroud correlation. A typical PI of 14% gives an f1 value of 7.0, combined with a typical SPT 'N' value of 19, this gives a typical c_u of 133kN/m^2. The c_u values from triaxial test was 73.2kN/m^2. A typical c_u value of 100kN/m^2 was considered suitable as a conservative measure due to the lack of other sets of data.
(6) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using typical SPT 'N' value of 19, Eu = 7.5MN/m^2. Therefore E' = .6MN/m^2.
(7) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using correlation with SPT 'N' values (Peck 1974). Using a typical 'N' value of 28 gives an angle of 35°.
(8) E' of Glaciofluvial Deposits (coarse grained) was determined using Bowles correlation E' = 1200 (N + 6) which (using typical 'N' value of 28) gives a value of 40.8MN/m^2.
(9) cu of Mercia Mudstone – III/IV was derived using the Stroud correlation. In the absence of sufficient PI data, the typical f1 value of 5.0 for Mercia Mudstone (CIRIA C570) was adopted; combined with a typical SPT 'N' value of

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94, this gives a cu of 470kN/m^2. This value exceeds the range given in the AMAR GIR; therefore the upper bound of the range was adopted.

(10) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using typical SPT 'N' value of 94, Eu = 30.0MN/m^2. Therefore E' = 24MN/m^2.

(11) Geotechnical parameters for the Mercia Mudstone I/II is based on values derived in the AMAR GIR.

(12) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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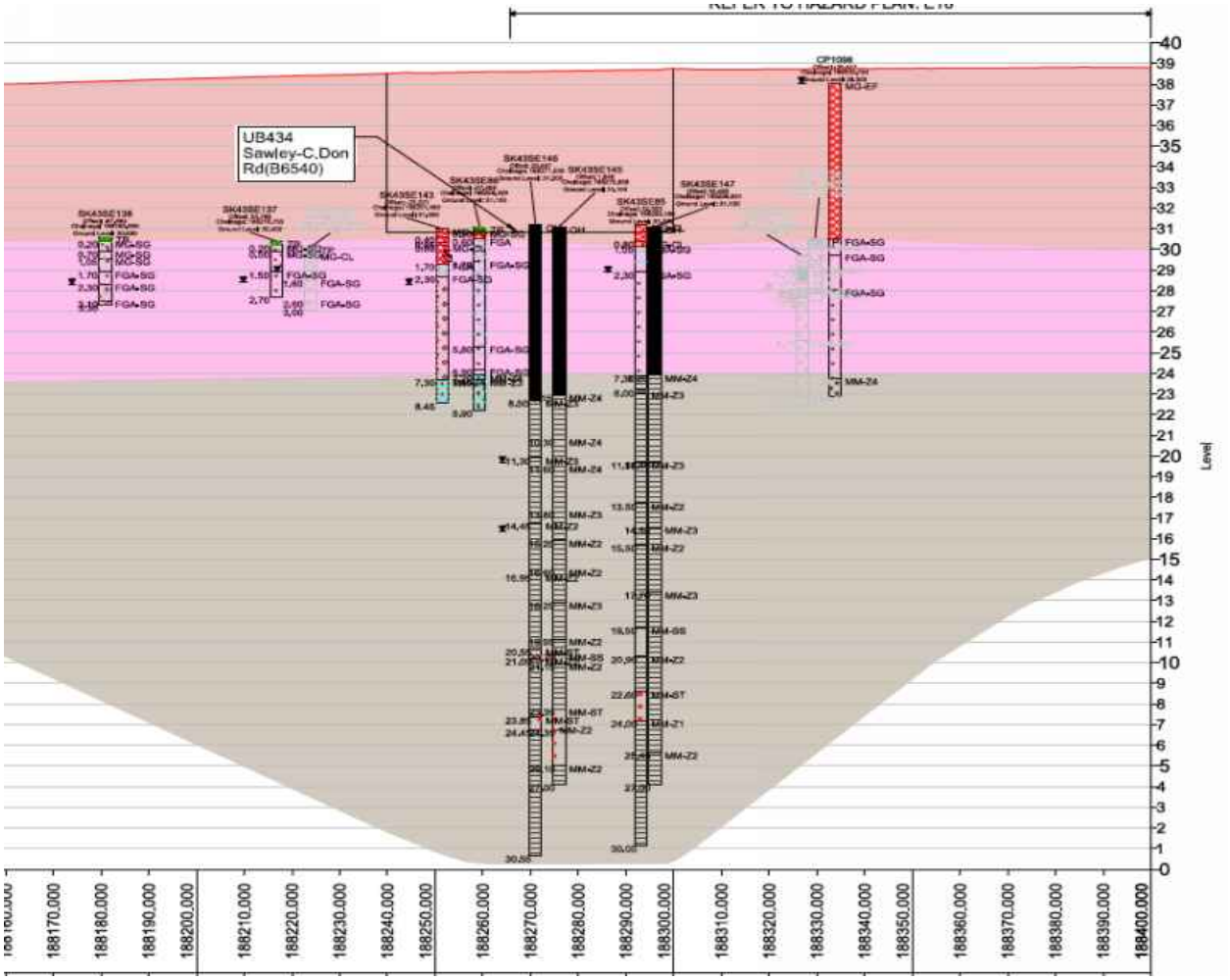


Figure 5 : Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
188230	188250	Full Height Embankment Widening (1:2.0)	6.2	26.6 (1V:2H)
188380	188400	Granular Wedge at Embankment Crest (1:2.0)	4.0	26.6 (1V:2H)

Proposed Structural Solution:

N/A

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FURTHER GROUND INVESTIGATION

No further ground investigation has been proposed at this location.

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HISTORICAL EXPLORATORY HOLES

Borehole Log

Borehole No. **CP1098** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446675.00 - 330583.00	Hole Type CP
Location:		Level: 38.05mbgl	Scale 1:50
Client: Highways England		Dates: 20/10/2006 - 23/10/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									MADE GROUND: Grass over firm becoming very stiff brown locally pale yellow green sandy gravelly silt/clay. Gravel is subangular fine and medium of sandstone and cobbles of sandstone. MG-EF
		1.20 - 1.65	2U	14blows					
		1.70	3D						
		2.20	SPT (S)	N=19 (4,5/5,4,5,5)	Casing=2.20m Water=DRY				
		2.20 - 2.65	4D						
		2.20 - 2.70	5B						
		3.20 - 3.65	6U	70blows					
		3.70	7D						
		4.20	SPT (S)	N=24 (3,4/4,6,7,7)	Casing=3.00m Water=DRY				*From 4.20m; with gravel of sandstone, mudstone and siltstone.*
		4.20 - 4.65	8D						
		4.20 - 4.70	9B						
		5.20 - 5.65	10U	100blows					
		5.70	11D						
		6.20	SPT (S)	N=41 (8,8/10,9,10,12)	Casing=5.50m Water=DRY				
		6.20 - 6.65	12D						
		6.20 - 6.70	13B						
		7.20 - 7.50	14U	100blows					
		7.50	15D			7.55	30.50		
		7.55	SPT (C)	50 (25 for 120mm/50 for 115mm)	Casing=6.30m Water=DRY				Very dense brown gravelly SAND. Gravel is angular to rounded fine to coarse of quartz, sandstone and siltstone with some subangular to subrounded cobble sized fragments of the same. FGA-SG
		7.55 - 8.30	16B						
		8.30 - 8.75	17U	100blows		8.30	29.75		Medium dense brown locally black slightly clayey SAND with cobble sized pockets of sandy clay. Sand is medium. With rare subangular coarse gravel of siltstone. FGA-SG
		8.75	18D						*From 8.30m to 8.60m; driller notes firm to stiff grey silty clay.*
		8.80	SPT (S)	N=15 (1,1/3,3,4,5)	Casing=8.30m Water=DAMP				
		8.80 - 9.25	19D						
		8.80 - 9.30	20B						
						10.00	28.05		Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 10.00m.;The borehole was advanced by chiselling methods from 7.60m to 8.10m (1.25 hours) and 14.60m to 15.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **CP1098** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446675.00 - 330583.00	Hole Type CP
Location:		Level: 38.05mbgl	Scale 1:50
Client: Highways England		Dates: 20/10/2006 - 23/10/2006	Logged By MW

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		10.00	SPT (C)	50 (5,6/50 for 255mm)	Casing=10.00m Water=ADDED				Dense brown coarse SAND and GRAVEL. Gravel is angular to rounded fine to coarse of quartz, sandstone, granite and siltstone. Some to many subrounded cobbles. FGA-SG
		10.00 - 10.50	21B						
		11.50	SPT (C)	N=37 (2,5/7,8,10,12)	Casing=11.50m Water=ADDED				*Below 11.50m; with many subangular to subrounded cobbles*
		11.50 - 12.00	22B						
		13.00	SPT (C)	N=47 (4,5/8,11,14,14)	Casing=13.00m Water=ADDED				*At 13.00m; sandy gravel.*
		13.00 - 13.50	23B						
		14.30	SPT (S)	50 (25 for 115mm/50 for 125mm)	Casing=14.30m Water=ADDED	14.30	23.75		Very stiff grey green slightly sandy SILT with gypsum laminae (1-5mm). MM-Z4
		14.30 - 14.54	24D						
		14.30 - 15.00	25B						
		15.00	SPT (S)	50 (25 for 95mm/50 for 90mm)	Casing=14.70m Water=ADDED	15.19	22.86		End of borehole at 15.19 m
		15.00 - 15.19	26D						

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 10.00m.;The borehole was advanced by chiselling methods from 7.60m to 8.10m (1.25 hours) and 14.60m to 15.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **SK43SE8** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446650.00 - 330650.00	Hole Type CP
Location:		Level: 30.60mbgl	Scale 1:50
Client: Highways England		Dates: 12/02/1962 - 15/02/1962	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.15	30.45		Top soil TP Brown loamy clay ALV
		0.76	1D						
		1.37	2D			1.22	29.38		Loamy brown sand FGA-SG
						1.52	29.08		Sand & gravel FGA-SG
		1.83	10B						
		1.83	3D						
		1.83	SPT (S)	N=72 (75,13/15,19,17,21)	Water=-				
		1.83 - 2.29	14SP TLS						
		3.35	11B						
		3.35	4D						
		3.35	SPT (S)	N=69 (75,9/13,17,17,22)	Water=-				
		3.35 - 3.81	15SP TLS						
		4.88	12B						
		4.88	5D						
		4.88	SPT (S)	N=66 (75,11/13,15,17,21)	Water=-				
		4.88 - 5.33	16SP TLS						
		6.40	6D						
						6.71	23.89		Red marl MM-Z3
		7.32	7D						
		7.32 - 7.77	13U	203blows					
						8.23	22.37		Brown CLAY MM-Z4
		9.14	8D						
									Continued on next sheet

Remarks

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Borehole Log

Borehole No. **SK43SE8** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446650.00 - 330650.00	Hole Type CP
Location:		Level: 30.60mbgl	Scale 1:50
Client: Highways England		Dates: 12/02/1962 - 15/02/1962	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		10.67	9D						
						12.19	18.41		End of borehole at 12.19 m

Remarks

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Rotary Core Log

Borehole No. **SK43SE85** HISTORIC Sheet 1 of 5

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446738.00 - 330561.00	Hole Type CP+RC
Location:		Level: 31.19mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 21/04/1988 - 28/04/1988	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.60 - 1.20	B1B					0.80	30.39		Firm brown sandy CLAY with some gravel (Foreman's description) (MADE GROUND) MG-CL
								1.05	30.14		Stiff blue grey sandy silty CLAY (Foreman's description) (MADE GROUND) MG-CL
		1.55 - 2.00	U2U								Yellow brown very clayey SAND with occasional pockets of dark grey organic sand and rare rounded gravel (ALLUVIUM) FGA-SG
	▼	2.10	J3J				10 (0 for 0mm/10,..)				
		2.10 - 2.55	SPT(S)					2.30	28.89		
		2.40 - 2.90	B4B								Medium dense brown SAND and subrounded to subangular GRAVEL with occasional cobbles. (RIVER SANDS AND GRAVELS) FGA-SG
		3.05	SPT(C)				21 (0 for 0mm/21,..)				
		3.10 - 3.70	B5B								
		4.50	SPT(C)				25 (0 for 0mm/25,..)				
		4.60 - 5.20	B6B								
		6.05	SPT(C)				10 (0 for 0mm/10,..)				
		6.20 - 6.70	B7B								
		6.90	W8W								
								7.30	23.89		Red brown moderately to highly
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
21/04/1988 00:00	8.00	3.20	7.80	
26/04/1988 08:00	7.90		7.90	
26/04/1988 18:00	15.00		12.00	
27/04/1988 08:00	15.00	8.40	12.00	
27/04/1988 18:00	26.65		12.00	
28/04/2015 08:00	26.65	10.40	12.00	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks
Hand excavated inspection pit to 1.50m. Water added to assist boring 2.30 to 4.50m.

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Rotary Core Log

Borehole No. **SK43SE85** HISTORIC Sheet 2 of 5

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446738.00 - 330561.00	Hole Type CP+RC
Location:		Level: 31.19mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 21/04/1988 - 28/04/1988	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		7.70 7.80 7.80 - 8.00	J9J J10J SPT(S)				50 (0 for 0mm/50 for 72mm)	8.00	23.19		weathered MUDSTONE very weak to weak with frequent gypsum veining and with much CLAY (KEUPER MARL: ZONE III) MM-Z3
		8.10 - 9.10		87		26					Red brown mottled light greenish grey thinly laminated extremely closely fractured slightly to moderately weathered MUDSTONE weak. With much gypsum veining. And with very closely to closely spaced subhorizontal irregular rough fractures. (KEUPER MARL: ZONE II - III) MM-Z3
		9.10 - 10.10		10		0					
		10.10 - 11.10		42		10					
		11.10 - 12.00		50		12		11.50	19.69		Red brown and light greenish grey moderately to slightly weathered MUDSTONE weak to moderately weak with some to much gypsum veins and inclusions. And with closely spaced subhorizontal to 40° irregular rough fractures. (KEUPER MARL: ZONE II - III) MM-Z3
		~~12.00~~	SPT(S)				50 (0 for 0mm/50 for 50mm)				
		12.00 - 13.00		95		53					
		13.00 - 15.00		82		23		13.50	17.69		Red brown moderately to slightly weathered MUDSTONE weak to moderately weak. With occasional medium to closely spaced 5 to 10mm fibrous gypsum veins. And with occasional to some light greenish grey reduction spots. And with medium to closely spaced highly fractured and highly weathered zones generally non
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
21/04/1988 00:00	8.00	3.20	7.80	
26/04/1988 08:00	7.90		7.90	
26/04/1988 18:00	15.00		12.00	
27/04/1988 08:00	15.00	8.40	12.00	
27/04/1988 18:00	26.65		12.00	
28/04/2015 08:00	26.65	10.40	12.00	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Hand excavated inspection pit to 1.50m. Water added to assist boring 2.30 to 4.50m.

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Rotary Core Log

Borehole No. **SK43SE85** HISTORIC Sheet 3 of 5

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446738.00 - 330561.00	Hole Type CP+RC
Location:		Level: 31.19mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 21/04/1988 - 28/04/1988	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											intact. (KEUPER MARL:ZONE II-III) MM-Z2
								15.50	15.69		Red brown slightly weathered MUDSTONE moderately weak to moderately strong with gypsum veins and with occasional light greenish grey reduction spots. (KEUPER MARL : ZONE II) MM-Z2
		15.00 - 18.00		99		49					
		18.00 - 20.00		66		33					
								19.50	11.69		Red brown fresh to slightly weathered SANDSTONE moderately strong with occasional light greenish grey reduction spots and some gypsum veins. (KEUPER MARL : ZONE I - II) MM-SS
		20.00 - 20.50		90		24					
		20.50 - 22.00		98		86		20.90	10.29		Red brown fresh to slightly weathered MUDSTONE moderately weak with occasional light greenish grey reduction spots and some gypsum veins. (KEUPER MARL : ZONE I - II) MM-Z2
											Continued on next sheet

16 17 18 19 20 21 22

Shift Information

Date & Time	Depth	Water	Casing	Remarks
21/04/1988 00:00	8.00	3.20	7.80	
26/04/1988 08:00	7.90		7.90	
26/04/1988 16:00	15.00		12.00	
27/04/1988 08:00	15.00	8.40	12.00	
27/04/1988 16:00	26.65		12.00	
28/04/2015 08:00	26.65	10.40	12.00	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks
Hand excavated inspection pit to 1.50m. Water added to assist boring 2.30 to 4.50m.

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446738.00 - 330561.00	Borehole No. **SK43SE85** HISTORIC Sheet 4 of 5
Location:		Level: 31.19mbgl Orientation: ° Inclination: °	Hole Type CP+RC
Client: Highways England		Dates: 21/04/1988 - 28/04/1988	Scale 1:50
			Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		22.00 - 24.00		99		49		22.60	8.59		Generally light greenish grey fresh to slightly weathered SILTSTONE moderately weak to moderately strong with some gypsum veins (KEUPER MARL : ZONE I - II) MM-ST *Red brown* *Very closely spaced sub horizontal planar rough fractures*
		24.00 - 26.65		22		0		24.00	7.19		Red brown fresh to slightly weathered MUDSTONE moderately weak in parts weak, with occasional light greenish grey reduction spots. With extremely to very closely spaced gypsum veins and with very closely to closely spaced sub horizontal irregular rough fractures. (MKEUPER MARL: ZONE I - II) MM-Z1 *Poor quality core due to bolt falling down hole and advancing in front of core barrel* *Light greenish grey*
		26.65 - 28.05		99		50					*Non-Intact* *Light greenish grey*
		28.05 - 30.05		97		65					Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
21/04/1988 00:00	8.00	3.20	7.80	
26/04/1988 08:00	7.90		7.90	
26/04/1988 18:00	15.00		12.00	
27/04/1988 08:00	15.00	8.40	12.00	
27/04/1988 18:00	26.65		12.00	
28/04/2015 08:00	26.65	10.40	12.00	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Hand excavated inspection pit to 1.50m. Water added to assist boring 2.30 to 4.50m.

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Rotary Core Log

Borehole No. **SK43SE85** HISTORIC Sheet 5 of 5

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446738.00 - 330561.00	Hole Type CP+RC
Location:		Level: 31.19mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 21/04/1988 - 28/04/1988	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
								30.05	1.14		End of borehole at 30.05 m

31 32 33 34 35 36 37

Shift Information

Date & Time	Depth	Water	Casing	Remarks
21/04/1988 00:00	8.00	3.20	7.80	
26/04/1988 08:00	7.90		7.90	
26/04/1988 18:00	15.00		12.00	
27/04/1988 08:00	15.00	8.40	12.00	
27/04/1988 18:00	26.65		12.00	
28/04/2015 08:00	26.65	10.40	12.00	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Hand excavated inspection pit to 1.50m. Water added to assist boring 2.30 to 4.50m.

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Borehole Log

Borehole No. **SK43SE86** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446682.00 - 330507.00	Hole Type CP
Location:		Level: 31.10mbgl	Scale 1:50
Client: Highways England		Dates: 22/04/1988 - 22/04/1988	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 0.60	B1B			0.20	30.90		TOPSOIL TP Brown clayey SAND with much up to cobble size pieces of brick (MADE GROUND) MG-SG
		0.60 - 1.20	B2B			0.60	30.50		Soft to firm orange brown sandy becoming very sandy CLAY with a little fine and medium gravel (ALLUVIUM) FGA
	▽	1.55 - 2.00	U3U	20blows		1.70	29.40		Loose becoming medium dense brown SAND and subrounded GRAVEL with occasional pockets of brown clay (RIVER SANDS AND GRAVELS) FGA-SG
		2.10	SPT (S)	7 (0 for 0mm/7,...)	Water=7.00m				
		2.10 - 2.70	B4B						
		3.00	SPT (C)	19 (0 for 0mm/19,...)	Water=19.00m				
		3.20 - 3.70	B5B						
		4.70 - 5.30	B6B						
						5.80	25.30		Medium dense brown SAND with some to much subangular to subrounded gravel (RIVER SANDS AND GRAVELS) FGA-SG
		6.10	SPT (C)	11 (0 for 0mm/11,...)	Water=11.00m				
		6.20 - 6.70	B7B						
						6.90	24.20		SAND and GRAVEL (Foreman's description) (RIVER SANDS AND GRAVELS) FGA-SG
						7.20	23.90		
		7.30	J8J			7.40	23.70		Stiff red brown very silty CLAY with rare subrounded fine and medium quartz gravel (REWORKED KEUPER MARL) MM-Z4
		7.60 - 7.89	J9J						
		7.89	W10 W						
		8.40 - 8.60	J11J						Very stiff red brown very silty CLAY with occasional fine gravel size lithorelicts and relict structure. And with occasional bands of red brown thinly laminated MUDSTONE very weak (KEUPER MARL: ZONE IV - III) MM-Z3
		8.70	SPT (S)	50 (0 for 0mm/50 for 38mm)	Water=395.00m				
		8.70 - 8.89	J12J			8.90	22.20		End of borehole at 8.60m

Remarks

Hand excavated inspection pit from G.L. to 1.50m. Water added to assist boring, 1.70 to 4.00m. Hole grouted to 3.00m, backfilled with arisings to G.L.

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Trial Pit Log

Trialpit No
SK43SE137
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446782.00 - 330495.00 Level: 30.40mbgl	Date 14/08/1990
Location:		Dimensions: 3.20m × 1.10m Inclination: 90° Orientation: 170° Depth: 2.70m	Scale 1:50
Client: Highways England			Logged

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
					0.20	30.20		TOPSOIL TP
					0.50	29.90		Loose light brown silty SAND with occasional rootlets. (MADE GROUND) MG-SG
	0.90 0.90	B1 J1A						Dense orange brown silty fine to medium SAND with black and orange staining below 0.80m. (MADE GROUND) MG-SG *1 number brick*
					1.50	28.90		Dense light yellow medium to coarse SAND with some rounded fine to coarse gravel. (ALLUVIUM) FGA-SG
▼	2.00 2.00	B2 J2A						
					2.70	27.70		End of pit at 2.70 m

Shift Information				Backfill			Water Strike						Depth Related Remarks		
Date & Time	Depth	Water	Remarks	Top	Base	Description	Struck	Rose to	Date	Time	Sealed	Remarks	Top	Base	Remarks

Remarks:

Stability: Unstable below 2.00

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Trial Pit Log

Trialpit No **SK43SE138** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446693.00 - 330428.00 Level: 30.60mbgl	Date 09/08/1990
Location:		Dimensions: 3.60m x 1.50m Inclination: 90° Orientation: 40° Depth: 2.30m	Scale 1:50
Client: Highways England			Logged

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
					0.20	30.40		TOPSOIL TP
					0.70	29.90		Loose multicoloured silty fine to coarse SAND with occasional angular fine to coarse gravel and rare pieces of plastic. (MADE GROUND) MG-SG
	1.00 1.00	B1B J1AJ			1.05	29.55		Loose brown silty fine to coarse SAND with occasional subrounded fine to coarse gravel, with some up to cobble sized pockets of black organic material. (MADE GROUND) MG-SG
	1.40 1.40	B2B J2AJ			1.70	28.90		Loose yellow brown mottled black and orange fine to coarse SAND with some rounded fine to medium gravel. (possible MADE GROUND) MG-SG
▼	2.30 2.30	B3B J3AJ			2.30	28.30		Loose yellow and light brown fine to coarse SAND with rounded to subangular fine to coarse gravel. (FLUVIAL DEPOSITS) FGA-SG
					3.10	27.50		Dense yellow and light brown sandy subangular to subrounded fine to coarse GRAVEL of predominantly quartzite and occasional clay lenses. (FLUVIAL DEPOSITS) FGA-SG
					3.30	27.30		Dense yellow and light brown very sandy subangular to subrounded fine to medium GRAVEL of predominantly quartzite. (FLUVIAL DEPOSITS) FGA-SG
								End of pit at 2.30 m

Shift Information				Backfill			Water Strike						Depth Related Remarks		
Date & Time	Depth	Water	Remarks	Top	Base	Description	Struck	Rose to	Date	Time	Sealed	Remarks	Top	Base	Remarks

Remarks:

Stability: Unstable below 2.30m

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Borehole Log

Borehole No. **SK43SE143** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446698.00 - 330504.00	Hole Type CP
Location:		Level: 31.00mbgl	Scale 1:50
Client: Highways England		Dates: 09/09/1990 - 10/09/1990	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.40	30.60		TARMAC MG-SG
		0.65 - 1.20	B1B			0.65	30.35		GRAVEL and COBBLE MG-SG
						0.80	30.20		Grey sandy gravelly CLAY (MADE GROUND) MG-CL
		1.50 - 1.95	U2U						Stiff brown sandy CLAY. (MADE GROUND) MG-CL
						1.70	29.30		Soft to firm brown mottled black and orange brown sandy CLAY. (ALLUVIUM) FGA *with much sand and some to much subrounded fine to coarse gravel*
		2.05	J3J						
		2.10	SPT (S)	20 (0 for 0mm/20,..)	Water=20.00m	2.30	28.70		
		2.10 - 2.55	J4J						Medium dense brown sandy to very sandy subangular to rounded fine to coarse GRAVEL of predominantly quartzite. (FLUVIAL DEPOSITS) FGA-SG
	▼	2.20 - 2.80	B5B						
		3.10	W6W						
		3.15	SPT (C)	28 (0 for 0mm/28,..)	Water=28.00m				
		3.15 - 3.60	B7B						
		4.15	SPT (C)	28 (0 for 0mm/28,..)	Water=28.00m				
		4.30 - 5.00	B8B						
		5.20	SPT (C)	20 (0 for 0mm/20,..)	Water=20.00m				
		5.20 - 5.65	B9B						
		6.00	SPT (S)	22 (0 for 0mm/22,..)	Water=22.00m				
		6.00 - 6.45	J10J						
		6.01 - 6.81	B11B						
		7.00	SPT (C)	15 (0 for 0mm/15,..)	Water=15.00m				
						7.30	23.70		Stiff greenish grey and reddish brown very silty CLAY with some gypsum veining and occasional greenish grey alteration spots (MERCIA MUDSTONE GROUP) MM-Z4
		7.60	SPT (S)	82 (0 for 0mm/82 for 205mm)	Water=120.00m				
		7.60 - 7.96	J12J						
		8.15	SPT (S)	56 (0 for 0mm/56 for 130mm)	Water=129.00m				*RECOVERED AS UP TO FINE GRAVEL SIZED PIECES OF GREENISH GREY SILTSTONE AND WHITE GYPSUM*
		8.15 - 8.43	J13J			8.45	22.55		End of borehole at 8.45 m

Remarks

Inspection pit to 1.25m, 250mm iron water main located at 1.10m depth 1.25m from kerb.

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Rotary Core Log

Borehole No. **SK43SE145** HISTORIC Sheet 1 of 4

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446714.00 - 330535.00	Hole Type RC
Location:		Level: 31.10mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 30/08/1990 - 30/08/1990	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											CABLE PERCUSSION OPEN HOLE OH
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
01/09/1990 08:00	8.15	2.80	8.10	
01/09/1990 16:00	19.70	11.80	8.70	
02/09/1990 08:00	19.70	2.90	8.70	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow
8.15	8.50			
8.50	10.00			
8.85	9.50			
11.60	11.60			

Remarks

AGS

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446714.00 - 330535.00	Borehole No. **SK43SE145** HISTORIC Sheet 2 of 4
Location:		Level: 31.10mbgl Orientation: ° Inclination: °	Hole Type RC
Client: Highways England		Dates: 30/08/1990 - 30/08/1990	Scale 1:50
			Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		8.15 - 8.85		50	14	0	assessed zone of core loss non intact	8.15	22.95		Light reddish brown highly weathered sandy MUDSTONE very weak to weak (MERCIA MUDSTONE GROUP) MM-Z4
		8.85 - 9.60		13	0	0	assessed zone of core loss				
		9.60 - 10.60		100	60	0		10.30	20.80		Reddish brown mottled greenish grey highly weathered MUDSTONE weak with closely spaced gypsum veins and nodules (<3mm). (MERCIA MUDSTONE GROUP) MM-Z4
		10.60 - 12.20		88	75	43	Subhorizontal gypsum vein (40mm)	11.60	19.50		Reddish brown mottled grey green moderately weathered very silty MUDSTONE weak with closely space gypsum veins (<30mm). (MERCIS MUDSTONE GROUP) MM-Z4
		~~12.20~~ 12.20 - 13.70		100	70	22	35 (0 for 0mm/35 for 75mm) Subhorizontal gypsum vein (15mm) very closely spaced gypsum veins (<30mm) grey				
		13.70 - 15.20		100	87	24	greenish grey siltstone	13.80	17.30		Reddish brown mottled grey moderately weathered MUDSTONE weak with very closely to closely spaced gypsum veins (<20mm). (MERCIA MUDSTONE GROUP) MM-Z3
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
01/09/1990 08:00	8.15	2.80	8.10	
01/09/1990 16:00	19.70	11.80	8.70	
02/09/1990 08:00	19.70	2.90	8.70	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow
8.15	8.50			
8.50	10.00			
8.85	9.50			
11.60	11.60			

Remarks

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Rotary Core Log

Borehole No. **SK43SE145** HISTORIC Sheet 3 of 4

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446714.00 - 330535.00	Hole Type RC
Location:		Level: 31.10mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 30/08/1990 - 30/08/1990	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
								15.20	15.90		
		15.20 - 16.70		100	100	50	mottled greenish grey non intact 35 (0 for 0mm/35 for 72mm)				Reddish brown slightly weathered MUDSTONE moderately weak with very closely to medium spaced gypsum veins (<3mm) (MERCIA MUDSTONE GROUP) MM-Z2
		16.70						16.60	14.50		
		16.70 - 18.20		100	50	12	friable very weak				Reddish brown moderately weathered MUDSTONE very weak to weak with closely spaced gypsum veins (<3mm). (MERCIA MUDSTONE GROUP) MM-Z2
		18.20 - 19.70		93	75	30		18.20	12.90		Reddish brown slightly weathered very silty MUDSTONE moderately weak with very closely spaced horizontal to subhorizontal gypsum veins (<5mm). (MERCIA MUDSTONE GROUP) MM-Z3
		19.70 - 21.00		100	17	17	subvertical irregular rough fracture intersecting subvertical fractures mottled greenish grey non intact	19.95	11.15		Reddish brown moderately weathered MUDSTONE weak with closely spaced intersecting subvertical and inclined joints and subhorizontal partings. (MERCIA MUDSTONE GROUP) MM-Z2
								20.70	10.40		Grey green fine grained slightly to moderately weathered SANDSTONE moderately weak with occasional gypsum veins and nodules. (MERCIA MUDSTONE GROUP) MM-SS
		21.15 21.00 - 22.50		100	43	18	57 (0 for 0mm/57 for 140mm) mottled greenish grey	21.15	9.95		Reddish brown slightly weathered MUDSTONE weak to moderately weak with closely spaced gypsum veins (<5mm). (MERCIA MUDSTONE
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
01/09/1990 08:00	8.15	2.60	8.10	
01/09/1990 16:00	19.70	11.80	8.70	
02/09/1990 08:00	19.70	2.90	8.70	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow
8.15	8.50			
8.50	10.00			
8.85	9.50			
11.60	11.60			

Remarks

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Rotary Core Log

Borehole No. **SK43SE145** HISTORIC Sheet 4 of 4

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446714.00 - 330535.00	Hole Type RC
Location:		Level: 31.10mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 30/08/1990 - 30/08/1990	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
							50 deg smooth planar fracture				GROUP) MM-Z2
		22.50 - 24.00		100	73	57	non intact	23.35	7.75		Light grey slightly weathered slightly sandy SILTSTONE moderately weak to moderately strong with closely spaced gypsum veins (<3mm) (MERCIA MUDSTONE GROUP) SILTSTONE MM-ST
		24.00 - 25.50		97	90	41	subhorizontal gypsum vein (40mm) weak mudstone	24.35	6.75		Reddish brown mottled grey slightly weathered sandy SILTSTONE moderately weak to moderately strong with very closely spaced subhorizontal gypsum veins (<3mm). (MERCIA MUDSTONE GROUP) MM-ST
		25.50 - 27.00		83	42	17		26.10	5.00		Reddish brown slightly weathered slightly sandy MUDSTONE moderately weak with very closely spaced gypsum veins (<4mm). (MERCIA MUDSTONE GROUP) MM-Z2
		~~27.00~~					35 (0 for 0mm/35 for 70mm)	27.00	4.10		End of borehole at 27.00 m

23 24 25 26 27 28 29 30

Shift Information

Date & Time	Depth	Water	Casing	Remarks
01/09/1990 08:00	8.15	2.80	8.10	
01/09/1990 16:00	19.70	11.80	8.70	
02/09/1990 08:00	19.70	2.90	8.70	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow
8.15	8.50			
8.50	10.00			
8.85	9.50			
11.60	11.60			

Remarks

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Rotary Core Log

Borehole No. **SK43SE146** HISTORIC Sheet 1 of 5

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446742.00 - 330539.00	Hole Type RC
Location:		Level: 31.20mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 11/08/1990 - 11/08/1990	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											OPEN HOLE OH

1 2 3 4 5 6 7

Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
16/09/1990 09:30	8.50	9.90	8.50	
16/09/1990 12:00	11.50		8.95	
16/09/1990 18:00	19.45	2.90	8.95	
17/09/1990 08:00	19.45	2.90	8.95	
17/09/1990 13:30	30.55	2.90	8.95	
16/09/2015 15:00	14.85		8.95	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow
8.50	9.47			
9.47	9.54			
9.77	9.80			
9.85	10.40			

Remarks

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446742.00 - 330539.00	Borehole No. **SK43SE146** HISTORIC Sheet 2 of 5
Location:		Level: 31.20mbgl Orientation: ° Inclination: °	Hole Type RC
Client: Highways England		Dates: 11/08/1990 - 11/08/1990	Scale 1:50
			Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
							no recovery	8.50	22.70		Reddish brown mottled greenish grey moderately weathered MUDSTONE weak in parts very silty. (MERCIA MUDSTONE GROUP) MM-Z3
		8.85 - 9.85		38	28	26	non intact non intact				
		~~9.85~~					0 (0 for 0mm/0 for 900mm)				
		9.85 - 10.40		0	0	0	no recovery				
		10.40 - 11.30		43	24	0	no recovery generally non intact				
	▼	~~11.30~~					0 (0 for 0mm/0 for 900mm)	11.30	19.90		Reddish brown in parts mottled greenish grey slightly weathered MUDSTONE weak to moderately weak with very closely spaced randomly orientated gypsum veins (<15mm). (MERCIA MUDSTONE GROUP) MM-Z3
		11.50 - 12.85		85	69	19	no recovery non intact irregular gypsum vein (40mm) non intact non intact gypsum vein (20mm)				
		~~12.85~~					non intact 5No subhorizontal gypsum veins				
		12.85 - 14.45		96	90	48	57 (0 for 0mm/57 for 140mm) no recovery greenish grey gypsum vein (30mm) gypsum vein (20mm) gypsum vein (50mm) non intact	14.45	16.75		Reddish brown slightly weathered MUDSTONE weak to moderately weak with extremely closely spaced generally
	▼										Continued on next sheet

8 9 10 11 12 13 14 15

Shift Information

Date & Time	Depth	Water	Casing	Remarks
16/09/1990 09:30	8.50	9.90	8.50	
16/09/1990 12:00	11.50		8.95	
16/09/1990 18:00	19.45	2.90	8.95	
17/09/1990 08:00	19.45	2.90	8.95	
17/09/1990 13:30	30.55	2.90	8.95	
16/09/2015 15:00	14.85		8.95	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow
8.50	9.47			
9.47	9.54			
9.77	9.80			
9.85	10.40			

Remarks

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Rotary Core Log

Borehole No. **SK43SE146** HISTORIC Sheet 3 of 5

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446742.00 - 330539.00	Hole Type RC
Location:		Level: 31.20mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 11/08/1990 - 11/08/1990	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		14.45 - 16.95		100	91	60	3No gypsum veins (<10mm) non intact in parts no intact				subhorizontal gypsum veins (<5mm). (MERCIA MUDSTONE GROUP) MM-Z2
		16.95 - 19.45		46	34	6	no recovery weak gypsum vein (25mm) non intact non intact non intact	16.95	14.25		Reddish brown slightly weathered MUDSTONE weak with extremely closely spaced generally subhorizontal gypsum veins (<5mm). (MERCIA MUDSTONE GROUP) MM-Z2
		19.45 - 21.00		96	84	41	no recovery non intact gypsum vein (30mm)	20.55	10.65		Greenish grey mottled reddish brown slightly weathered SILTSTONE moderately weak to weak. (MERCIA MUDSTONE GROUP) MM-ST
		~~21.00~~ 21.00 - 22.50		97	53	35	non intact 60 (0 for 0mm/60 for 110mm) non intact occasional green grey alteration spots (<30mm) non intact gypsum vein (30mm)	21.00	10.20		Reddish brown slightly weathered MUDSTONE weak with extremely closely spaced generally subhorizontal gypsum veins (<5mm). (MERCIA MUDSTONE GROUP) MM-Z2
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
16/09/1990 09:30	8.50	9.90	8.50	
16/09/1990 12:00	11.50		8.95	
16/09/1990 18:00	19.45	2.90	8.95	
17/09/1990 08:00	19.45	2.90	8.95	
17/09/1990 13:30	30.55	2.90	8.95	
16/09/2015 15:00	14.85		8.95	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow
8.50	9.47			
9.47	9.54			
9.77	9.80			
9.85	10.40			

Remarks

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Rotary Core Log

Borehole No. **SK43SE146** HISTORIC Sheet 4 of 5

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446742.00 - 330539.00	Hole Type RC
Location:		Level: 31.20mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 11/08/1990 - 11/08/1990	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		22.50 - 23.90		97	73	34	mottled greenish grey non intact non intact mottled greenish grey non intact	23.85	7.35		Bluish grey slightly weathered SILTSTONE moderately strong with extremely closely spaced subhorizontal gypsum veins (>0.5mm). (MERCIA MUDSTONE GROUP) MM-ST
		24.45 23.90 - 26.05		100	100	66	greenish grey gypsum vein (30mm) 35 (0 for 0mm/35 for 60mm) greenish grey gypsum vein (30mm) very silty greenish grey	24.45	6.75		Reddish brown slightly weathered MUDSTONE weak to moderately weak with extremely closely spaced generally subhorizontal gypsum veins (<5mm). (MERCIA MUDSTONE GROUP) MM-Z2
		26.05 - 27.55		100	87	47	non intact 45 deg planar smooth fracture greenish grey				
		27.55 - 29.15		100	100	89	greenish grey greenish grey greenish grey				
		29.15 - 30.55		97	87	28	greenish grey non intact greenish grey non intact				

Continued on next sheet

23 24 25 26 27 28 29 30

Shift Information

Date & Time	Depth	Water	Casing	Remarks
16/09/1990 09:30	8.50	9.90	8.50	
16/09/1990 12:00	11.50		8.95	
16/09/1990 18:00	19.45	2.90	8.95	
17/09/1990 08:00	19.45	2.90	8.95	
17/09/1990 13:30	30.55	2.90	8.95	
16/09/2015 15:00	14.85		8.95	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow
8.50	9.47			
9.47	9.54			
9.77	9.80			
9.85	10.40			

Remarks

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446742.00 - 330539.00	Borehole No. **SK43SE146** HISTORIC Sheet 5 of 5
Location:		Level: 31.20mbgl Orientation: ° Inclination: °	Hole Type RC
Client: Highways England		Dates: 11/08/1990 - 11/08/1990	Scale 1:50
			Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		~~30.55~~					non intact gypsum vein (20mm) 58 (0 for 0mm/58 for 135mm)	30.55	0.65		End of borehole at 30.55 m

31 32 33 34 35 36 37

Shift Information

Date & Time	Depth	Water	Casing	Remarks
16/09/1990 09:30	8.50	9.90	8.50	
16/09/1990 12:00	11.50		8.95	
16/09/1990 18:00	19.45	2.90	8.95	
17/09/1990 08:00	19.45	2.90	8.95	
17/09/1990 13:30	30.55	2.90	8.95	
16/09/2015 15:00	14.85		8.95	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow
8.50	9.47			
9.47	9.54			
9.77	9.80			
9.85	10.40			

Remarks

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Rotary Core Log

Borehole No. **SK43SE147** HISTORIC Sheet 1 of 4

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446738.00 - 330564.00	Hole Type RC
Location:		Level: 31.10mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 16/08/1990 - 16/08/1990	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											CABLE PERCUSSION OPEN HOLE OH
							assessed zone of core loss	7.20	23.90		Reddish brown mottled greenish grey
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow
7.20	8.55			
8.63	9.41			
9.85	10.31			
10.88	11.30			

Remarks

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Rotary Core Log

Borehole No. **SK43SE147** HISTORIC Sheet 2 of 4

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446738.00 - 330564.00	Hole Type RC
Location:		Level: 31.10mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 16/08/1990 - 16/08/1990	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		7.20 - 8.60		6	3	0					highly weathered very silty MUDSTONE weak to very weak with extremely to very closely spaced gypsum veins (<9mm) (MERCIA MUDSTONE GROUP) MM-Z4
		8.60 - 9.85		64	65	17	56 (0 for 0mm/56 for 150mm) assessed zone of core loss				
		9.85 - 11.37		70	36	0	assessed zone of core loss 3 No subhorizontal gypsum veins (<39mm)				
		11.37 - 12.85		85	74	24	47 (0 for 0mm/47 for 150mm) assessed zone of core loss 7 No subhorizontal gypsum veins (<50mm) greenish grey	11.40	19.70		Reddish brown mottled greenish grey highly to moderately weathered MUDSTONE weak with very closely to medium spaced gypsum veins (<6mm). (MERCIA MUDSTONE GROUP) MM-Z2
		12.85 - 14.37		99	80	39	4 No subhorizontal gypsum veins (<35mm)				
		14.37 - 15.45		100	68	24		14.55	16.55		Reddish brown moderately weathered MUDSTONE weak with closely space
											Continued on next sheet

8 9 10 11 12 13 14 15

Shift Information

Date & Time	Depth	Water	Casing	Remarks

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow
7.20 8.63 9.85 10.88	8.55 9.41 10.31 11.30			

Remarks

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Rotary Core Log

Borehole No. **SK43SE147** HISTORIC Sheet 3 of 4

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446738.00 - 330564.00	Hole Type RC
Location:		Level: 31.10mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 16/08/1990 - 16/08/1990	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											subhorizontal gypsum veins (<5mm) and occasional greenish grey alteration spots. (MERCIA MUDSTONE GROUP) MM-Z3
		16.55					subvertical irregular rough fracture				
		15.45 - 18.45		100	62	18	35 (0 for 0mm/35 for 50mm) non intact 2 No subhorizontal gypsum veins (<16mm) moderately weathered with many 40-70 deg fractures	17.70	13.40		Reddish brown moderately to slightly weathered MUDSTONE moderately weak with very closely to medium spaced gypsum veins (<5mm) and occasional greenish grey alteration spots. (MERCIA MUDSTONE GROUP) MM-Z3
		~~18.45~~					35 (0 for 0mm/35 for 25mm)				
		18.45 - 21.50		90	82	57	mottled greenish grey greenish grey				
		~~21.50~~					35 (0 for 0mm/35 for 25mm) 70 deg planar smooth fracture 30 deg gypsum vein				
											Continued on next sheet

16 17 18 19 20 21 22

Shift Information

Date & Time	Depth	Water	Casing	Remarks

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow
7.20 8.63 9.85 10.88	8.55 9.41 10.31 11.30			

Remarks

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Rotary Core Log

Borehole No. **SK43SE147** HISTORIC Sheet 4 of 4			
Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446738.00 - 330564.00	Hole Type RC
Location:		Level: 31.10mbgl Orientation: ° Inclination: °	Scale 1:50
Client: Highways England		Dates: 16/08/1990 - 16/08/1990	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		21.50 - 24.20		100	84	38	greenish gre subhorizontal gypsum vein (27mm)				
		~~24.20~~					35 (0 for 0mm/35 for 10mm) subhorizontal gypsum vein (33m) non intact greenish grey				
		24.20 - 27.00		100	63	26	very closely spaced 50-70 deg planar smooth fractures and gypsum veins	25.45	5.65		Reddish brown slightly to moderately weathered MUDSTONE moderately weak to weak with closely to medium spaced gypsum veins (<12mm). (MERCIA MUDSTONE GROUP) MM-Z2
		~~27.00~~					35 (0 for 0mm/35 for 15mm)	27.00	4.10		End of borehole at 27.00 m

23 24 25 26 27 28 29 30

Shift Information

Date & Time	Depth	Water	Casing	Remarks

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow
7.20 8.63 9.85 10.88	8.55 9.41 10.31 11.30			

Remarks

AGS

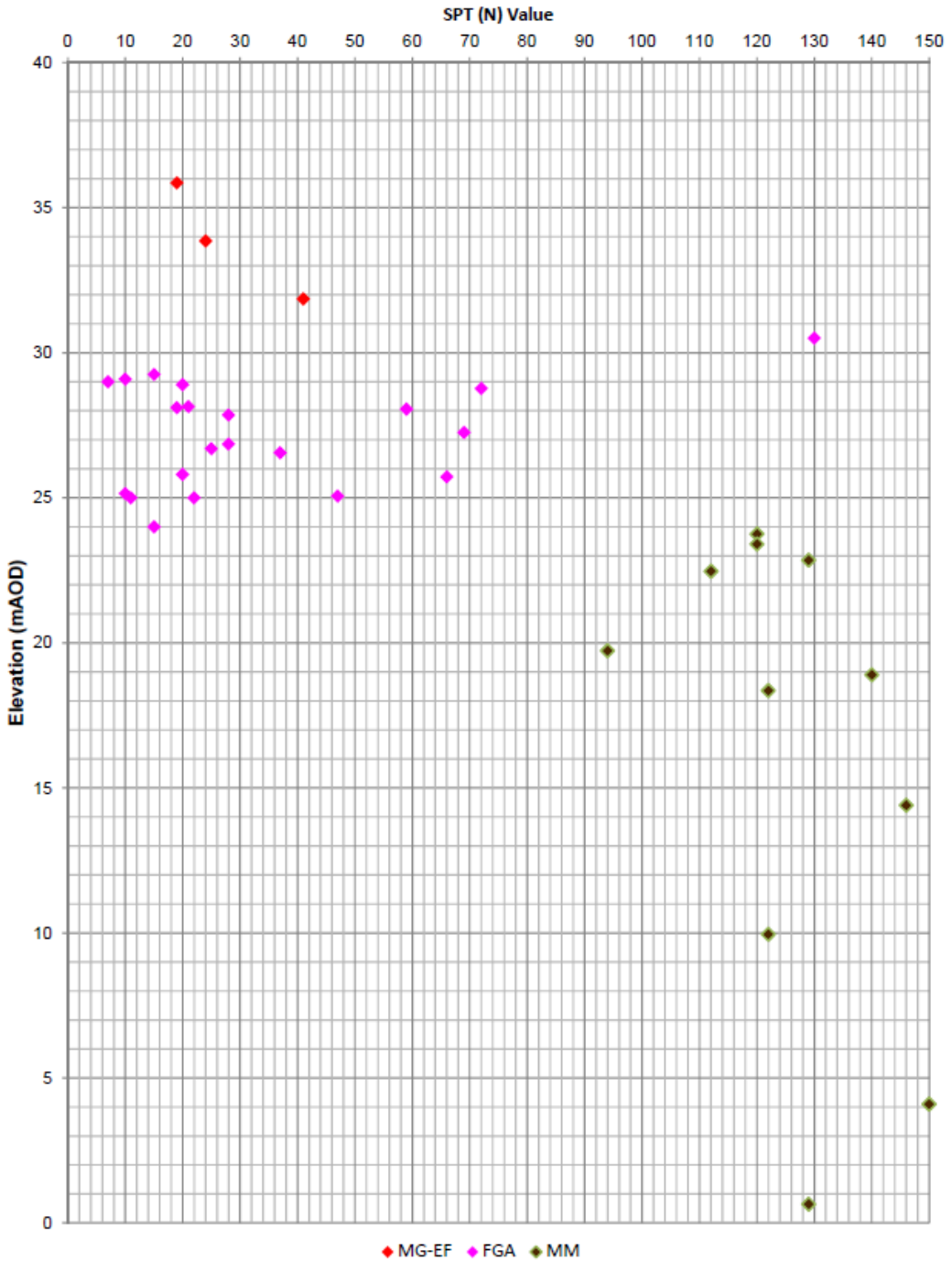
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PLOTS

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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188230-188400SB**
Client: **Highways England**	Borehole ID: **CP1098, SK43SE143, SK43SE8, SK43SE85, SK43SE143, SK43SE145, SK43SE146, SK43SE147 and SK43SE86**	



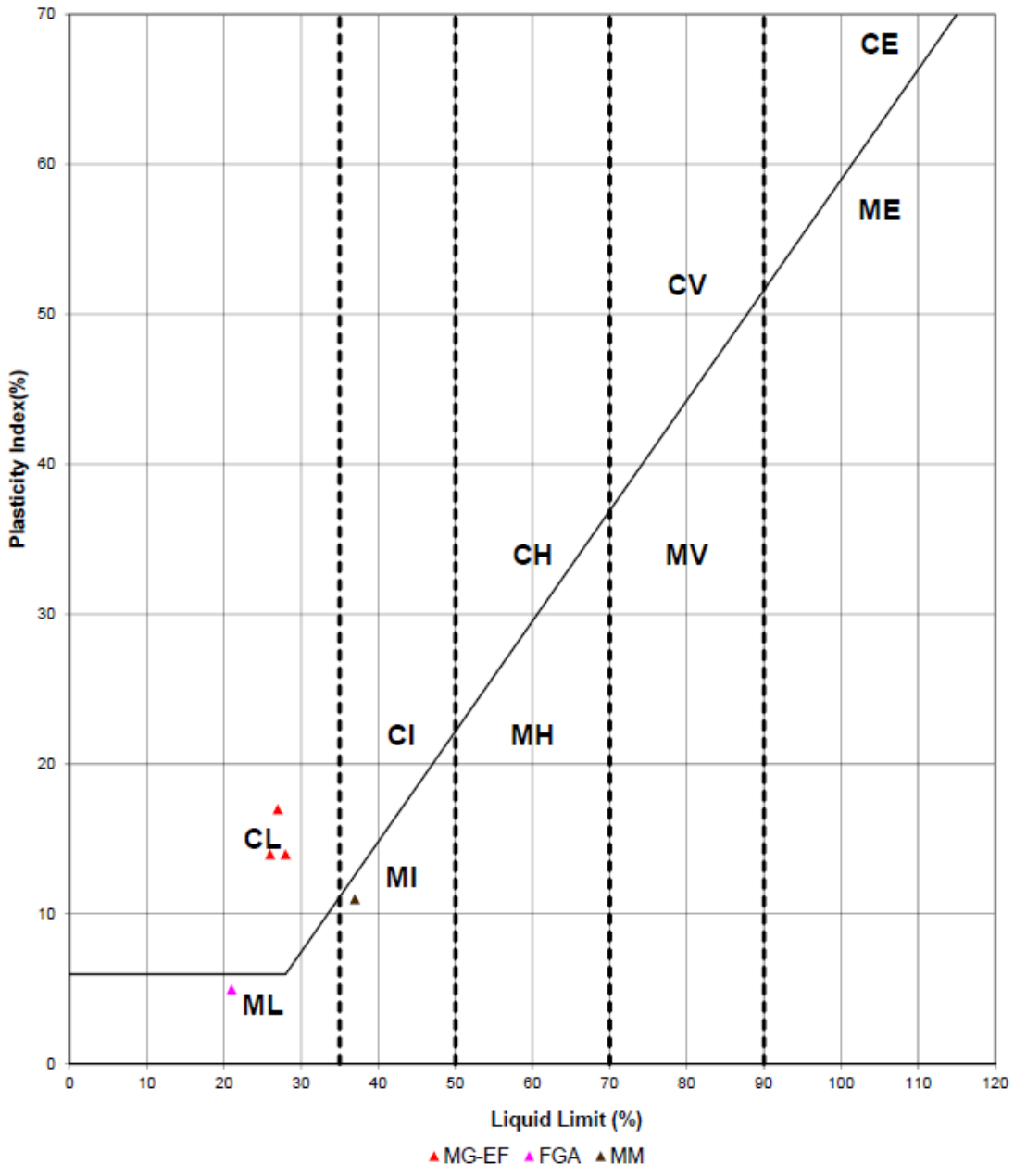
Extrapolated SPT (N) Values >150 have not been shown

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amey ARUP

A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188230-188400SB**
Client: **Highways England**	Borehole ID: **CP1098**	



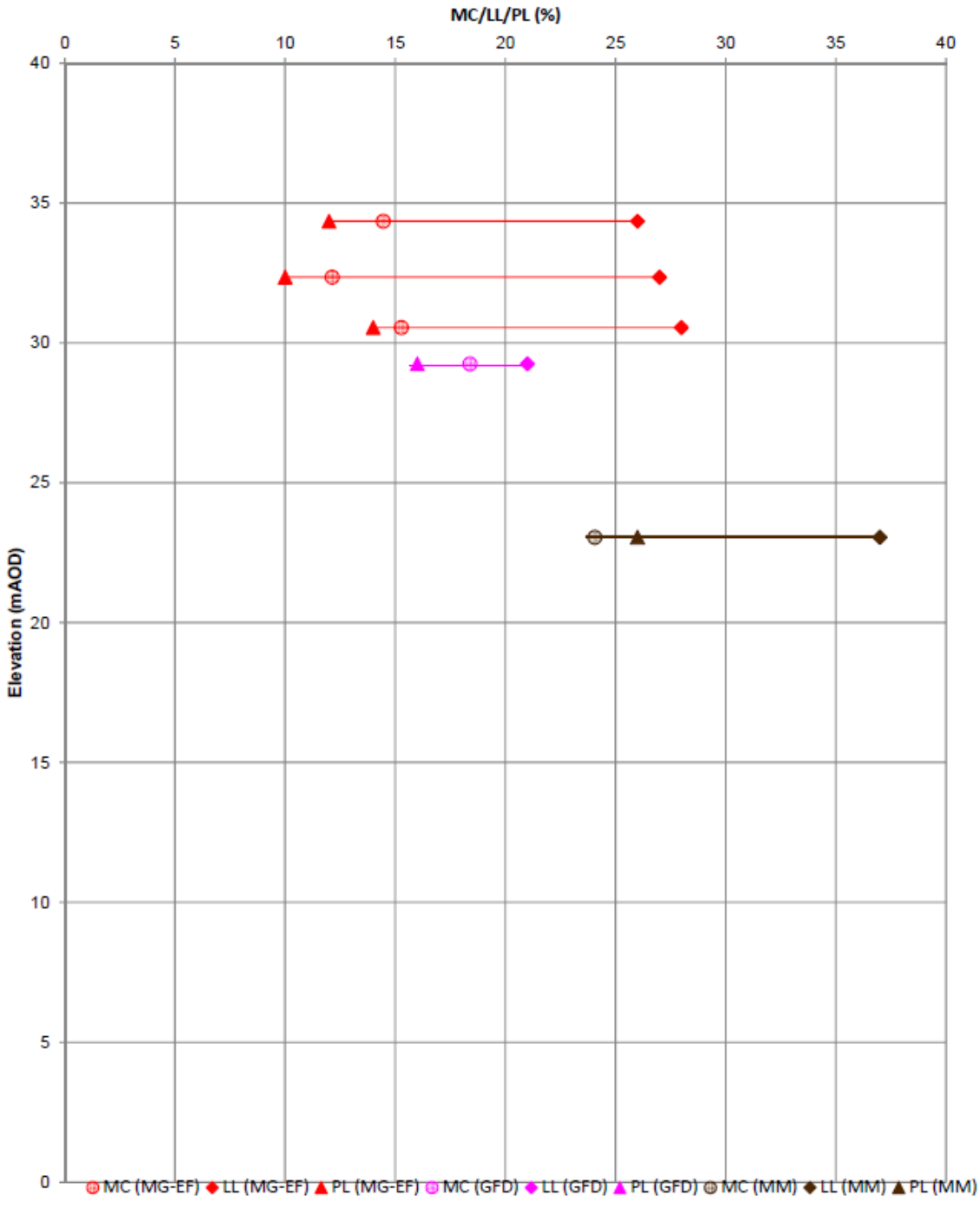
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

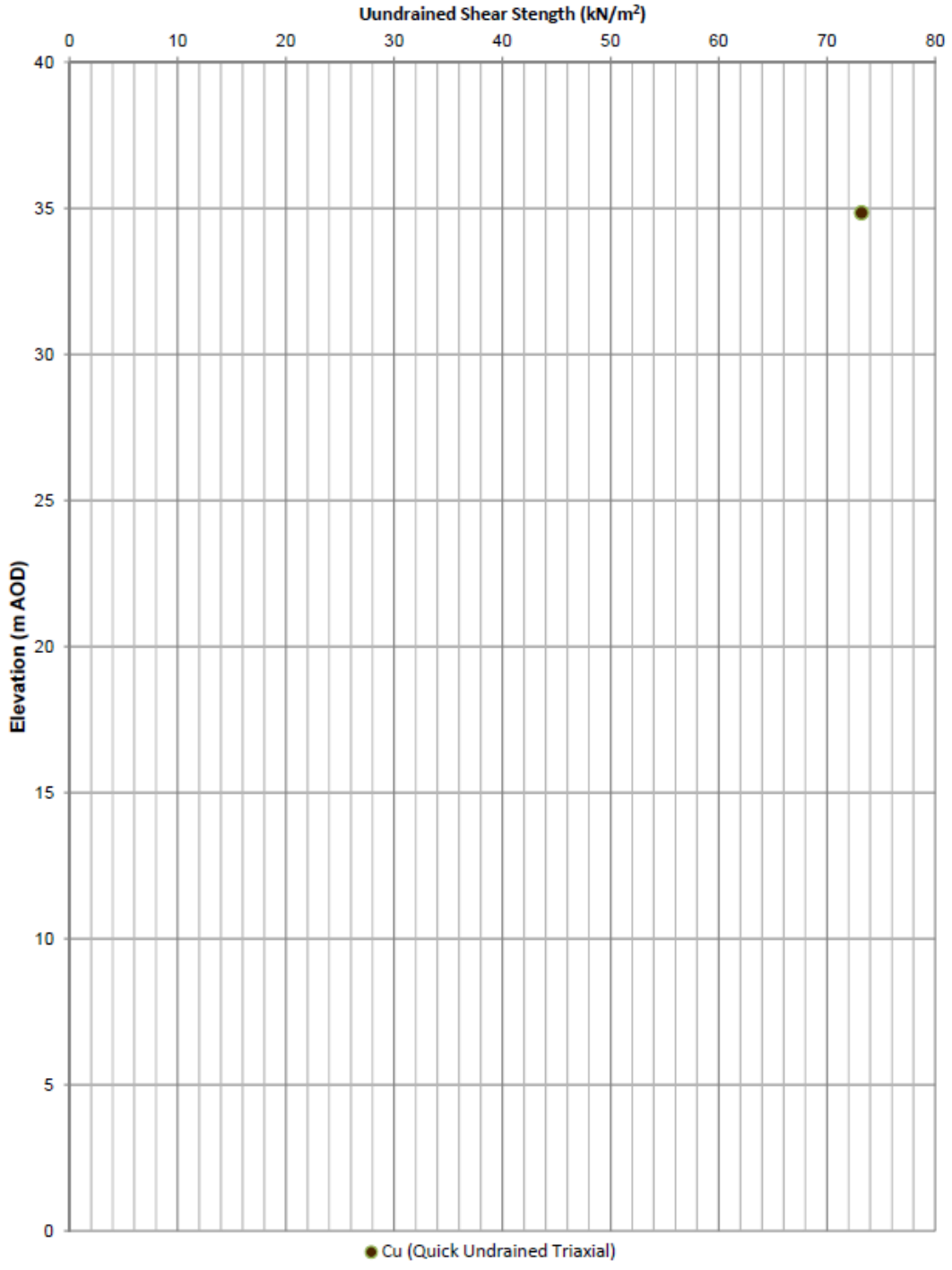
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188230-188400SB**
Client: **Highways England**	Borehole ID: **CP1098**	



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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188230-188400SB**
Client: **Highways England**	Borehole ID: **CP1098**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-188410_188550SB-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	E3-B1		
Structure Type	Emergency Refuge Area (ERA)		
Design Chainage	188410-188550		
Carriageway	Southbound		
Marker Post	MP188/4B+10 – MP188/5B+50		
National Grid Reference	E 446693, N 330671 – E 446649, N 330799		
Existing Ground Level at Location	Carriageway	38.70 mAOD	
	Toe of embankment	29.86mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_21871	HAGDMS designation
Earthwork Height	NB: N/A	SB: 8.84	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 24°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Simon Arinze	19/01/2017	[redacted]
Checked	Alice Bazen	26/01/2017	
Reviewed	Gary Summerfield	17/02/2017	
Approved	Tom Bulteel	24/02/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- King Sheet Pile Retaining Wall

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment. The embankment has a height of 7.0-8.4m and a typical slope gradient of 24°.

The critical sections at chainages 188460 and 188500 are based on section with the greatest retained heights.



Figure 2a: Topographic Critical Cross Section Chainage 188460

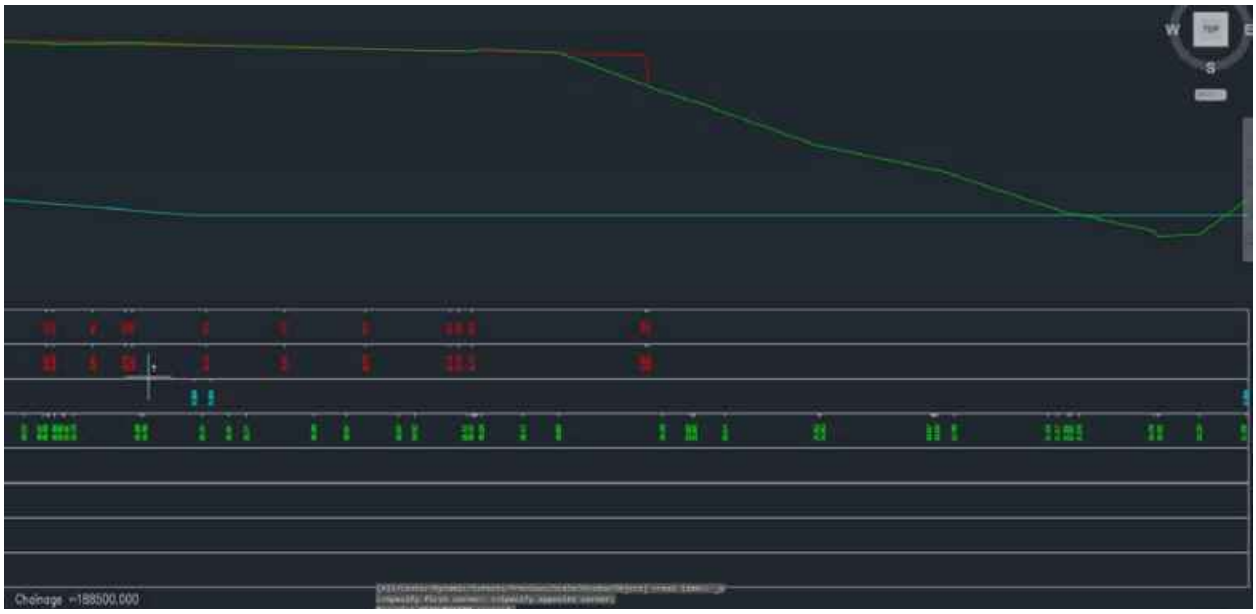


Figure 2b: Topographic Critical Cross Section Chainage 188500

Utilities:

There are no known existing utilities within the vicinity of the chainage extents

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Hemington Member (Silt & Gravel)

Solid Deposits: Edwalton Member (Mercia Mudstone Group), Mudstone

Ground Investigation:

There are 3 No. historical exploratory holes recorded within the design chainage, with additional 1 no. relevant exploratory holes considered as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000031, Rev P01..

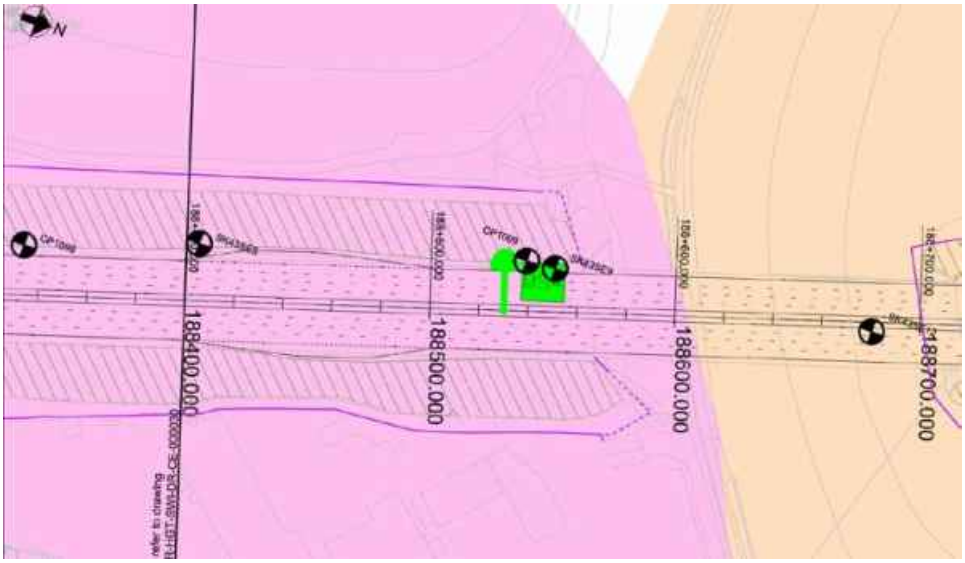


Figure 3: Borehole Location Plan

Flood Risk:

The design flood level is at 31.05mAOD. Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	CP1099
Borehole Chainage	188539
Borehole Location	Northbound
National Grid Reference	E 446611, N 330778
Ground Level at Exploratory Hole	38.60mAOD
RAG Analysis	Green
Date Drilled	24/10/2006
Other suitable holes	CP1098, SK43SE8, SK43SE9 & SK43SE12

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Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Made Ground – Embankment Fill	9.10	29.50	12-32 (12)
River Terrace Deposits	16.60	22.00	38-83 (38)
Glaciofluvial Deposits	19.79	18.81	15-130 (15)
Mercia Mudstone – III/IV	>22.84	<15.76	29->150

(1) Ground level is assumed to be at carriageway level;
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes CP1098, CP1099, SK43SE8, SK43SE9 and SK43SE12.

Groundwater:

No reliable groundwater data is available for any of the boreholes mentioned above.

Groundwater Design Level:

No local groundwater data is available. Therefore a groundwater level of 31.05mAOD (flood level) has been assumed for WALLAP analysis of the king and intermediate sheet pile. When checking the global stability check of the earthwork and king and intermediate sheet pile (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

8 No. Atterberg Limit Tests and 8 No. Natural Moisture Content tests were undertaken within the Mercia Mudstone – III/IV within SK42NE6 with the following results:

Stratum	Depth to Top of Test (mAOD)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Made Ground – Embankment Fill	4.20	9	25	12	13	CL
Made Ground – Embankment Fill	3.70	14	26	12	14	CL
Made Ground – Embankment Fill	5.70	12	27	10	17	CL
Made Ground – Embankment Fill	7.70	6	25	12	13	CL
Made Ground – Embankment Fill	7.50	15	28	14	14	CL
Glaciofluvial Deposits (coarse grained)	8.80	18	21	16	5	ML
Mercia Mudstone – III/IV	15.00	24.06	37	26	11	MI
Mercia Mudstone – III/IV	18.40	15.34	29	20	9	CL

(1) 1 No. Atterberg Limit Test was undertaken within the fine grained elements of the Glaciofluvial Deposits (coarse grained). This sample was not considered to be representative of the stratum as a whole, therefore it has not been used to derive geotechnical parameters.

Lab Test Data – BRE Classification:

The relevant chemical tests are presented in the table below:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Water Soluble Sulphate as SO4	Water	2	0.04-0.37	g/l SO4
Embankment Fill	pH	Solid	2	8.20-8.5	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Validation Ground Investigation.

Ground Model – 188410-188500

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γ_b (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Made Ground – Embankment Fill	0.00-8.90	38.70-29.80	8.90	21	27	0	72	5.40	4.32	-	0.50	0.20	-	DS-2 AC-2
River Terrace Deposits	8.90-11.00	29.80-27.70	2.10	20	38	-	-	-	52.80	-	-	0.35	-	DS-3 AC-3
Glaciofluvial Deposits (Coarse Grained)	11.00-17.30	27.70-21.40	6.30	21	38	-	-	-	25.20	-	-	0.25	-	DS-3 AC-3
Mercia Mudstone – III/IV	>17.30	<21.40	-	21	30	2	50	10.80	8.60	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical borehole CP1097.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) A conservative SPT N value of 12 has been used for the Made Ground – Embankment Fill, combined with an f1 value of 6.
(5) Eu for Made Ground – Embankment Fill can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 12 gives Eu = 5.4MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 4.32MN/m^2.
(6) E' for River Terrace Deposits can be derived using N values (Bowles) where E' = 1200 (N+6); using a conservative N value of 38 gives E' = 52.8MN/m2.
(7) E' for Glaciofluvial Deposits can be derived using N values (Bowles) where E' = 1200 (N+6); using a conservative N value of 15 gives E' = 25.2MN/m2.
(8) Due to lack of near-by reliable GI data, parameters derived from the AMAR GIR have been used for the Mercia Mudstone – III/IV
(9) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

Ground Model – 188500-188550

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Made Ground – Embankment Fill	0.00-8.65	38.55-29.90	8.65	21	27	0	72	5.40	4.32		0.50	0.20	-	DS-2 AC-2
River Terrace Deposits	8.65-14.55	29.90-24.00	5.90	20	38	-	-	-	52.80		-	0.35	-	DS-3 AC-3
Glaciofluvial Deposits (Coarse Grained)	14.55-20.05	24.00-18.50	5.50	21	38	-	-	-	25.20		-	0.25	-	DS-3 AC-3
Mercia Mudstone – III/IV	>20.05	<18.50	-	21	30	2	50	10.80	8.60		0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical borehole CP1097.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) A conservative SPT N value of 12 has been used for the Made Ground – Embankment Fill, combined with an f1 value of 6.
(5) Eu for Made Ground – Embankment Fill can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 12 gives Eu = 5.4MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 4.32MN/m^2.
(6) E' for River Terrace Deposits can be derived using N values (Bowles) where E' = 1200 (N+6); using a conservative N value of 38 gives E' = 52.8MN/m2.
(7) E' for Glaciofluvial Deposits can be derived using N values (Bowles) where E' = 1200 (N+6); using a conservative N value of 15 gives E' = 25.2MN/m2.
(8) Due to lack of near-by reliable GI data, parameters derived from the AMAR GIR have been used for the Mercia Mudstone – III/IV.
(9) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

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Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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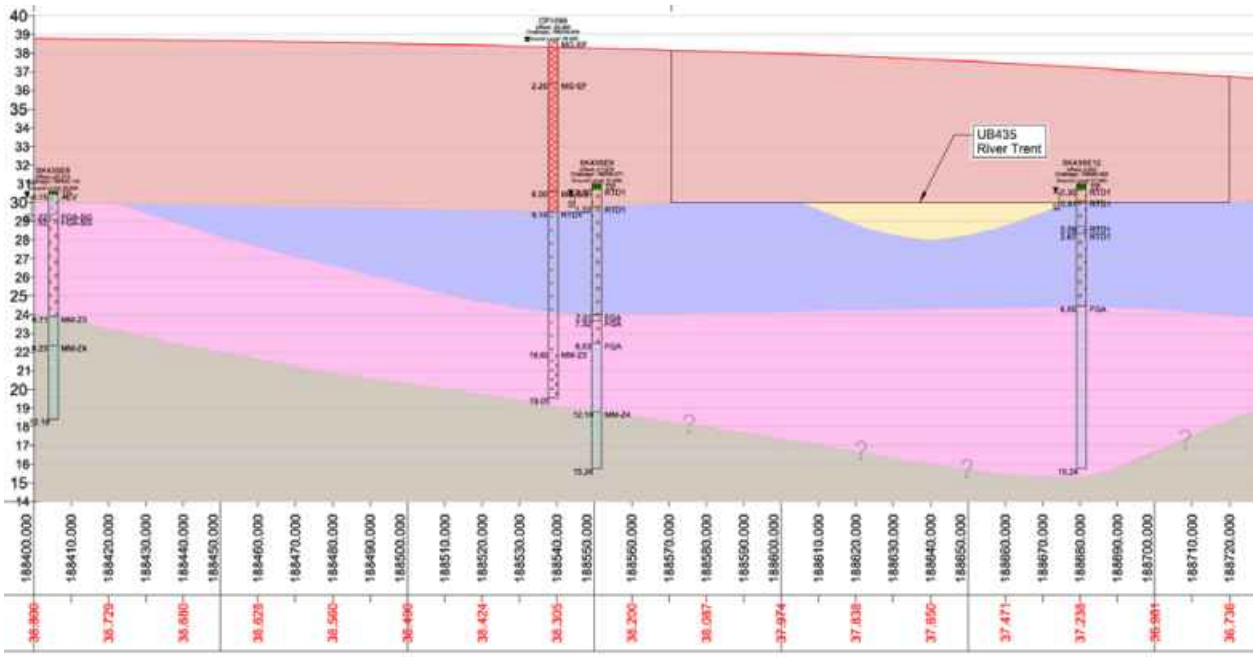


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to the flood plain, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	King Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
188410	188500	AZ-46 S 390 GP	2.7	8.3	11.0	89	83	46.0	192.3
188500	188550	AZ-24 S 390 GP	2.0	6.0	8.0	82	70	29.0	52.6

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH – E3-B1.1 at chainage 188425, southbound, dynamic sample with rotary follow to 14m bgl.
- BH – E3-B1.2 at chainage 188525, Southbound, dynamic sample with rotary follow to 11m bgl.

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LOGS

Rotary Core Log

Borehole No. CP1098 Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446675.00 - 330583.00	Hole Type CP
Location:		Level: 38.05	Scale 1:50
Client: Highways England		Dates: 20/10/2006 - 23/10/2006	Logged By MW

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										MADE GROUND: Grass over firm becoming very stiff brown locally pale yellow green sandy gravelly silt/clay. Gravel is subangular fine and medium of sandstone and cobbles of sandstone. MG-EF
		1.20 - 1.65	U							
		1.70	D							
		2.20 - 2.65	D							
		2.20 - 2.70	B							
		3.20 - 3.65	U							
		3.70	D							
		4.20 - 4.65	D							
		4.20 - 4.70	B							*From 4.20m, with gravel of sandstone, mudstone and siltstone*
		5.20 - 5.65	U							
		5.70	D							
		6.20 - 6.65	D							
		6.20 - 6.70	B							
		7.20 - 7.50	U							
		7.50	D				7.55	30.50		
		7.55 - 8.30	B							Very dense brown gravelly SAND. Gravel is angular to rounded fine to coarse of quartz, sandstone and siltstone with some subangular to subrounded cobble sized fragments of the same. FGA-SG
		8.30 - 8.75	U				8.30	29.75		
		8.75	D							Medium dense brown locally black slightly clayey SAND with cobble sized pockets of sandy clay. Sand is medium. With rare subangular coarse gravel of siltstone. FGA-SG
		8.80 - 9.25	D							*From 8.20m to 8.60m; driller notes firm to stiff grey silty clay*
		8.80 - 9.30	B							
		10.00 - 10.50	B				10.00	28.05		Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 10.00m.;The borehole was advanced by chiselling methods from 7.60m to 8.10m (1.25 hours) and 14.60m to 15.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1098
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446675.00 - 330583.00	Hole Type CP
Location:		Level: 38.05	Scale 1:50
Client: Highways England		Dates: 20/10/2006 - 23/10/2006	Logged By MW

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Dense brown coarse SAND and GRAVEL. Gravel is angular to rounded fine to coarse of quartz, sandstone, granite and siltstone. Some to many subrounded cobbles. FGA-SG
		11.50 - 12.00	B							Below 11.50m, with many subangular to subrounded cobbles
		13.00 - 13.50	B							At 13.00m, sandy gravel
		14.30 - 14.54	D				14.30	23.75		
		14.30 - 15.00	B							Very stiff grey green slightly sandy SILT with gypsum laminae (1-5mm). MM-Z4
		15.00 - 15.19	D				15.19	22.86		End of borehole at 15.19 m

Remarks
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 10.00m.;The borehole was advanced by chiselling methods from 7.60m to 8.10m (1.25 hours) and 14.60m to 15.00m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1099 Sheet 1 of 2

Project Name:	SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446611.00 - 330778.00
Location:			Level: 38.60
Client:	Highways England		Dates: 24/10/2006 - 25/10/2006

Hole Type CP | Scale 1:50 | Logged By RMS/JS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										MADE GROUND: Brown slightly silty sand. Sand is fine to coarse. With occasional gravel of subangular fine to coarse weathered weak sandstone. MG-EF
		1.20 - 1.65	U							
		1.70	D							
		2.20 - 2.65	D				2.20	36.40		
		2.20 - 2.70	B							MADE GROUND: Stiff brown mottled green slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is subangular to subrounded coarse of sandstone, siltstone, mudstone and coal. With occasional rootlets and gypsum. Slight organic odour. MG-EF
		3.20 - 3.65	U							
		3.70	D							
		4.20 - 4.65	D							
		4.20 - 4.70	B							
		5.20 - 5.65	U							
		5.70	D							
		6.20 - 6.65	D							
		6.20 - 6.70	B							
		7.20 - 7.65	U							
		7.70	D							
		8.00 - 8.50	B				8.00	30.60		MADE GROUND: Very dense brown clayey sand with gravel of angular to subrounded fine to coarse mudstone, limestone and sandstone. Occasional subrounded cobbles of the same. MG-SG
		9.30 - 9.80	B				9.10	29.50		Dense brown SAND and GRAVEL. Sand is mainly medium to coarse, gravel is angular to subrounded fine to coarse of mixed lithologies. Occasional to some subrounded cobbles. RTD1
		9.80	W							

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 8.00m to 9.00m (2.5 hours), 11.00m to 11.30m (0.5 hours) and 18.50m to 18.90m (1 hour).;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 9.30m to 16.60m.;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1099 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446611.00 - 330778.00	Hole Type CP
Location:		Level: 38.60	Scale 1:50
Client: Highways England		Dates: 24/10/2006 - 25/10/2006	Logged By RMS/JS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.80 - 11.30	B							SAND and GRAVEL (as previous sheet)
		12.30 - 12.70	B							
		13.80 - 14.30	B							
		15.30 - 15.80	B							
		16.60	D				16.60	22.00		
		16.70 - 17.15	D							Stiff to very stiff brown slightly sandy SILT with occasional angular to subangular fine to coarse lithorelics of weathered siltstone and sandstone. MM-Z3
		16.70 - 17.20	B							
		18.20 - 18.40	U							
		18.40	D							Below 18.40m, recovered as brown slightly sandy fine to coarse angular to subangular gravel sized fragments of finely laminated weathered SILTSTONE. With occasional laminae of gypsum (<2mm)
		18.45	D							
		18.45 - 18.90	B							
		18.90	D							
							19.05	19.55		End of borehole at 19.05 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 9.00m to 9.00m (2.5 hours), 11.00m to 11.30m (0.5 hours) and 18.50m to 18.90m (1 hour).;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 9.30m to 16.60m.;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. SK43SE12
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446590.00 - 330920.00	Hole Type CP
Location:		Level: 31.00	Scale 1:50
Client: Highways England		Dates: 06/02/1962 - 09/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	30.70		Topsoil TP
		0.61	W							Sandy subsoil RTD1
		0.76	D				0.91	30.09		
		1.22	B							Gravel RTD1
		1.22 - 1.68	SPTL							
		1.52	S							
			D							
							2.29	28.71		Silt RTD1
		2.44	D				2.67	28.33		
		3.05	D							Sand & gravel RTD1
		3.05 - 3.51	SPTL							
		3.35	S							
			B							
		4.57	D							
		5.18	B							
		5.18 - 5.64	SPTL							
			S							
		6.10	D							
							6.55	24.45		
		6.71	D							Brown boulder clay FGA
		7.62 - 8.08	U							
		8.08	D							
		9.14 - 9.53	U							
		9.60	D							
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK43SE12
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446590.00 - 330920.00	Hole Type CP
Location:		Level: 31.00	Scale 1:50
Client: Highways England		Dates: 06/02/1962 - 09/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.97	D							
		10.97 - 11.51	U							
		12.50	D							
		12.65 - 13.03	U							
		14.02	D							
		14.78 - 15.14	U							
		15.24	D				15.24	15.76		End of borehole at 15.24 m

11 12 13 14 15 16 17 18 19 20

Remarks

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Rotary Core Log

Borehole No. SK43SE8
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446650.00 - 330650.00	Hole Type CP
Location:		Level: 30.60	Scale 1:50
Client: Highways England		Dates: 12/02/1962 - 15/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
	▼						0.15	30.45		Top soil TP Brown loamy clay ALV
		0.76	D							
	▽	1.37	D				1.22	29.38		Loamy brown sand FGA-SG
							1.52	29.08		Sand & gravel FGA-SG
		1.83 1.83 1.83 - 2.29	D B SPTL S							
		3.35 3.35 3.35 - 3.81	D B SPTL S							
		4.88 4.88 4.88 - 5.33	B D SPTL S							
		6.40	D							
							6.71	23.89		Red marl MM-Z3
		7.32 7.32 - 7.77	D U							
							8.23	22.37		Brown CLAY MM-Z4
		9.14	D							
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK43SE8
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446650.00 - 330650.00	Hole Type CP
Location:		Level: 30.60	Scale 1:50
Client: Highways England		Dates: 12/02/1962 - 15/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.67	D				12.19	18.41		End of borehole at 12.19 m

Remarks

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Rotary Core Log

Borehole No. SK43SE9
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446610.00 - 330790.00	Hole Type CP
Location:		Level: 31.00	Scale 1:50
Client: Highways England		Dates: 15/02/1962 - 23/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	D				0.30	30.70		Top soil TP
		0.61	D							Sandy subsoil RTD1
							1.22	29.78		Gravel & sand RTD1
		1.52	D							
		1.83 - 2.29	SPTL							
		1.83 - 2.29	S B							
		3.05	D							
		3.66 - 4.11	SPTL							
		3.66 - 4.11	S B							
		4.57	D							
		5.18 - 5.64	B							
		5.18 - 5.64	SPTL S							
		6.10	D							
							7.01	23.99		Organic material FGA
		7.16	D				7.32	23.68		Silt & gravel FGA
		7.62	D							
		7.62 - 8.08	B							
		7.62 - 8.08	SPTL S							
		8.53	D				8.53	22.47		Red & grey marl FGA
		8.84 - 9.30	U							
										Continued on next sheet

Remarks
No core possible in Marl & Gypsum

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Rotary Core Log

Borehole No. SK43SE9
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446610.00 - 330790.00	Hole Type CP
Location:		Level: 31.00	Scale 1:50
Client: Highways England		Dates: 15/02/1962 - 23/02/1962	Logged By

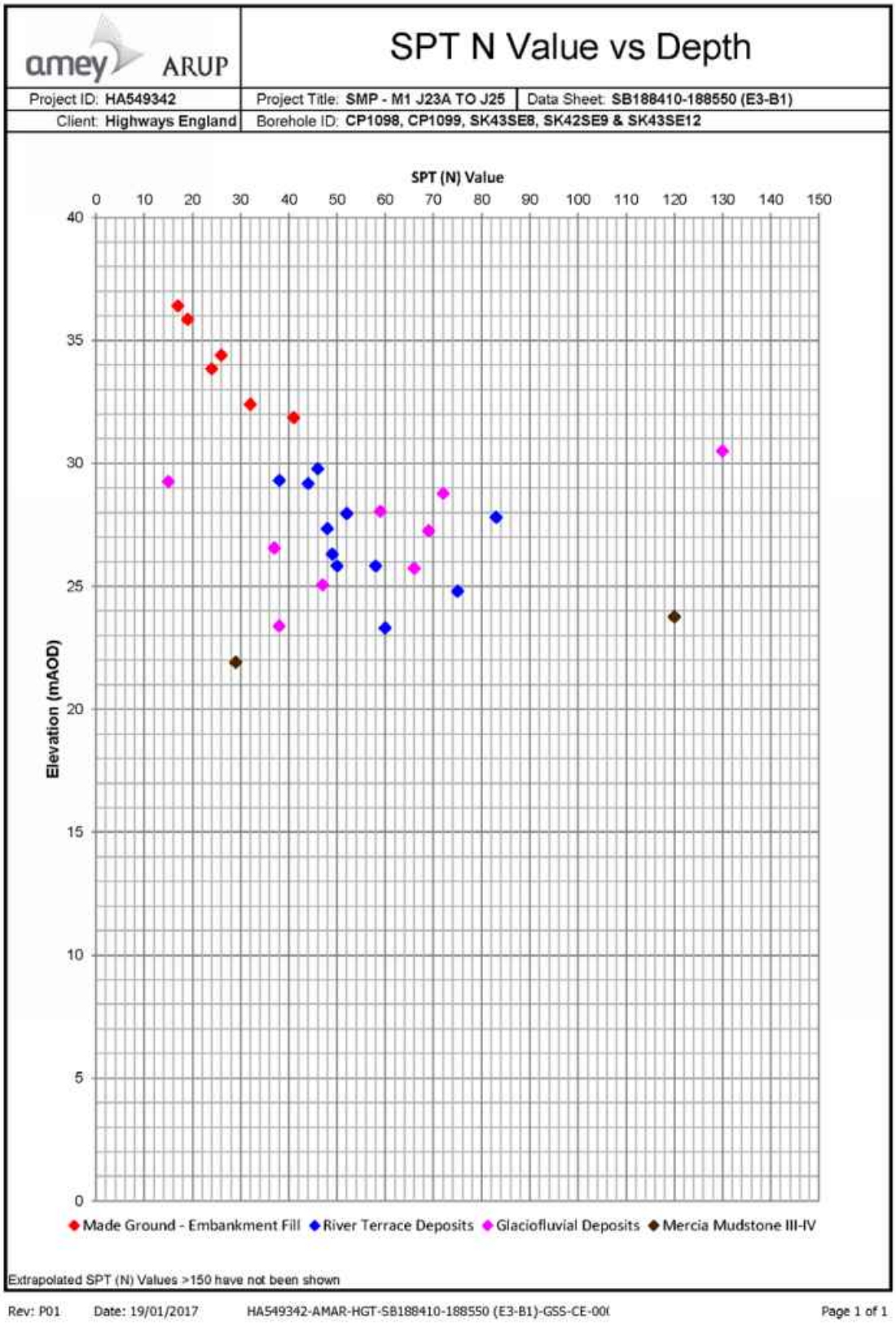
Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.06	D							
		10.52 - 10.67	U							
		10.67	D							
		12.19	D				12.19	18.81		Red marl and gypsum MM-Z4
		12.19 - 12.29	U							
		13.72	D							
		13.72 - 13.77	U							
		15.24	D				15.24	15.76		End of borehole at 15.24 m

Remarks
No core possible in Marl & Gypsum

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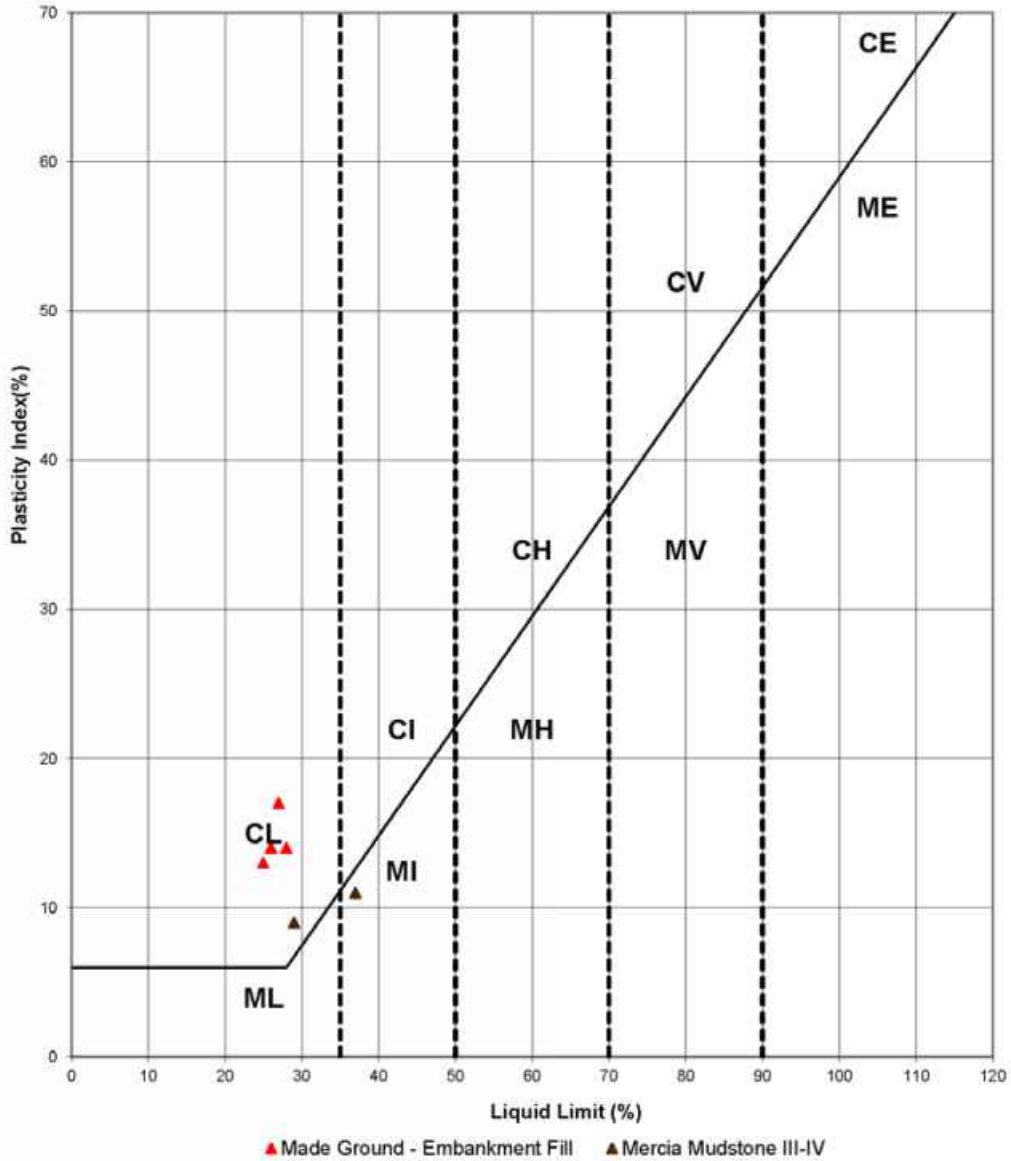
PLOTS



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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **SB188410-188550 (E3-B1)**
Client: **Highways England**	Borehole ID: **CP1098 & CP1099**	



Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

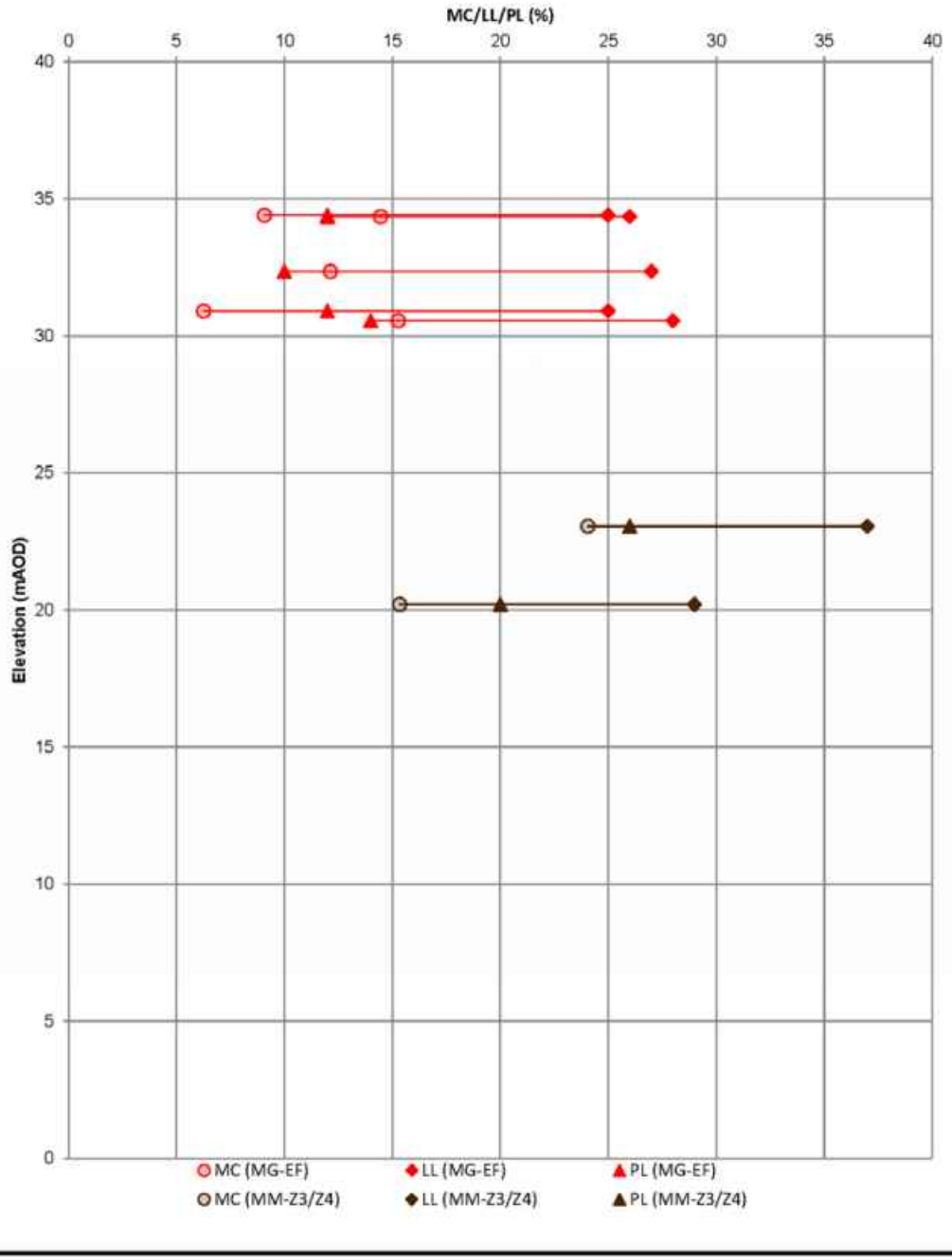
Rev: P01 Date: 19/01/2017 HA549342-AMAR-HGT-SB188410-188550 (E3-B1)-GSS-CE-00(Page 1 of 1

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **SB188410-188550 (E3-B1)**
Client: **Highways England**	Borehole ID: **CP1098 & CP1099**	



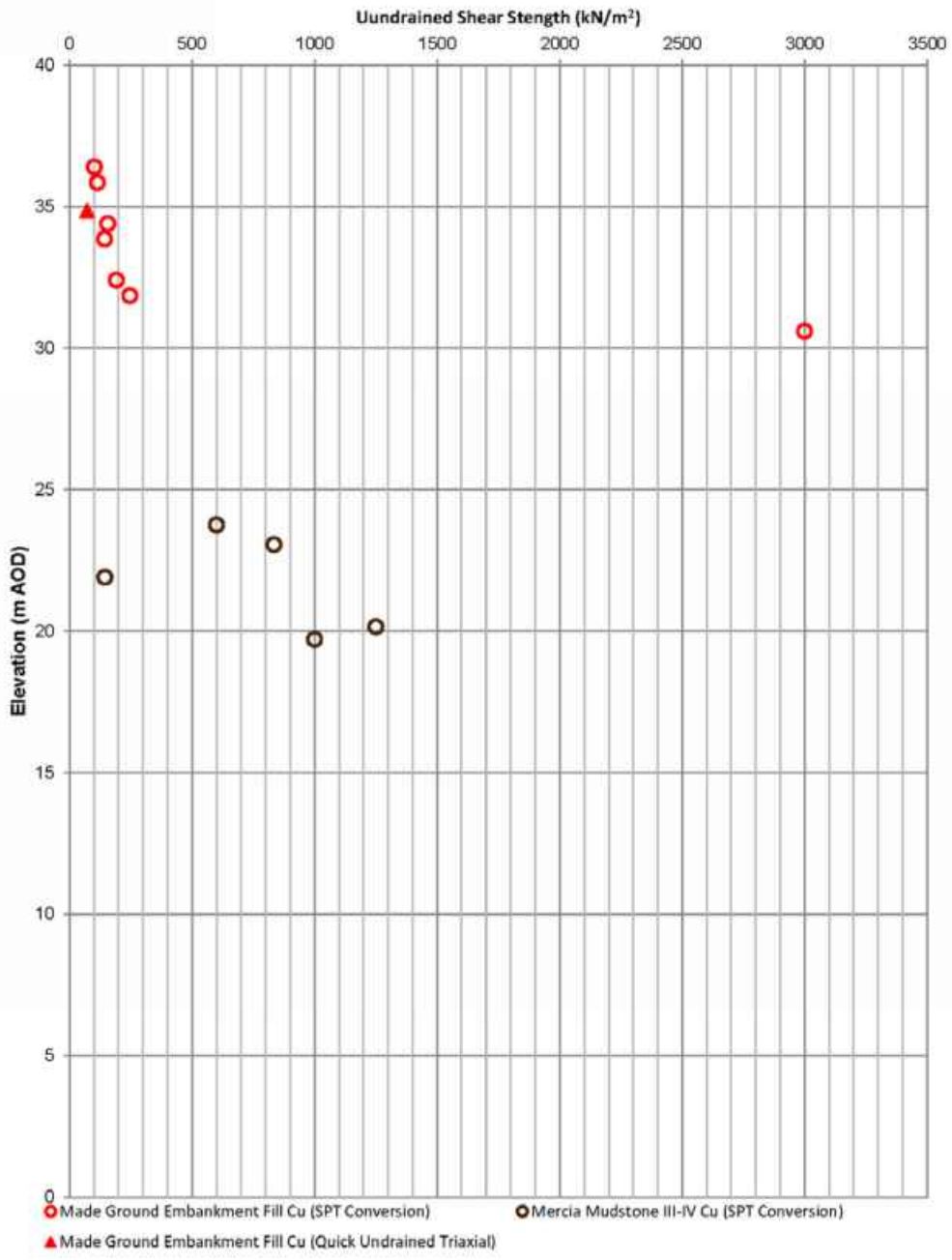
Rev: P01 Date: 19/01/2017 ': HA549342-AMAR-HGT-SB188410-188550 (E3-B1)-GSS-CE-000(Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **SB188410-188550 (E3-B1)**
Client: **Highways England**	Borehole ID: **CP1098 & CP1099**	



Rev: P01 Date: 19/01/2017 HA549342-AMAR-HGT-SB188410-188550 (E3-B1)-GSS-CE-00(Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-188100_187890SB-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	Gantry 308		
Structure Type	ADS Cantilever		
Design Chainage	188750-188770		
Carriageway	Southbound		
Marker Post	MP188/7B+7500 – MP188/7B+70		
National Grid Reference	E 446588, N 330992 – E 446578, N 331008		
Existing Ground Level at Location	Carriageway	36.26 mAOD	
	Toe of embankment	30.01 mOAD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_54261	HAGDMS designation
Earthwork Height	NB: N/A	SB: 6.25m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 18°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Simon Arinze	19/01/2017	[redacted]
Checked	Alice Bazen	26/01/2017	
Reviewed	Gary Summerfield	17/02/2017	
Approved	Tom Bulteel	24/02/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this structure. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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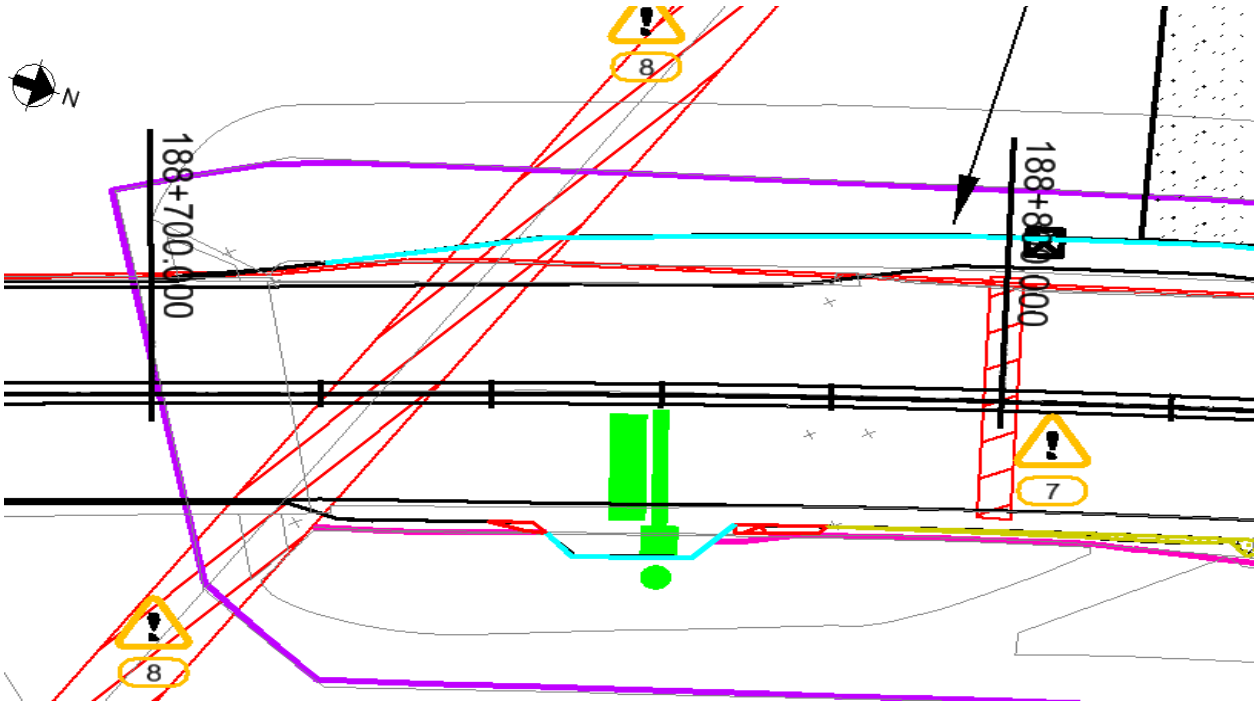


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- King Sheet Pile Retaining wall is required at this location as there is insufficient space to allow for an earthworks regrade without encroaching onto the flood plain.

Proposed Major Structures:

A new ADS Cantilever Gantry (Gantry 308) proposed at chainage 188760.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment of 5.8-5.9m height with a typical slope gradient of 25°.

The critical cross sections (i.e. the cross section with the greatest retained height) used is Ch188760.



Figure 2: Topographic Critical Cross Section Chainage 188760

Utilities:

High voltage overhead power cables (Western Power) cross the motorway approximately 20m south of this location.

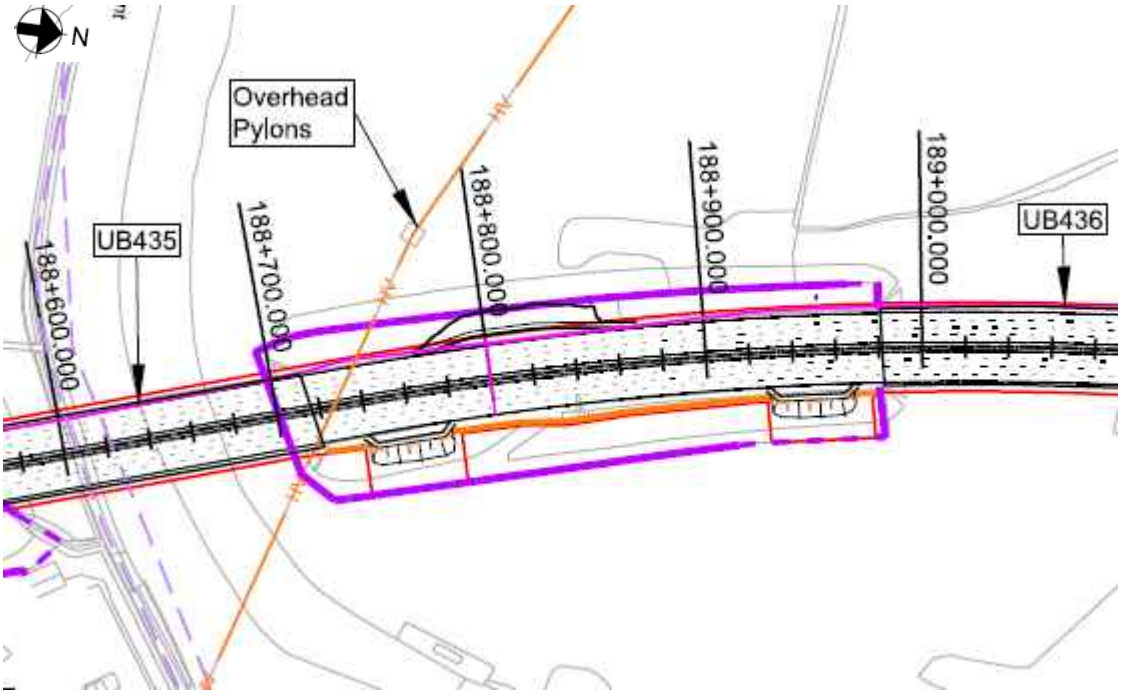


Figure 3: Utilities Location Plan

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Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Alluvium (Clay, Silt, Sand & Gravel)

Solid Deposits: Edwalton Member (Mercia Mudstone Group), Mudstone

Ground Investigation:

There is 1 No. historical exploratory holes recorded within the design chainage, with additional 2 no. relevant exploratory holes considered outside design chainage; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000031, Rev P01.

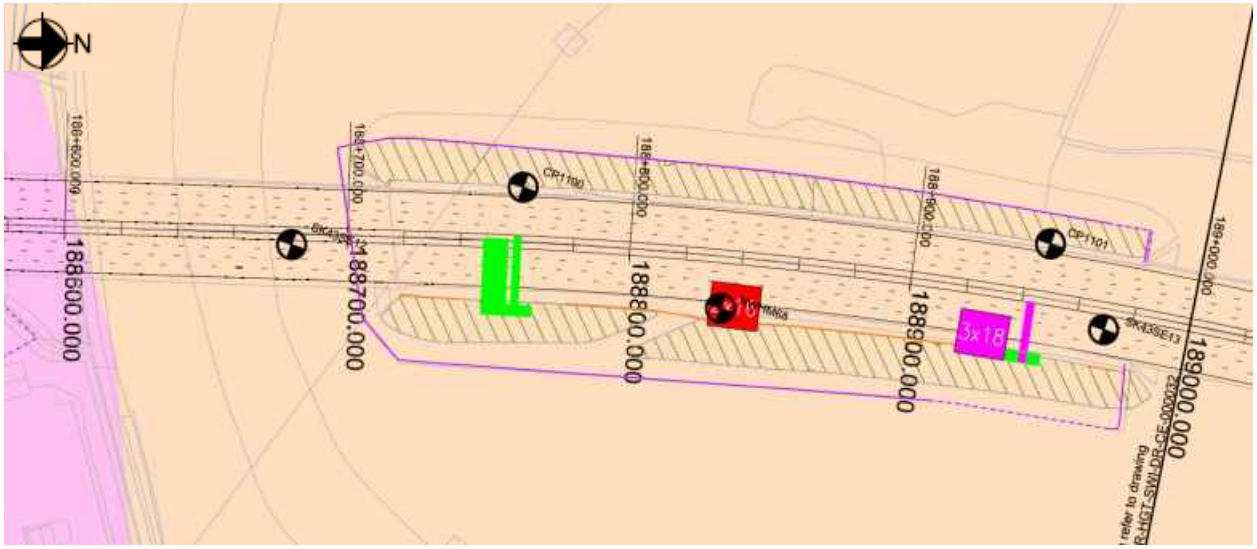


Figure 3: Borehole Location Plan

Flood Risk:

The design flood level has been recorded as 32.20mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04

Historical Boreholes:

Relevant Borehole Number	CP1100
Borehole Chainage	188760
Borehole Location	Northbound
National Grid Reference	E 446543, N 330990
Ground Level at Exploratory Hole	36.25mAOD

RAG Analysis	Green
Date Drilled	26/10/2006
Termination Depth	14.70 metres below ground level (mbgl)
Other suitable holes	SK43SE12 & NWHM68

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Made Ground – Embankment Fill	5.60	30.65	19->150 (19)
River Terrace Deposits	12.80	23.45	25->150 (25)
Glaciofluvial Deposits (Coarse Grained)	>14.70	<21.55	>150

(1) Ground level is assumed to be at carriageway level;
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes CP1100, NWHM68 & SK43SE12.

Groundwater:

No groundwater data is available for any of the boreholes mentioned above.

Groundwater Design Level:

No local groundwater data is available. Therefore a groundwater level of 32.20mAOD (flood level) has been assumed for WALLAP analysis of the king and intermediate sheet pile. When checking the global stability check of the earthwork and king and intermediate sheet pile (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

3 No Atterberg Limit Tests and 5 No Natural Moisture Content tests were undertaken within the Made Ground embankment Fill and the Glaciofluvial Deposits within CP1100 & NWHM68 with the following results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	3.70	10.25	31.00	16.00	15.00	CL
River Terrace Deposits	5.60	3.35	-	NP	-	-
Glaciofluvial Deposits (Coarse Grained)	12.00	5.90	-	-	-	-
Glaciofluvial Deposits (Coarse Grained)	13.40	9.37	29.00	14.00	15.00	CL
Glaciofluvial Deposits (Coarse Grained)	14.20	12.00	20.00	15.00	5.00	ML

Lab Test Data - Chemical:

1 No water soluble sulphate test, 2 No chloride tests, 1 No nitrate test and 2 No pH tests were undertaken within the Made Ground in boreholes CP1100 and NWHM68.

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Sulphate (Total) as SO4	Solid	1	0.06	%SO4

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Made Ground – Embankment Fill	0.00-5.61	36.26-30.65	5.61	21	27	0	114	7.50	6.00	-	0.50	0.20	-	2.50	0.40	-	6.2*	-	DS-2 AC-2
River Terrace Deposits	5.61-12.81	30.65-23.45	7.20	20	38	-	-	-	37.20	-	-	0.35	-	13.80	-	1.0	-	50	DS-3 AC-3
Glaciofluvial Deposits (Coarse Grained)	12.81-15.66	23-45-20.60	2.85	21	38	-	-	-	19.20	-	-	0.25	-	7.70	-	1.0	-	50	DS-3 AC-3
Mercia Mudstone – III/IV	>15.66	<20.60	-	21	30	2	50	10.80	8.60	-	0.50	0.20	-	3.60	0.76	-	9.0	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from data recorded on historical borehole CP1097.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) A conservative SPT N value of 19 has been used for the Made Ground – Embankment Fill, combined with an f1 value of 6.

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(5) Eu for Made Ground – Embankment Fill can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 19 gives Eu = 7.5MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 6.00MN/m^2.
(6) Adhesion Factor for Made Ground – Embankment Fill is based on BS8004 (equation 41).
(7) E' for River Terrace Deposits can be derived using N values (Bowles) where E' = 1200 (N+6); using a conservative N value of 25 gives E' = 37.2MN/m^2.
(8) Due to lack of near-by reliable GI data, parameters derived from the AMAR GIR have been used for the Glaciofluvial Deposits.
(9) Due to lack of near-by reliable GI data, parameters derived from the AMAR GIR have been used for the Mercia Mudstone – III/IV
(10) Shear modulus is based on G = E/2(1+v).
(11) Adhesion Factor for Mercia Mudstone is based on BS8004 (equation 41).
(12) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl
(13) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).
(14) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1). For sandstone, Nq is derived based on a very dense siliceous cohesionless soil (Tomlinson Table 7.1).
(15) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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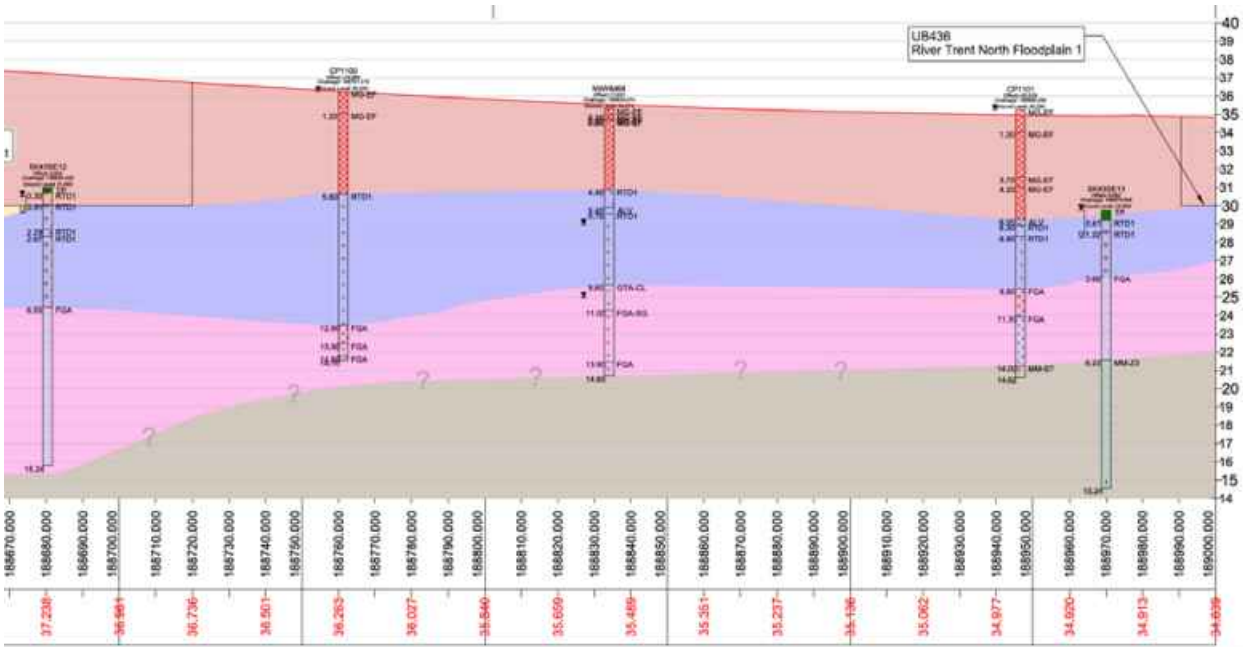


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to the flood plain, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
188750	188770	AZ-24 S 390 GP	2.3	5.2	7.5	87	48	29	67.6

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 2.5m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	900	26	2.70	13	413	1214

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BG-G308 at chainage 188760, southbound, dynamic sample with rotary follow to 31m bgl.

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LOGS

amey

Rotary Core Log

Borehole No. **CP1100** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446543.00 - 330990.00	Hole Type CP
Location:		Level: 36.25	Scale 1:50
Client: Highways England		Dates: 26/10/2006 - 26/10/2006	Logged By MW

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.50	B							MADE GROUND. Brown very gravelly sand. Sand is fine and medium. Gravel is angular to subrounded fine to coarse, of sandstone, mudstone, limestone and concrete with some subangular cobbles of concrete. MG-EF
		1.20 - 1.65	U				1.20	35.05		MADE GROUND. Stiff to very stiff purple brown slightly sandy, friable silt, clay and silt/clay fill. Occasional to some fragments of siltstone and mudstone and occasional to some angular to subangular fine to coarse, gravel of sandstone. MG-EF
		1.70	D							
		2.20 - 2.65 2.20 - 2.70	D B							
		3.20 - 3.65	U							
		3.70	D							
		4.20 - 4.65 4.20 - 4.70	D B							
		5.20 - 5.55	U							
		5.60 5.60 - 6.10	D B				5.60	30.65		Dense to very dense, brown SAND and GRAVEL. Sand is fine to coarse, gravel is angular to subrounded fine to coarse of mixed lithologies including rare granite. RTD1
		6.60 - 7.10	B							
		7.60 - 8.10	B							Below 7.60m, some subrounded cobbles
		9.10 - 9.60	B							
										Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring 6.60m to 12.80m.;The borehole was advanced by chiselling methods from 13.80m to 14.20m (1 hour) and from 14.20m to 14.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1100 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446543.00 - 330990.00	Hole Type CP
Location:		Level: 36.25	Scale 1:50
Client: Highways England		Dates: 26/10/2006 - 26/10/2006	Logged By MW

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.60 - 11.10	B							SAND and GRAVEL (as previous sheet) Below 10.60m; some to many cobbles
		12.10 - 12.60	B							
		12.80	D				12.80	23.45		
		12.90 - 13.35	U							Stiff brown sandy slightly gravelly SILT. Gravel is subangular to subrounded medium to coarse, of sandstone, mudstone, siltstone, quartz and coal. FGA
		13.40	D							
		13.80 - 14.10	D				13.80	22.45		
		13.80 - 14.20	B							Brown gravelly SAND with some cobble sized pockets of grey brown sandy silt and sandy clay. Sand is fine and medium. Gravel is angular to subrounded fine and medium, of quartz, siltstone, mudstone, coal and sandstone with some subangular cobbles. Silt is locally gravelly to very gravelly. Clay is locally slightly gravelly. FGA-SG
		14.20 - 14.44	D							
		14.20 - 14.50	B							
		14.50 - 14.68	D				14.50	21.75		
							14.70	21.55		Grey brown, locally dark grey brown sandy gravelly SILT/CLAY. Gravel is subangular to subrounded fine to coarse, of sandstone, siltstone, quartz and coal. FGA
										End of borehole at 14.70 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. :An amount of water was added to facilitate boring 6.60m to 12.80m.:The borehole was advanced by chiselling methods from 13.80m to 14.20m (1 hour) and from 14.20m to 14.50m (1 hour).:No visual or olfactory indication of contamination was observed.:

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Rotary Core Log

Borehole No. NWHM68
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446559.25 - 331070.13	Hole Type CP
Location:		Level: 35.28	Scale 1:50
Client: Highways England		Dates: 09/09/1999 - 13/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00	D							MADE GROUND: Topsoil with some fine to coarse gravel, on to terram. MG-EF
		0.00	D				0.30	34.98		
		0.30	D				0.50	34.78		MADE GROUND: Red brown sand with occasional gravel and cobbles. MG-EF
		0.30	D				0.60	34.68		
		0.50	D							MADE GROUND: Grey fine to coarse subangular gravel of limestone. MG-EF
		0.50	D							
		0.60	D							MADE GROUND: Firm to stiff locally stiff red brown locally mottled grey slightly sandy clay with a little fine and medium subangular gravel of mudstone. (Mercia Mudstone Fill) MG-EF
		0.60	D							
		1.00	D							
		1.00	D							
		1.20	D							
		1.20	D							
		2.00 - 2.50	B							
		2.00 - 2.50	B							
		3.00 - 3.50	B							
		3.00 - 3.50	B							
		4.00	B							
		4.00 - 4.40	B							
		4.40	D				4.40	30.88		Very dense reddish brown medium SAND with some to much fine to coarse subangular to rounded gravel of sandstone and quartz. (River Terrace Deposits) RTD1
		4.40	D							
		4.50 - 4.90	B							
		4.50 - 4.90	B							
		5.40	D				5.40	29.88		Firm dark grey green organic (peaty) CLAY with traces of fibrous matter. Organic odour. (Alluvium) ALV
		5.40	D				5.70	29.58		
		6.00	B							Medium dense brown medium SAND and GRAVEL: Gravel content fine to coarse subangular to rounded of limestone, sandstone and quartz. (River Terrace Deposits) RTD1
	▼	6.00 - 6.50	B							
		6.50 - 7.00	B							
		6.50 - 7.00	B							
		7.50	B							
		7.50 - 8.00	B							
		8.50	D							
		8.50	D							
		9.00 - 9.50	B							
		9.00 - 9.50	B							
		9.60	D				9.60	25.68		Firm to stiff and stiff red brown slightly sandy CLAY with a little fine and medium subangular to
		9.60	D							
		9.70	B							
		9.70	U							
										Continued on next sheet

Remarks
1. Hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. Upon completion of borehole at 14.60m borehole grouted from base to0.50m. Topsoil replaced. 3. Marker Post Ref 188/9 -50S.

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Rotary Core Log

Borehole No. NWHM68
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446559.25 - 331070.13	Hole Type CP
Location:		Level: 35.28	Scale 1:50
Client: Highways England		Dates: 09/09/1999 - 13/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.70	U							rounded gravel of sandstone and mudstone, rare coal traces. (Glacial Till) GTA-CL
	▼	9.70 - 10.00	B							
		10.50	D							
		10.50	D							
		11.00	D				11.00	24.28		Dense grey brown clayey SAND and GRAVEL - Gravel content fine to coarse subangular to rounded of sandstone, quartz and limestone. FGA-SG
		11.00	D							
		11.50	D							
		11.50	D							
		12.00	D							
		12.00	D							
		12.50	B							
		12.50 - 13.50	B							
		13.80	D				13.80	21.48		Very stiff grey sandy locally slightly sandy CLAY with a little fine to coarse subangular to rounded gravel of sandstone, mudstone, coal and limestone. (Glacial Till) FGA
		13.80	D							
		13.90	U							
		13.90	U							
		14.60	D				14.60	20.68		End of borehole at 14.60 m
		14.60	D							

Remarks
1. Hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. Upon completion of borehole at 14.60m borehole grouted from base to0.50m. Topsoil replaced. 3. Marker Post Ref 188/9 -50S.

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Rotary Core Log

Borehole No. SK43SE12
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446590.00 - 330920.00	Hole Type CP
Location:		Level: 31.00	Scale 1:50
Client: Highways England		Dates: 06/02/1962 - 09/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	30.70		Topsoil TP
		0.61	W							Sandy subsoil RTD1
		0.76	D				0.91	30.09		
		1.22	B							Gravel RTD1
		1.22 - 1.68	SPTL							
		1.52	S							
			D							
							2.29	28.71		Silt RTD1
		2.44	D				2.67	28.33		
		3.05	D							Sand & gravel RTD1
		3.05 - 3.51	SPTL							
		3.35	S							
			B							
		4.57	D							
		5.18	B							
		5.18 - 5.64	SPTL							
			S							
		6.10	D							
							6.55	24.45		
		6.71	D							Brown boulder clay FGA
		7.62 - 8.08	U							
		8.08	D							
		9.14 - 9.53	U							
		9.60	D							
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK43SE12
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446590.00 - 330920.00	Hole Type CP
Location:		Level: 31.00	Scale 1:50
Client: Highways England		Dates: 06/02/1962 - 09/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.97	D							
		10.97 - 11.51	U							
		12.50	D							
		12.65 - 13.03	U							
		14.02	D							
		14.78 - 15.14	U							
		15.24	D				15.24	15.76		End of borehole at 15.24 m

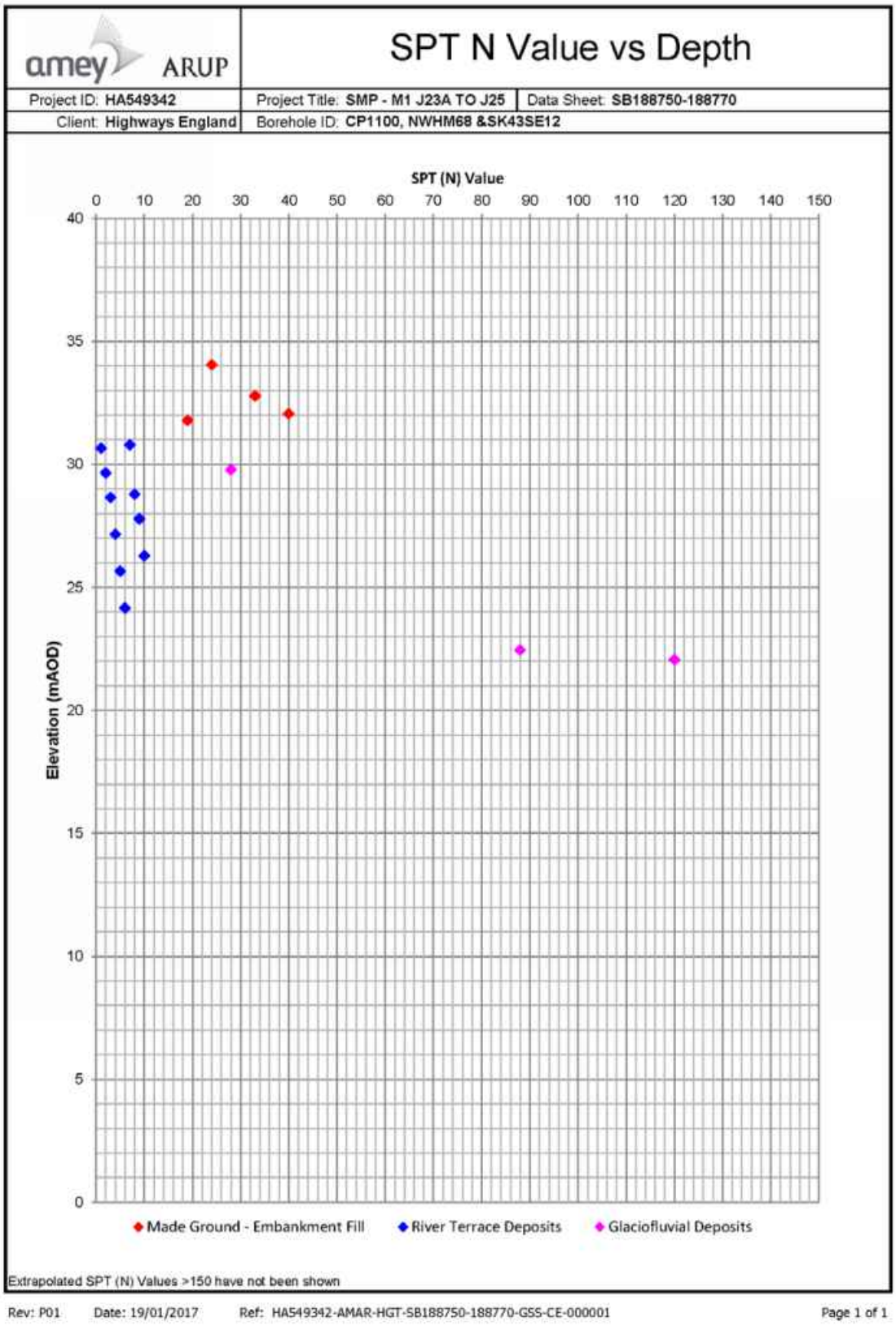
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Remarks

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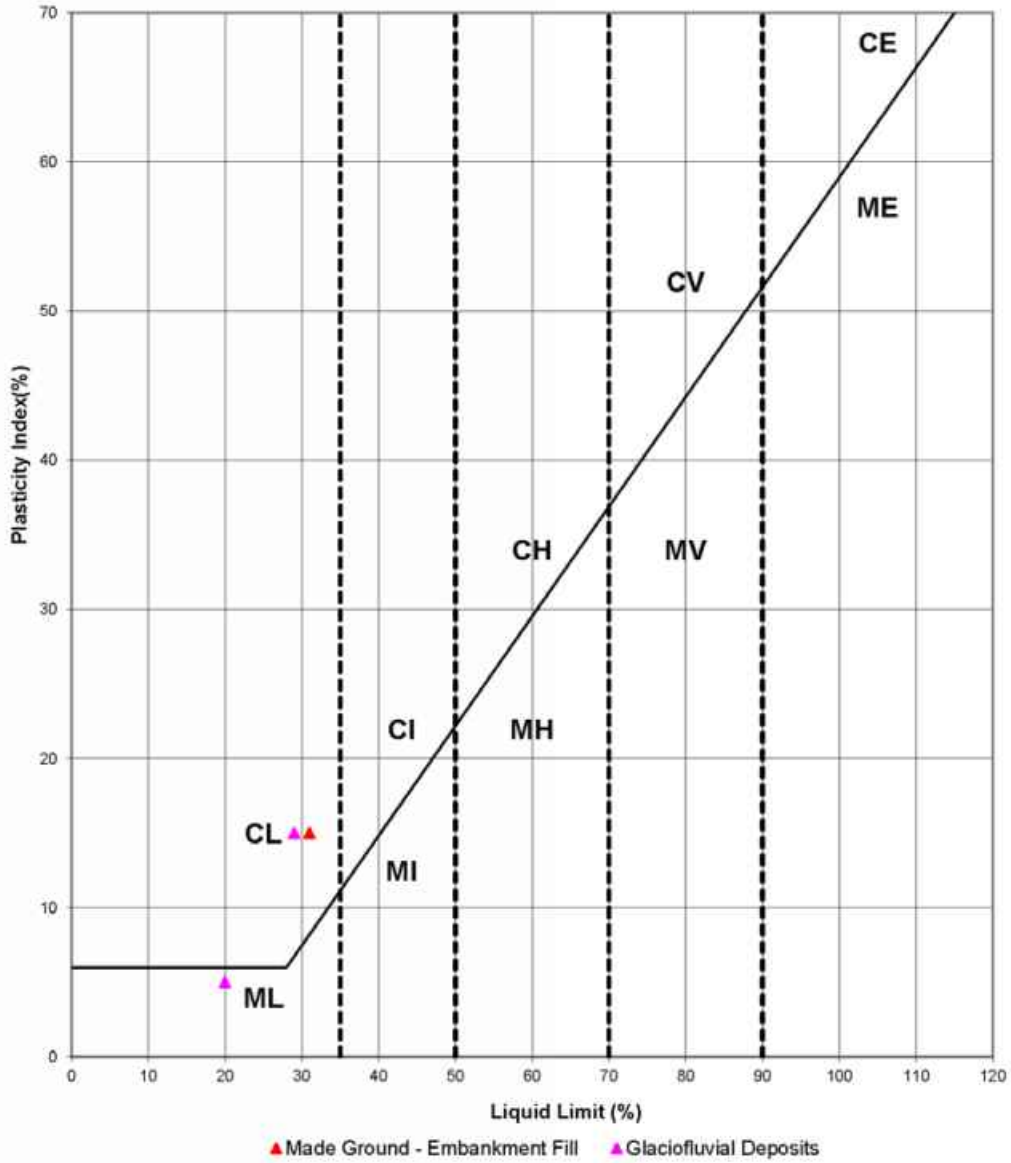
PLOTS



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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **SB188750-188770**
Client: **Highways England**	Borehole ID: **CP1100 & NWHM68**	



Key

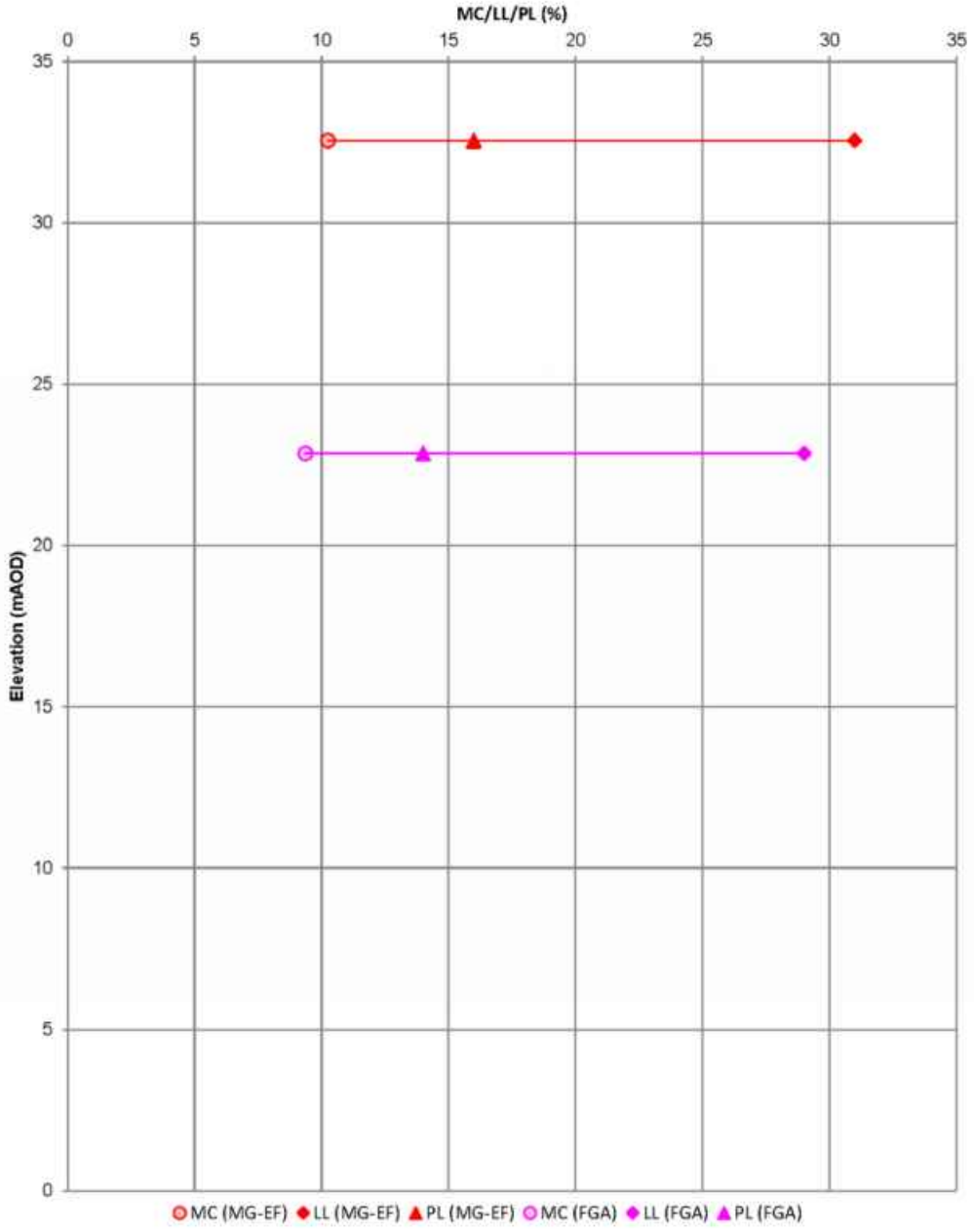
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 19/01/2017 Ref: HA549342-AMAR-HGT-SB188750-188770-GSS-CE-000001 Page 1 of 1

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **SB188750-188770**
Client: **Highways England**	Borehole ID: **CP1100 & NWHM68**	

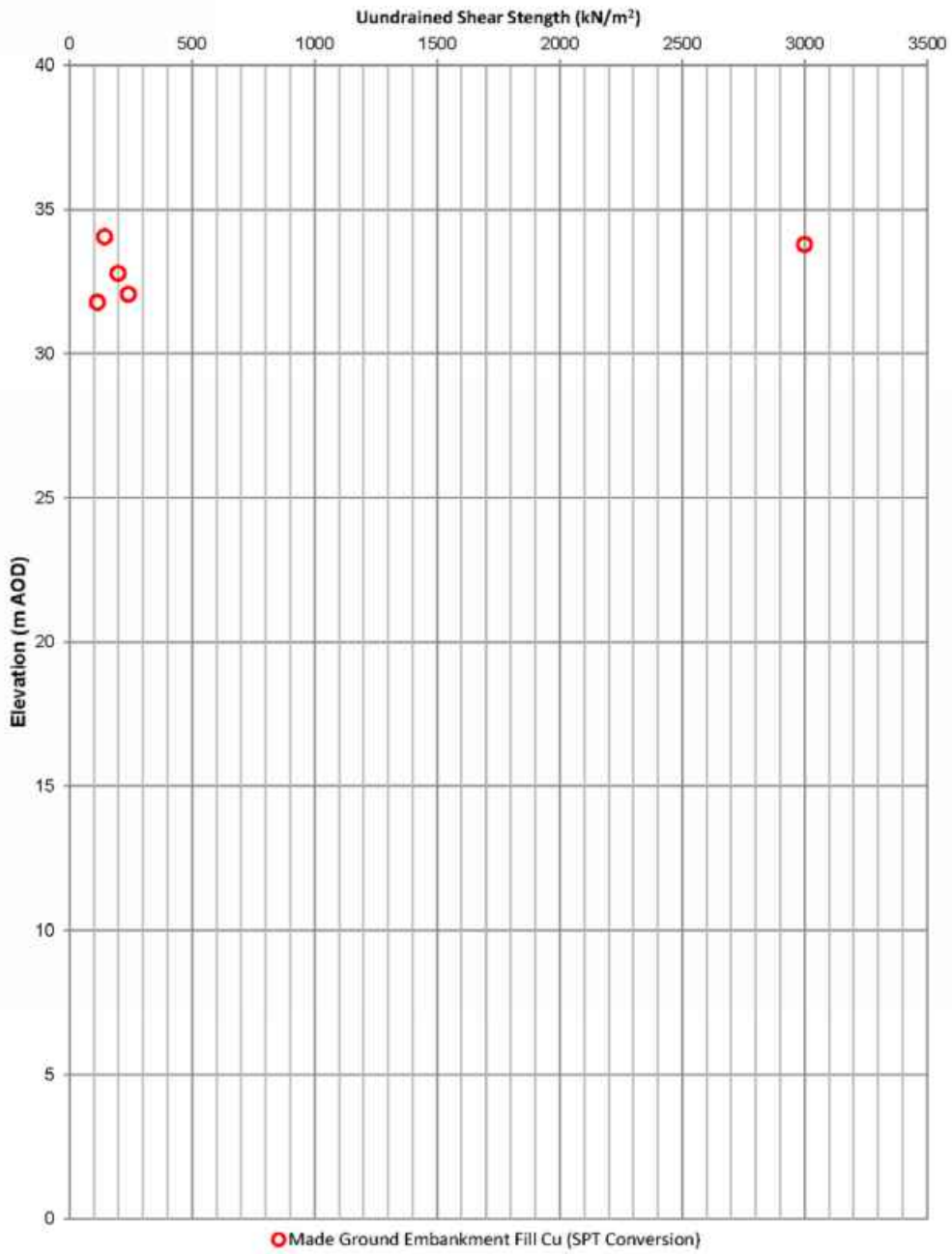


Rev: P01 Date: 19/01/2017 Ref: HA549342-AMAR-HGT-SB188750-188770-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **SB188750-188770**
Client: **Highways England**	Borehole ID: **CP1100 & NWHM68**	



Rev: P01 Date: 19/01/2017 Ref: HA549342-AMAR-HGT-SB188750-188770-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-188940-188960SB-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	Gantry 309		
Structure Type	MS3 Cantilever		
Design Chainage	188940 - 188960		
Carriageway	Southbound		
Marker Post	MP188/9B+40 – MP188/9B+60		
National Grid Reference	E 446535, N 331172 – E 446533, N 331192		
Existing Ground Level at Location	Carriageway	34.4mAOD	
	Toe of embankment	29.9mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_54261	HAGDMS designation
Earthwork Height	NB: N/A	SB: 4.5m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 19°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Roheel Masrat	15/02/2107	[redacted]
Checked	Alice Bazen	17/02/2017	
Reviewed	Gary Summerfield	17/02/2017	
Approved	Tom Bulteel	24/02/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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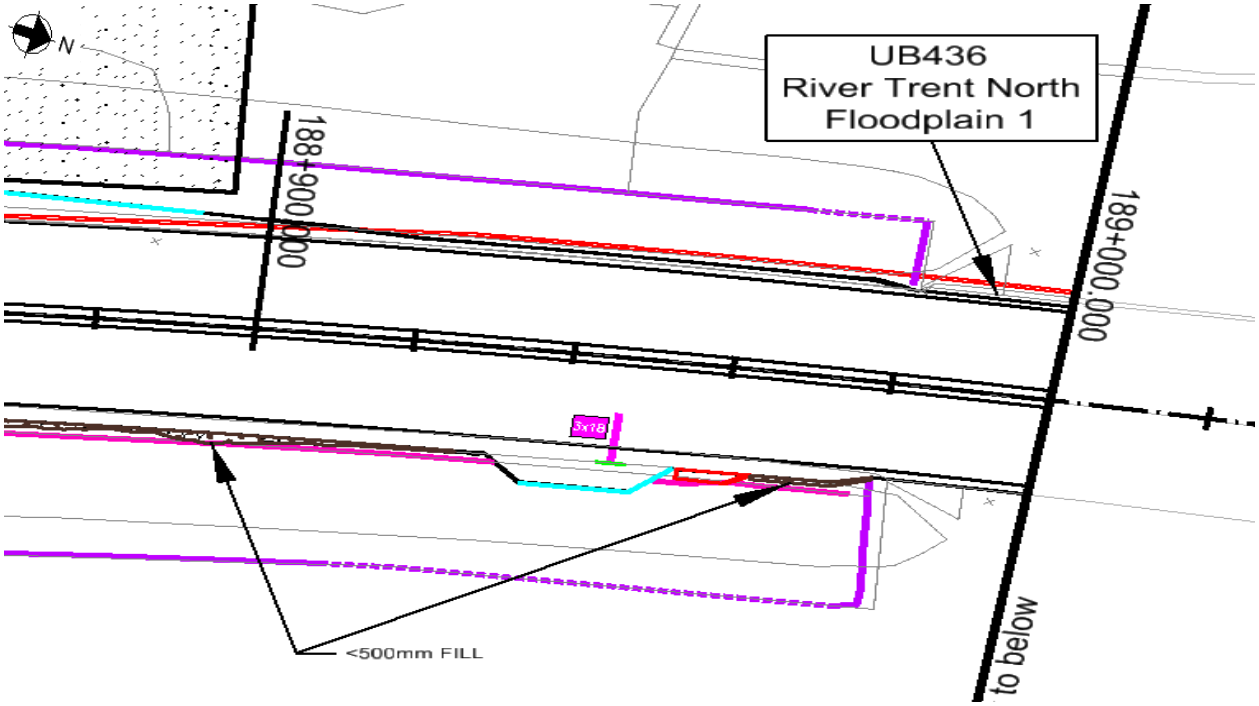


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- King Sheet Pile Retaining Wall.

Proposed Structures:

A new MS3 Cantilever Gantry (Gantry 309) has been proposed at chainage 188947..

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is classified as an embankment of 4.4-4.5m height and a typical slope angle of 19°.

The critical cross section design of the retaining wall was at Ch188950 and is based on the section with the greatest retained height.

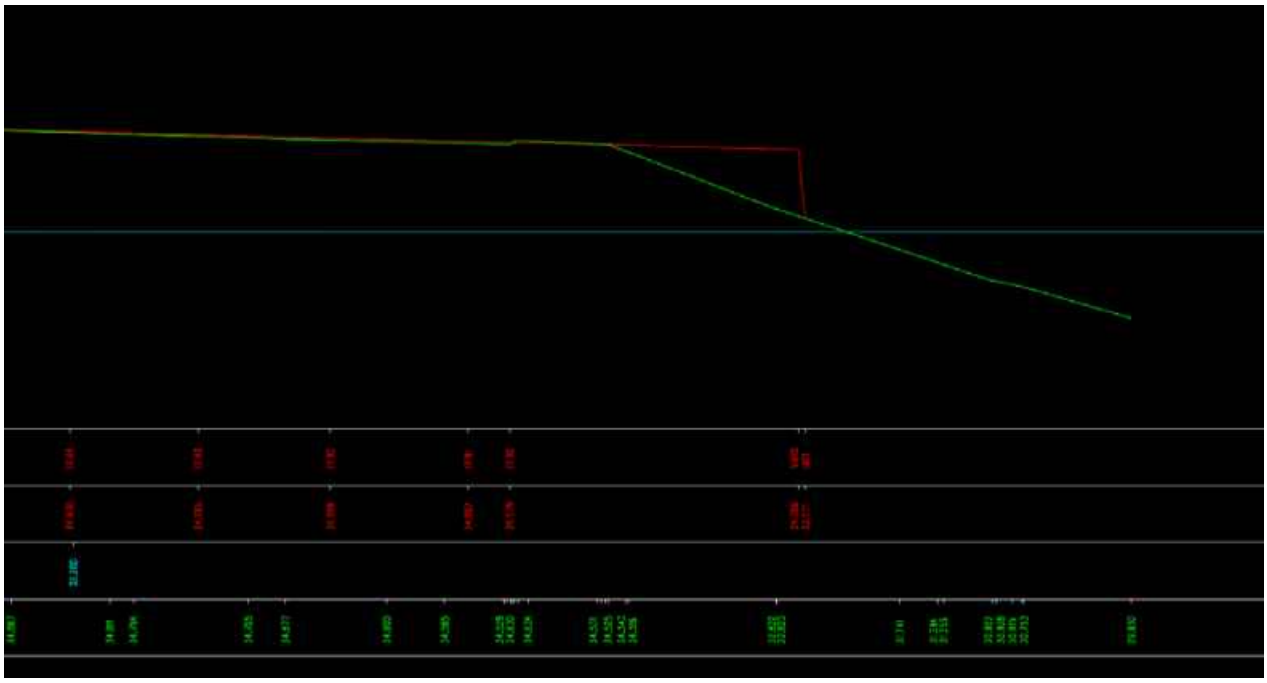


Figure 2: Topographic Critical Cross Section Ch188950

Utilities:

A Western Power Overhead Mid Voltage cable is recorded at the crest of the embankment on the STATs plan for this location (Drawing No. HA549342-AMAR-VUT-MLC-DR-CU-000007, Rev P01).

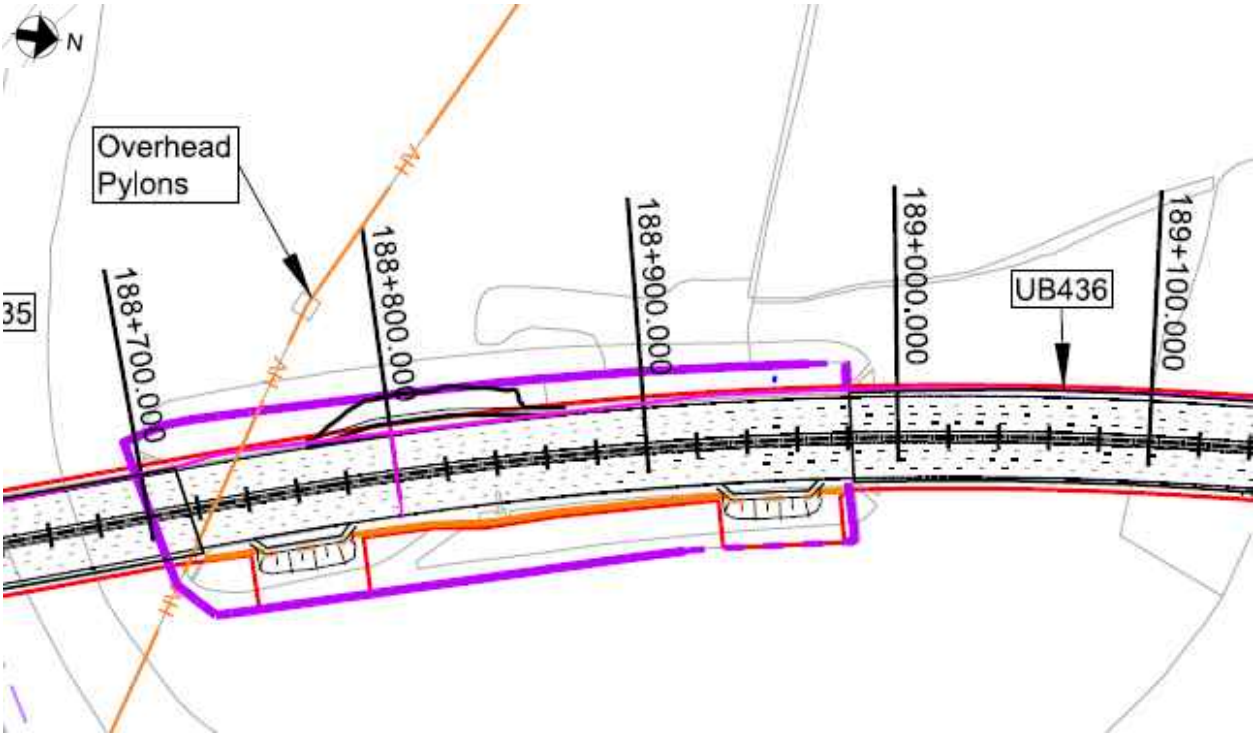


Figure 3 – Utilities Location Plan

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Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Alluvium

Solid Deposits: Edwalton Member (Mercia Mudstone Group)

Ground Investigation:

There are 2 No. historical exploratory holes recorded within the design chainage, with additional 1 no. relevant exploratory holes considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000031 Rev P01.

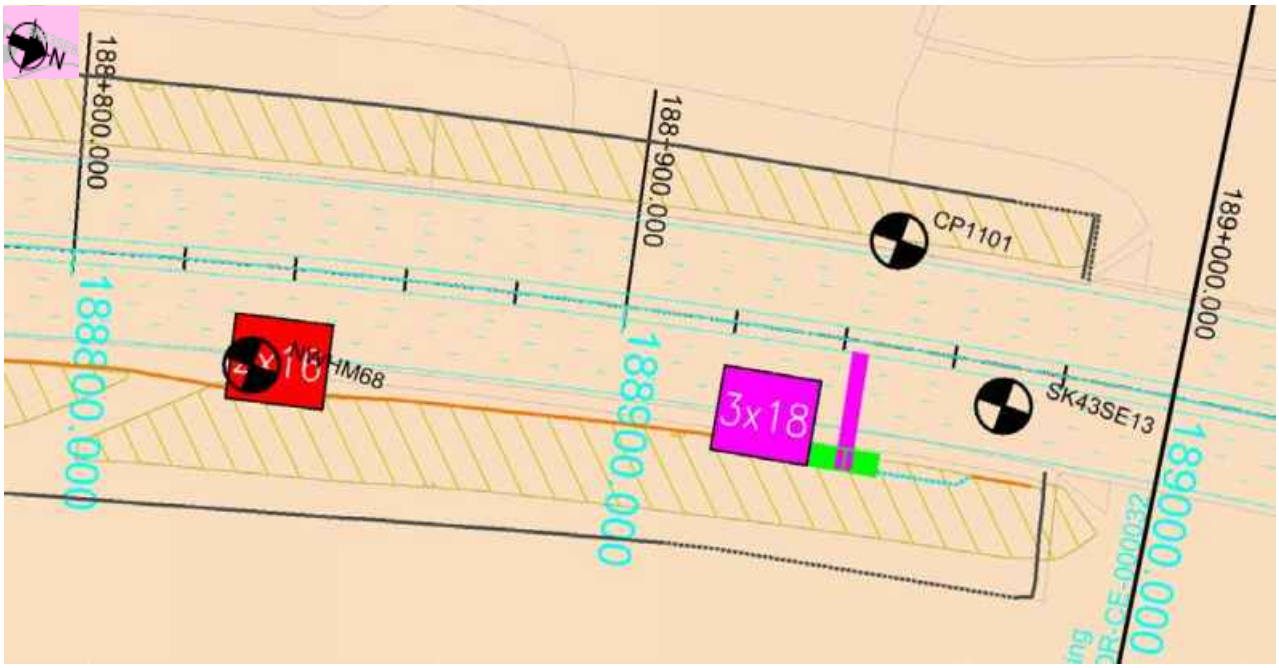


Figure 3: Borehole Location Plan

Flood Risk:

The design flood level has been recorded as 32.20mAOD. Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	SK43SE13
Borehole Chainage	188970
Borehole Location	Southbound
National Grid	E 446520, N 331200

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Reference	
Ground Level at Exploratory Hole	29.80AOD
RAG Analysis	Amber
Date Drilled	09/02/1962 – 14/02/1962
Termination Depth	15.24 metres below ground level (mbgl)
Other suitable holes	CP1101 and NWHM68

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl[+])	Depth to Base (mAOD)	SPT 'N' Value Range*
Embankment Fill	4.5	29.9	19-150 (30)
River Terrace Deposits	8.3	26.1	13-79 (40)
Glaciofluvial Deposits (fine grained)	12.8	21.6	38-150 (38)
Mercia Mudstone – III/IV	Not proven	Not proven	Not recorded

(1) Ground level is assumed to be at carriageway level;
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within historical exploratory holes CP1101, SK43SE13 and NWHM68.

Groundwater:

The following groundwater strikes were recorded in the historical exploratory holes:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
NWHM68	River Terrace Deposits	6.30	29.00	-	-	-
SK43SE13	River Terrace Deposits	1.52	28.30	20 mins	1.52	28.30

Groundwater Design Level:

Limited local groundwater data is available. Therefore a groundwater level of 32.20mAOD (flood level) has been assumed for WALLAP analysis of the king and intermediate sheet pile. When checking the global stability check of the earthwork and king and intermediate sheet pile (analysed using SLOPE W) a Ru value of 0.2 for has been used for all strata**.**

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

3 No. Atterberg Limit Tests and 3 No. Moisture Content Tests were undertaken within historical exploratory holes with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	1.7	13	25	12	13	CL
Embankment Fill	3.7	9	25	11	14	CL
Glaciofluvial Deposits (fine grained)	13.3	20	23	21	12	CL

1 No. undrained triaxial test was undertaken within the embankment fill with the following results:

Stratum	Depth to Top of Test (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	6.1	64

Lab Test Data – BRE Classification:

The following pH testing data was available from the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Sulphate (Total) as SO4	Solid	1	0.06	%SO4
Embankment Fill	Water Soluble Sulphate as SO4	Water	1	0.03	g/l SO4
Embankment Fill	pH	Solid	1	8.4	-
Embankment Fill	pH	Water	1	8.6	

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000031 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outlines the assumed anticipated ground model, to be confirmed by 'Just in Time' validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment Fill	0.0-4.5	34.4-29.9	4.5	21	27	0	150	10.8	8.6	-	0.50	0.20		6.20	0.40	-	6.2*	-	DS-2 AC-2
River Terrace Deposits	4.5-8.3	29.9-26.1	3.8	20	38	-	-	-	55.2	-	-	0.35		20.44	-	1.0	-	50	DS-3 AC-3
Glaciofluvial Deposits (fine grained)	8.3-12.8	26.1-21.6	4.5	21	26	0	190	13.2	10.6	-	0.50	0.20		4.42	0.40	-	9.0	-	DS-3 AC-3
Mercia Mudstone – III/IV	>12.8	<21.6	-	21	30	2	150	16.8	13.4	-	0.50	0.20		5.60	0.40	-	9.0	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Given the insufficient amount of local PI data for Embankment Fill, the characteristic ϕ' given in the AMAR GIR was adopted.
(4) A typical SPT 'N' value of 30 was used for Embankment Fill, combined with a typical f1 value of 5.0 (for Mercia Mudstone after CIRIA C570, given the lack of local PI data and that the material comprises reworked Mercia Mudstone), using the Stroud correlation gives a c_u of 150kN/m^2.
(5) Eu for Embankment Fill was derived using SPT 'N' values (Bowles) where Eu = 300 (N+6); using a characteristic SPT 'N' value of 30 gives Eu = 10.8MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 8.6MN/m^2.
(6) ϕ' of River Terrace Deposits was determined using correlation with SPT 'N' values (Peck 1974). Using a characteristic SPT 'N' value of 40 gives an angle of 38°.
(7) E' for River Terrace Deposits was derived using SPT 'N' values (Bowles) where E' = 1200 (N+6); using a characteristic SPT 'N' value of 40 gives E' = 55.2MN/m^2.

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(8) Given the insufficient amount of local PI data for Glaciofluvial Deposits (fine grained), the characteristic ϕ' given in the AMAR GIR was adopted.
(9) A characteristic SPT 'N' value of 38 was used for the Glaciofluvial Deposits (fine grained), combined with an assumed f1 value of 5.0, using the Stroud correlation gives a c_u of 190kN/m^2.
(10) Eu for Glaciofluvial Deposits (fine grained) was derived using SPT 'N' values (after Bowles) where Eu = 300 (N+6); using a characteristic SPT 'N' value of 38 gives Eu = 13.2MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 10.6MN/m^2.
(11) Due to lack of local GI data, parameters derived from the AMAR GIR have been used for the Mercia Mudstone – III/IV.
(12) Shear modulus is based on G = E/2(1+v).
(13) Adhesion Factor for Mercia Mudstone is based on BS8004 (equation 41).
(14) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl
(15) K_o/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).
(16) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1). For sandstone, Nq is derived based on a very dense siliceous cohesionless soil (Tomlinson Table 7.1).
(17) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for River Terrace Deposits, Glaciofluvial Deposits and Mercia Mudstone, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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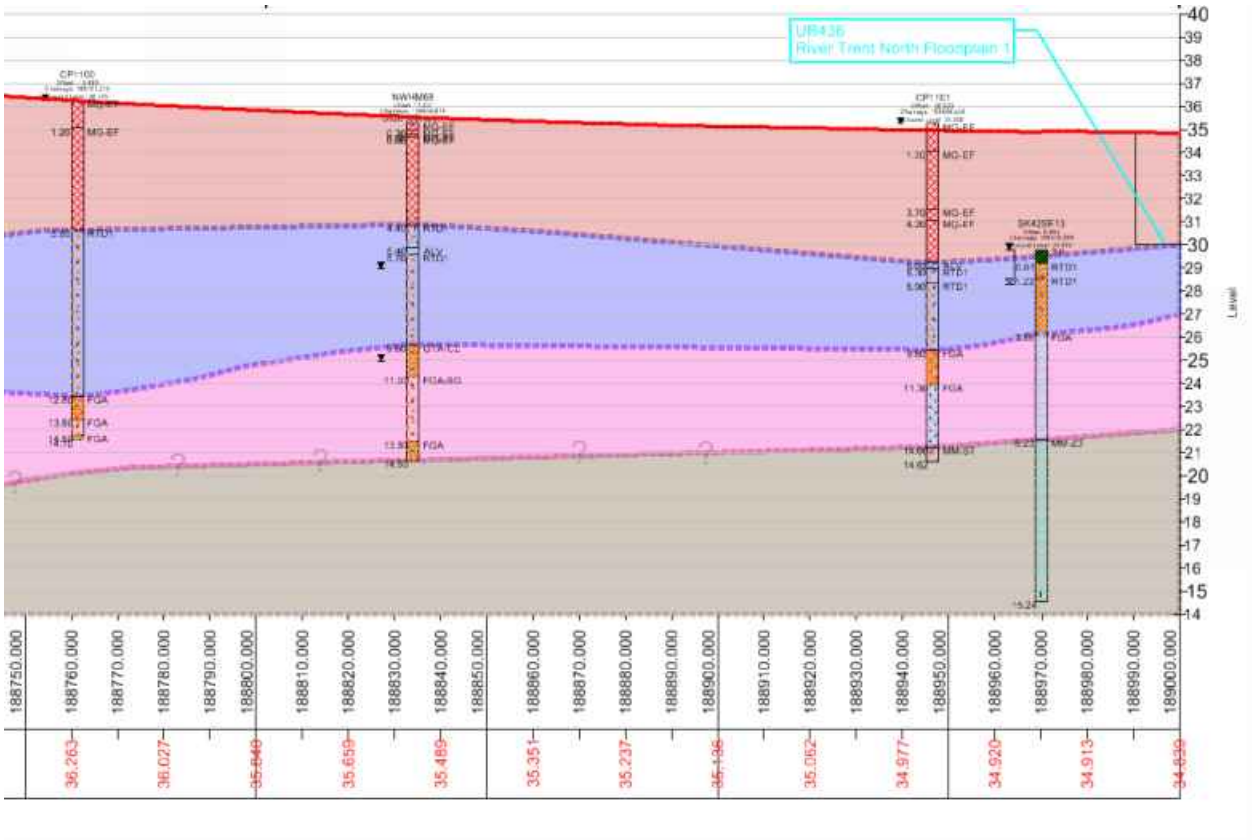


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to flood plain, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
188940	188960	AZ-24 S 390 GP	2.1	5.7	8.0	85	51	22.0	115.2

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	750	12.0	2.25	10	146	396

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:
:

- BH-G309 at chaiange 188947, 17m deep dynamic sample hole with rotary core follow on, to be located in southbound verge.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **CP1101** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446498.00 - 331172.00	Hole Type CP
Location:		Level: 35.25	Scale 1:50
Client: Highways England		Dates: 18/10/2006 - 31/10/2006	Logged By MW

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 1.20	B							MADE GROUND. Gravelly to very gravelly sand. Gravel is angular to subangular, fine to coarse of sandstone and limestone with some subangular and subrounded cobbles of sandstone. MG-EF
		1.20 - 1.65	U				1.20	34.05		MADE GROUND. Stiff red brown, locally grey green, slightly sandy to sandy, locally gravelly silt, locally a silt/clay. Gravel is subangular to subrounded, medium to coarse of sandstone, siltstone and rare quartz. MG-EF
		1.70	D							
		2.20 - 2.65	D							
		2.20 - 2.70	B							
		3.20 - 3.65	U							
		3.70	D				3.70	31.55		MADE GROUND. Red brown locally grey green and yellow sandy gravel of fine to coarse angular to subangular sandstone with occasional bands of siltstone. MG-EF
		4.20 - 4.49	D				4.20	31.05		MADE GROUND. Very dense brown fine to medium sandy gravel, becoming sand and gravel. Gravel is fine to coarse angular to subrounded of mixed lithologies. MG-EF
		4.30 - 4.80	B							
		5.20 - 5.70	B							*Below 5.20m: rare subrounded cobbles.*
		6.00	D				6.00	29.25		Firm grey black slightly sandy, slightly gravelly SILT to SILT/CLAY. Gravel is fine to medium subrounded of quartz. ALV
		6.10 - 6.55	U				6.30	28.95		
		6.55	D							Medium dense brown slightly gravelly SAND. Sand is medium to coarse. Gravel is fine to medium subangular to subrounded of quartz. Occasional coarse gravel sized pockets/bands of silty sand. RTD1
		6.60 - 7.05	D							
		6.60 - 7.10	B				6.90	28.35		
		7.60 - 8.10	B							*Below 6.60m: occasional subrounded cobbles* Dense to very dense brown SAND and GRAVEL to a sandy GRAVEL. Sand is coarse. Gravel is fine to coarse angular to subrounded of mixed lithologies, predominantly quartz. Occasional subrounded cobbles. RTD1
		9.10 - 9.60	B							
		9.80 - 10.25	D				9.80	25.45		Very stiff brown sandy slightly gravelly SILT.
		9.80 - 10.30	B							

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 4.50m to 4.80m (0.75 hours), 4.80m to 5.00m (1 hour), 9.40m to 9.80m (1.5 hours) and 14.00m to 14.40m (1 hour).;No visual or olfactory indication of contamination was observed.;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.20m.;

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No.: COCDFL1SMP01	Co-ords: 446498.00 - 331172.00	Borehole No.: CP1101 Sheet 2 of 2
Location:		Level: 35.25	Hole Type: CP
Client: Highways England		Dates: 18/10/2006 - 31/10/2006	Scale: 1:50
			Logged By: MW

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Gravel is subrounded medium of sandstone and siltstone. FGA
		11.30 - 11.75	D				11.30	23.95		Red brown locally green grey SILT, locally a CLAY to a SILT/CLAY. Occasional fine gravel sized lithorelics and rare coarse subrounded gravel sized lithorelics. Gravel is fine to coarse subangular to subrounded of quartz and siltstone. FGA
		11.30 - 11.80	B							
		12.80 - 13.25	U							
		13.30	D							
		14.00	D				14.00	21.25		SILTSTONE recovered as red brown locally green grey silt locally a clay with fine to coarse subangular to subrounded gravel sized fragments. With possible quartz and occasional gypsum. MM-ST
		14.00 - 14.40	B							
		14.40	D							
							14.62	20.63		End of borehole at 14.62 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 4.50m to 4.80m (0.75 hours), 4.80m to 5.00m (1 hour), 9.40m to 9.80m (1.5 hours) and 14.00m to 14.40m (1 hour).;No visual or olfactory indication of contamination was observed.;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.20m.;

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Rotary Core Log

Borehole No. **NWHM68**
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446559.25 - 331070.13	Hole Type CP
Location:		Level: 35.28	Scale 1:50
Client: Highways England		Dates: 09/09/1999 - 13/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00	D							
		0.00	D							
		0.30	D				0.30	34.98		MADE GROUND: Topsoil with some fine to coarse gravel, on to terram. MG-EF
		0.30	D				0.50	34.78		
		0.50	D				0.60	34.68		MADE GROUND: Red brown sand with occasional gravel and cobbles. MG-EF
		0.50	D							
		0.60	D							MADE GROUND: Grey fine to coarse subangular gravel of limestone. MG-EF
		0.60	D							
		1.00	D							
		1.00	D							MADE GROUND: Firm to stiff locally stiff red brown locally mottled grey slightly sandy clay with a little fine and medium subangular gravel of mudstone. (Mercia Mudstone Fill) MG-EF
		1.20	D							
		1.20	D							
		2.00 - 2.50	B							
		2.00 - 2.50	B							
		3.00 - 3.50	B							
		3.00 - 3.50	B							
		4.00	B							
		4.00 - 4.40	B							
		4.40	D				4.40	30.88		Very dense reddish brown medium SAND with some to much fine to coarse subangular to rounded gravel of sandstone and quartz. (River Terrace Deposits) RTD1
		4.40	D							
		4.50 - 4.90	B							
		4.50 - 4.90	B							
		5.40	D				5.40	29.88		Firm dark grey green organic (peaty) CLAY with traces of fibrous matter. Organic odour. (Alluvium) ALV
		5.40	D				5.70	29.58		
		6.00	B							Medium dense brown medium SAND and GRAVEL: Gravel content fine to coarse subangular to rounded of limestone, sandstone and quartz. (River Terrace Deposits) RTD1
	▼	6.00 - 6.50	B							
		6.50 - 7.00	B							
		6.50 - 7.00	B							
		7.50	B							
		7.50 - 8.00	B							
		8.50	D							
		8.50	D							
		9.00 - 9.50	B							
		9.00 - 9.50	B							
		9.60	D				9.60	25.68		Firm to stiff and stiff red brown slightly sandy CLAY with a little fine and medium subangular to
		9.60	D							
		9.70	B							
		9.70	U							

Continued on next sheet

Remarks

1. Hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. Upon completion of borehole at 14.60m borehole grouted from base to0.50m. Topsoil replaced. 3. Marker Post Ref 188/9 -50S.

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Rotary Core Log

Borehole No. **NWHM68** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446559.25 - 331070.13	Hole Type CP
Location:		Level: 35.28	Scale 1:50
Client: Highways England		Dates: 09/09/1999 - 13/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.70	U							rounded gravel of sandstone and mudstone, rare coal traces. (Glacial Till) GTA-CL
	▼	9.70 - 10.00	B							
		10.50	D							
		10.50	D							
		11.00	D				11.00	24.28		Dense grey brown clayey SAND and GRAVEL:- Gravel content fine to coarse subangular to rounded of sandstone, quartz and limestone. FGA-SG
		11.00	D							
		11.50	D							
		11.50	D							
		12.00	D							
		12.00	D							
		12.50	B							
		12.50 - 13.50	B							
		13.80	D				13.80	21.48		Very stiff grey sandy locally slightly sandy CLAY with a little fine to coarse subangular to rounded gravel of sandstone, mudstone, coal and limestone. (Glacial Till) FGA
		13.80	D							
		13.90	U							
		13.90	U							
		14.60	D				14.60	20.68		End of borehole at 14.60 m
		14.60	D							

Remarks

1. Hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. Upon completion of borehole at 14.60m borehole grouted from base to0.50m. Topsoil replaced. 3. Marker Post Ref 188/9 -50S.

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Rotary Core Log

Borehole No. **SK43SE13**
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446520.00 - 331200.00	Hole Type CP
Location:		Level: 29.80	Scale 1:50
Client: Highways England		Dates: 09/02/1962 - 14/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	D				0.61	29.19		Topsoil TP
		0.91	D				1.22	28.58		Brown subsoil RTD1
		1.52	D							Gravel & sand RTD1
		1.83 - 2.29	SPTL							
		1.83 - 2.29	S							
			B							
		3.05	D							
							3.66	26.14		Sandy boulder clay FGA
		3.96	D							
		4.27 - 4.57	U							
		5.49	D							
		5.79 - 6.10	U							
		7.01	D							
		7.32 - 7.62	U							
							8.23	21.57		Red & grey marl MM-Z3
		8.53	D							
		8.84 - 9.14	U							
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK43SE13**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446520.00 - 331200.00	Hole Type CP
Location:		Level: 29.80	Scale 1:50
Client: Highways England		Dates: 09/02/1962 - 14/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.06	D							
		10.36 - 10.74	U							
		11.58	D							
		12.04 - 12.24	U							
		13.11	D							
		13.41 - 13.54	U							
		14.63	D							
		15.09 - 15.24	U							
		15.24	D				15.24	14.56		End of borehole at 15.24 m

Remarks

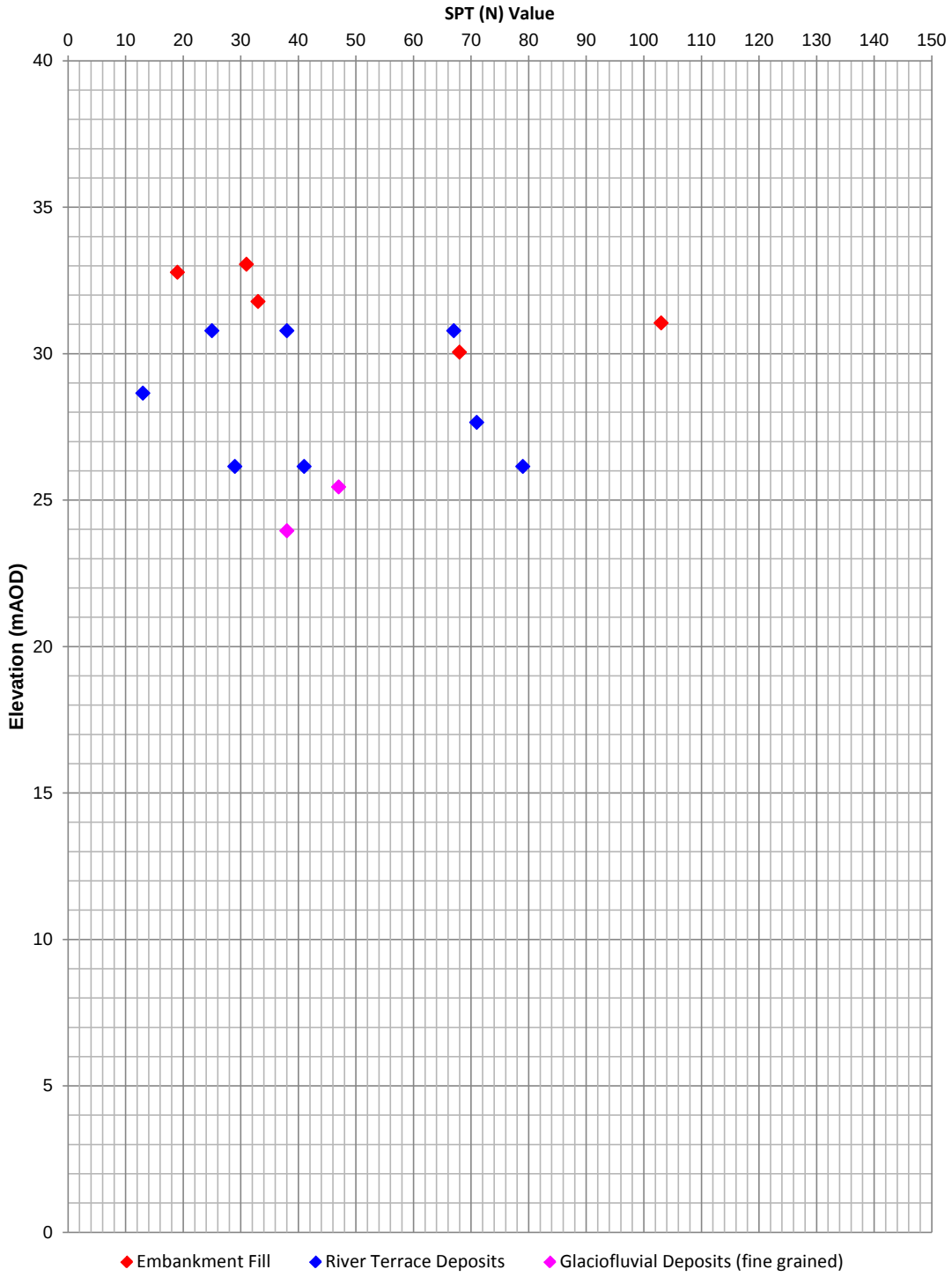
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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188940-188960SB**
Client: **Highways England**	Borehole ID: **CP1101, SK43SE13, NWHM68**	



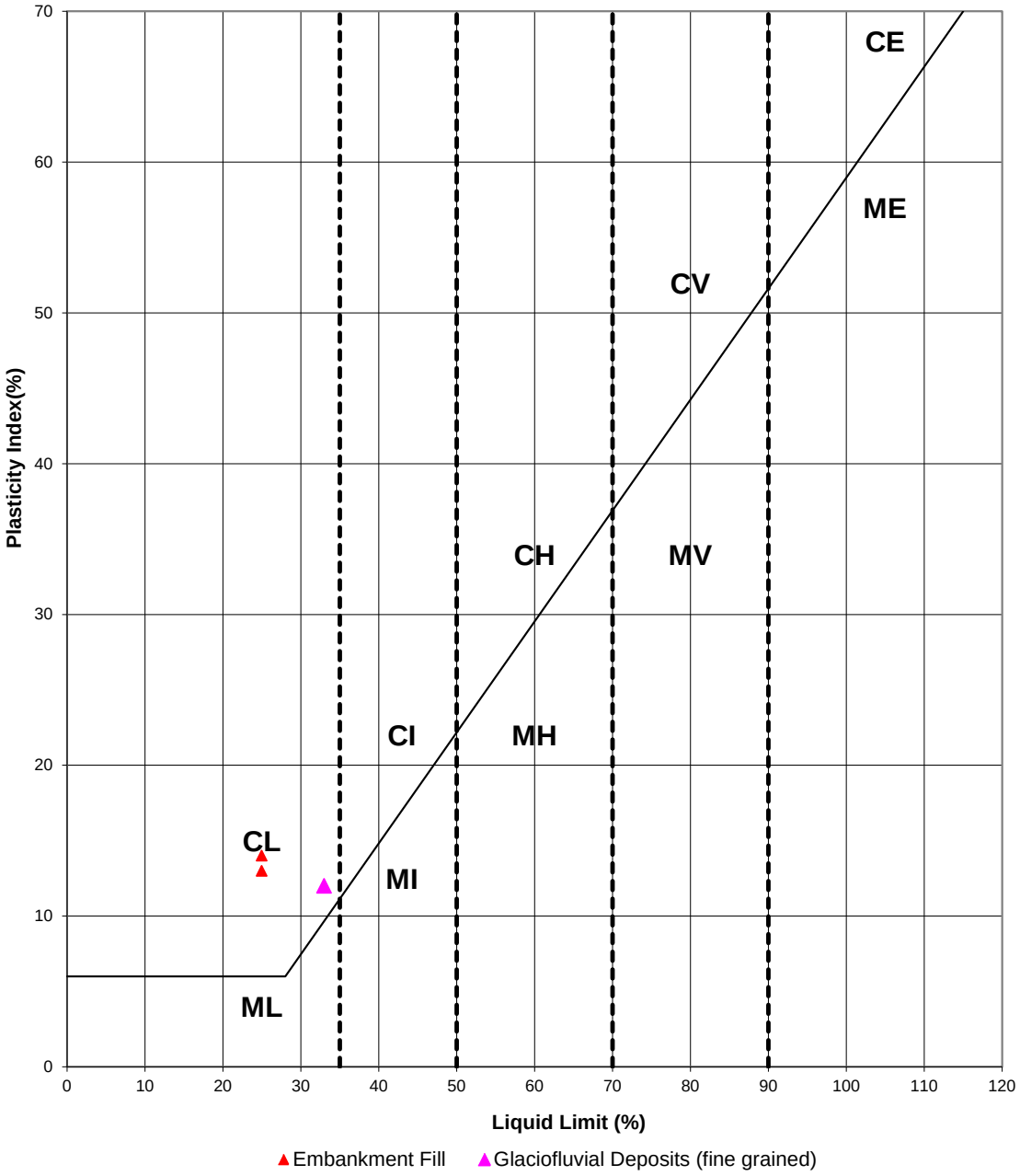
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 20/01/2017 Ref: HA549342-AMAR-HGT-188940-188960SB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188940-188960SB**
Client: **Highways England**	Borehole ID: **CP1101**	



Key

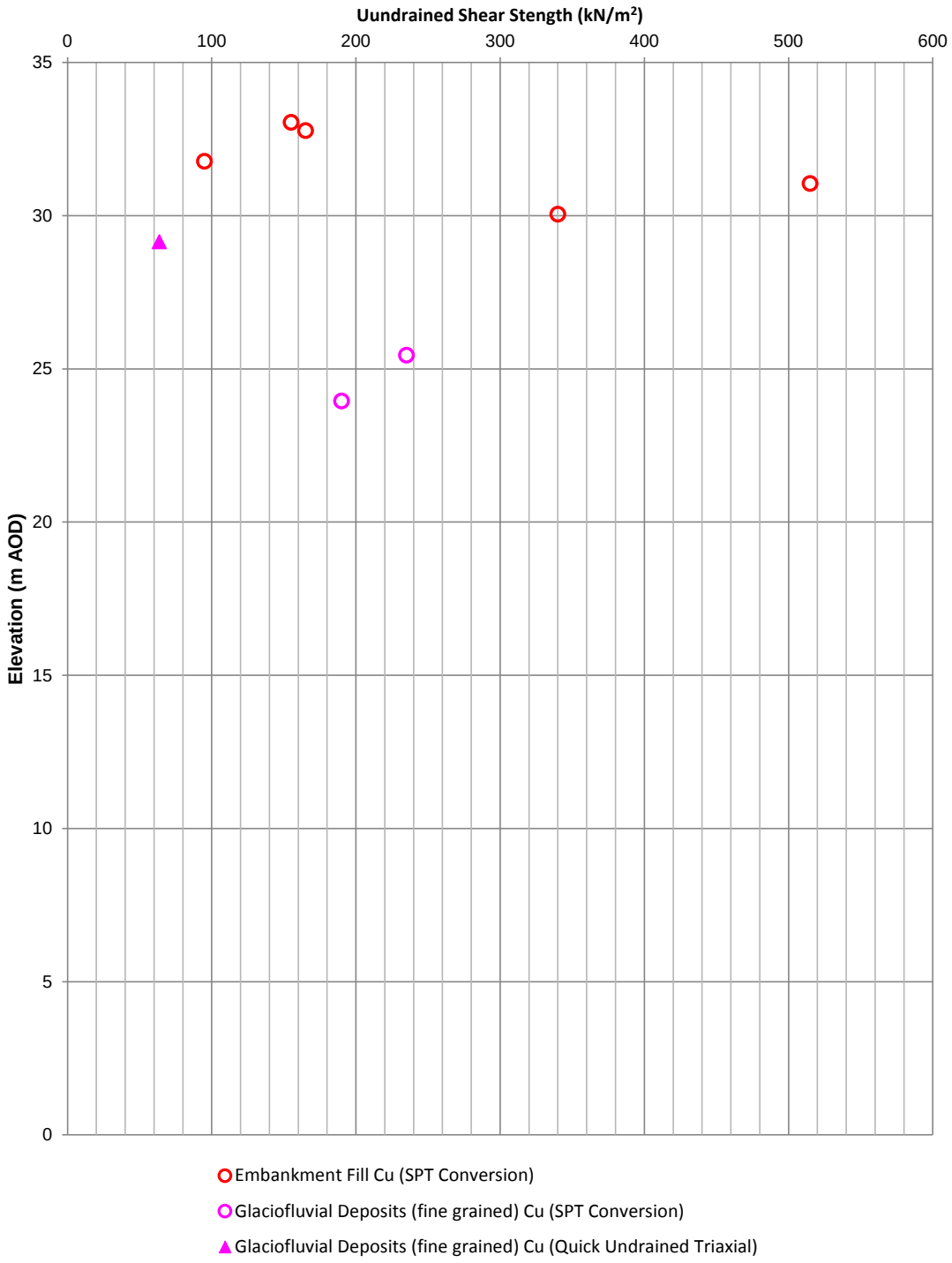
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 20/01/2017 Ref: HA549342-AMAR-HGT-188940-188960SB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188940-188960SB**
Client: **Highways England**	Borehole ID: **CP1101, NWHM68**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-189160-189170SB-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	Gantry 310		
Structure Type	MS4 Cantilever Gantry		
Design Chainage	189160-189170		
Carriageway	Southbound		
Marker Post	189/1B+60 – 189/1B+70		
National Grid Reference	E 446509, N 331388 – E 446508, N 331400		
Existing Ground Level	Carriageway	34.27mAOD	
	Toe of Embankment	29.97mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_21157	HAGDMS designation
Earthwork Height	NB: N/A	SB: 4.3m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 22°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	23/01/2017	[redacted]
Checked	Alice Bazen	26/01/2017	
Reviewed	Gary Summerfield	01/02/2017	
Approved	Tom Bulteel	08/02/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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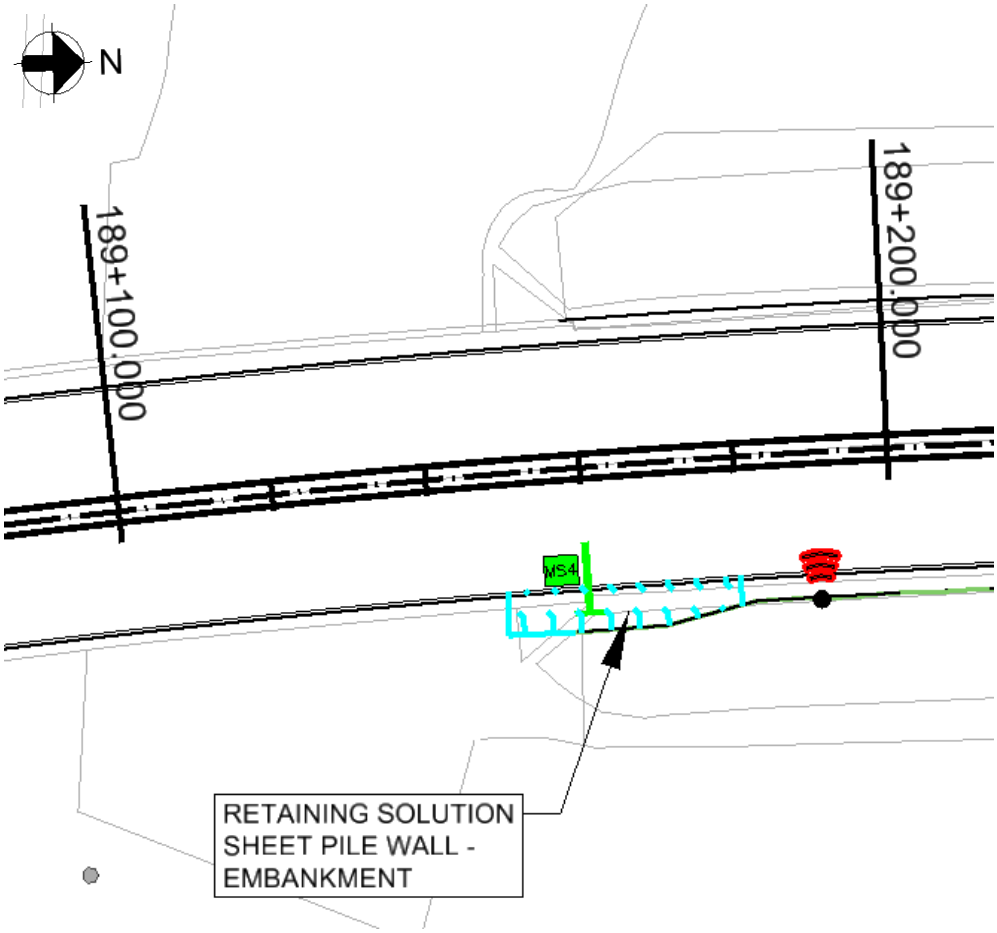


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- King sheet pile retaining wall

Proposed Major Structure:

New proposed MS4 Cantilever Gantry (Gantry 310) proposed at chainage 189160.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment. The embankment ranges from approximately 4.1-4.3m in height and has a typical slope angle of 22°.

The critical cross section at chaiange 189160 is based on the section with the greatest earthwork height.

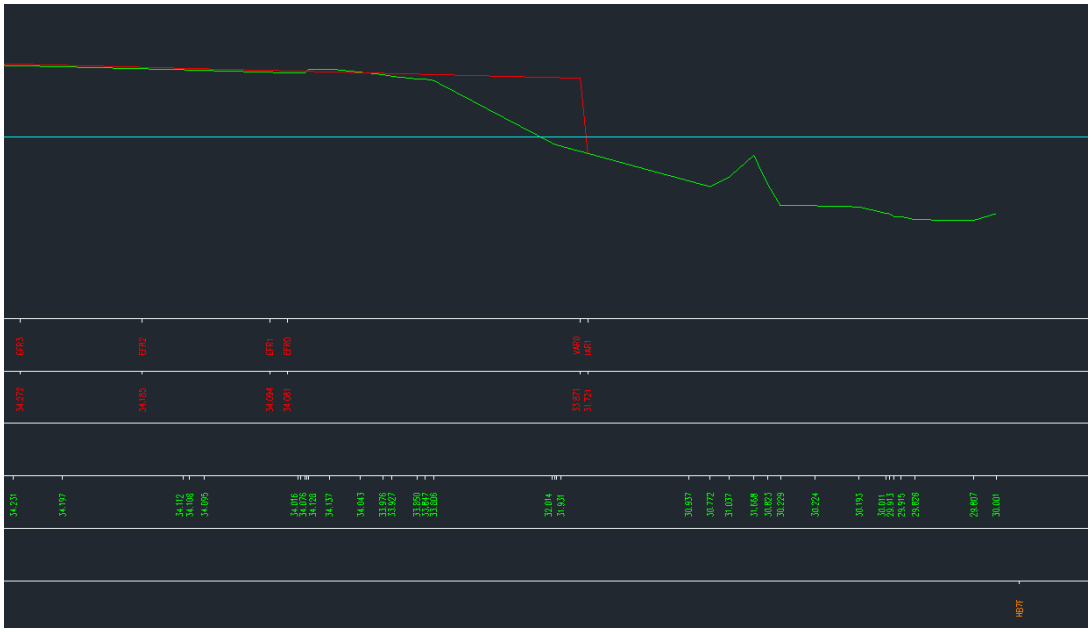


Figure 2: Topographic Critical Cross Section Ch189160

Utilities:

There are no known utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Alluvium (Clay, Silt, Sand and Gravel)

Solid Deposits: Edwalton Member, Mercia Mudstone Group (Mudstone)

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however 3 no. relevant exploratory holes have been considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000031, Rev P01.

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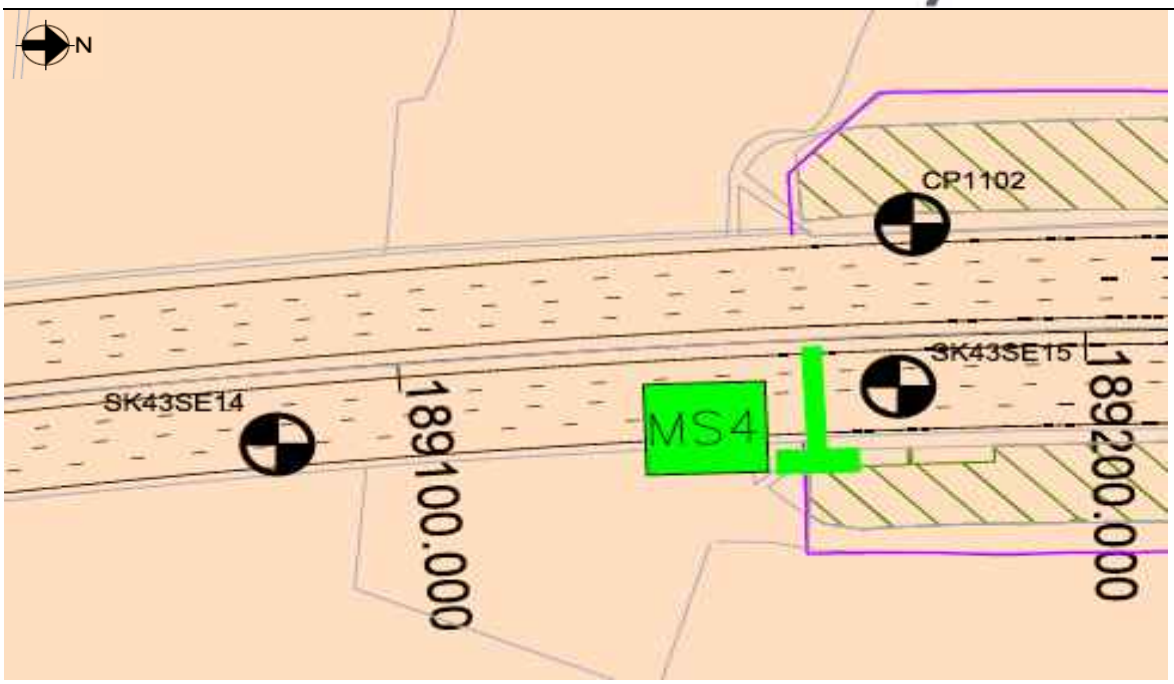


Figure 3: Borehole Location Plan

Flood Risk:

The design flood level is 32.2mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	SK43SE15	CP1102	SK43SE14
Borehole Chainage	189174	189081	189172
Borehole Location	Southbound (beneath mainline carriageway, completed before motorway construction)	Northbound (existing verge)	Southbound (beneath mainline carriageway, completed before motorway construction)
National Grid Reference	E 446500, N 331400	E 446472, N 331402	E 446510, N 331310
Ground Level at Exploratory Hole	30.10mAOD	34.65mAOD	29.30mAOD
RAG Analysis	Amber	Green	Amber
Date Drilled	01/02/1962 – 05/02/1962	18/10/2006 – 01/11/2006	31/01/1962 – 08/02/1962

Termination Depth	14.86m	22.17m	14.06m
Other suitable holes	None		

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Embankment Fill (fine grained)	4.1	29.8	35
River Terrace Deposits (coarse grained)	9.1	24.8	27-150 (27)
Glaciofluvial Deposits (fine grained)	13.2	20.7	83
Mercia Mudstone – III/IV	Not proven	Not proven	None recorded

(1) Ground level is assumed to be at the carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Embankment Fill was recorded as coarse grained material in historical exploratory hole CP1102 within the bottom 2m of the fill. This borehole was undertaken within the embankment on the northbound carriageway; therefore it is not confirmed whether the same coarse grained material will be present within the bottom 2m of fill for the southbound embankment. As a conservative assumption, fine grained materials are assumed for the full extents of the Embankment Fill. As a result of the above assumption, any in situ or laboratory test undertaken within the coarse grained materials of the Embankment Fill has not been used to derive parameters for the Embankment Fill at this location.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within historical exploratory holes CP1102, SK43SE14 and SK43SE15.

Groundwater:

The following groundwater strikes were recorded in historical exploratory holes for this location:

- SK43SE14 – 0.9mbgl (28.4mAOD) within River Terrace Deposits (coarse grained);
- SK43SE15 – 2.0mbgl (28.1mAOD) within River Terrace Deposits (coarse grained), rising to 1.6mbgl (28.5mAOD) within River Terrace Deposits (coarse grained) after 4.5hours.

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
SK43SE14	River Terrace Deposits	0.90	28.40	-	-	-
SK43SE15	River Terrace Deposits	2.00	28.10	4.5 hours	1.60	28.50

Groundwater Design Level:

Limited groundwater data is available. Therefore a groundwater level of 32.20mAOD (flood level) has been assumed for WALLAP analysis of the king and intermediate sheet piles. When checking the global stability check of the earthwork and king and intermediate sheet piles

(analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata

GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

3 No. Atterberg Limit tests and 3 No. Moisture Content tests were undertaken within historical exploratory hole CP1102. The results for these tests are summarised in the table below:

Stratum	Depth (m)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class*
Embankment Fill	1.7	7	23	11	12	CL
Embankment Fill	3.7	4	24	11	13	CL
Glaciofluvial Deposits (fine grained)	10.75	14	30	11	19	CL

2 No. quick undrained triaxial test was undertaken within historical exploratory hole CP1102, with the results presented in the table below:

Stratum	Depth (m)	Undrained Shear Strength (kN/m^2)
Embankment Fill	4, 7	69
Embankment Fill	-	102

Lab Test Data – BRE Classification:

Chemical test data is presented in the table below:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Water Soluble Sulphate as SO4	Water	1	0.06	g/l SO4
Embankment Fill	pH	Water	1	8.70	-

:

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Assumed Ground Model For Design:

Ground model based on geological long section HA549342-AMAR-HGT-SWI-DR-CE-000032 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment Fill	0-4.1	33.9-29.8	4.1	21	27	0	100	7.8	6.2	-	0.50	0.20	-	0.45	2.60	6.2	-	-	DS-2 AC-2
River Terrace Deposits (coarse grained)	4.1-9.1	29.8-24.8	5.0	20	35	-	-	-	39.6	-	-	0.35	-	-	14.70	-	-	50	DS-3 AC-3
Glaciofluvial Deposits (fine grained)	9.1-13.2	24.8-20.7	4.1	21	26	0	100	7.8	6.2	-	0.50	0.20	-	0.45	2.60	9	-	-	DS-3 AC-3
Mercia Mudstone – III/IV	>13.2	<20.7	-	21	30	2	100	16.8	13.4	-	0.50	0.20	-	0.45	5.60	-	-	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used as a basis for the parameters above.
(3) Given the limited amount of GI data for Embankment Fill, the typical parameters given in the AMAR GIR were adopted.
(4) ϕ' of River Terrace Deposits can be determined using correlation with SPT (Peck 1974) 'N' values. Using a conservative SPT 'N' value of 27 gives an angle of 35°.
(5) E' of River Terrace Deposits can be determined using Bowles correlation E' = 1200 (N + 6) which (using a conservative SPT 'N' value of 27) gives a value of 39.6MN/m^2.
(6) Given the limited amount of localised GI data for Glaciofluvial Deposits (fine grained), the typical parameters given in the AMAR GIR were adopted.
(7) Given the absence of localised GI data for Mercia Mudstone – III/IV, the typical parameters given in the AMAR GIR were adopted.
(8) Adhesion factor, for use in the design of bored piles, is based on BS8004 (equation 41).
(9) Shear modulus is based on G = E/2(1+v).

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(10) Nc is based on CIRIA C570.
(11) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).
(12) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1).
(13) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1). For sandstone, Nq is derived based on a dense to very dense siliceous cohesionless soil (Tomlinson Table 7.1).
(14) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of king sheet piles in embankments; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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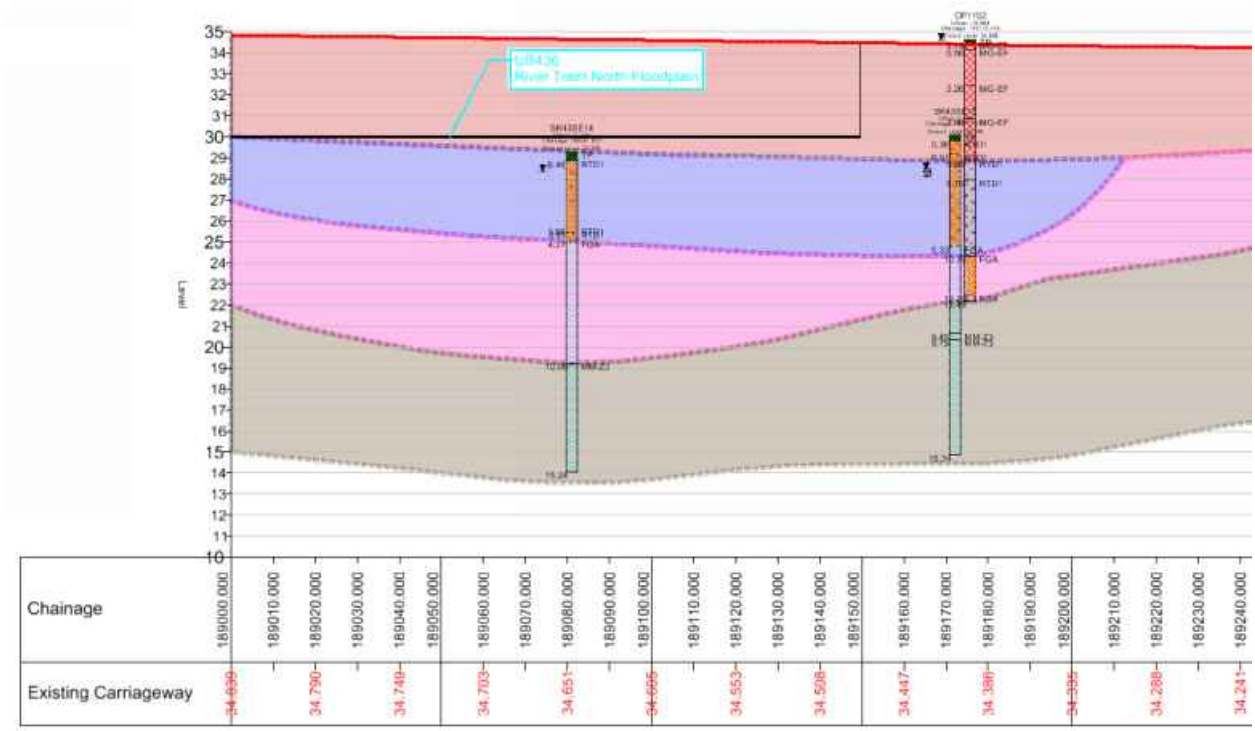


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to this encroaching on the flood plain, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
189160	189170	AZ-24 S 390 GP	2.5	5.3	8.0	82	41	23.0	109.2

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	750	6.0	2.25	10	160	578

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-G310 at chainage189160, Southbound - 11m deep dynamic sample hole with rotary core follow on, to be located in southbound hardstrip.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **CP1102** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446472.00 - 331402.00	Hole Type CP
Location:		Level: 34.65	Scale 1:50
Client: Highways England		Dates: 18/10/2006 - 01/11/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.15	34.50		TOPSOIL TP
		0.50 - 1.20	B				0.50	34.15		MADE GROUND. Light red brown, slightly clayey, very gravelly sand. Gravel is subangular and angular, fine to coarse of sandstone and mudstone. MG-EF
		1.20 - 1.65	U							MADE GROUND. Stiff red brown, clayey, slightly gravelly fine and medium sand. Gravel is subangular and subrounded, fine to coarse of sandstone. MG-EF
		1.70	D							
		2.20 - 2.65 2.20 - 2.70	D B				2.20	32.45		MADE GROUND. Very stiff red brown gravelly clay with some rootlets. Gravel is subangular and subrounded, fine to coarse of weathered mudstone and sandstone. MG-EF
		3.20 - 3.65	U							At 3.20m, firm.
		3.70 3.80 - 4.30	D B				3.80	30.85		MADE GROUND. Very dense brown, very gravelly sand with some pockets of brown gravelly clay. Gravel is subrounded and rounded, fine to coarse of quartz and sandstone. MG-EF
		4.80 - 5.30	B							
		5.80 - 6.80	B				5.80	28.85		Very dense dark grey with some red brown mottling, very clayey, gravelly SAND. Gravel is subangular to rounded, fine to coarse of quartz and sandstone. Organic odour. RTD1
		6.80 - 7.30	B				6.70	27.95		Dense, brown grey and white coarse SAND, and subangular to rounded fine to coarse GRAVEL of quartz. RTD1
		7.80 - 8.30	B							
		9.30 - 9.80	B							Below 9.50m, some cobbles of quartz
										Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 4.00m to 4.20m (1/2 hour), from 5.60m to 6.40m (2 hours), and from 12.20m to 12.40m (1 hour) ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 6.80m to 10.70m.;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. **CP1102** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446472.00 - 331402.00	Hole Type CP
Location:		Level: 34.65	Scale 1:50
Client: Highways England		Dates: 18/10/2006 - 01/11/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.30	D				10.30	24.35		SAND and GRAVEL (as previous sheet)
		10.40 - 10.70	U							Soft to firm grey sandy slightly gravelly CLAY and SILT/CLAY. Sand is fine to coarse, gravel is subangular to rounded fine and medium of mudstone and sandstone FGA
		10.75	D							From 10.75m to 11.90m firm and friable
		11.90 - 12.23	D							Below 11.90m mottled red brown and grey
		11.90 - 12.40	B				12.20	22.45		
		12.40 - 12.48	D				12.48	22.17		SILTSTONE, recovered as light green grey subangular and subrounded fine to coarse gravel sized fragments. Possible boulder in FGA-SG
										End of borehole at 12.48 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 4.00m to 4.20m (1/2 hour), from 5.60m to 6.40m (2 hours), and from 12.20m to 12.40m (1 hour) ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 6.80m to 10.70m.;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. **SK43SE14**

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446510.00 - 331310.00	Hole Type CP
Location:		Level: 29.30	Scale 1:50
Client: Highways England		Dates: 31/01/1962 - 08/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	D				0.46	28.84		Topsoil TP
	▼	0.76	D							Gravel & sand RTD1
		1.52 - 1.98	SPTL S							
		2.13	D							
		3.05 - 3.51	SPTL S							
		3.66	D				3.66 3.81	25.64 25.49		Boulders RTD1 Gravel sand & boulders RTD1
							4.27	25.03		Boulder clay FGA
		4.57	D							
		4.88 - 5.21	U							
		6.40	D							
		6.71 - 7.16	U							
		7.92	D							
		8.23 - 8.33	U							
		9.45	D							

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK43SE14
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446510.00 - 331310.00	Hole Type CP
Location:		Level: 29.30	Scale 1:50
Client: Highways England		Dates: 31/01/1962 - 08/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.36 - 10.49	U				10.06	19.24		Red & grey marl MM-Z3
		10.97	D							
		11.89 - 12.19	U							
		12.50	D							
		13.41 - 13.72	U							
		13.87	D							
		14.94 - 15.09	U							
		15.24	D				15.24	14.06		End of borehole at 15.24 m

Remarks

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Rotary Core Log

Borehole No. **SK43SE15**
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446500.00 - 331400.00	Hole Type CP
Location:		Level: 30.10	Scale 1:50
Client: Highways England		Dates: 01/02/1962 - 05/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	29.80		Topsoil TP
										Loamy sandy subsoil RTD1
		0.76	D				0.91	29.19		
		1.22	D							Sand & gravel RTD1
	▼	1.52	B							
	▽	1.52 - 1.98	SPTL S							
		2.13	W							
		2.74	D							
		3.05	B							
		3.05 - 3.51	SPTL S							
		4.27	D							
		4.57	B							
		4.57 - 5.03	SPTL S							
		5.49	D				5.33	24.77		Brown boulder clay FGA
		6.10 - 6.55	U							
		7.01	D							
		7.62 - 8.00	U							
		8.53	D							
		9.14	D							
							9.45	20.65		Green decomposed rock MM-Z3
							9.75	20.35		Red marl
										Continued on next sheet

Remarks
Unable to take any cores after 12.80m - 102mm or 51mm

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Rotary Core Log

Borehole No. **SK43SE15**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446500.00 - 331400.00	Hole Type CP
Location:		Level: 30.10	Scale 1:50
Client: Highways England		Dates: 01/02/1962 - 05/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.67	D							MM-Z3
		11.43 - 11.68	U							
		12.19	D							
		12.80 - 12.98	U							
		13.72	D							
		15.24	D				15.24	14.86		End of borehole at 15.24 m

Remarks
Unable to take any cores after 12.80m - 102mm or 51mm

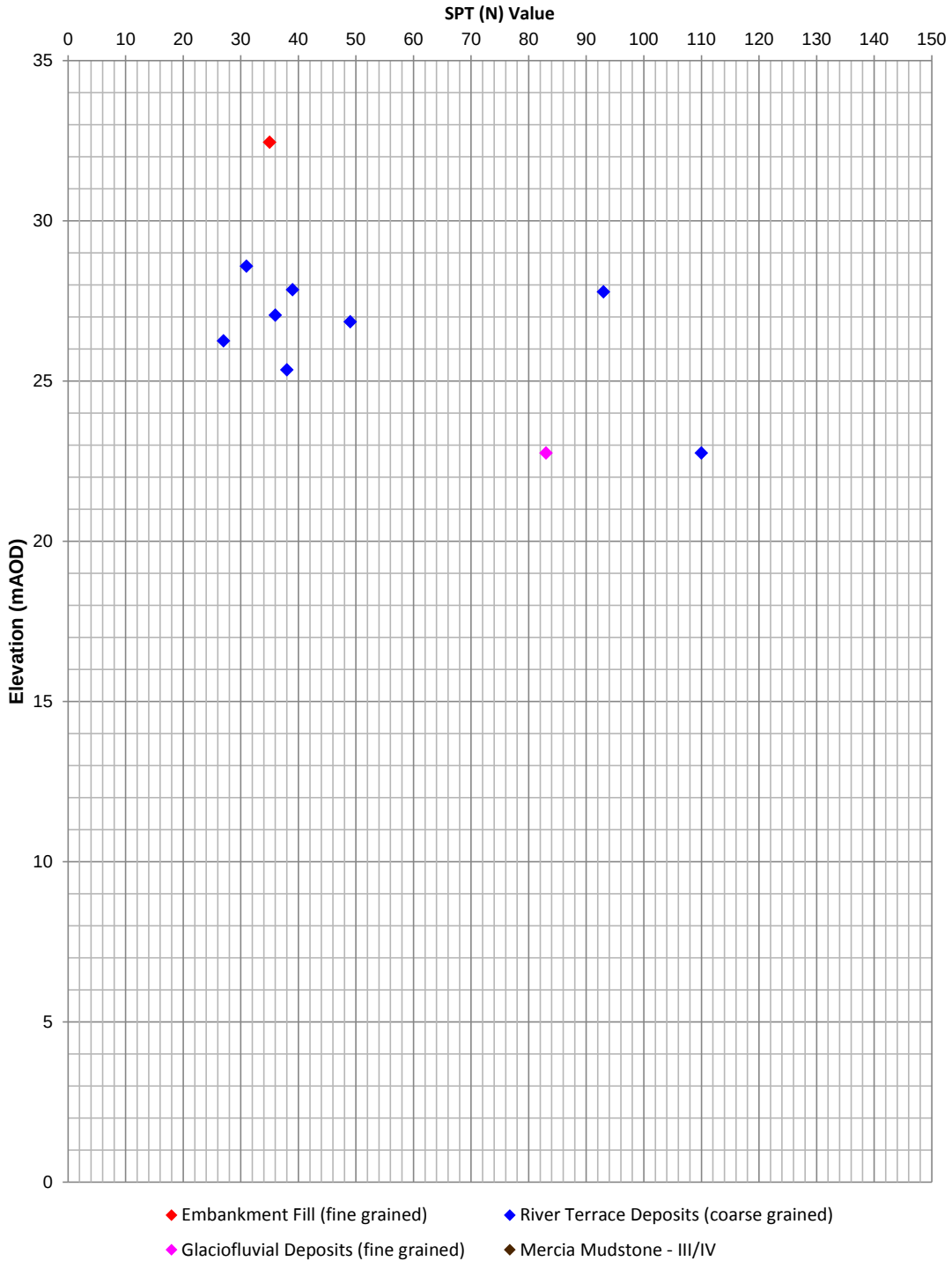
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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **189160-189170**
Client: **Highways England**	Borehole ID: **CP1102, SK43SE14, SK43SE15**	



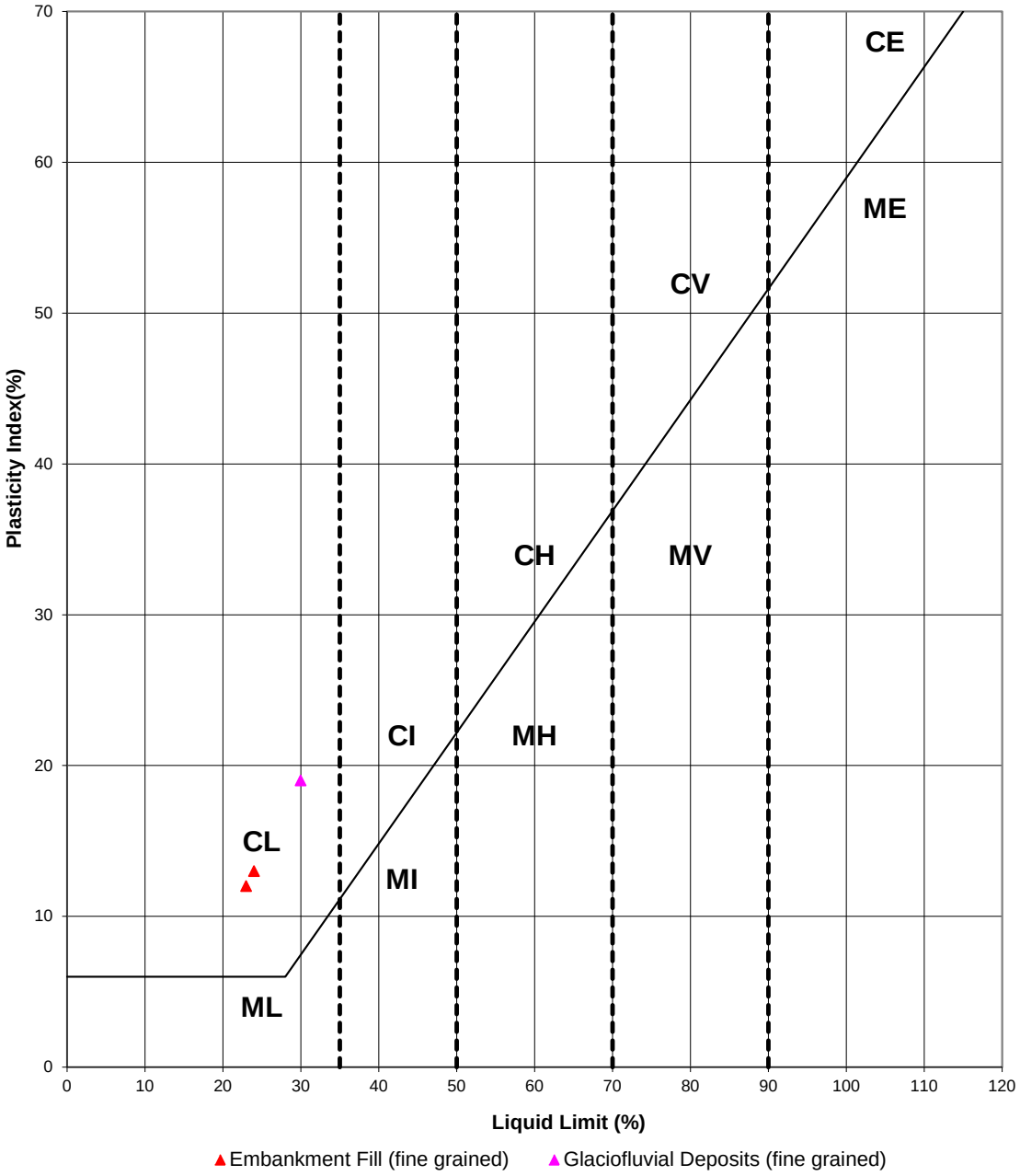
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 18/01/2017 Ref: HA549342-AMAR-HGT-189160-189170-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **181960-181970**
Client: **Highways England**	Borehole ID: **CP1102**	



Key

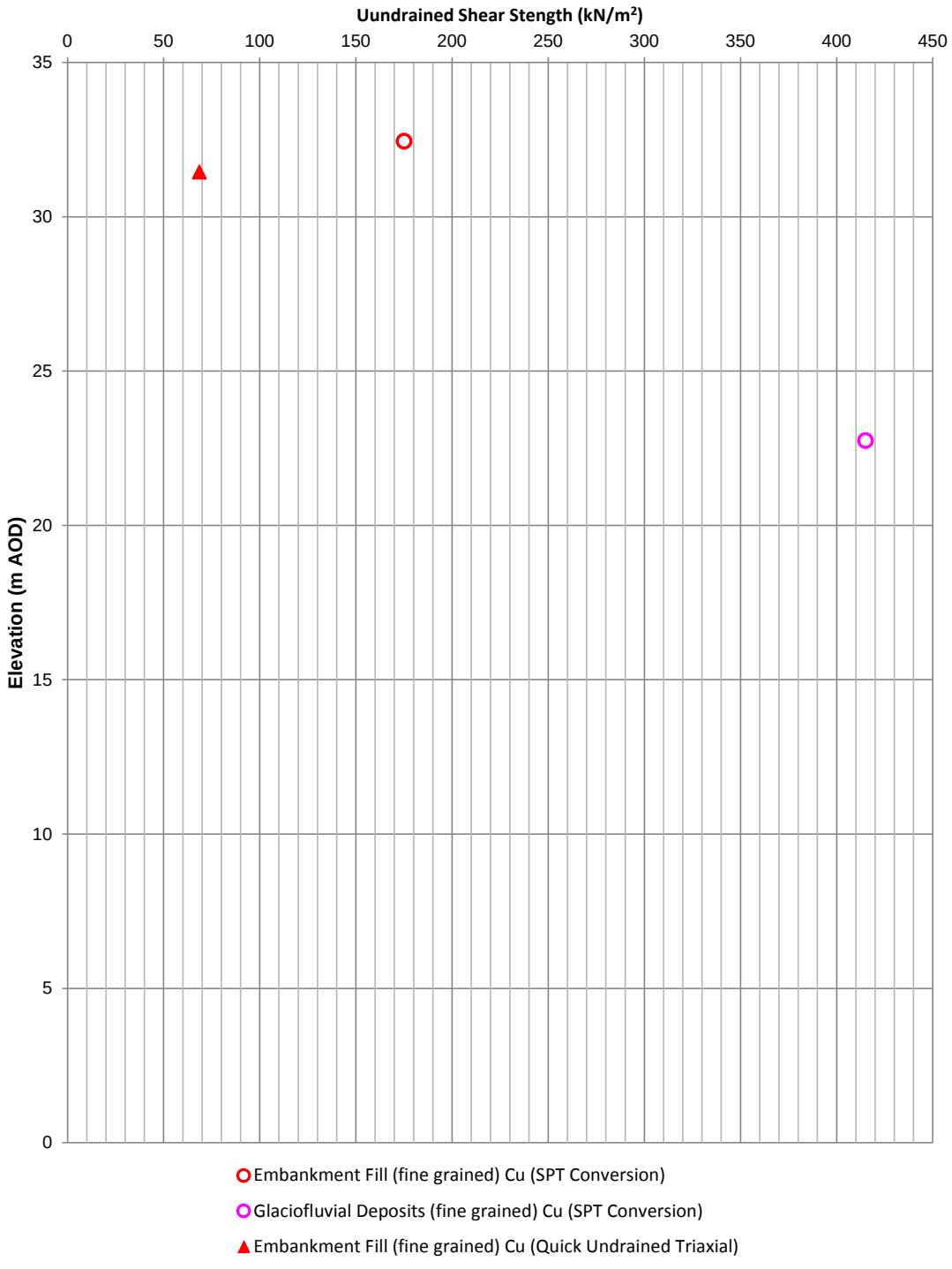
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 21/12/2016 Ref: HA549342-AMAR-HGT-181960-181970-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **181960-181970**
Client: **Highways England**	Borehole ID: **CP1102, SK43SE15, SK43SE14**	



Rev: P01 Date: 18/01/2017 Ref: HA549342-AMAR-HGT-181960-181970-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-189280-189310SB-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	189280-189310		
Carriageway	Southbound		
Marker Post	MP189/2B+80 – MP189/3B+10		
National Grid Reference	E 446509, N 331507 – E 446511, N 331539		
Existing Ground Level at Location	Carriageway	33.6mAOD	
	Toe of Embankment	29.1mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_22157	HAGDMS designation
Earthwork Height	NB: N/A	SB: 4.5m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 23°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Simon Arinze	16/02/2017	[redacted]
Checked	Alice Bazen	17/02/2017	
Reviewed	Gary Summerfield	20/02/2017	
Approved	Tom Bulteel	27/02/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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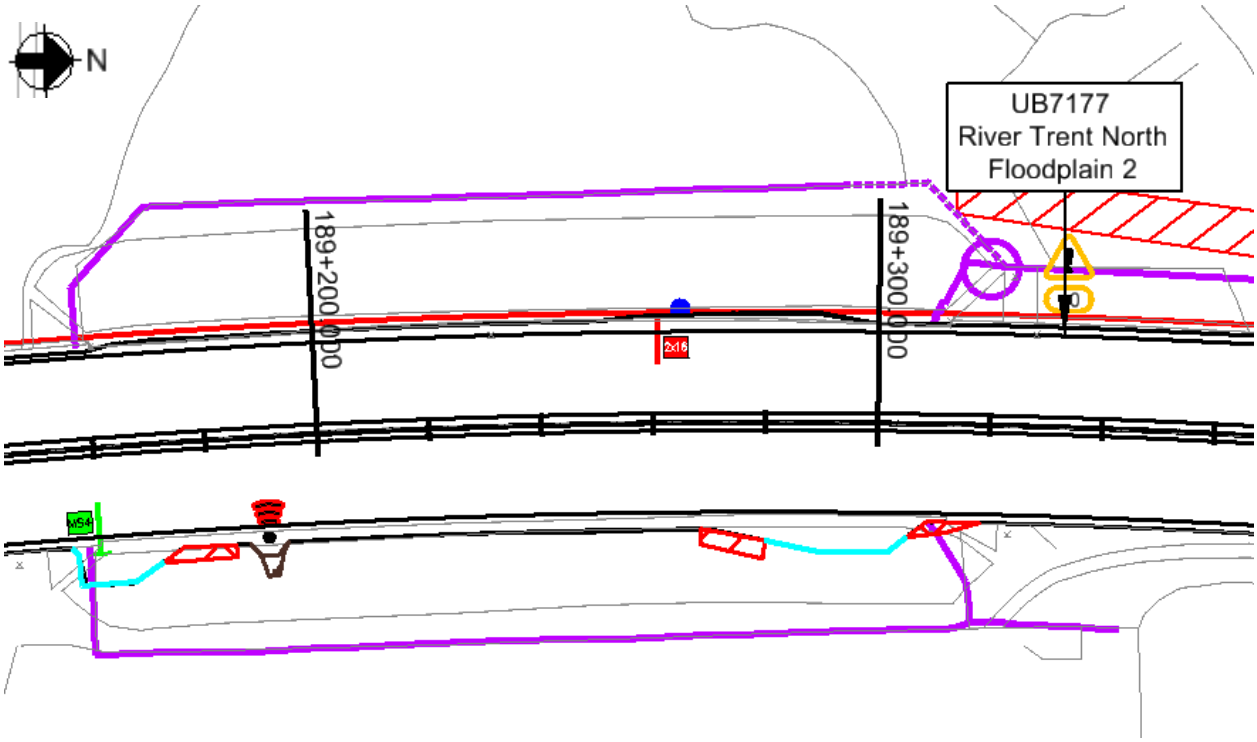


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- King sheet pile retaining wall.

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment. Within Ch189280-189310 the embankment has a height of 4.0-4.5m and a typical slope angle of 23°.

The critical cross sections (i.e. the cross section with the greatest retained height) used is Ch189300.

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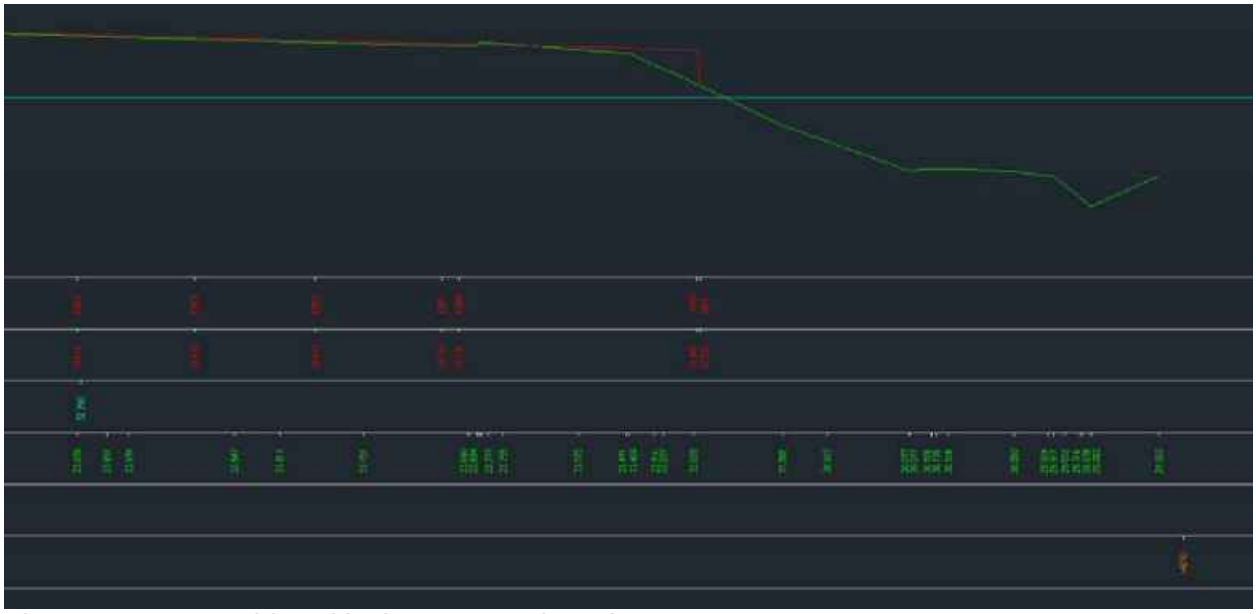


Figure 2: Topographic Critical Cross Section Ch189300

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Alluvium

Solid Deposits: Edwalton Member (Mercia Mudstone Group)

Ground Investigation:

There are 2 No. historical exploratory holes recorded within the design chainage, with additional 5 no. relevant exploratory holes considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000032, Rev P01.

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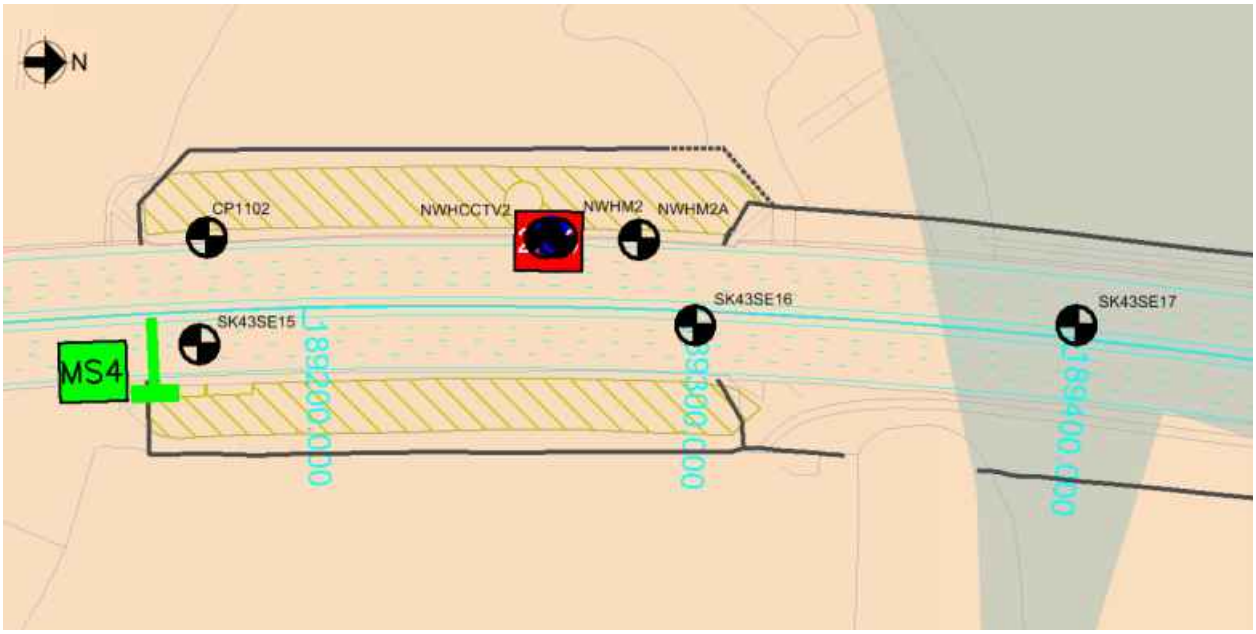


Figure 3: Borehole Location Plan

Flood Risk:

The design flood level is 32.20mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Closest Borehole Number	SK43SE16
Borehole Chainage	189303
Borehole Location	Southbound
National Grid Reference	E 446495, N 331530
Ground Level at Exploratory Hole	30.00mAOD
RAG Analysis	Amber
Date Drilled	29/01/1962
Termination Depth	12.19 metres below ground level (mbgl)
Other suitable holes	CP1102, NWHCCTV2, NWHM2, NWHM2A, SK43SE15 & SK43SE17

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Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Made Ground – Embankment Fill	4.5	29.1	20-120 (22)
Glaciofluvial Deposits (coarse grained)	7.7	25.9	10-150* (30)
Mercia Mudstone III-IV	Not proven	Not proven	30, 30 (30)

(1) Ground level is assumed to be at carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model. Mercia Mudstone – I/II and Mercia Mudstone – Siltstone were recorded within some historical exploratory holes; however, the closest exploratory hole SK43SE16 only recorded Mercia Mudstone – III/IV. Therefore, Mercia Mudstone – I/II and Mercia Mudstone – Siltstone have been excluded from the ground model for this location. In situ and laboratory data for Mercia Mudstone – I/II and Mercia Mudstone – Siltstone has not been used to determine geotechnical parameters of Mercia Mudstone – III/IV.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory holes CP1102, NWHCCTV2. NWHM2, NWHM2A, SK43SE15, SK43SE16 & SK43SE17.

Groundwater:

The following groundwater strikes were recorded in the historical exploratory holes:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
NWHCCTV2	Glaciofluvial Deposits	7.10	27.69	-	-	-
NWHM2A	Glaciofluvial Deposits	6.00	28.59	-	-	-
SK43SE15	River Terrace Deposits	1.98	28.12	4.5 hours	1.60	28.50
SK43SE16	Glaciofluvial Deposits	1.52	24.48	-	-	-
SK43SE17	Alluvium	1.22	29.28	-	-	-
SK43SE17	River Terrace Deposits to Alluvium	3.96	26.54	-	0.80	29.70

Groundwater Design Level:

A groundwater level of 32.20mAOD (flood level) has been assumed for WALLAP analysis of the king and intermediate sheet pile. When checking the global stability check of the earthwork and king and intermediate sheet pile (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

2 No. Atterberg Limit Tests and 2 No. Moisture Content Tests were undertaken within historical exploratory holes with the following results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	1.7	7	23	11	12	CL
Embankment Fill	3.7	4	24	11	13	CL

2 No. undrained triaxial tests were undertaken within the embankment fill with the following results:

Stratum	Depth to Top of Test (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	1.2	102
Embankment Fill	3.2	69

Lab Test Data – BRE Classification:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Sulphate (Total) as SO4	Solid	3	0.02-0.07	%SO4
Embankment Fill	Water Soluble Sulphate as SO4	Water	1	0.06	g/l SO4
Embankment Fill	pH	Solid	3	8.2-9.2	-
Embankment Fill	pH	Water	1	8.7	-

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Assumed Ground Model For Design:

Ground model based on geological long section HA549342-AMAR-HGT-SWI-DR-CE-000032 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0.0-4.5	33.6-29.1	4.5	21	27	0	100	8.4	6.7	-	0.50	0.20	-	DS-2 AC-2
Glaciofluvial Deposits (coarse grained)	4.5-7.7	29.1-25.9	3.2	21	36	-	-	-	43.2	-	-	0.25	-	DS-3 AC-3
Mercia Mudstone – III/IV	>7.7	<25.9	-	21	30	2	150	10.8	8.6	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.

(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.

(3) Given the absence of sufficient local PI data for Embankment Fill, the ϕ' of Embankment Fill was taken as the characteristic value given in the AMAR GIR.

(4) Eu for Embankment Fill can be derived using SPT 'N' values (Bowles) where Eu = 300 (N+6); using a typical SPT 'N' value of 22 gives Eu = 8.4MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 6.7MN/m^2.

(5) Based on SPT converted c_u values (using the Stroud correlation and an f_1 value of 5.0) and results of quick undrained triaxial tests, it was determined that a c_u value of 100kN/m^2 was suitable for Embankment Fill.

(6) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a typical SPT 'N' value of 30, ϕ' was found to be 36^o.

(7) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a characteristic SPT 'N' value of 30, E' = 43.2MN/m^2.

(8) Given the absence of sufficient local PI data for Mercia Mudstone – III/IV, the ϕ' of Mercia Mudstone – III/IV was taken as the characteristic value given in the AMAR GIR.

(9) c_u of Mercia Mudstone – III/IV was derived using the Stroud correlation. A typical SPT 'N' value of 30 was used for Mercia Mudstone – III/IV, combined with an f_1 value of 5 (after guidance in CIRIA C570) to derive a cu of 150kN/m^2.

(10) Eu for Mercia Mudstone – III/IV can be derived using N values (Bowles) where Eu = 300 (N+6); using a characteristic SPT 'N' value of 30 gives Eu = 10.8MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 8.6MN/m^2.

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(11) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Glaciofluvial Deposits and Mercia Mudstone-III/IV, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of king and intermediate sheet piles in embankments; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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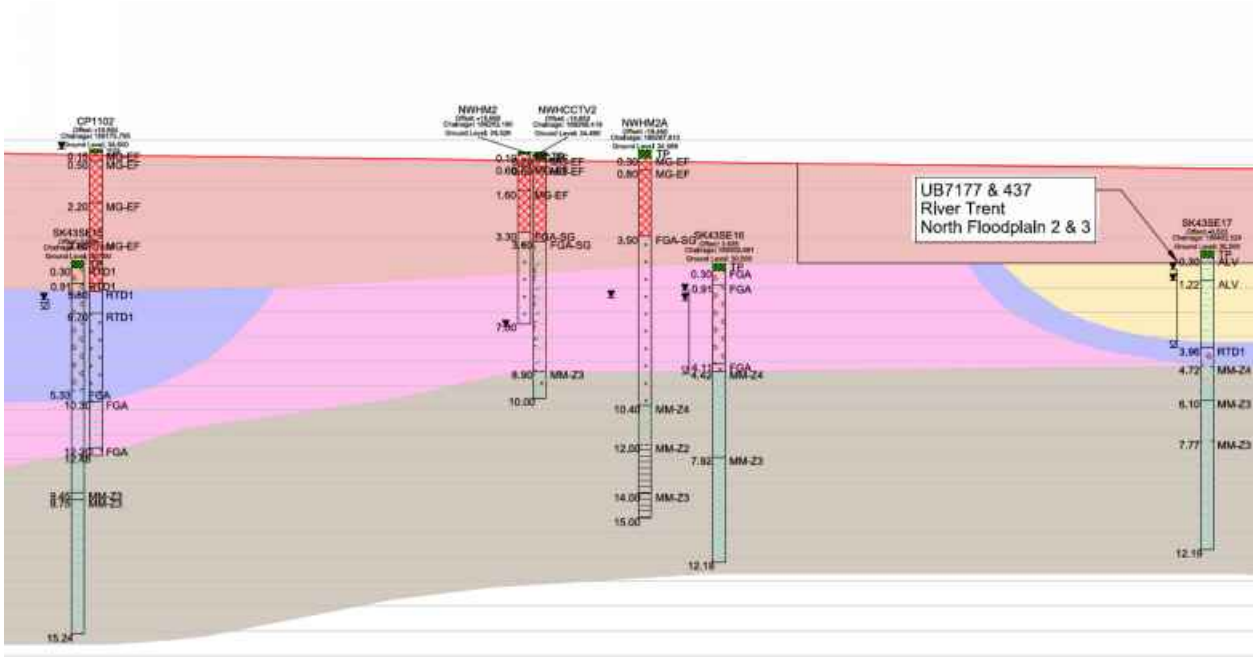


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to this encroaching on to the flood plain, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	King Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
189280	189310	AZ-12 S 390 GP	1.5	5.0	6.5	88	41	18.0	48.4

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-CPT-07 at chainage 189303, Southbound - 5m deep CPT exploratory hole, located in northbound existing grass verge using excavator mounted equipment.

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HISTORICAL EXPLORATORY HOLES

Rotary Core Log

Borehole No. CP1102 Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446472.00 - 331402.00	Hole Type CP
Location:		Level: 34.65	Scale 1:50
Client: Highways England		Dates: 18/10/2006 - 01/11/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.15	34.50		TOPSOIL TP
		0.50 - 1.20	B				0.50	34.15		MADE GROUND. Light red brown, slightly clayey, very gravelly sand. Gravel is subangular and angular, fine to coarse of sandstone and mudstone. MG-EF
		1.20 - 1.65	U							MADE GROUND. Stiff red brown, clayey, slightly gravelly fine and medium sand. Gravel is subangular and subrounded, fine to coarse of sandstone. MG-EF
		1.70	D							
		2.20 - 2.65 2.20 - 2.70	D B				2.20	32.45		MADE GROUND. Very stiff red brown gravelly clay with some rootlets. Gravel is subangular and subrounded, fine to coarse of weathered mudstone and sandstone. MG-EF
		3.20 - 3.65	U							At 3.20m, firm
		3.70 3.80 - 4.30	D B				3.80	30.85		MADE GROUND. Very dense brown, very gravelly sand with some pockets of brown gravelly clay. Gravel is subrounded and rounded, fine to coarse of quartz and sandstone. MG-EF
		4.80 - 5.30	B							
		5.80 - 6.80	B				5.80	28.85		Very dense dark grey with some red brown mottling, very clayey, gravelly SAND. Gravel is subangular to rounded, fine to coarse of quartz and sandstone. Organic odour. RTD1
		6.80 - 7.30	B				6.70	27.95		Dense, brown grey and white coarse SAND, and subangular to rounded fine to coarse GRAVEL of quartz. RTD1
		7.80 - 8.30	B							
		9.30 - 9.80	B							Below 9.50m: some cobbles of quartz
										Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 4.00m to 4.20m (1/2 hour), from 5.60m to 6.40m (2 hours), and from 12.20m to 12.40m (1 hour) ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 6.80m to 10.70m ;No visual or olfactory indication of contamination was observed ;

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Rotary Core Log

Borehole No. CP1102 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446472.00 - 331402.00	Hole Type CP
Location:		Level: 34.65	Scale 1:50
Client: Highways England		Dates: 18/10/2006 - 01/11/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.30	D				10.30	24.35		SAND and GRAVEL (as previous sheet)
		10.40 - 10.70	U							Soft to firm grey sandy slightly gravelly CLAY and SILT/CLAY. Sand is fine to coarse, gravel is subangular to rounded fine and medium of mudstone and sandstone FGA
		10.75	D							From 10.75m to 11.90m firm and friable
		11.90 - 12.23	D							Below 11.90m mottled red brown and grey
		11.90 - 12.40	B				12.20	22.45		
		12.40 - 12.48	D				12.48	22.17		SILTSTONE, recovered as light green grey subangular and subrounded fine to coarse gravel sized fragments. Possible boulder in FGA-SG
										End of borehole at 12.48 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 4.00m to 4.20m (1/2 hour), from 5.60m to 6.40m (2 hours), and from 12.20m to 12.40m (1 hour) ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 6.80m to 10.70m.;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. NWHCCTV2
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446472.06 - 331493.83	Hole Type CP
Location:		Level: 34.49	Scale 1:50
Client: Highways England		Dates: 07/09/1999 - 08/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00	D							TOPSOIL
		0.00	D				0.20	34.29		TP
		0.20	D							MADE GROUND: Grey sandy fine to coarse subangular gravel of limestone. (Hardcore)
		0.20	D				0.60	33.89		MG-EF
		0.50	D							MADE GROUND: Firm to stiff red brown mottled grey slightly sandy clay with a little fine and medium subangular gravel of mudstone. Rare traces of sandstone noted. (Mercia Mudstone Fill)
		0.50	D							MG-EF
		0.60	D							
		0.60	D							
		1.20	D							
		1.20	D							
		2.00 - 2.50	B							
		2.00 - 2.50	B							
		3.00 - 3.50	B							
		3.00 - 3.50	B							
							3.60	30.89		Medium dense brown locally reddish slightly clayey very sandy fine to coarse subangular to rounded GRAVEL of sandstone, limestone and quartz. (River Terrace Deposits)
		4.00 - 4.50	B							FGA-SG
		4.00 - 4.50	B							
		4.50 - 5.00	B							*—from 4.50m to 6.50m generally dense with occasional cobbles noted*
		4.50 - 5.00	B							
		5.50 - 6.00	B							
		5.50 - 6.00	B							
		6.50 - 7.00	B							
		6.50 - 7.00	B							*—from 6.50m medium dense*
	▼									
		7.50 - 8.00	B							
		7.50 - 8.00	B							
		8.00 - 8.50	B							
		8.00 - 8.50	B							
		8.90	D				8.90	25.59		Stiff red brown locally mottled/dappled grey slightly sandy CLAY with some fine to coarse subangular gravel of mudstone/siltstone. (Mercia Mudstone - Grade III/II)
		8.90	D							MM-Z3
		10.00	D				10.00	24.49		Continued on next sheet

Remarks
1. Hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. CCTV2 completed at 10.00m. Grouted 0.50m to 10.00m. Topsoilreplaced. 3. Marker Post Ref 189/2 +90N.

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Rotary Core Log

Borehole No. NWHCCTV2
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446472.06 - 331493.83	Hole Type CP
Location:		Level: 34.49	Scale 1:50
Client: Highways England		Dates: 07/09/1999 - 08/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.00	D							End of borehole at 10.00 m

Remarks
1. Hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. CCTV2 completed at 10.00m. Grouted 0.50m to 10.00m. Topsoilreplaced. 3. Marker Post Ref 189/2 +90N.

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Rotary Core Log

Borehole No. **NWHM2** Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446472.25 - 331490.60	Hole Type RC
Location:		Level: 34.53	Scale 1:50
Client: Highways England		Dates: 02/09/1999 - 02/09/1999	Logged By NBR

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.10 - 0.60 0.10 - 0.60	D D				0.10	34.43		TOPSOIL. TP
		0.60 0.60 - 0.80 0.80	D D D				0.60	33.93		MADE GROUND: Light brownish grey slightly sandy fine to coarse angular gravel sized fragments of limestone. MG-EF
		1.25 - 2.00	99	53	0	0	1.60	32.93		MADE GROUND: Reddish brown very silty clay with some fine subangular gravel of mudstone (Mercia Mudstone fill) MG-EF
										MADE GROUND: Orangish brown clayey fine to coarse subangular gravel of sandstone MG-EF
		2.45 - 3.00	97	0	0	0				
							3.30	31.23		Dense fine and medium SAND and fine to coarse subangular to rounded GRAVEL of sandstone. (River Terrace Deposits) FGA-SG
		3.45 - 4.00	97	0	0	0				
										from 4.00m sandy becomes fine to coarse
		4.35 - 5.00	97	0	0	0				
										from 5.00m to 5.45m brown clayey sandy coarse rounded gravel of quartz and sandstone
		5.45 - 6.00	97	0	0	0				
		6.50 6.45 - 7.00	B 97	0	0	0				
							7.00	27.53		End of borehole at 7.00 m
		9.00	B							

Remarks
1. Inspection pit excavated to 0.80m. 2. Borehole terminated at 7.00m. 3. Borehole backfilled with arisings. 4. Marker Post Ref 189/3 +20N. 5. See alsoM2A for cable tool position.

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Rotary Core Log

Borehole No. **NWHM2A** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446472.63 - 331515.32	Hole Type CP
Location:		Level: 34.59	Scale 1:50
Client: Highways England		Dates: 08/09/1999 - 09/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00	D							TOPSOIL.
		0.00	D							TP
		0.30	D				0.30	34.29		MADE GROUND: Dark grey and grey sandy fine to coarse gravel and occasional cobble of limestone. (Hardcore)
		0.30	D							MG-EF
		0.50	D							
		0.50	D				0.80	33.79		MADE GROUND: Firm to stiff red brown dappled grey sandy clay with some fine to coarse gravel of mudstone, rare sandstone noted. (Mercia Mudstone Fill)
		0.80	D							MG-EF
		0.80	D							
		1.20	D							
		1.20	D							
		2.00 - 2.50	B							
		2.00 - 2.50	B							
		3.00 - 3.40	B							
		3.00 - 3.40	B							
		3.50	D				3.50	31.09		Dense brown fine to coarse SAND and GRAVEL: Gravel content fine to coarse subangular to rounded of sandstone, limestone and quartz. (River Terrace Deposits)
		3.50	D							FGA-SG
		3.50 - 4.00	B							
		3.50 - 4.00	B							
		4.50 - 5.00	B							
		4.50 - 5.00	B							
		5.50 - 6.00	B							—from 5.50m medium dense, locally grading to sand with some and much gravel
		5.50 - 6.00	B							
	▼	6.20	D							
		6.20	D							
		6.50 - 7.00	B							
		6.50 - 7.00	B							
		7.20	D							
		7.20	D							
		7.50 - 8.00	B							
		7.50 - 8.00	B							
		8.50	D							
		8.50	D							
		9.00 - 9.50	B							
		9.00 - 9.50	B							
		10.00	D							Continued on next sheet

Remarks

1. Hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. See also rotary log for M2. Cable percussion hole bored to provebase of dense gravel. 3. Upon completion of borehole a slotted 50mmstandpipe was installed to 15.00m bgl. 4. Marker Post ref 189/3 + 20N.

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Rotary Core Log

Borehole No. **NWHM2A** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446472.63 - 331515.32	Hole Type CP
Location:		Level: 34.59	Scale 1:50
Client: Highways England		Dates: 08/09/1999 - 09/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.00	D							
		10.40	D				10.40	24.19		Firm red brown (friable) sandy CLAY with some fine to coarse gravel sized lithorelicts of mudstone. (Mercia Mudstone - Zone IVa/IVb) MM-Z4
		10.40	D							
		11.00 - 11.50	B							
		11.00 - 11.50	B							
							12.00	22.59		Grey green locally red brown thickly laminated highly weathered MUDSTONE, weak and very weak. (Mercia Mudstone - Zone I/II?) MM-Z2
										from 12.50m to 13.50m locally grading to stiff clay possibly III/IVa?
		13.00	D							
		13.00	D							
		14.00	D				14.00	20.59		Red brown thickly laminated highly weathered MUDSTONE, very weak recovered as a firm clay with many lithorelicts. (Mercia Mudstone - Zone I/II?) MM-Z3
		14.00	D							
		14.50	D							
		14.50	D							
⊘		15.00	D				15.00	19.59		End of borehole at 15.00 m
		15.00	D							

Remarks
1. Hand excavated inspection pit to 1.20m. Position CAT scanned at GL and 1.20m. 2. See also rotary log for M2. Cable percussion hole bored to provebase of dense gravel. 3. Upon completion of borehole a slotted 50mmstandpipe was installed to 15.00m bgl. 4. Marker Post ref 189/3 + 20N.

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Rotary Core Log

Borehole No. **SK43SE15**
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446500.00 - 331400.00	Hole Type CP
Location:		Level: 30.10	Scale 1:50
Client: Highways England		Dates: 01/02/1962 - 05/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	29.80		Topsoil TP
		0.76	D							Loamy sandy subsoil RTD1
							0.91	29.19		Sand & gravel RTD1
		1.22	D							
	▼	1.52	B							
		1.52 - 1.98	SPTL S							
		2.13	W							
		2.74	D							
		3.05	B							
		3.05 - 3.51	SPTL S							
		4.27	D							
		4.57	B							
		4.57 - 5.03	SPTL S							
							5.33	24.77		Brown boulder clay FGA
		5.49	D							
		6.10 - 6.55	U							
		7.01	D							
		7.62 - 8.00	U							
		8.53	D							
		9.14	D							
							9.45	20.65		Green decomposed rock MM-Z3
							9.75	20.35		Red marl
										Continued on next sheet

Remarks
Unable to take any cores after 12.80m - 102mm or 51mm

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Rotary Core Log

Borehole No. **SK43SE15** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446500.00 - 331400.00	Hole Type CP
Location:		Level: 30.10	Scale 1:50
Client: Highways England		Dates: 01/02/1962 - 05/02/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.67	D							MM-Z3
		11.43 - 11.68	U							
		12.19	D							
		12.80 - 12.98	U							
		13.72	D							
		15.24	D				15.24	14.86		End of borehole at 15.24 m

Remarks
Unable to take any cores after 12.80m - 102mm or 51mm

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Rotary Core Log

Borehole No. **SK43SE16**

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446495.00 - 331530.00	Hole Type CP
Location:		Level: 30.00	Scale 1:50
Client: Highways England		Dates: 29/01/1962 - 31/01/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	29.70		Topsoil TP
		0.76	D							Loamy sandy subsoil FGA
							0.91	29.09		Sand & gravel FGA-SG
		1.52	W							
		1.52	D							
		1.52 - 1.98	B							
		1.52 - 1.98	SPTL S							
		2.29	D							
		3.05 - 3.51	SPTL S							
		3.05 - 3.51	B							
		3.81	D							
							4.11	25.89		Brown silt FGA
		4.27	D							
		4.42 - 5.03	U				4.42	25.58		Red & green soft marl MM-Z4
		5.03	D							
		5.79 - 6.25	U							
		6.40	D							
		7.32 - 7.77	U							
		7.92	D				7.92	22.08		Red shaley marl MM-Z3
		8.84 - 9.30	U							
		9.45	D							
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK43SE16** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446495.00 - 331530.00	Hole Type CP
Location:		Level: 30.00	Scale 1:50
Client: Highways England		Dates: 29/01/1962 - 31/01/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.36 - 10.82	U							
		10.97	D							
		11.73 - 12.19	U							
		12.19	D				12.19	17.81		End of borehole at 12.19 m

Remarks

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Rotary Core Log

Borehole No. **SK43SE17** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446495.00 - 331630.00	Hole Type CP
Location:		Level: 30.50	Scale 1:50
Client: Highways England		Dates: 25/01/1962 - 30/01/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	D				0.30	30.20		Topsoil TP
		0.46	D							Mottled clay ALV
		1.07	D				1.22	29.28		Black river mud ALV
		1.52 - 1.98	U							
		1.83	W							
		2.13	D							
		3.05	D							
		3.05 - 3.51	U							
		3.51 - 3.96	U							
		4.11	D				3.96	26.54		Silty gravel & sand RTD1
		4.27	D							
		4.27 - 4.72	B							
		4.27 - 4.72	SPTL							
		4.72	S				4.72	25.78		Red & grey marl MM-Z4
		4.72 - 5.18	D							
			U							
		5.33	D							
		6.10 - 6.40	U				6.10	24.40		Red & grey marl (Hard) MM-Z3
		6.40	D							
		7.47	D							
		7.62 - 7.77	U				7.77	22.73		Red marl MM-Z3
		8.84 - 9.14	U							
		9.30	D							

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK43SE17
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446495.00 - 331630.00	Hole Type CP
Location:		Level: 30.50	Scale 1:50
Client: Highways England		Dates: 25/01/1962 - 30/01/1962	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.21 - 10.67	U							
		10.67	D							
		11.73 - 12.19	U							
		12.19	D				12.19	18.31		End of borehole at 12.19 m

Remarks

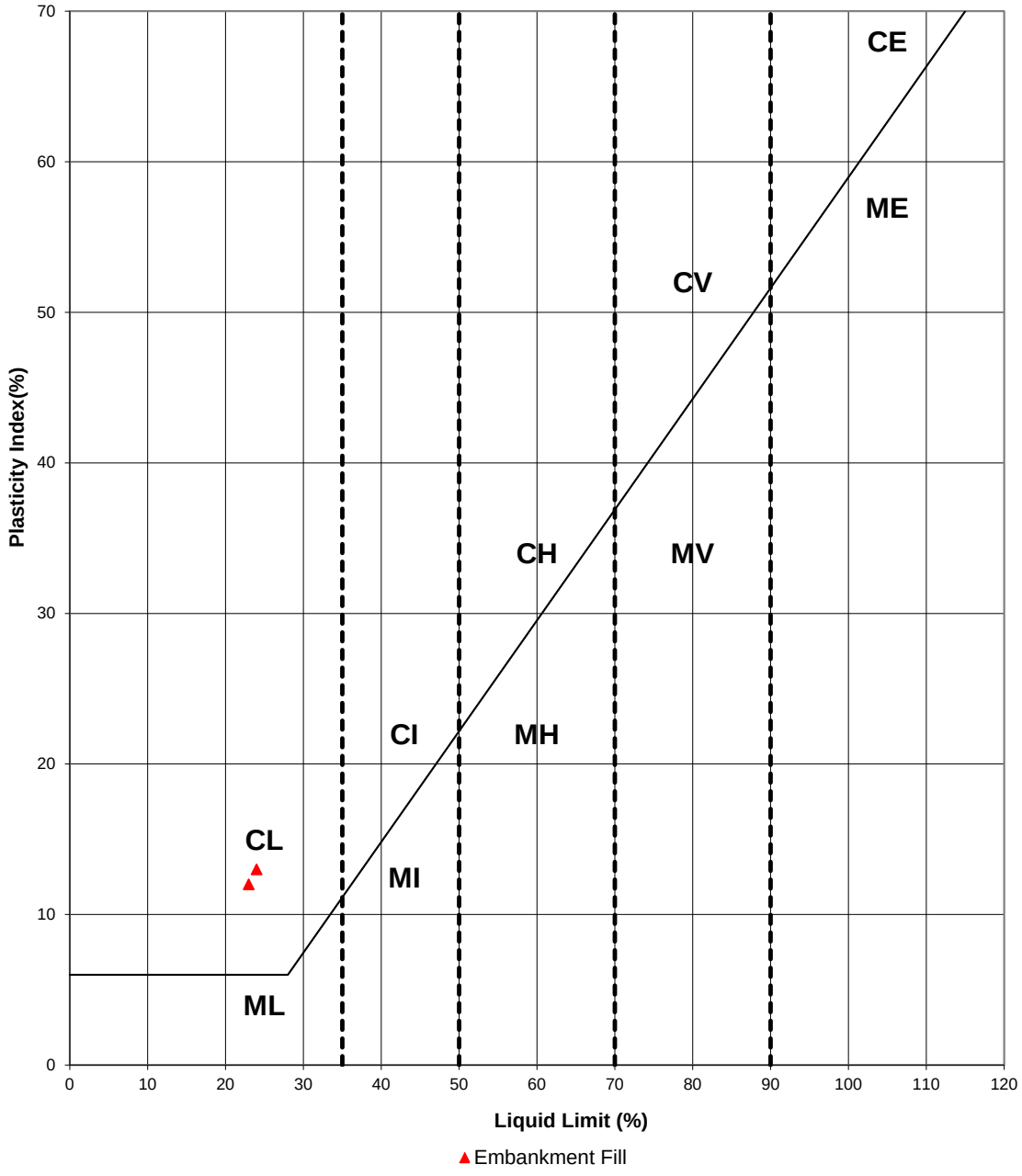
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PLOTS

A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **189280-189310SB**
Client: **Highways England**	Borehole ID: **CP1102, NWHM2**	



Key

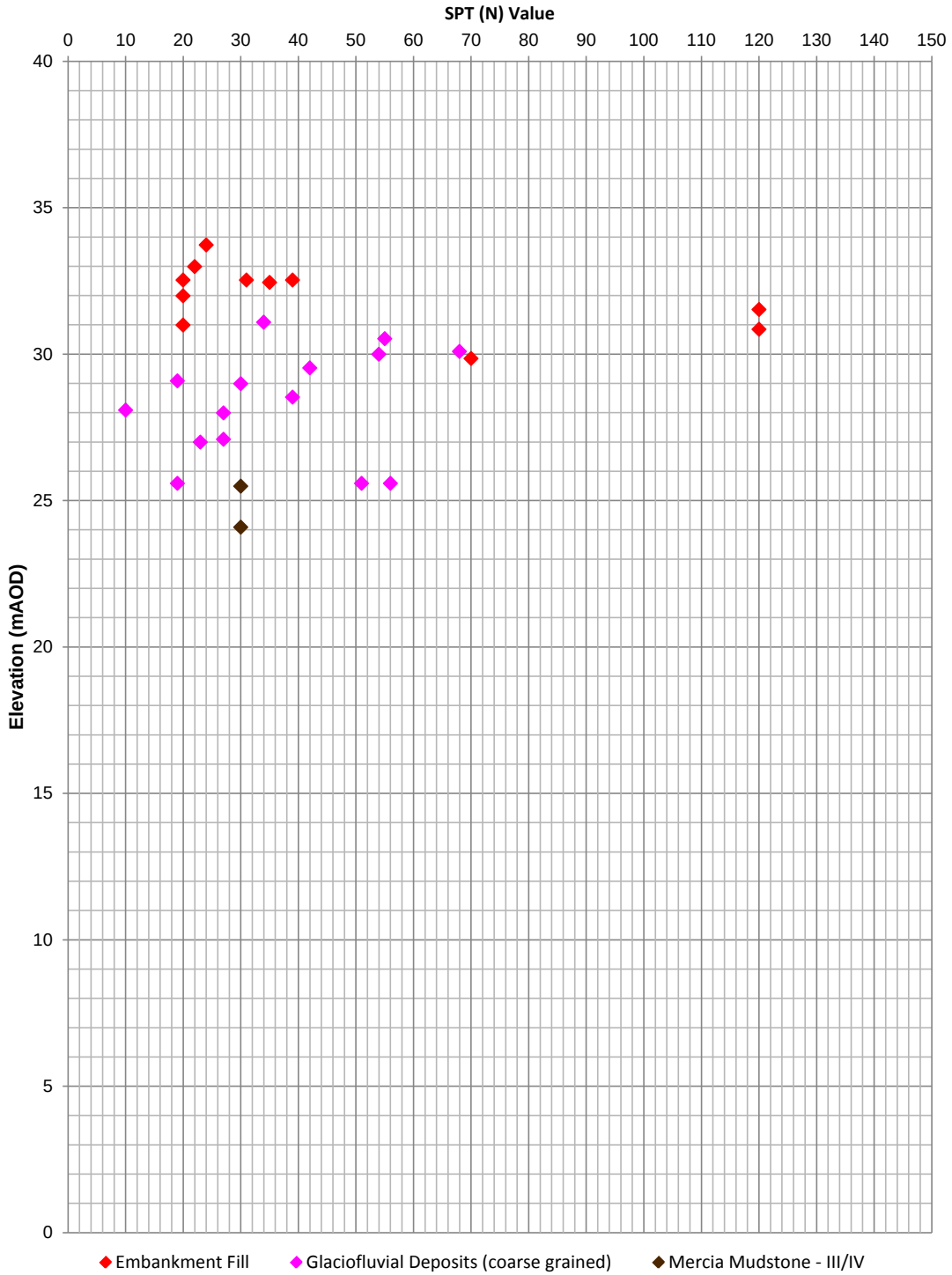
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 19/01/2017 Ref: HA549342-AMAR-HGT-189280-189310SB-GSS-CE-000001 Page 1 of 1

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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **189280-189310SB**
Client: **Highways England**	Borehole ID: **CP1102, NWHCCTV2, NWHM2, NWHM2A, SK43SE15, SK43SE16, SK43SE17**	

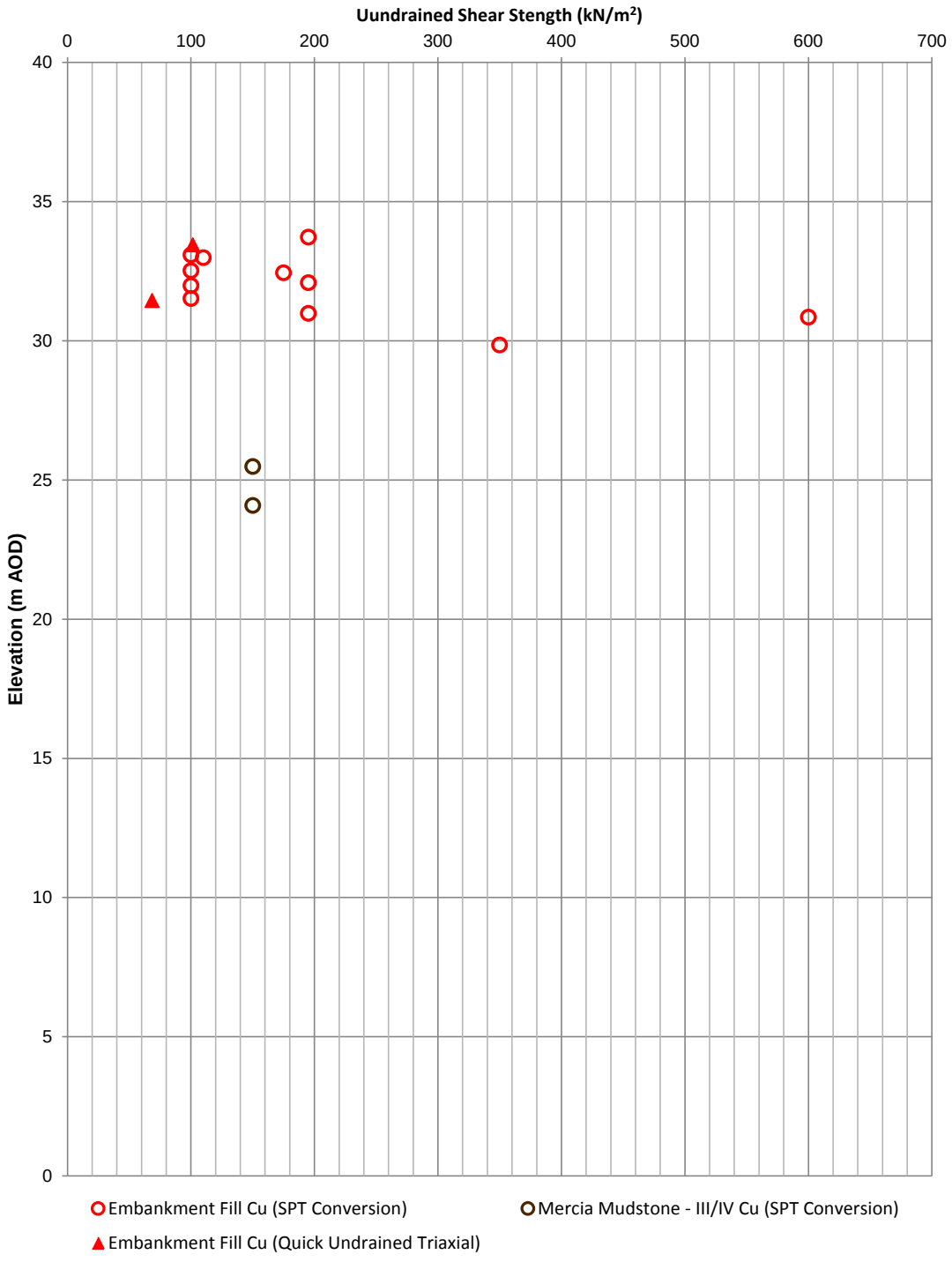


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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **189280-189310SB**
Client: **Highways England**	Borehole ID: **CP1102, NWHCCTV2, NWHM2, NWHM2A, SK43SE15, SK43SE16, SK43SE17**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-189560-189930SB-GSS-000001		
Earthwork Widening Solution	Granular Wedge at Embankment Crest 1:2.0, King Sheet Pile Retaining Wall		
Structure Number	Gantry 311		
Structure Type	Superspan Portal Gantry		
Design Chainage	189560 – 189930		
Carriageway	Southbound		
Marker Post	MP189/5B+60 – MP189/9B+30		
National Grid Reference	E 446539, N 331782 – E 446646, N 332133		
Existing Ground Level at Location	Carriageway	37.66mAOD	
	Toe of Embankment	31.15mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_22136	HAGDMS designation
Earthwork Height	NB: N/A	SB: 6.5m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 22°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	10/02/2017	[redacted]
Checked	Alice Bazen	07/03/2017	
Reviewed	Gary Summerfield	07/03/2017	
Approved	Tom Bulteel	14/03/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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DESK STUDY

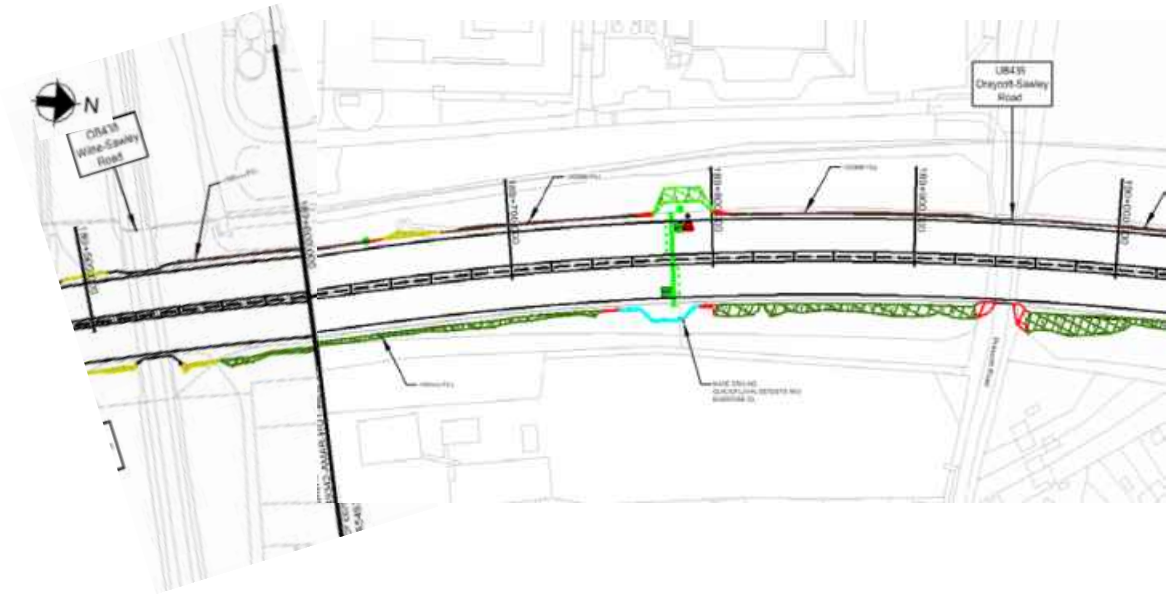


Figure 1: Location Plan

Proposed Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- 189560-189740 & 189800-189930 – Granular Wedge at Embankment Crest 1:2.0
- 189770-189790 – King Sheet Pile Retaining Wall

Proposed Major Structures:

- Superspan Portal Gantry 311 at chainage 189780;

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment ranging in height from 2.6m to 6.5m with a typical slope angle of 22 degrees.

The critical cross section with the greatest retained height is used at Ch 189780 for king sheet pile wall design.

The critical cross section with the greatest embankment height is used at Ch 189920 for earthwork design.

King Sheet Pile Retaining Wall – 189770-189790



Figure 2.1: Topographic Critical Cross Section Chainage 189780

Granular Wedge at Embankment Crest – 189560-189740 & 189800-189930

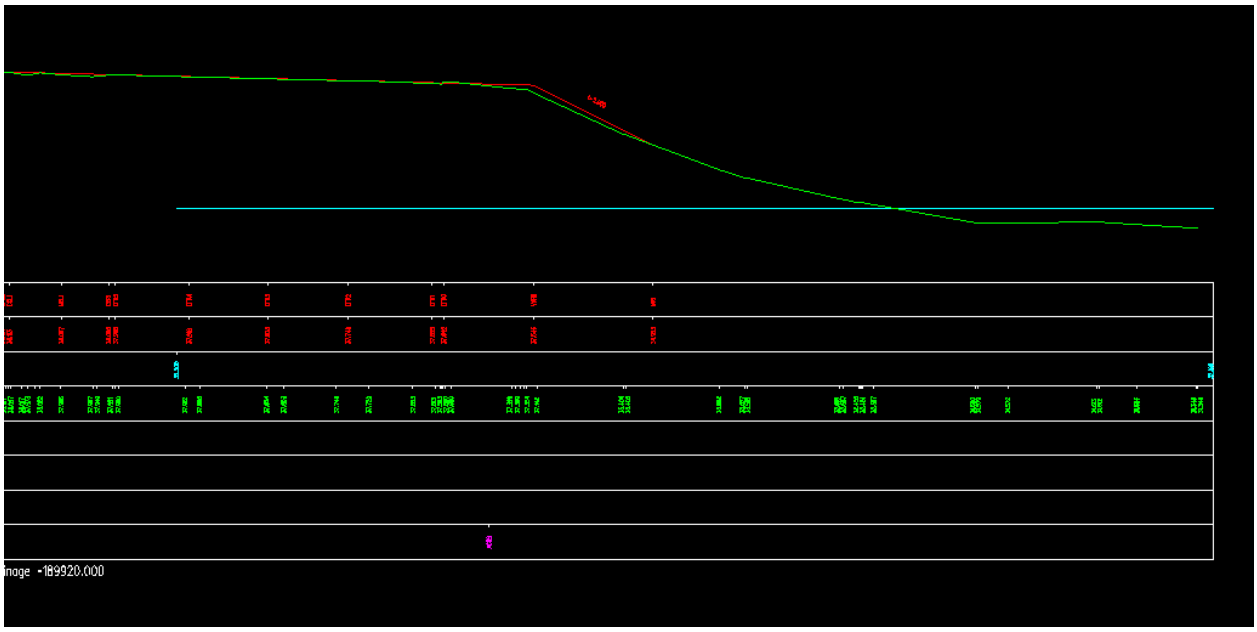


Figure 2.2: Topographic Critical Cross Section Chainage 189920

Utilities:

Western Power High cable located at the underbridge UB439. See Figure 3 for details:

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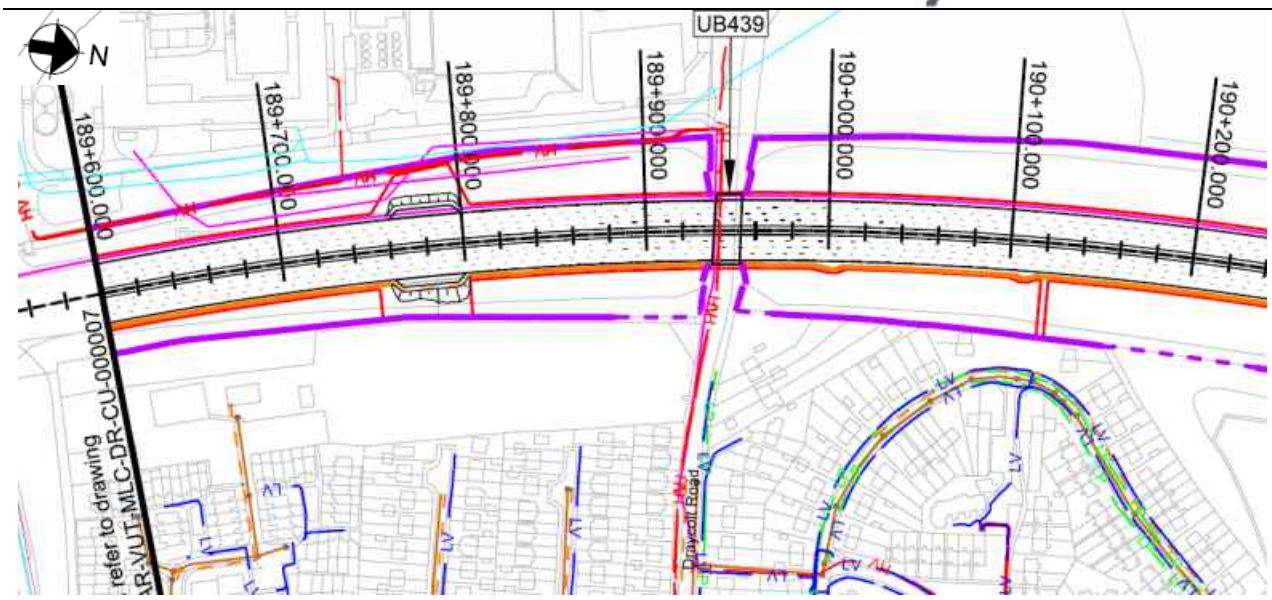


Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Hemington Member - Silt And Gravel

Solid Deposits: Cotgrave Sandstone Member – Sandstone/Edwalton Member - Mudstone

Ground Investigation:

1 No. historical borehole was undertaken between Ch189560 and Ch.189930, with 10 No additional exploratory holes considered as shown on Geological Long Section, Drawing No. HA549342-AMAR-HCT-SWI-DR-CE-000028, Rev P01.

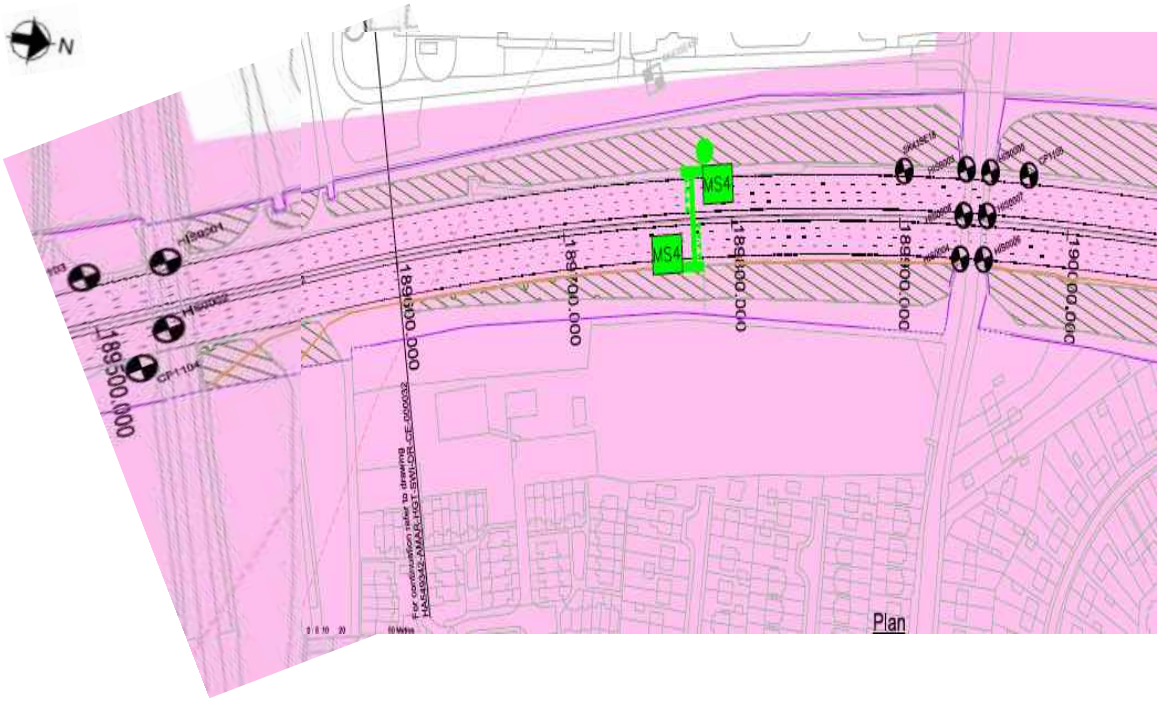


Figure 4: Borehole Location Plan

Flood Risk:

The earthworks are located within a flood risk zone. The flood risk level is at 32.20mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	HIS0004	HIS0008	HIS0003	SK43SE18
Borehole Chainage	189937	189938	189939	189902
Borehole Location	Southbound	Central Reserve	Northbound	Northbound
National Grid Reference	E 446645, N 332139	E 446629, N 332147	E 446612, N 332155	E 446600, N 332120
Ground Level at Exploratory Hole	31.70mAOD	31.70mAOD	31.70mAOD	32.10mAOD
RAG Analysis	Amber	Amber	Amber	Amber

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Date Drilled	01/06/1964 – 03/06/1964	15/07/1964 – 16/07/1964	04/06/1964 – 06/06/1964	17/01/1962 – 24/01/1962
Termination Depth	8.84 metres below ground level (mbgl)	5.57 metres below ground level (mbgl)	8.84 metres below ground level (mbgl)	9.14 metres below ground level (mbgl)
Other suitable holes	HIS0001, HIS0002,HIS0005, HIS0006, HIS0007, CP1104, CP1105			

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LIDAR Survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Embankment Fill	7.10	30.56	16-64 (16)
Glaciofluvial Deposits (coarse grained)	11.49	26.31	9-103 (30)
Mercia Mudstone – III-IV	>11.49	<26.31	49->150 (49)

(1) Ground level is assumed to be at carriageway level
(2) Due to variations in Embankment height the depth of Embankment Fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken in exploratory holes HIS0001, HIS0002, HIS0003, HIS0004, HIS0005, HIS0006, HIS0007, HIS0008, CP1104, CP1105 and SK43SE18.

Groundwater:

Groundwater strike are presented in the table below:

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Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
SK43SE18	Glaciofluvial Deposits	1.52	30.58	N/A	0.61	31.49
HIS0001	Glaciofluvial Deposits	3.35	28.45	N/A	1.83	29.97
HIS0002	Glaciofluvial Deposits	0.15		-	-	-
HIS0003	Glaciofluvial Deposits	1.98	29.72	-	-	-
HIS0004	Glaciofluvial Deposits	1.80	29.90	-	-	-
HIS0005	Glaciofluvial Deposits	1.98	29.92	-	-	-
HIS0006	Mercia Mudstone to Glaciofluvial Deposits	6.40	25.3	N/A	1.68	30.02
HIS0007	Glaciofluvial Deposits	2.13	29.57	-	-	-
HIS0008	Glaciofluvial Deposits	1.52	30.18	-	-	-

Groundwater Design Level:

A groundwater level of 32.20mAOD (flood level) has been assumed for WALLAP analysis of the king sheet pile. When checking the global stability check of the earthwork and king sheet pile (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

In addition to the above, during earthwork design, design groundwater level of 32.20mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

5 No Atterberg limit tests, 5 No. Moisture Content Tests were completed, with the results presented in the table below:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	1.7	16.0	32.0	13.0	19.0	CL
Embankment Fill	1.7	10.0	26.0	16.0	9.0	CL
Embankment Fill	3.7	13.0	30.0	12.0	18.0	CL
Embankment Fill	5.7	16.0	33.0	16.0	17.0	CL
Mercia Mudstone	7.7	21.0	31.0	20.0	11.0	CL
Mercia Mudstone	10.2	18.0	32.0	19.0	13.0	CL

2 No Quick Undrained Triaxial Tests were was completed, with the results presented in the table below:

Stratum	Depth to Top of Test (mbgl)	Cu (kN/m^2)
Embankment Fill	5.2	210
Mercia Mudstone	7.2	146

Lab Test Data - BRE Classification :

The table below presents the environmental were undertaken within exploratory holes HIS0001, HIS0002, HIS0003, HIS0004, HIS0005 and HIS0006. The results are summarised in the table below:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Glaciofluvial Deposits	Sulphate (Total) as SO4	Solid	8	0.02-0.04	%SO4
Glaciofluvial Deposits	Sulphate (Total) as SO4	Water	3	0.16-0.20	g/l SO4
Glaciofluvial Deposits	pH	Water	3	7.5	-
Mercia Mudstone	Sulphate (Total) as SO4	Solid	9	0.01-0.22	%SO4
Mercia Mudstone	Sulphate (Total) as SO4	Water	2	0.92-0.22	g/l SO4
Mercia Mudstone	pH	Water	2	7.5	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment fill	0.00 – 7.10	37.66 – 30.56	7.10	21	26	0	96	6.60	5.30	-	0.50	0.20	-	2.20	0.47	-	6.2*	-	DS-2 AC-2
Glaciofluvial Deposits (coarse grained)	7.10 – 11.49	30.56 – 26.17	4.7	21	36	-	-	-	43.20	-	-	0.25	-	17.30	-	1.0	-	50	DS1 AC-1
Mercia Mudstone – III/IV	>11.49	<26.17	-	21	30	2	245	16.50	13.20	-	0.50	0.20	-	5.50	0.45	-	9	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from the interpreted geological long section.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion, and Poisson's ratio derived in the AMAR GIR are used.
(4) ϕ' of Embankment Fill was based on PI value from Table 2 (BS8002:2015). For an average PI value of 17, ϕ' is 26^0.
(5) C_u of Embankment Fill was derived using the Stroud correlation. A typical PI of 17% gives an f1 value of 6.0, combined with a typical SPT 'N' value of 16, this gives a typical c_u of 96kN/m^2.
(6) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using typical SPT 'N' value of 16, Eu = 6.6MN/m^2. Therefore E' = 5.3MN/m^2.
(7) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using correlation with SPT 'N' values (Peck 1974). Using a typical 'N' value of 30 gives an angle of 35°.
(8) E' of Glaciofluvial Deposits (coarse grained) was determined using Bowles correlation E' = 1200 (N + 6) which (using typical 'N' value of 30) gives a value of 43.2MN/m^2.
(9) cu of Mercia Mudstone – III/IV was derived using the Stroud correlation. In the absence of sufficient PI data, the typical f1 value of 5.0 for Mercia Mudstone (CIRIA C570) was adopted; combined with a typical SPT 'N' value of

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94, this gives a cu of 245kN/m^2. This value exceeds the range given in the AMAR GIR; therefore the upper bound of the range was adopted.

(10) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using typical SPT 'N' value of 94, Eu = 16.5MN/m^2. Therefore E' = 13.2MN/m^2.

(11) Shear modulus is based on G = E/2(1+v).

(12) Adhesion Factor for Mercia Mudstone is based on BS8004 (equation 41).

(13) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl

(14) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl. Embankment Fill is assumed to comprise reworked Mercia Mudstone.

(15) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).

(16) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Embankment Fill, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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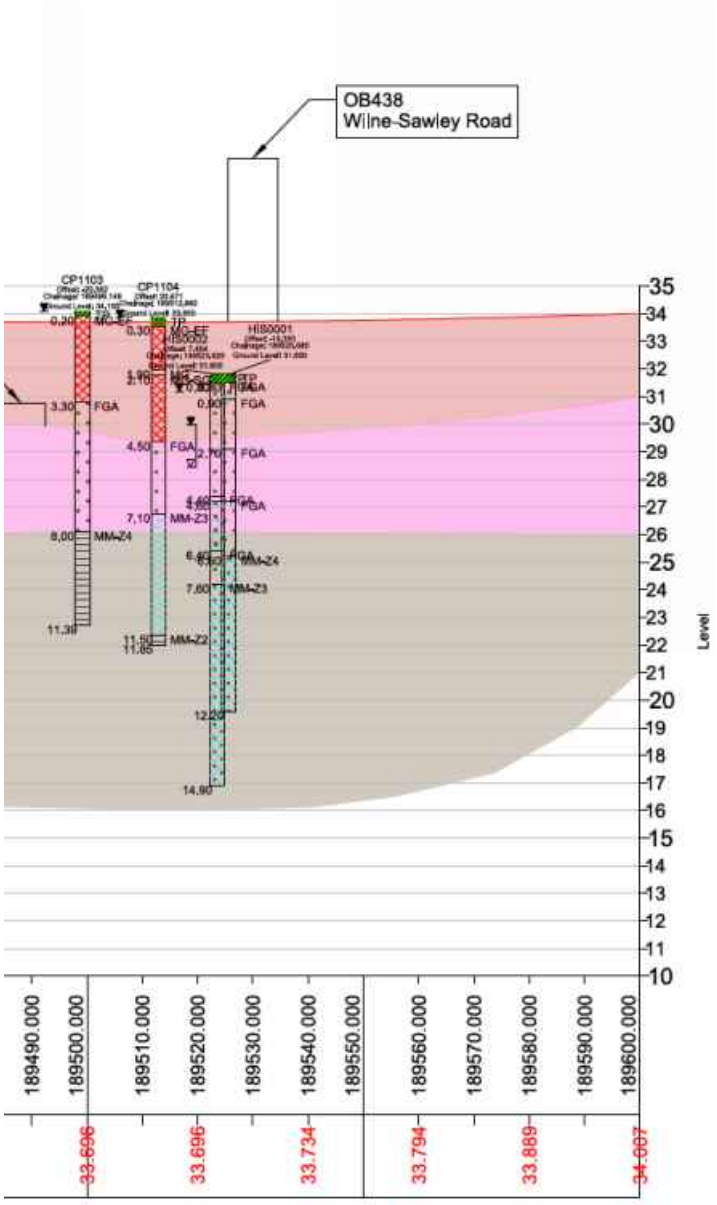


Figure 5.1 : Geological Long Section 189560-189600

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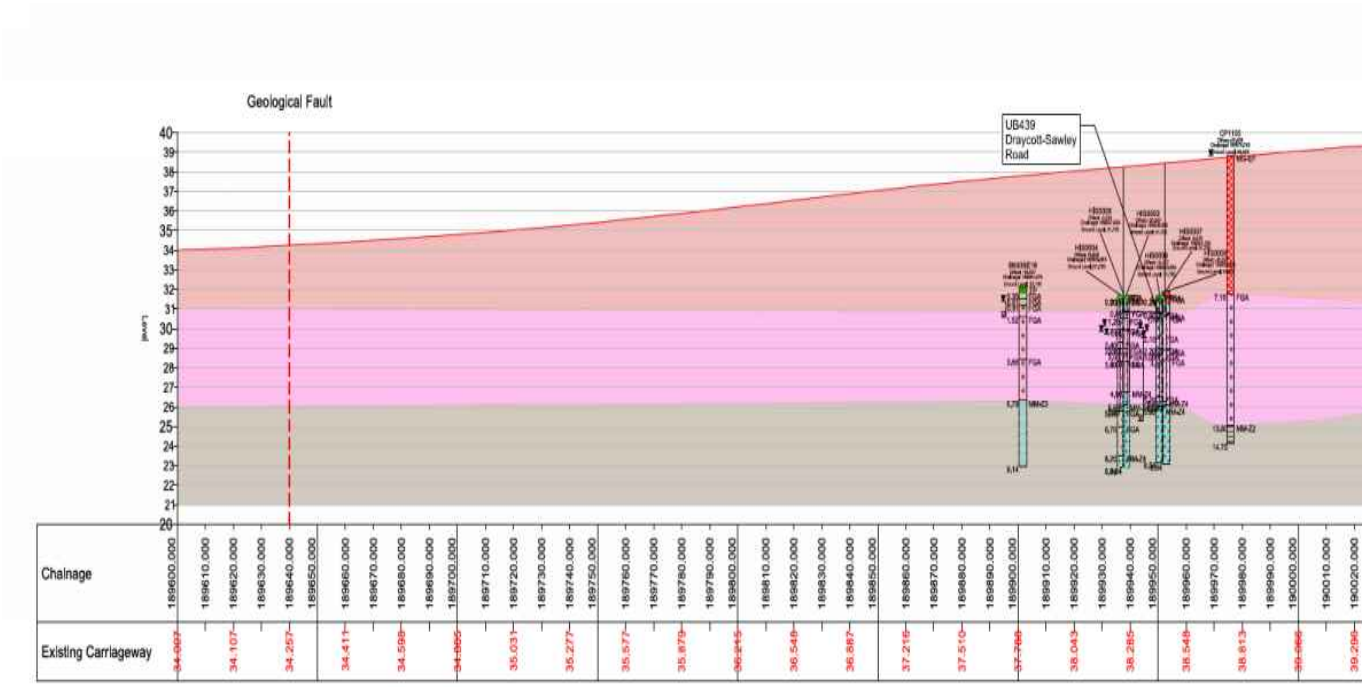


Figure 5.2 : Geological Long Section 189600-189930

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Based Width	Batter Angle
189560	189740	Granular Wedge at Embankment Crest 1:2.0	4.5	45
189800	189930	Granular Wedge at Embankment Crest 1:2.0	4.5	45

Earthwork regrade was considered between chainage 189770-189790, however due to this impeding on the highway boundary, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
189750	189790	AZ-24 S 390 GP	2.9	6.1	9.0	68	54	35.0	164.6

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

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Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	900	15.5	2.7	11	591	499

FURTHER GROUND INVESTIGATION

Further ground investigation has been proposed during the 'Just in Time' GI and will comprise the following:

- BH-G311B, Ch189780, Southbound and Northbound - Dynamic Sample with Rotary Core follow on to a scheduled depth of 21m bgl.

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HISTORICAL BOREHOLE LOGS

Borehole Log

Borehole No. **CP1104** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446534.00 - 331735.00	Hole Type CP
Location:		Level: 33.85mbgl	Scale 1:50
Client: Highways England		Dates: 15/11/2006 - 15/11/2006	Logged By OP

Well	Water Strikes	Samples and In Situ Testing Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 1.20	1B			0.30	33.55		TOPSOIL. TP MADE GROUND. Firm and stiff red brown slightly sandy slightly gravelly clay. Gravel is subangular to subrounded, fine to coarse of mudstone. Sand is fine and medium. MG-EF
		1.20 - 1.65	2U	60blows					
		1.70	3D						
		1.90 - 2.10	4B			1.90	31.95		
						2.10	31.75		MADE GROUND. Concrete. MG
		2.20	SPT (C)	50 (25 for 40mm/50 for 50mm)	Casing=2.20m Water=DRY				MADE GROUND. Red brown sand and gravel. Gravel is subangular to rounded, fine to coarse of quartz, mudstone and concrete. Sand is medium to coarse. MG-SG
		2.20 - 2.70	5B						
		3.20	PID	2ppmv					
		3.20	SPT (C)	50 (25 for 80mm/50 for 70mm)	Casing=3.20m Water=DRY				*From 3.20m: no concrete.*
		3.20 - 3.70	6B						
		4.20	PID	0ppmv					
		4.20	SPT (C)	50 (25 for 50mm/50 for 85mm)	Casing=4.20m Water=DRY	4.50	29.35		Dense to very dense brown slightly clayey SAND and subangular to rounded, fine to coarse GRAVEL of quartz. Sand is fine to coarse. FGA-SG
		4.20 - 4.70	7B						
		5.20	PID	0ppmv					
		5.20	SPT (C)	N=32 (2,3/5,7,8,12)	Casing=5.20m Water=ADDED				
		5.20 - 5.70	8B						
		6.20	PID	0ppmv					
		6.20	SPT (C)	50 (4,8/50 for 285mm)	Casing=6.20m Water=ADDED				
		6.20 - 6.70	9B						
		7.10	10D			7.10	26.75		Stiff to very stiff friable red brown occasionally grey CLAY with subangular fine to coarse gravel sized fragments of very weak mudstone. MM-Z3
		7.10	PID	0ppmv					
		7.20 - 7.65	11U	69blows					
		7.70	12D						
		8.70	PID	0ppmv					
		8.70	SPT (S)	N=49 (4,5/7,11,14,17)	Casing=8.70m Water=ADDED				
		8.70 - 9.15	13D						
		8.70 - 9.20	14B						

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 1.90m to 2.10m (1 hour), from 2.30m to 2.50m (0.75 hour), from 3.90m to 4.20m (0.75 hour) and from 11.00m to 11.50m (1 hour).;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 4.20m.;A hand held Photo-Ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.;

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Borehole Log

Borehole No. **CP1104** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446534.00 - 331735.00	Hole Type CP
Location:		Level: 33.85mbgl	Scale 1:50
Client: Highways England		Dates: 15/11/2006 - 15/11/2006	Logged By OP

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		10.20	PID	0ppmv					From 10.20m: slightly sandy. Sand is fine to coarse.
		10.20	SPT (S)	132 (11,14/132 for 295mm)	Casing=10.20m Water=DAMP				
		10.20 - 10.64	15D						
		10.20 - 11.50	16B						
		11.50	PID	0ppmv		11.50	22.35		Recovered as red brown clayey sandy subangular, fine to coarse gravel sized fragments of weak MUDSTONE. MM-Z2
		11.50	SPT (S)	118 (13,19/118 for 200mm)	Casing=11.50m Water=DAMP	11.85	22.00		End of borehole at 11.85 m
		11.50 - 11.85	17D						

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 1.90m to 2.10m (1 hour), from 2.30m to 2.50m (0.75 hour), from 3.90m to 4.20m (0.75 hour) and from 11.00m to 11.50m (1 hour).;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 4.20m.;A hand held Photo-Ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.;

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Borehole Log

Borehole No. **CP1105** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446627.00 - 332189.00	Hole Type CP
Location:		Level: 38.85mbgl	Scale 1:50
Client: Highways England		Dates: 06/11/2006 - 07/11/2006	Logged By SM

Well	Water Strikes	Samples and In Situ Testing Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.50 - 1.20	1B						MADE GROUND: Stiff red brown slightly sandy slightly gravelly clay. Sand is fine. Gravel is subangular fine to coarse of weak mudstone and angular fine to coarse sandstone and siltstone. MG-EF
		1.20 - 1.65	2U	50blows	Dia.=100mm				
		1.70	3D						
		2.20	4D						
		2.20	SPT (S)	N=16 (4,3/4,4,4,4)	Casing=1.70m Water=DRY				
		2.20 - 2.70	5B						
		3.20 - 3.65	6U	67blows	Dia.=100mm				
		3.70	7D						
		4.20	8D						
		4.20	SPT (S)	50 (4,9/50 for 235mm)	Casing=4.20m Water=DRY				
		4.20 - 4.70	9B						
		5.20 - 5.65	10U	91blows	Dia.=100mm				At 5.20m; very stiff.
		5.70	11D						
		6.20	12D						
		6.20	SPT (S)	N=18 (2,4/4,4,5,5)	Casing=6.20m Water=DRY				
		6.20 - 6.70	13B						
		7.10	SPT (C)	N=43 (4,7/9,12,11,11)	Casing=7.10m Water=DRY	7.10	31.75		Dense to very dense grey brown slightly sandy GRAVEL. Sand is fine to coarse. Gravel is subrounded and rounded fine to coarse of sandstone, siltstone and flint. FGA-SG
		7.10 - 7.60	14B						
		8.10	SPT (C)	50 (6,9/50 for 200mm)	Casing=8.10m Water=ADDED				At 8.10m; sand and gravel.
		8.10 - 8.60	15B						
		9.60	SPT (C)	N=51 (4,7/8,11,14,18)	Casing=9.60m Water=ADDED				
		9.60 - 10.10	16B						
									Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring below 8.10m.;The borehole was advanced by chiselling methods from 4.50m to 4.80m (0.75 hours), 11.50m to 11.70m (0.75 hours), 12.70m to 13.40m (2 hours) and 14.20m to 14.60m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **CP1105** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446627.00 - 332189.00	Hole Type CP
Location:		Level: 38.85mbgl	Scale 1:50
Client: Highways England		Dates: 06/11/2006 - 07/11/2006	Logged By SM

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
									GRAVEL (as previous sheet)
		11.10 11.10 - 11.60	SPT (C) 17B	50 (2,9/50 for 155mm)	Casing=11.10m Water=ADDED				
		12.60 12.60 - 13.10	SPT (C) 18B	50 (4,11/50 for 145mm)	Casing=12.60m Water=ADDED				
		13.80 13.80 13.80 - 14.50	19D SPT (S) 20B	126 (7,12/126 for 295mm)	Casing=14.00m Water=ADDED	13.80	25.05		Weak red brown MUDSTONE recovered as red brown subangular and subrounded fine to coarse gravel sized fragments. MM-Z2
		14.50 14.50	21D SPT (S)	80 (25 for 125mm/80 for 125mm)	Casing=14.50m Water=ADDED	14.75	24.10		End of borehole at 14.75 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring below 8.10m.;The borehole was advanced by chiselling methods from 4.50m to 4.80m (0.75 hours), 11.50m to 11.70m (0.75 hours), 12.70m to 13.40m (2 hours) and 14.20m to 14.80m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **HIS0001** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446497.00 - 331755.00	Hole Type CP
Location:		Level: 31.80mbgl	Scale 1:50
Client: Highways England		Dates: 04/06/1964 - 06/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	1D			0.30	31.50		TOPSOIL TP
		0.49 - 0.91	2U		Dia.=100mm				Stiff brown sandy clay FGA
		0.91	3D			0.90	30.90		Medium dense fine to medium brown SAND with occasional fine to medium gravel FGA-SG
		1.22	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
	▼	1.83	24W						
		1.83	4B						
		2.13	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		2.44 - 2.74	5B						
						2.70	29.10		Medium dense brown sandy fine to medium GRAVEL FGA-SG
		3.05	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
	▽	3.35 - 3.66	6B						
		3.96	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.27 - 4.57	7B						
						4.60	27.20		Medium dense to dense brown fine to medium GRAVEL with occasional coarse gravel FGA-SG
		4.88	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.18 - 5.49	8B						
		5.79	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		6.10 - 6.40	9B						
						6.60	25.20		Very stiff to hard friable red-brown silty CLAY (Keuper Marl) MM-Z4
		6.71 - 7.16	10U		Dia.=100mm				
		7.62 - 8.08	11U		Dia.=100mm				
		8.53	12D						
		9.45	13U		Dia.=100mm				
									Continued on next sheet

Remarks

Ground-water was first encountered at a depth of 3.4m below ground level during boring. On completion of boring ground-water stood at a depth of 1.8m and a sample was taken. Full penetration of sampler not attained. Unable to recover sample.

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Borehole Log

Borehole No. **HIS0001** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446497.00 - 331755.00	Hole Type CP
Location:		Level: 31.80mbgl	Scale 1:50
Client: Highways England		Dates: 04/06/1964 - 06/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		10.36	14D						
		10.36	18D						
		10.52	19D						
		10.82	15U		Dia.=100mm				
		10.82 - 11.28	20U		Dia.=100mm				
		11.28	21D						
		11.73	16D						
		11.73 - 12.19	22U		Dia.=100mm				
		12.19	17U		Dia.=100mm	12.20	19.60		End of borehole at 12.20 m
		12.19	23D						

Remarks

Ground-water was first encountered at a depth of 3.4m below ground level during boring. On completion of boring ground-water stood at a depth of 1.8m and a sample was taken. Full penetration of sampler not attained. Unable to recover sample.

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Borehole Log

Borehole No. **HIS0002** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446523.00 - 331748.00	Hole Type CP
Location:		Level: 31.80mbgl	Scale 1:50
Client: Highways England		Dates: 29/05/1964 - 03/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.05	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				TOPSOIL TP
		0.10	2B			0.30	31.50		Medium dense brown fine to medium SAND and GRAVEL FGA-SG
	▼	0.15	1D						
		0.15	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		0.20	3B						
		0.23	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		0.30	4B						
		0.56	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.42	5D			4.40	27.40		Sandstone BOULDER FGA-SG
		4.72	6U		Dia.=100mm	4.60	27.20		Firm brown silty CLAY with gravel FGA
						6.40	25.40		Medium dense brown GRAVEL FGA-SG
		7.62	7D			7.60	24.20		Stiff to very stiff friable red-brown silty CLAY with mudstone fragments; some gypsum below 13.1m. MM-Z3
		7.77	8U		Dia.=100mm				
		8.23	9D						
		8.53	10D						
		8.69	11U		Dia.=100mm				
		9.14	12D						
		9.60	13U		Dia.=100mm				
									Continued on next sheet

Remarks

Ground-water was first encountered at a depth of 0.6m below ground level during boring. On completion of boring a water sample was taken. Full penetration of sampler was not attained.

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Borehole Log

Borehole No. **HIS0002** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446523.00 - 331748.00	Hole Type CP
Location:		Level: 31.80mbgl	Scale 1:50
Client: Highways England		Dates: 29/05/1964 - 03/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		10.06	14D						
		10.52	15U		Dia.=100mm				
		10.97	16D						
		11.43	17U		Dia.=100mm				
		12.34	18U		Dia.=100mm				
		12.80	19D						
		13.26	20U		Dia.=100mm				
		13.41	21D						
		13.72	22D						
		14.17	23U		Dia.=100mm				
		14.33	24D						
		14.90	25D			14.90	16.90		End of borehole at 14.90 m
		14.90	26W						

Remarks

Ground-water was first encountered at a depth of 0.6m below ground level during boring. On completion of boring a water sample was taken. Full penetration of sampler was not attained.

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Borehole Log

Borehole No. **HIS0003** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446612.00 - 332155.00	Hole Type CP
Location:		Level: 31.70mbgl	Scale 1:50
Client: Highways England		Dates: 04/06/1964 - 06/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.20	31.50		TOPSOIL TP
		0.46 - 0.91	1U		Dia.=100mm				Firm brown silty CLAY with gravel FGA
		0.91	2D			0.80	30.90		Medium dense brown sandy fine to medium GRAVEL FGA-SG
		1.07 - 1.52 1.22	3B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
	▼					1.80	29.90		Medium dense brown fine to medium GRAVEL FGA-SG
		2.44 - 2.90 2.59	4B SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
						3.40	28.30		Medium dense brown slightly sandy fine to medium GRAVEL FGA-SG
		3.66 - 4.11 3.81	5B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
						4.90	26.80		Very stiff to hard friable red-brown silty CLAY (Keuper Marl) MM-Z4
		5.18 - 5.64	6U		Dia.=100mm				
		5.64	7D						
		6.10	8D						
		6.71 - 7.16	9U		Dia.=100mm				
		7.16	10D						
		7.62	11D						
		8.23 - 8.69	12U		Dia.=100mm				
		8.69	13D						
						8.84	22.86		End of borehole at 8.84 m

Remarks
Water was standing in the borehole at a depth of 1.98m below ground level 3.5 hrs after completion of boring.

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Borehole Log

Borehole No. **HIS0004** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446645.00 - 332139.00	Hole Type CP
Location:		Level: 31.70mbgl	Scale 1:50
Client: Highways England		Dates: 01/06/1964 - 03/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.20	31.50		TOPSOIL TP
		0.46 - 0.91	1U		Dia.=100mm				Stiff brown sandy CLAY with occasional gravel FGA
		0.91	2D						
	▼					1.70	30.00		Medium dense brown fine to medium SAND. FGA-SG
		2.13	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
						2.40	29.30		Brown sandy fine to medium GRAVEL. FGA-SG
		2.74 - 3.05	3B			2.70	29.00		Stiff red-brown sandy CLAY. FGA
						3.40	28.30		Medium dense brown sandy fine to coarse GRAVEL. FGA-SG
		3.66 - 4.11 3.81	4B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.57 - 5.03 4.72	5B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.49 - 5.94 5.64	6B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
						5.90	25.80		Medium dense brown fine to medium SAND with occasional gravel. FGA-SG
		6.25	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
		6.25 - 6.55	7B			6.70	25.00		Medium dense brown sandy fine to medium GRAVEL FGA-SG
		7.32 - 7.77 7.47	8B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
						8.20	23.50		Stiff friable red-brown silty CLAY (Keuper Marl) MM-Z4
		8.38 - 8.84	9U		Dia.=100mm				
		8.80 8.80	10D 11W			8.84	22.86		End of borehole at 8.84 m

Remarks
Ground-Water was first encountered at a depth of 1.8m below ground level. On completion of boring a water sample was taken.

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Borehole Log

Borehole No. **HIS0005** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446618.00 - 332168.00	Hole Type CP
Location:		Level: 31.90mbgl	Scale 1:50
Client: Highways England		Dates: 29/05/1964 - 30/05/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.30	1B						FILL (tarmac and hard core) MG-SG
						0.30	31.60		Stiff brown silty CLAY FGA
		0.61 - 1.07	2U		Dia.=100mm				
		1.07	3D						
		1.37 - 1.83	4B			1.20	30.70		Medium dense to dense brown very sandy fine to medium GRAVEL FGA-SG
		1.52	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
	▼	1.98	16W						
		2.44 - 2.90	5B						
		2.59	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
						3.00	28.90		Brown clayey SAND with occasional fine to medium gravel FGA-SG
		3.20 - 3.51	6B						
						3.50	28.40		Medium dense brown sandy fine to coarse GRAVEL. FGA-SG
		3.66 - 4.11	7B						
		3.84	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.57 - 5.03	8B						
		4.72	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
						5.80	26.10		Stiff to very stiff friable red-brown silty CLAY (Keuper Marl). MM-Z4
		5.94 - 6.40	9U		Dia.=100mm				
		6.40	10D						
		6.71	11D						
		7.32 - 7.77	12U		Dia.=100mm				
		7.77	13D						
		8.38 - 8.84	14U		Dia.=100mm				
		8.84	15D			8.84	23.06		End of borehole at 8.84 m

Remarks

Water was added to assist boring and stood at a depth of 1.98m below ground level on completion of boring, when a sample was taken. A week later the water table was still at the same level and a second sample was taken.

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Borehole Log

Borehole No. **HIS0006** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446650.00 - 332152.00	Hole Type CP
Location:		Level: 31.70mbgl	Scale 1:50
Client: Highways England		Dates: 26/05/1964 - 28/05/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	1D			0.20	31.50		TOPSOIL TP
		0.46 - 0.91	2U		Dia.=100mm				Firm brown silty CLAY with some gravel. FGA
						0.90	30.80		Medium dense brown sandy fine to medium GRAVEL FGA-SG
		1.22 - 1.68	3B						
		1.37	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
	▼	1.68	13W						
						2.10	29.60		Medium dense brown medium SAND. FGA-SG
		2.29	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
						2.70	29.00		Medium dense brown fine to medium SAND and GRAVEL FGA-SG
		2.90 - 3.35	4U		Dia.=100mm	3.00	28.70		Medium dense brown very sandy fine to medium GRAVEL with occasional coarse gravel. FGA-SG
		3.51 - 3.96	5B						
		3.66	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.42 - 4.88	6B						
		4.57	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.18 - 5.49	7B			5.20	26.50		Brown fine to medium SAND. FGA-SG
						5.80	25.90		Very stiff to hard friable red-brown silty CLAY (Keuper Marl) MM-Z4
		6.10 - 6.55	8U		Dia.=100mm				
		6.55	9D						
		7.16	10D						
		7.92 - 8.38	11U		Dia.=100mm				
		8.38	12D						
						8.54	23.16		End of borehole at 8.54 m

Remarks

Ground-water was first encountered at a depth of 6.4m below ground level and rose overnight to a depth of 1.98m. On completion of boring the water level stood at a depth of 1.68m and a sample was taken

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Borehole Log

Borehole No. **HIS0007** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446634.00 - 332160.00	Hole Type CP
Location:		Level: 31.70mbgl	Scale 1:50
Client: Highways England		Dates: 14/07/1964 - 15/07/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									Stiff brown CLAY FGA
		1.22 - 1.68 1.37	1B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	1.10	30.60		Loose to medium dense brown sandy fine to medium GRAVEL FGA-SG
	▼	2.13 - 2.59 2.29	2B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.20 - 3.66 3.35	3B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.11 - 4.57 4.27	4B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.03 - 5.49 5.18	5B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	5.40	26.30		Stiff friable red-brown silty CLAY (Keuper Marl) MM-Z4
						5.64	26.06		End of borehole at 5.64 m

Remarks
Ground-water was first encountered at a depth of 2.1m below ground level.

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Borehole Log

Borehole No. **HIS0008** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446629.00 - 332147.00	Hole Type CP
Location:		Level: 31.70mbgl	Scale 1:50
Client: Highways England		Dates: 15/07/1964 - 16/07/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									Stiff brown silty CLAY with gravel FGA
	▼	1.37 - 1.83 1.52	1B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	1.20	30.50		Medium dense brown sandy fine to medium GRAVEL FGA-SG
		2.29 - 2.74 2.44	2B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
						2.70	29.00		Stiff brown silty CLAY FGA
		3.20 - 3.66 3.35	3B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	3.00	28.70		Loose to medium dense brown sandy fine to medium GRAVEL FGA-SG
		4.11 - 4.57 4.27	4B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.03 - 5.49 5.18	5B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
						5.60	26.10		Stiff red-brown silty CLAY (Keuper Marl) MM-Z4
						5.80	25.90		End of borehole at 5.79 m

Remarks

Ground-water was standing at a depth of 1.5m below ground level on completion of the borehole, but water had been added to assist the boring.

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Borehole Log

Borehole No. **SK43SE18** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446600.00 - 332120.00	Hole Type CP
Location:		Level: 32.10mbgl	Scale 1:50
Client: Highways England		Dates: 17/01/1962 - 24/01/1962	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.15	1D						Topsoil TP
						0.30	31.80		
		0.46	2D						Brown sandy subsoil FGA
						0.61	31.49		
		0.76	3D						Mottled sandy clay FGA
						0.91	31.19		
		1.07	4D						Yellow clayey sand FGA-SG
						1.52	30.58		
		1.68	5D						Coarse brown gravelly sand FGA-SG
		1.68	SPT (S)	N=54 (75,12/15,15,11,13)	Water=-				
		1.68 - 2.13	12B						
		1.68 - 2.13	18SP TLS						
		2.13	6D						
		3.05	SPT (S)	N=62 (75,12/14,14,16,18)	Water=-				
		3.05 - 3.51	13B						
		3.05 - 3.51	19SP TLS			3.66	28.44		Gravel & sand (grey) FGA-SG
		3.51	7D						
		4.57	SPT (S)	N=67 (75,8/14,14,18,21)	Water=-				
		4.57 - 5.03	14B						
		4.57 - 5.03	20SP TLS						
		5.03	8D						
						5.79	26.31		Red marl MM-Z3
		6.10	9D						
		6.10 - 6.40	15U	221blows					
		7.32 - 7.62	16U	338blows					
		7.62	10D						
		8.69 - 9.14	17U	222blows					
		9.14	11D			9.14	22.96		End of borehole at 9.14m

Remarks
From 3.66m B.S. Gravel & sand blowing back up inside casing, still coming in until cased to 7.32m

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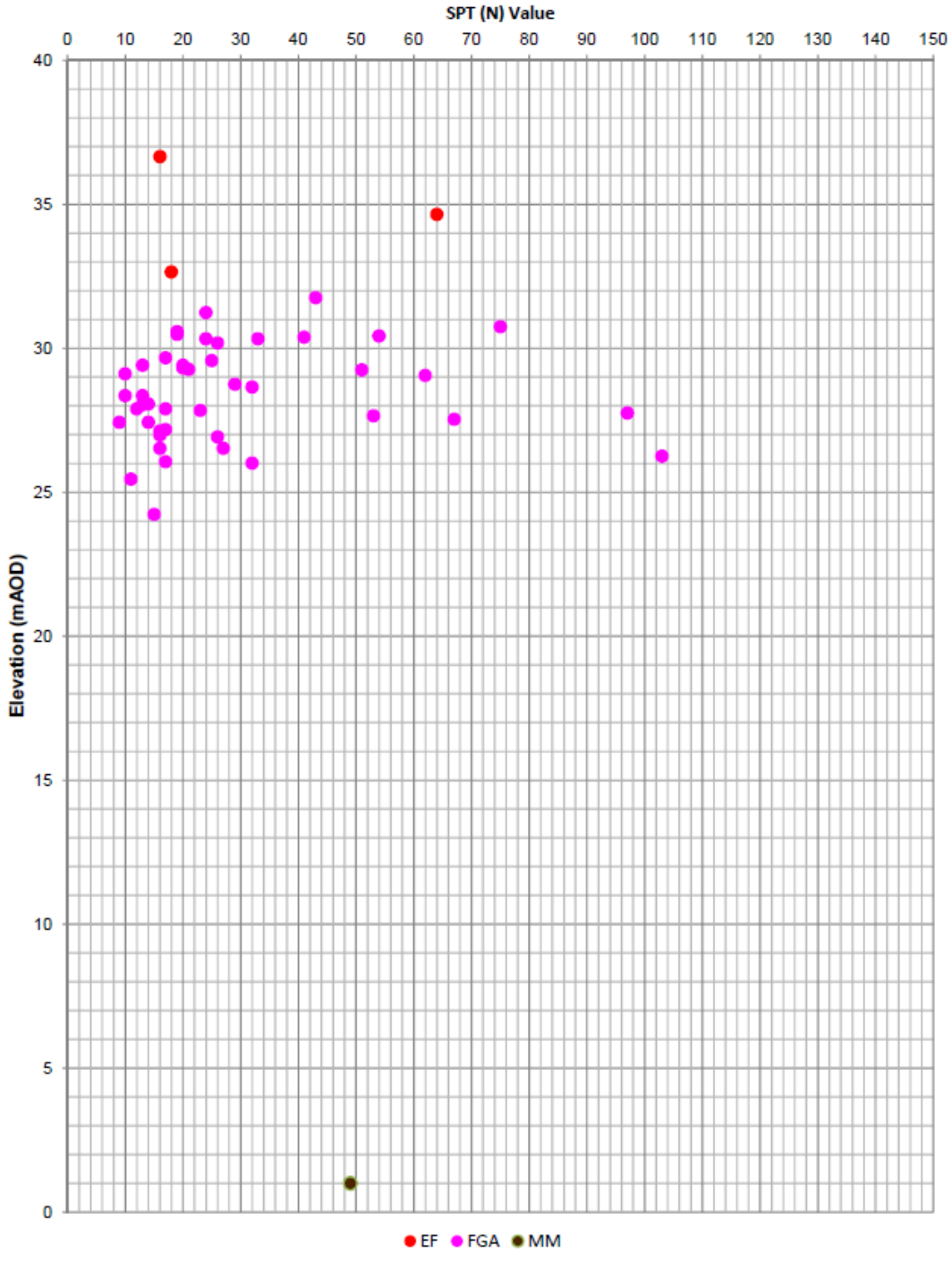
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PLOTS

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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **189560-189930SB**
Client: **Highways England**	Borehole ID: **CP1105, CP1105, HIS0001, HIS0002, HIS0003, HIS0004, HIS0005, HIS0006, HIS0007, HIS0008 and SK43SE18**	



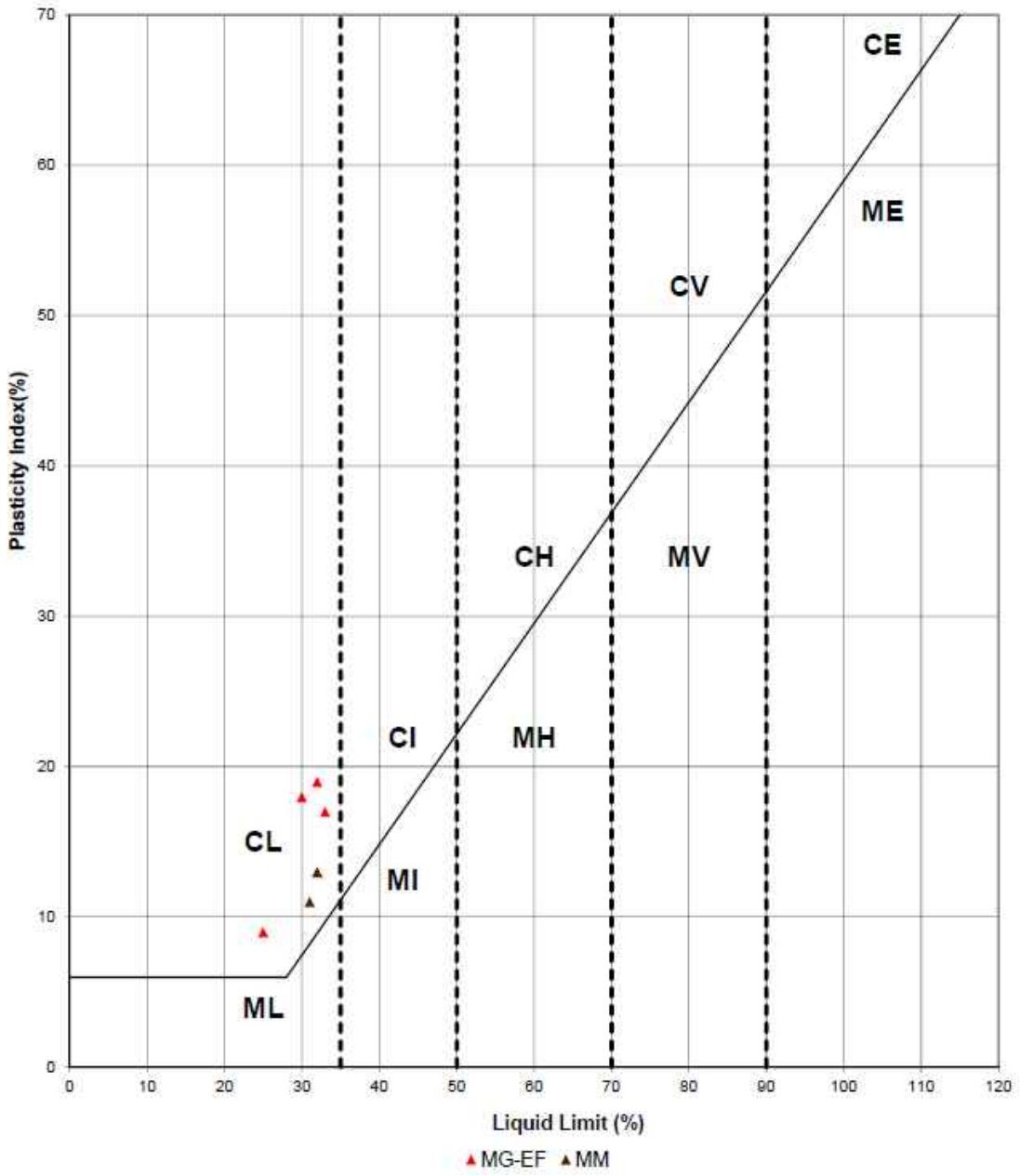
Extrapolated SPT (N) Values >150 have not been shown

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A Line Plot

Project ID: HA549342	Project Title: SMP - M1 J23A TO J25	Data Sheet: 189560-189930SB
Client: Highways England	Borehole ID: CP1104 and CP1105	



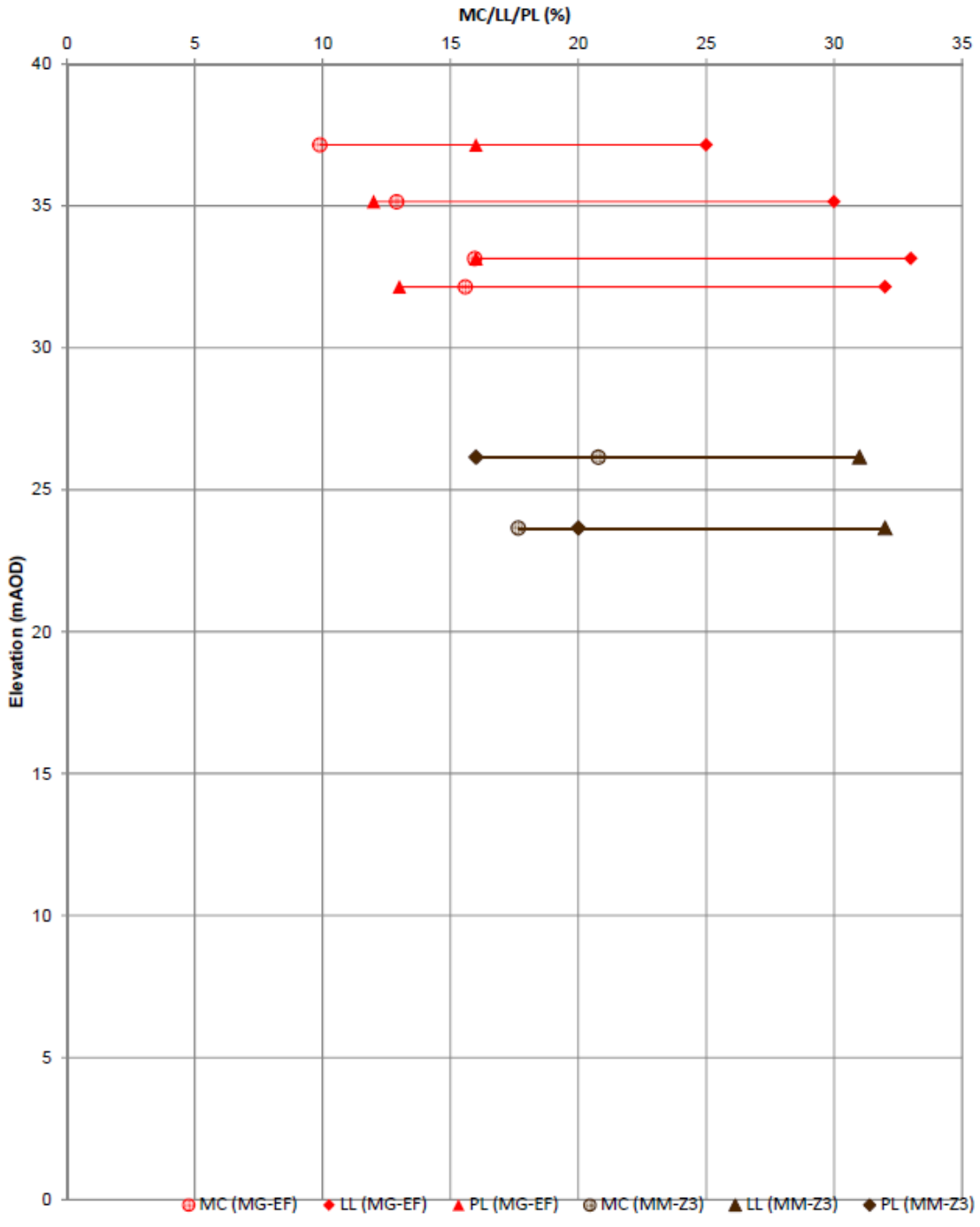
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

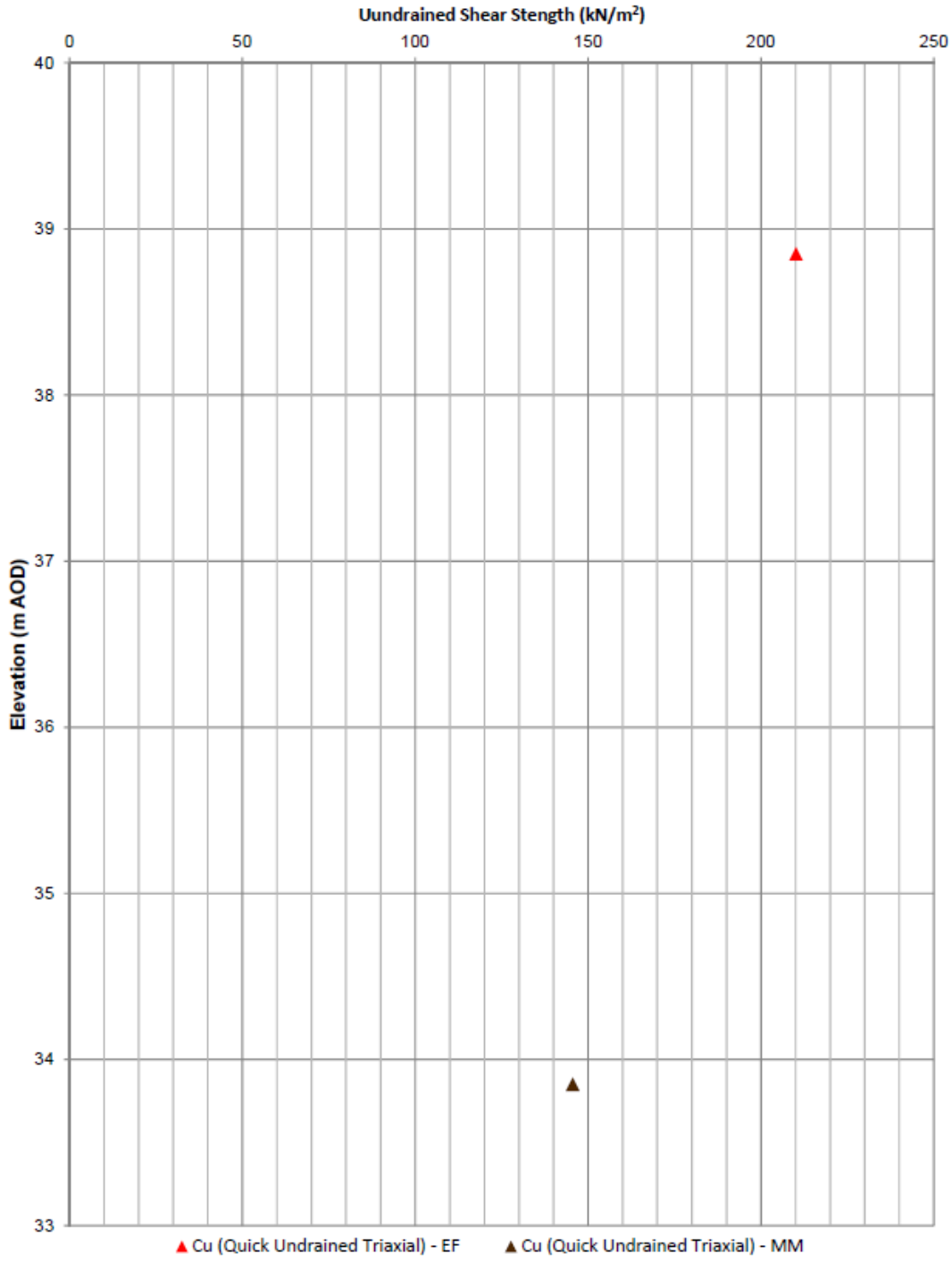
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **189560-189930 SB**
Client: **Highways England**	Borehole ID: **CP1104 and CP1105**	



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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **188560-188930SB**
Client: **Highways England**	Borehole ID: **CP1104 and CP1105**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-189960-190370SB-GSS-000001		
Earthwork Widening Solution	Granular Wedge at Embankment Crest 1:2.0		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	189960-190370		
Carriageway	Southbound		
Marker Post	MP189/9B+60 – MP190/3B+70		
National Grid Reference	E 446659, N 332158 – E 446856, N 332517		
Existing Ground Level at Location	Carriageway	39.90mAOD	
	Toe of Embankment	31.38mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_21155	HAGDMS designation
Earthwork Height	NB: N/A	SB: 9.4m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB:16°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	13/02/2017	[redacted]
Checked	Alice Bazen	08/03/2017	
Reviewed	Gary Summerfield	09/03/2017	
Approved	Tom Bulteel	16/03/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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Figure 1.1: Location Plan – 189960-190200

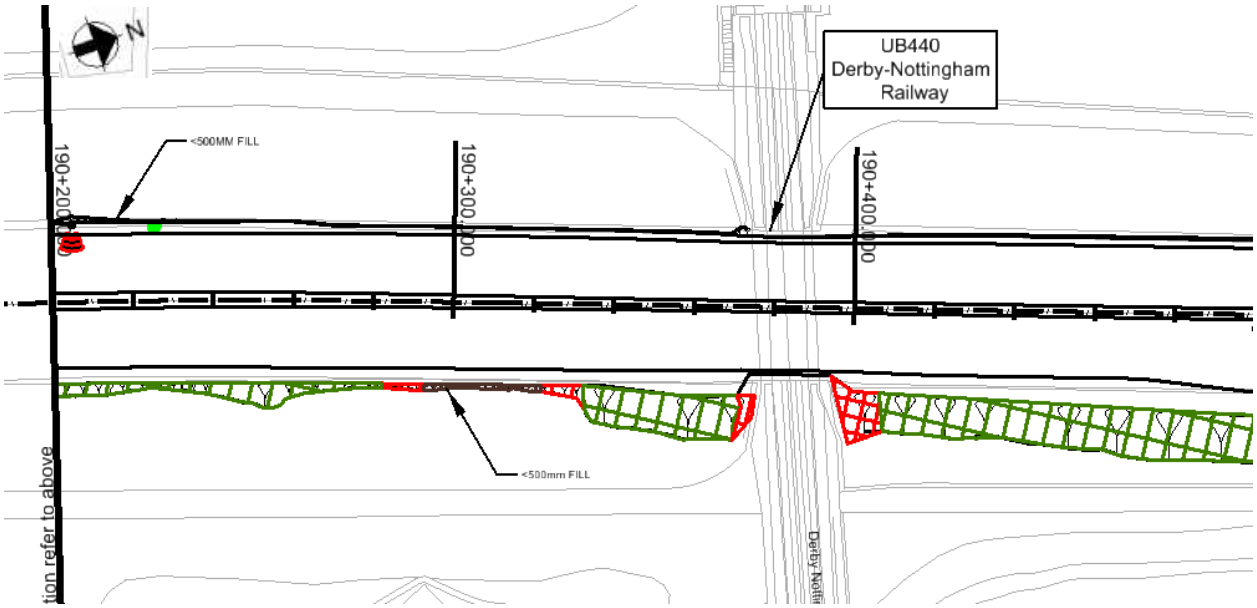


Figure 1.2: Location Plan – 190200-190370

Proposed Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

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- 189960-190280 - Granular Wedge at Embankment Crest 1:2.0
- 190930-190370 – Granular Wedge at Embankment Crest 1:2.0

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as an embankment ranging in height from 6.60m to 9.40m with a typical slope angle of 16 degrees.

The critical cross section with the greatest earthwork height was used. This was at Ch 190250.

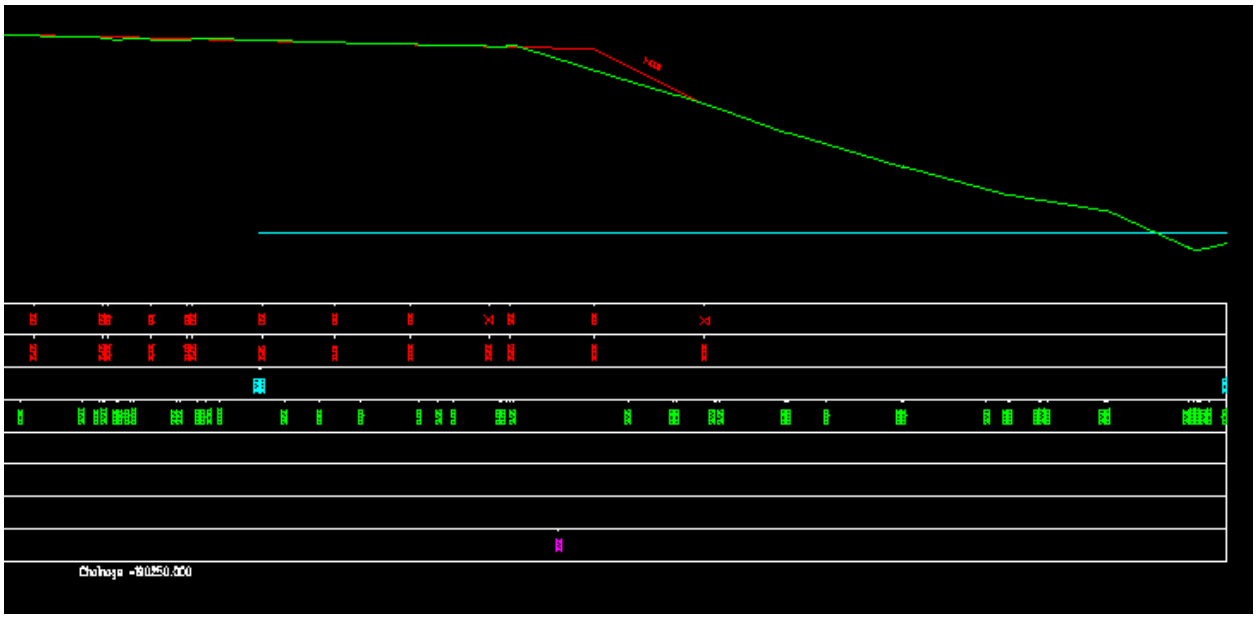


Figure 2: Topographic Critical Cross Section Chainage 190250

Utilities:

Western Power High cable located at the underbridge UB439. See Figure 3 for details:

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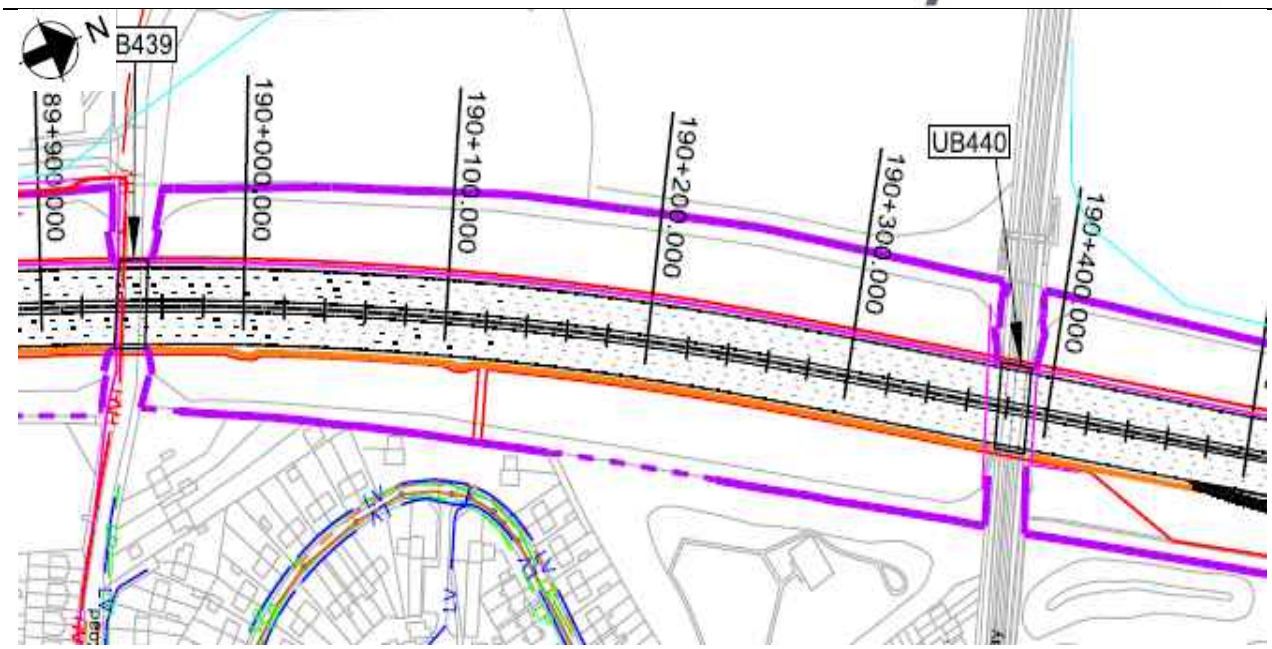


Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Hemington Member - Silt And Gravel

Solid Deposits: Edwalton Member - Mudstone

Ground Investigation:

There are 3 No. historical exploratory holes recorded within the design chainage, with additional 13 no. relevant exploratory holes considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000028, Rev P01.

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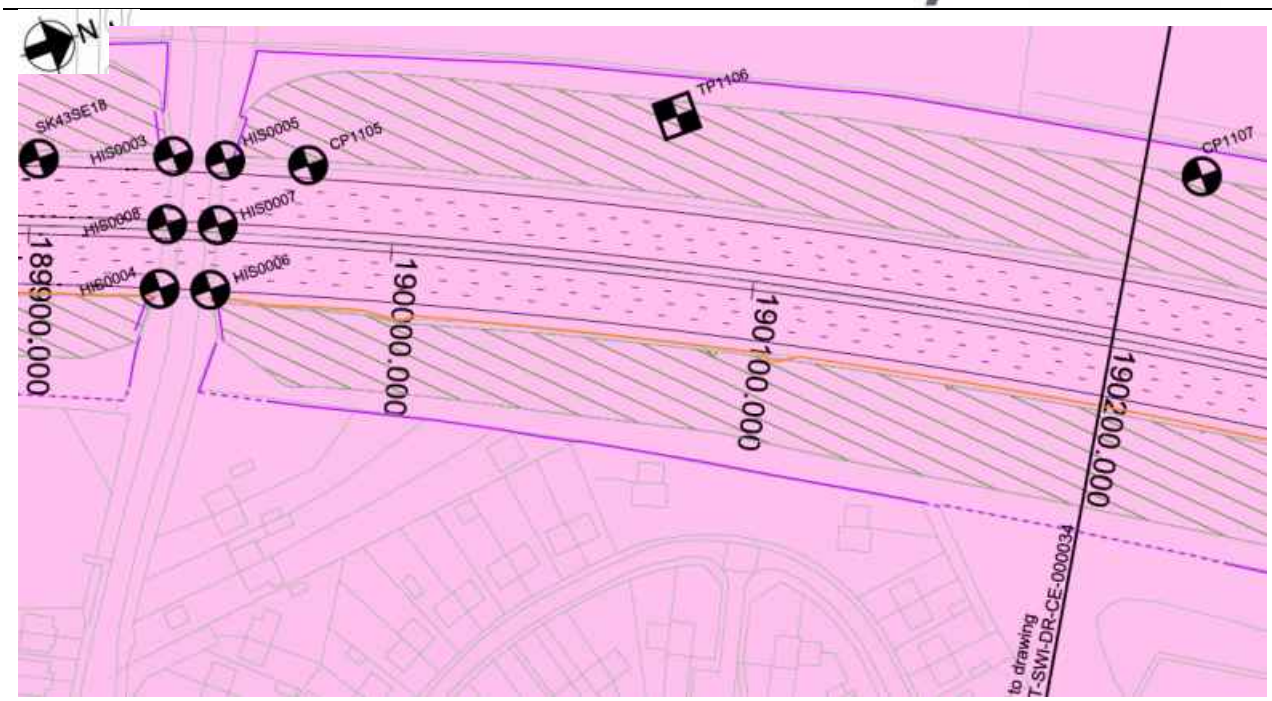


Figure 4.1: Borehole Location Plan – 189960-190200

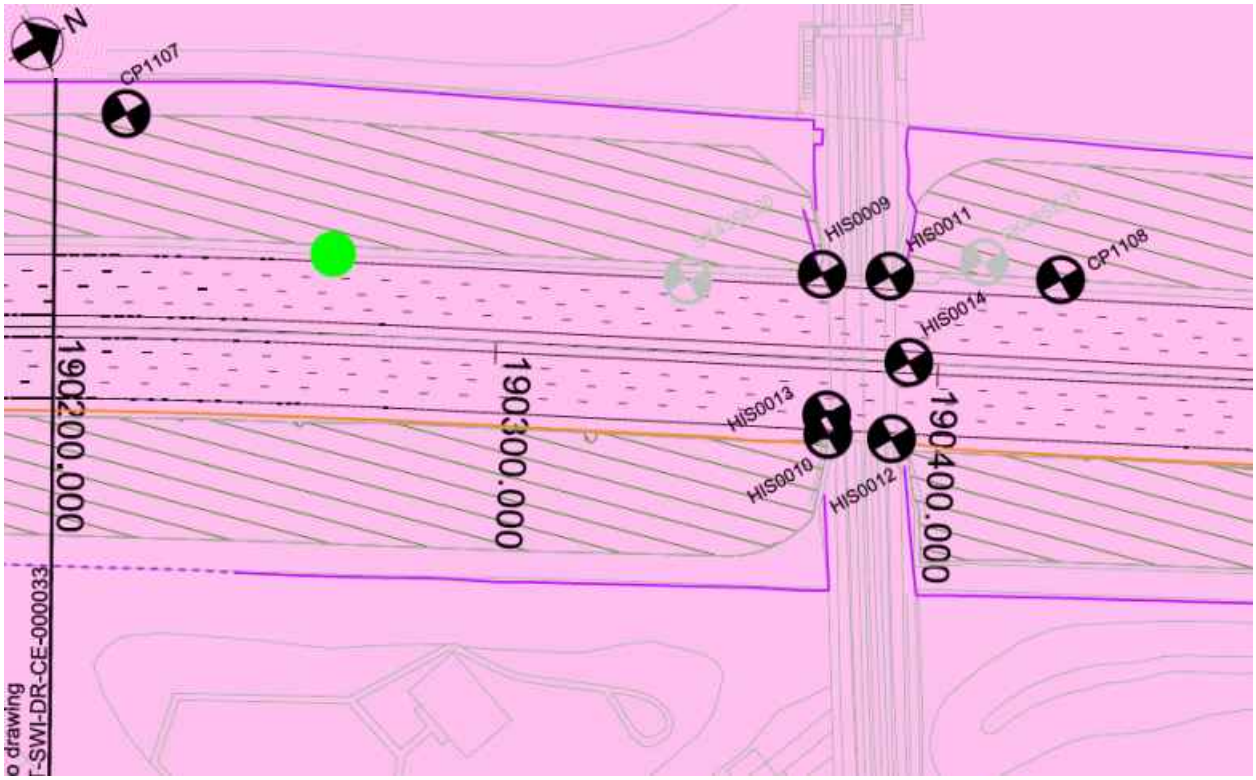


Figure 4.1: Borehole Location Plan – 190200-190370

Flood Risk:

The earthworks are located within a flood risk zone. The flood risk level is at 31.20mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04

Historical Boreholes:

Relevant Borehole Number	HIS0010	CP1105	CP1107	HIS0013
Borehole Chainage	190376	189975	190215	190375
Borehole Location	Southbound	Northbound	Northbound	Southbound
National Grid Reference	E 446856, N 332520	E 446627, N 332189	E 446714, N 332419	E 446852, N 332522
Ground Level at Exploratory Hole	31.12mAOD	38.85mAOD	31.80mAOD	31.10mAOD
RAG Analysis	Green	Green	Green	Green
Date Drilled	10/06/1964 – 11/06/1964	06/11/2006 – 07/11/2006	09/10/2006 – 07/10/2006	10/08/1964 – 15/08/1964
Termination Depth	7.93 metres below ground level (mbgl)	14.75 metres below ground level (mbgl)	8.50 metres below ground level (mbgl)	18.36 metres below ground level (mbgl)
Other suitable holes	CP1108, HIS0003, HIS0004, HIS0005, HIS0006, HIS0007, HIS0008,HIS0009, HIS0011, HIS0012, HIS0014, TP1106			

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Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Embankment Fill	9.90	30.0	15-64 (16)
Glaciofluvial Deposits (coarse grained)	12.9	27.00	9-103 (30)
Mercia Mudstone – III-IV	>12.9	<27.00	24->150 (24)

(1) Ground level is assumed to be at the crest of carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken in exploratory holes CP1108, HIS0003, HIS0004, HIS0005, HIS0006, HIS0007, HIS0008, HIS0009, HIS0010, HIS0011, HIS0012, HIS0013, HIS0014, CP1105 and CP1107

Groundwater:

Groundwater strike are presented in the table below:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
HIS0003	Glaciofluvial Deposits	1.98	29.72	-	-	-
HIS0004	Glaciofluvial Deposits	1.80	29.90	-	-	-
HIS0005	Glaciofluvial Deposits	1.98	29.92		-	
HIS0006	Mercia Mudstone to Glaciofluvial Deposits	6.40	25.30	-	1.68	30.02
HIS0007	Glaciofluvial Deposits	2.13	29.57	-	-	-
HIS0008	Glaciofluvial Deposits	1.52	30.18	-	-	-
HIS0009	Glaciofluvial Deposits	3.35	28.05	-	-	-
HIS0010	Glaciofluvial Deposits	0.90	30.22		-	
HIS0011	Mercia Mudstone	7.00	24.20	-	-	-
HIS0012	Glaciofluvial Deposits	0.61	30.50	-	-	-
HIS0013	Glaciofluvial Deposits	1.52	29.58	-	-	-
HIS0014	Glaciofluvial Deposits	1.83	29.57	-	-	-

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Groundwater Design Level:

A design groundwater level of 31.20mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

9 No Atterberg limit tests, 9 No. Moisture Content Tests and was completed, with the results presented in the table below:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	1.40	18	38	16	22	CL
Embankment Fill	1.60	31	46	27	19	MI
Embankment Fill	1.70	10	25	16	9	CL
Embankment Fill	2.00	16	35	16	19	CL
Embankment Fill	3.80	13	30	12	18	CL
Embankment Fill	4.00	14	33	12	21	CL
Embankment Fill	5.40	23	39	22	17	CI
Mercia Mudstone	5.70	16	33	16	17	CI
Mercia Mudstone	15.00	32	34	24	10	ML

3 No. quick undrained triaxial tests were completed with the results presented in the table below:

Stratum	Depth to Top of Test (mbgl)	C_u (kN/m^2)
Embankment Fill	1.2	85
Embankment Fill	3.2	105
Embankment Fill	4.5	210

Lab Test Data - Chemical:

68 No. Chemical Tests tests were undertaken within exploratory holes with the results presented in the table below:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Glaciofluvial Deposits	Sulphate (Total) as SO4	Solid	12	0.02-0.12	%SO4
Glaciofluvial Deposits	Water Soluble Sulphate as SO4	Water	3	0.19-0.20	g/l SO4
Glaciofluvial Deposits	pH	Solid	3	7.5	-
Mercia Mudstone	Sulphate (Total) as SO4	Solid	20	0.01-0.35	%SO4

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Mercia Mudstone	Water Soluble Sulphate as SO4	Water	6	0.19-0.73	g/l SO4
Mercia Mudstone	pH	Solid	6	7.0-7.5	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

The below table outlines the assumed anticipated ground model; strata type and depth will need to be confirmed with 'Just In Time' Ground Investigation.

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0 – 9.90	39.9 – 30.00	9.9	21	26	0	96	6.6	5.3	-	0.50	0.20	-	DS-2 AC-2
Glaciofluvial Deposits (coarse grained)	9.90 –12.90	30.00 – 27.00	4.7	21	36	-	-	-	43.2	-	-	0.25	-	DS-1 AC -1
Mercia Mudstone – III/IV	>12.90	<27.00	-	21	30	2	120	9.0	7.2	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from the interpreted geological long section.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion, and Poisson's ratio derived in the AMAR GIR are used.
(4) ϕ' of Embankment Fill was based on PI value from Table 2 (BS8002:2015). For an average PI value of 17, ϕ' is 26^0.
(5) C_u of Embankment Fill was derived using the Stroud correlation. A typical PI of 17% gives an f1 value of 6.0, combined with a typical SPT 'N' value of 16, this gives a typical c_u of 96kN/m^2.
(6) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using typical SPT 'N' value of 16, Eu = 6.6MN/m^2. Therefore E' = 5.3MN/m^2.
(7) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using correlation with SPT 'N' values (Peck 1974). Using a typical 'N' value of 30 gives an angle of 35°.

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(8) E' of Glaciofluvial Deposits (coarse grained) was determined using Bowles correlation E' = 1200 (N + 6) which (using typical 'N' value of 30) gives a value of 43.2MN/m^2.

(9) cu of Mercia Mudstone – III/IV was derived using the Stroud correlation. In the absence of sufficient PI data, the typical f1 value of 5.0 for Mercia Mudstone (CIRIA C570) was adopted; combined with a typical SPT 'N' value of 24, this gives a cu of 120kN/m^2. This value exceeds the range given in the AMAR GIR; therefore the upper bound of the range was adopted.

(10) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using typical SPT 'N' value of 24, Eu = 9.0MN/m^2. Therefore E' = 7.2MN/m^2.

(11) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Embankment Fill, the classification used for the strata in the AMAR GIR was adopted

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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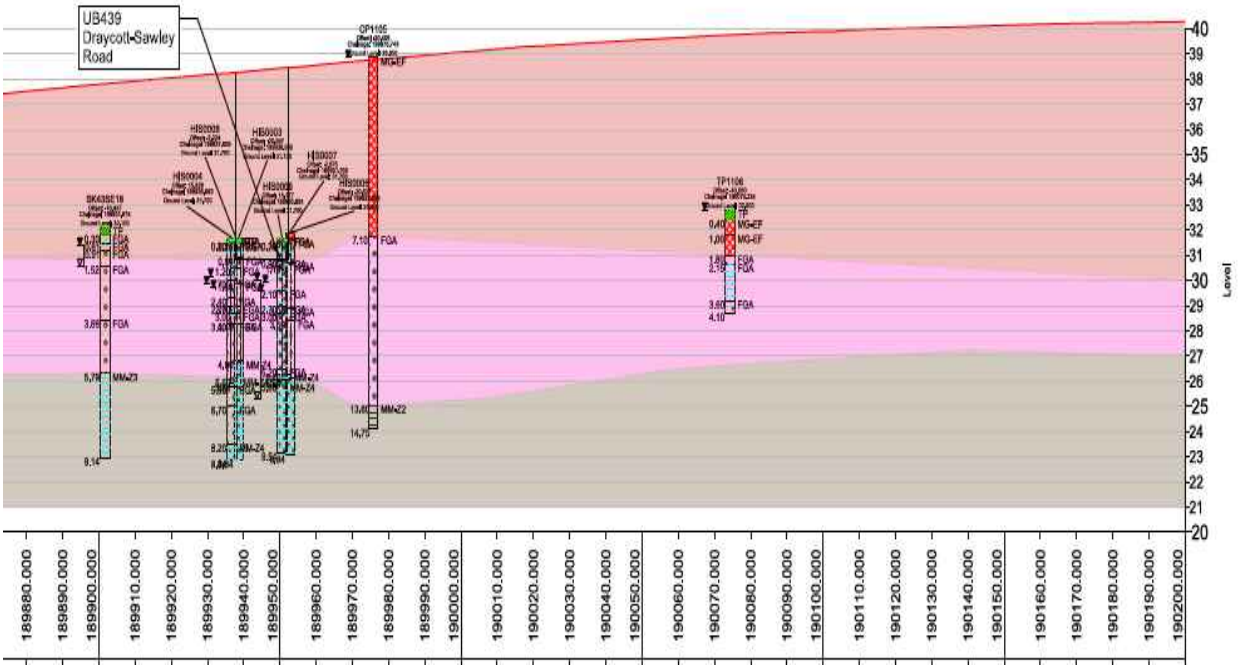


Figure 5.1 : Geological Long Section 189900-190200

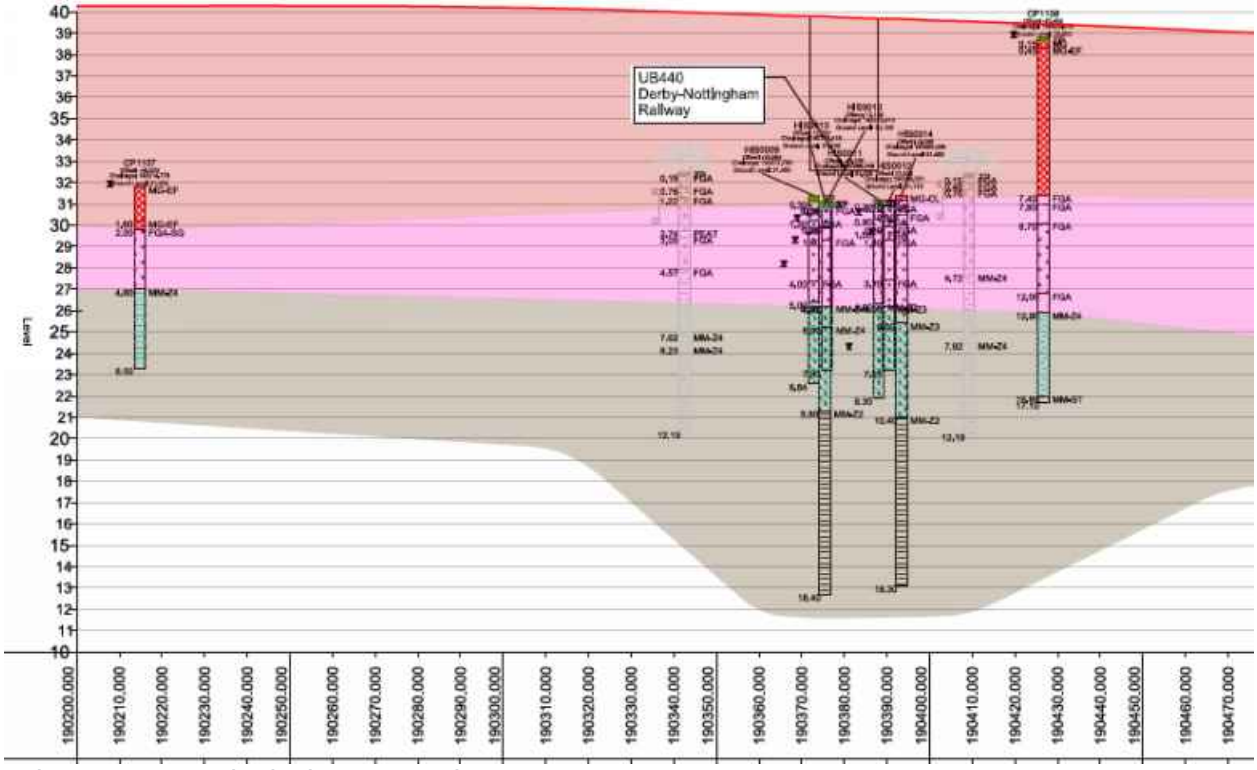


Figure 5.2 : Geological Long Section 190200-190470

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GEOTECHNICAL DESIGN CONCLUSIONS

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
189960	190280	Granular Wedge at Embankment Crest (1:2.0)	3.5	26.6 (1V:2H)
190330	190370	Granular Wedge at Embankment Crest (1:2.0)	3.5	26.6 (1V:2H)

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-R-FTPSB3, Ch190200, Southbound - Dynamic Sample with Rotary Core follow on to a scheduled depth of 15m bgl.
- TP-NW4, Ch1990120, Trial Pit and Thermal Resistivity Probe – required depth to be confirmed.

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HISTORICAL EXPLORATORY HOLES

Borehole Log

Borehole No. **CP1105** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446627.00 - 332189.00	Hole Type CP
Location:		Level: 38.85mbgl	Scale 1:50
Client: Highways England		Dates: 06/11/2006 - 07/11/2006	Logged By SM

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.50 - 1.20	1B						MADE GROUND: Stiff red brown slightly sandy slightly gravelly clay. Sand is fine. Gravel is subangular fine to coarse of weak mudstone and angular fine to coarse sandstone and siltstone. MG-EF
		1.20 - 1.65	2U	50blows	Dia.=100mm				
		1.70	3D						
		2.20	4D						
		2.20	SPT (S)	N=16 (4,3/4,4,4,4)	Casing=1.70m Water=DRY				
		2.20 - 2.70	5B						
		3.20 - 3.65	6U	67blows	Dia.=100mm				
		3.70	7D						
		4.20	8D						
		4.20	SPT (S)	50 (4,9/50 for 235mm)	Casing=4.20m Water=DRY				
		4.20 - 4.70	9B						
		5.20 - 5.65	10U	91blows	Dia.=100mm				*At 5.20m; very stiff.*
		5.70	11D						
		6.20	12D						
		6.20	SPT (S)	N=18 (2,4/4,4,5,5)	Casing=6.20m Water=DRY				
		6.20 - 6.70	13B						
		7.10	SPT (C)	N=43 (4,7/9,12,11,11)	Casing=7.10m Water=DRY	7.10	31.75		Dense to very dense grey brown slightly sandy GRAVEL. Sand is fine to coarse. Gravel is subrounded and rounded fine to coarse of sandstone, siltstone and flint. FGA-SG
		7.10 - 7.60	14B						
		8.10	SPT (C)	50 (6,9/50 for 200mm)	Casing=8.10m Water=ADDED				*At 8.10m; sand and gravel.*
		8.10 - 8.60	15B						
		9.60	SPT (C)	N=51 (4,7/8,11,14,18)	Casing=9.60m Water=ADDED				
		9.60 - 10.10	16B						

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring below 8.10m.;The borehole was advanced by chiselling methods from 4.50m to 4.80m (0.75 hours), 11.50m to 11.70m (0.75 hours), 12.70m to 13.40m (2 hours) and 14.20m to 14.60m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **CP1105** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446627.00 - 332189.00	Hole Type CP
Location:		Level: 38.85mbgl	Scale 1:50
Client: Highways England		Dates: 06/11/2006 - 07/11/2006	Logged By SM

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		11.10 11.10 - 11.60	SPT (C) 17B	50 (2,9/50 for 155mm)	Casing=11.10m Water=ADDED				*GRAVEL (as previous sheet)*
		12.60 12.60 - 13.10	SPT (C) 18B	50 (4,11/50 for 145mm)	Casing=12.60m Water=ADDED				
		13.80 13.80 13.80 - 14.50	19D SPT (S) 20B	126 (7,12/126 for 295mm)	Casing=14.00m Water=ADDED	13.80	25.05		Weak red brown MUDSTONE recovered as red brown subangular and subrounded fine to coarse gravel sized fragments. MM-Z2
		14.50 14.50	21D SPT (S)	80 (25 for 125mm/80 for 125mm)	Casing=14.50m Water=ADDED	14.75	24.10		End of borehole at 14.75 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring below 8.10m.;The borehole was advanced by chiselling methods from 4.50m to 4.80m (0.75 hours), 11.50m to 11.70m (0.75 hours), 12.70m to 13.40m (2 hours) and 14.20m to 14.80m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **CP1107** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446714.00 - 332419.00	Hole Type CP
Location:		Level: 31.80mbgl	Scale 1:50
Client: Highways England		Dates: 09/10/2006 - 09/10/2006	Logged By RMS

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	2D						MADE GROUND. Firm to stiff brown grey slightly gravelly silt/clay. Gravel is angular to subrounded fine to coarse of coal, siltstone, sandstone, mudstone and carbonaceous mudstone. Driller notes brick and metal fragments. MG-EF
		0.20 - 0.70	1B						*At 0.50m; red brown gravelly clay.* *From 0.00m to 1.60m; driller notes black mottled grey clay with organic material.*
		0.90	3D						
		1.20 - 1.60	4U	39blows					
		1.60 - 1.70	5D			1.60	30.20		MADE GROUND. Firm brown grey slightly gravelly clay. Gravel is subangular to subrounded fine to coarse, of coal, mudstone, slag, clinker and sandstone. MG-EF
		2.00 - 2.45	6D			2.00	29.80		Medium dense becoming dense brown SAND and GRAVEL locally slightly clayey. Gravel is subangular to subrounded fine to coarse of quartz, mudstone and sandstone. Sand is fine to coarse. FGA-SG
		2.00 - 2.50	7B						
		3.00	8D						
		3.00	SPT (C)	N=16 (3,4/4,3,4,5)	Casing=3.00m Water=ADDED				
		3.00 - 3.50	9B						
		4.00	10D						
		4.00	SPT (C)	N=33 (4,8/8,9,10,6)	Casing=4.00m Water=ADDED				
		4.00 - 4.50	11B						
		4.80	12D			4.80	27.00		Firm becoming very stiff red brown slightly sandy CLAY locally a silt. Sand is fine to coarse. MM-Z4
		5.00 - 5.40	13U	150blows					
		5.40	14D						*From 5.40m; locally mottled grey.*
		6.50	SPT (S)	50 (25 for 135mm/50 for 155mm)	Casing=6.10m Water=DAMP				*From 6.50m; with subangular fine to coarse gravel sized fragments of friable mudstone.*
		6.50 - 7.00	15B						
		7.50	16D						
		8.00	SPT (C)	50 (25 for 75mm/50 for 95mm)	Casing=6.10m Water=DAMP				
		8.00 - 8.50	17B			8.50	23.30		End of borehole at 8.50m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was advanced by chiselling methods from 4.50m to 4.80m (1 hour) and 8.00m to 8.50m (1 hour).;An amount of water was added to facilitate boring below 3.00m.;No visual or olfactory indication of contamination was observed.;

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Borehole Log

Borehole No. **CP1108** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446852.00 - 332583.00	Hole Type CP
Location:		Level: 38.80mbgl	Scale 1:50
Client: Highways England		Dates: 01/10/2006 - 01/10/2006	Logged By RMS

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.15	38.65		TOPSOIL. TP
		0.45	PID	1ppmv		0.45	38.35		MADE GROUND. Hard core (driller's description). MG
		0.45 - 1.20	1B						MADE GROUND. Firm to stiff becoming very stiff red brown gravelly clay with occasional gravel sized pockets of organic material. Gravel is subangular to subrounded, fine to coarse of mudstone, siltstone and sandstone. MG-EF
		1.50 - 1.95	1U	40blows					
		2.00	2D						
		2.50	3D						
		2.50	SPT (S)	N=15 (2,3/3,4,4,4)	Casing=2.50m Water=DRY				*From 2.50m; some grey mottling.*
		2.50 - 3.00	4B						
		3.50 - 3.95	5U	60blows					
		4.00	6D						*Between 4.00m to 5.50m; friable.*
		4.50	7D						
		4.50	SPT (S)	N=31 (4,5/7,7,8,9)	Casing=2.50m Water=DRY				
		4.50 - 5.00	8B						
		5.50 - 6.00	9U#B	100blows					
		6.50	10D						
		6.50	SPT (S)	N=49 (5,6/19,12,9,9)	Casing=2.50m Water=DRY				
		6.50 - 7.00	11B						
		7.40	12B			7.40	31.40		
		7.50 - 7.95	13U	60blows					Grey brown clayey SAND. Possible FGA-SG
		8.00	14D			7.80	31.00		Grey brown clayey slightly gravelly SAND. Gravel is subangular to subrounded, fine to coarse of sandstone and mudstone. FGA-SG
		9.00	SPT (C)	N=31 (5,4/6,7,9,9)	Casing=9.00m Water=4.60m	8.70	30.10		Brown clayey SAND and subangular to subrounded, fine to coarse GRAVEL of mudstone and sandstone. FGA-SG
		9.00 - 9.50	15B						
									Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.70m.;The borehole was advanced by chiselling methods from 17.00m to 17.10m (1 hour).;A hand held Photo-Ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.;

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Borehole Log

Borehole No. **CP1108** HISTORIC Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446852.00 - 332583.00	Hole Type CP
Location:		Level: 38.80mbgl	Scale 1:50
Client: Highways England		Dates: 01/10/2006 - 01/10/2006	Logged By RMS

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									SAND and GRAVEL (as previous sheet)
		10.50	SPT (C)	N=31 (6,5/6,7,8,10)	Casing=9.00m Water=4.60m				
		10.50 - 11.00	16B						
		12.00	SPT (C)	N=90 (9,14/16,20,24,30)	Casing=12.00m Water=5.90m	12.00	26.80		Brown grey gravelly SAND. Gravel is subrounded to rounded, fine to coarse of quartz. Sand is coarse. FGA-SG
		12.00 - 12.50	17B						
		12.90	18D			12.90	25.90		Firm red brown locally mottled grey green slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse possibly lithorelics of mudstone and siltstone. MM-Z4
		13.50 - 14.00	19U# B	30blows					
		15.00	20D						
		15.00	SPT (S)	N=24 (4,5/5,6,6,7)	Casing=15.00m Water=8.60m				
		15.00 - 15.50	21B						
		16.50 - 16.90	22U# B	100blows					
						16.80	22.00		Recovered as grey subangular to subrounded, fine to coarse gravel sized fragments of weak SANDSTONE and SILTSTONE. MM-ST
		17.00	23D						
		17.00	SPT (S)	50 (25 for 5mm/50 for 2mm)	Casing=17.00m Water=14.10m	17.10	21.70		
		17.10	SPT (C)	50 (25 for 0mm/50 for 0mm)	Casing=17.00m Water=14.90m				End of borehole at 17.10 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.70m.;The borehole was advanced by chiselling methods from 17.00m to 17.10m (1 hour).;A hand held Photo-Ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.;

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Borehole Log

Borehole No. **HIS0003** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446612.00 - 332155.00	Hole Type CP
Location:		Level: 31.70mbgl	Scale 1:50
Client: Highways England		Dates: 04/06/1964 - 06/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.20	31.50		TOPSOIL TP
		0.46 - 0.91	1U		Dia.=100mm				Firm brown silty CLAY with gravel FGA
		0.91	2D			0.80	30.90		
		1.07 - 1.52 1.22	3B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				Medium dense brown sandy fine to medium GRAVEL FGA-SG
	▼					1.80	29.90		Medium dense brown fine to medium GRAVEL FGA-SG
		2.44 - 2.90 2.59	4B SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
						3.40	28.30		Medium dense brown slightly sandy fine to medium GRAVEL FGA-SG
		3.66 - 4.11 3.81	5B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
						4.90	26.80		Very stiff to hard friable red-brown silty CLAY (Keuper Marl) MM-Z4
		5.18 - 5.64	6U		Dia.=100mm				
		5.64	7D						
		6.10	8D						
		6.71 - 7.16	9U		Dia.=100mm				
		7.16	10D						
		7.62	11D						
		8.23 - 8.69	12U		Dia.=100mm				
		8.69	13D						
						8.84	22.86		End of borehole at 8.84 m

Remarks
Water was standing in the borehole at a depth of 1.98m below ground level 3.5 hrs after completion of boring.

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Borehole Log

Borehole No. **HIS0004** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446645.00 - 332139.00	Hole Type CP
Location:		Level: 31.70mbgl	Scale 1:50
Client: Highways England		Dates: 01/06/1964 - 03/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.20	31.50		TOPSOIL TP
		0.46 - 0.91	1U		Dia.=100mm				Stiff brown sandy CLAY with occasional gravel FGA
		0.91	2D						
	▼					1.70	30.00		Medium dense brown fine to medium SAND. FGA-SG
		2.13	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
						2.40	29.30		Brown sandy fine to medium GRAVEL. FGA-SG
		2.74 - 3.05	3B			2.70	29.00		Stiff red-brown sandy CLAY. FGA
						3.40	28.30		Medium dense brown sandy fine to coarse GRAVEL. FGA-SG
		3.66 - 4.11 3.81	4B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.57 - 5.03 4.72	5B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.49 - 5.94 5.64	6B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
						5.90	25.80		Medium dense brown fine to medium SAND with occasional gravel. FGA-SG
		6.25	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
		6.25 - 6.55	7B			6.70	25.00		Medium dense brown sandy fine to medium GRAVEL FGA-SG
		7.32 - 7.77 7.47	8B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
						8.20	23.50		Stiff friable red-brown silty CLAY (Keuper Marl) MM-Z4
		8.38 - 8.84	9U		Dia.=100mm				
		8.80 8.80	10D 11W			8.84	22.86		End of borehole at 8.84 m

Remarks
Ground-Water was first encountered at a depth of 1.8m below ground level. On completion of boring a water sample was taken.

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Borehole Log

Borehole No. **HIS0005** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446618.00 - 332168.00	Hole Type CP
Location:		Level: 31.90mbgl	Scale 1:50
Client: Highways England		Dates: 29/05/1964 - 30/05/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.30	1B			0.30	31.60		FILL (tarmac and hard core) MG-SG
		0.61 - 1.07	2U		Dia.=100mm				Stiff brown silty CLAY FGA
		1.07	3D			1.20	30.70		
		1.37 - 1.83	4B						Medium dense to dense brown very sandy fine to medium GRAVEL FGA-SG
		1.52	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
	▼	1.98	16W						
		2.44 - 2.90	5B						
		2.59	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.20 - 3.51	6B			3.00	28.90		Brown clayey SAND with occasional fine to medium gravel FGA-SG
		3.66 - 4.11	7B			3.50	28.40		Medium dense brown sandy fine to coarse GRAVEL. FGA-SG
		3.84	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.57 - 5.03	8B						
		4.72	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.94 - 6.40	9U		Dia.=100mm	5.80	26.10		Stiff to very stiff friable red-brown silty CLAY (Keuper Marl). MM-Z4
		6.40	10D						
		6.71	11D						
		7.32 - 7.77	12U		Dia.=100mm				
		7.77	13D						
		8.38 - 8.84	14U		Dia.=100mm				
		8.84	15D			8.84	23.06		End of borehole at 8.84 m

Remarks

Water was added to assist boring and stood at a depth of 1.98m below ground level on completion of boring, when a sample was taken. A week later the water table was still at the same level and a second sample was taken.

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Borehole Log

Borehole No. **HIS0006** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446650.00 - 332152.00	Hole Type CP
Location:		Level: 31.70mbgl	Scale 1:50
Client: Highways England		Dates: 26/05/1964 - 28/05/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	1D			0.20	31.50		TOPSOIL TP
		0.46 - 0.91	2U		Dia.=100mm				Firm brown silty CLAY with some gravel. FGA
						0.90	30.80		Medium dense brown sandy fine to medium GRAVEL FGA-SG
		1.22 - 1.68	3B						
		1.37	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
	▼	1.68	13W						
						2.10	29.60		Medium dense brown medium SAND. FGA-SG
		2.29	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
						2.70	29.00		Medium dense brown fine to medium SAND and GRAVEL FGA-SG
		2.90 - 3.35	4U		Dia.=100mm	3.00	28.70		Medium dense brown very sandy fine to medium GRAVEL with occasional coarse gravel. FGA-SG
		3.51 - 3.96	5B						
		3.66	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.42 - 4.88	6B						
		4.57	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.18 - 5.49	7B			5.20	26.50		Brown fine to medium SAND. FGA-SG
						5.80	25.90		Very stiff to hard friable red-brown silty CLAY (Keuper Marl) MM-Z4
		6.10 - 6.55	8U		Dia.=100mm				
	▽	6.55	9D						
		7.16	10D						
		7.92 - 8.38	11U		Dia.=100mm				
		8.38	12D						
						8.54	23.16		End of borehole at 8.54 m

Remarks

Ground-water was first encountered at a depth of 6.4m below ground level and rose overnight to a depth of 1.98m. On completion of boring the water level stood at a depth of 1.68m and a sample was taken

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Borehole Log

Borehole No. **HIS0007** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446634.00 - 332160.00	Hole Type CP
Location:		Level: 31.70mbgl	Scale 1:50
Client: Highways England		Dates: 14/07/1964 - 15/07/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									Stiff brown CLAY FGA
		1.22 - 1.68 1.37	1B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	1.10	30.60		Loose to medium dense brown sandy fine to medium GRAVEL FGA-SG
	▼	2.13 - 2.59 2.29	2B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.20 - 3.66 3.35	3B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.11 - 4.57 4.27	4B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.03 - 5.49 5.18	5B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	5.40	26.30		Stiff friable red-brown silty CLAY (Keuper Marl) MM-Z4
						5.64	26.06		End of borehole at 5.64 m

Remarks
Ground-water was first encountered at a depth of 2.1m below ground level.

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Borehole Log

Borehole No. **HIS0008** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446629.00 - 332147.00	Hole Type CP
Location:		Level: 31.70mbgl	Scale 1:50
Client: Highways England		Dates: 15/07/1964 - 16/07/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
									Stiff brown silty CLAY with gravel FGA
	▼	1.37 - 1.83 1.52	1B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	1.20	30.50		Medium dense brown sandy fine to medium GRAVEL FGA-SG
		2.29 - 2.74 2.44	2B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
						2.70	29.00		Stiff brown silty CLAY FGA
		3.20 - 3.66 3.35	3B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	3.00	28.70		Loose to medium dense brown sandy fine to medium GRAVEL FGA-SG
		4.11 - 4.57 4.27	4B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.03 - 5.49 5.18	5B SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
						5.60	26.10		Stiff red-brown silty CLAY (Keuper Marl) MM-Z4
						5.80	25.90		End of borehole at 5.79 m

Remarks

Ground-water was standing at a depth of 1.5m below ground level on completion of the borehole, but water had been added to assist the boring.

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Borehole Log

Borehole No. **HIS0009** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446824.00 - 332537.00	Hole Type CP
Location:		Level: 31.40mbgl	Scale 1:50
Client: Highways England		Dates: 08/06/1964 - 09/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	1D			0.30	31.10		TOPSOIL TP
		0.46 - 0.91	2U		Dia.=100mm				Stiff brown silty CLAY FGA
		0.91	3D						
		1.37	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-	1.20	30.20		Medium dense to dense brown sandy fine to medium GRAVEL with occasional coarse gravel FGA-SG
		1.83 - 2.13	4B						
		2.29	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		2.59 - 2.90	5B						
	▼	3.20	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.51 - 3.96	6B						
		4.11	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	4.00	27.40		Medium dense brown fine to medium SAND and GRAVEL with occasional cobbles FGA-SG
		4.42 - 4.88	7B						
		5.03	8D			5.00	26.40		Firm to stiff friable red-brown and grey silty CLAY (Keuper Marl) MM-Z4
		5.18 - 5.64	9U		Dia.=100mm				
		5.64	10D						
		5.94	11D						
		6.10 - 6.55	12U		Dia.=100mm				
		6.55	13D						
		6.86	14D						
		7.01 - 7.47	15U		Dia.=100mm				
		7.47	16D						
		7.92	17D						
		8.38 - 8.84	18U		Dia.=100mm				
		8.84	19D			8.84	22.56		End of borehole at 8.80 m
		8.84	20W						

Remarks
Ground-water stood at a depth of 3.35m below ground level on completion of boring and a sample was taken.

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Borehole Log

Borehole No. **HIS0010** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446856.00 - 332520.00	Hole Type CP
Location:		Level: 31.12mbgl	Scale 1:50
Client: Highways England		Dates: 10/06/1964 - 11/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	1D						TOPSOIL TP
		0.30 - 0.76	2U		Dia.=100mm	0.30	30.82		Very stiff friable brown silty CLAY with occasional coal fragments. FGA
	▼	0.76	3D						
		1.37 - 1.80	4B			1.20	29.92		Brown fine to medium SAND and GRAVEL FGA-SG
		2.13	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	1.80	29.32		Medium dense to dense brown sandy fine to medium GRAVEL with occasional coarse gravel FGA-SG
		2.44 - 2.74	5B						
		3.05	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.35 - 3.66	6B						
		3.96	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.27 - 4.57	7B						
		5.03 - 5.49	8U		Dia.=100mm	4.90	26.22		Soft grey-brown silty CLAY MM-Z4
		5.49	9D						
		5.94 - 6.40	10U		Dia.=100mm	5.90	25.22		Stiff to very stiff friable red-brown silty CLAY (Keuper Marl). MM-Z4
		6.40	11D						
		7.50 - 7.92	12U		Dia.=100mm				
		7.92	13D			7.93	23.19		End of borehole at 7.93 m
		7.92	13W						

Remarks
Ground-water was first encountered at a depth of 0.9m below ground level. On completion of boring a water sample was taken.

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Borehole Log

Borehole No. **HIS0011** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446832.00 - 332550.00	Hole Type CP
Location:		Level: 31.20mbgl	Scale 1:50
Client: Highways England		Dates: 15/06/1964 - 17/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 0.76	1U		Dia.=100mm	0.20	31.00		TOPSOIL TP
		0.76	2D						Stiff brown sandy CLAY with fragments of coal FGA
		1.22	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	0.90	30.30		Medium dense brown SAND and GRAVEL FGA-SG
		1.83 - 2.29	3B			1.50	29.70		Medium dense to dense brown sandy fine to coarse GRAVEL with occasional cobbles. FGA-SG
		1.98	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		2.90	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.20 - 3.51	4B						
		3.81	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.11 - 4.42	5B						
		5.03 - 5.49	6U		Dia.=100mm	4.90	26.30		Firm to stiff friable red-brown and grey silty CLAY with mudstone fragements (Keuper Marl) MM-Z3
		5.49	7D						
		6.10 - 6.55	8U		Dia.=100mm				
		6.55	9D						
	▼								
		7.62 - 8.08	10U		Dia.=100mm				
		8.08	11D						
		8.69	12D						
		9.30	13D			9.30	21.90		End of borehole at 9.29m
		9.30	14W						

Remarks

Ground-water was first encountered at a depth of 7m below ground level and rose to a depth of 1.22m. On completion of boring a water sample was taken.

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Borehole Log

Borehole No. **HIS0012** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446864.00 - 332532.00	Hole Type CP
Location:		Level: 31.11mbgl	Scale 1:50
Client: Highways England		Dates: 12/06/1964 - 15/06/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 0.76	1U		Dia.=100mm	0.20	30.91		FILL MG-CL Firm brown sandy CLAY with gravel FGA
	▼	0.61	13W						
		0.76	2D						
		1.52	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	1.20	29.91		Dense fine to medium GRAVEL FGA-SG
		1.83 - 2.13	3B			1.80	29.31		Medium dense brown slightly sandy fine to medium GRAVEL with occasional coarse gravel FGA-SG
		2.44	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		2.74 - 3.05	4B						
		3.35	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.66 - 3.96	5B			3.70	27.41		Medium dense brown medium to coarse GRAVEL FGA-SG
		4.27	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		5.03 - 5.49	6U		Dia.=100mm	4.90	26.21		Soft to firm, becoming stiff red-brown and brown clayey SILT or silty CLAY with mudstone (Keuper Marl) MM-Z3
		5.49	7D						
		5.94 - 6.40	8U		Dia.=100mm				
		6.71 - 7.16	9U		Dia.=100mm				
		7.16	10D						
		7.47 - 7.92	11U		Dia.=100mm				
		7.92	12D			7.93	23.18		End of borehole at 7.92m

Remarks
Ground-water was first encountered at a depth of 0.61m below ground level and a sample was taken.

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Borehole Log

Borehole No. **HIS0013** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446852.00 - 332522.00	Hole Type CP
Location:		Level: 31.10mbgl	Scale 1:50
Client: Highways England		Dates: 10/08/1964 - 15/08/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
						0.30	30.80		TOPSOIL TP
		0.46 - 0.91	1U		Dia.=100mm				Stiff mottled brown and grey silty CLAY FGA
		0.91	2D						
						1.20	29.90		Dense brown medium to coarse GRAVEL FGA-SG
		1.52	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
	▼	1.52 - 1.83	3B						
		3.05	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.05 - 3.35	4B						
						4.90	26.20		Firm to stiff, becoming very stiff to hard, friable mottled red-brown and grey silty CLAY with fragments of mudstone (Keuper Marl) MM-Z3
		5.18 - 5.64	5U		Dia.=100mm				
		5.64	6D						
		6.71 - 7.16	7U		Dia.=100mm				
		7.16	8D						
		8.23 - 8.26	9U		Dia.=100mm				
		8.26	10D						
						9.80	21.30		Mottled grey and brown MUDSTONE with
									Continued on next sheet

Remarks

Ground-water was first encountered at a depth of 1.9m below ground level on the morning of 11.08.64 but had fallen to 2.4m below ground level by the morning of 15.08.64. Sample of ground-water taken. Full penetration of sampler not attained.

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Borehole Log

Borehole No. **HIS0014** HISTORIC Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446851.00 - 332544.00	Hole Type CP
Location:		Level: 31.40mbgl	Scale 1:50
Client: Highways England		Dates: 04/08/1964 - 08/08/1964	Logged By

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 0.76	1U		Dia.=100mm	0.20	31.20		FILL (clay and gravel) MG-CL
		0.76	2D						Firm brown and grey silty CLAY FGA
		1.07	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-	0.90	30.50		Medium dense to dense medium to coarse GRAVEL; some cobbles at between 3m and 3.6m FGA-SG
	▼	1.07 - 1.37	3B						
		2.13	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.05	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		3.66	4B						
		3.96	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		4.88	SPT (C)	0 (0 for 0mm/0 for 0mm)	Water=-				
		6.25 - 6.71	5U		Dia.=100mm	6.00	25.40		Stiff friable red-brown and grey silty CLAY (Keuper Marl) MM-Z3
		6.71	6D						
		7.32	7D						
		7.92 - 8.08	8U		Dia.=100mm				
		9.14	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-				
									Continued on next sheet

Remarks

Ground-water was first encountered at a depth of 1.83m below ground level on the morning of 5.08.64 and stood at this level on the mornings of 7.08.64 & 8.08.64. Sample of ground-water taken. Full penetration of sampler not attained. Unable to recover sample.

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Trial Pit Log

Trialpit No **TP1106** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446649.00 - 332289.00 Level: 32.80mbgl	Date 19/10/2006
Location:		Dimensions: 3.00m x 1.30m Inclination: 90° Orientation: ° Depth: 4.10m	Scale 1:50
Client: Highways England			Logged RMS

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
	0.20	1B			0.40	32.40		Dark brown TOPSOIL with occasional angular to subrounded fine to coarse gravel of brick fragments, quartz, tile, glass, coal and flint. (Stratum I) TP
	0.50	2B			1.00	31.80		MADE GROUND: Firm dark brown slightly gravelly CLAY. Gravel is fine to coarse subrounded to rounded brick fragments quartz, tile, glass, coal, flint and slag. (Stratum II) MG-EF
	1.40	3B			1.80	31.00		MADE GROUND. Stiff friable red brown mottled grey gravelly clay. Gravel is fine to coarse subrounded to subangular of grey siltstone, mudstone and sandstone. (Stratum III) MG-EF
	2.10	4B			2.15	30.65		Yellow brown gravelly SAND. Gravel is fine to coarse rounded to subrounded quartz. (Stratum IV) FGA-SG
	2.50	5B						Stiff grey brown slightly sandy locally sandy CLAY locally clayey SAND with organic matter. (Stratum V) FGA
	3.50	6B			3.60	29.20		*At 3.50m; orange brown mottled grey very sandy clay with occasional fine to coarse rounded gravel of quartz.*
	4.00	7B			4.10	28.70		Brown gravelly clay to clayey SAND and GRAVEL. (Stratum VI) FGA
	4.10	8W						End of pit at 4.10 m

Shift Information				Backfill			Water Strike						Depth Related Remarks		
Date & Time	Depth	Water	Remarks	Top	Base	Description	Struck	Rose to	Date	Time	Sealed	Remarks	Top	Base	Remarks
19/10/2006 08:00	0.00						0.00								
19/10/2006 16:00	4.10														

Remarks: Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. Services were not encountered.;On completion the trial pit was backfilled with compacted arisings.;No visual or olfactory indication of contamination was observed.;

Stability: The walls of the pit were stable during excavation.

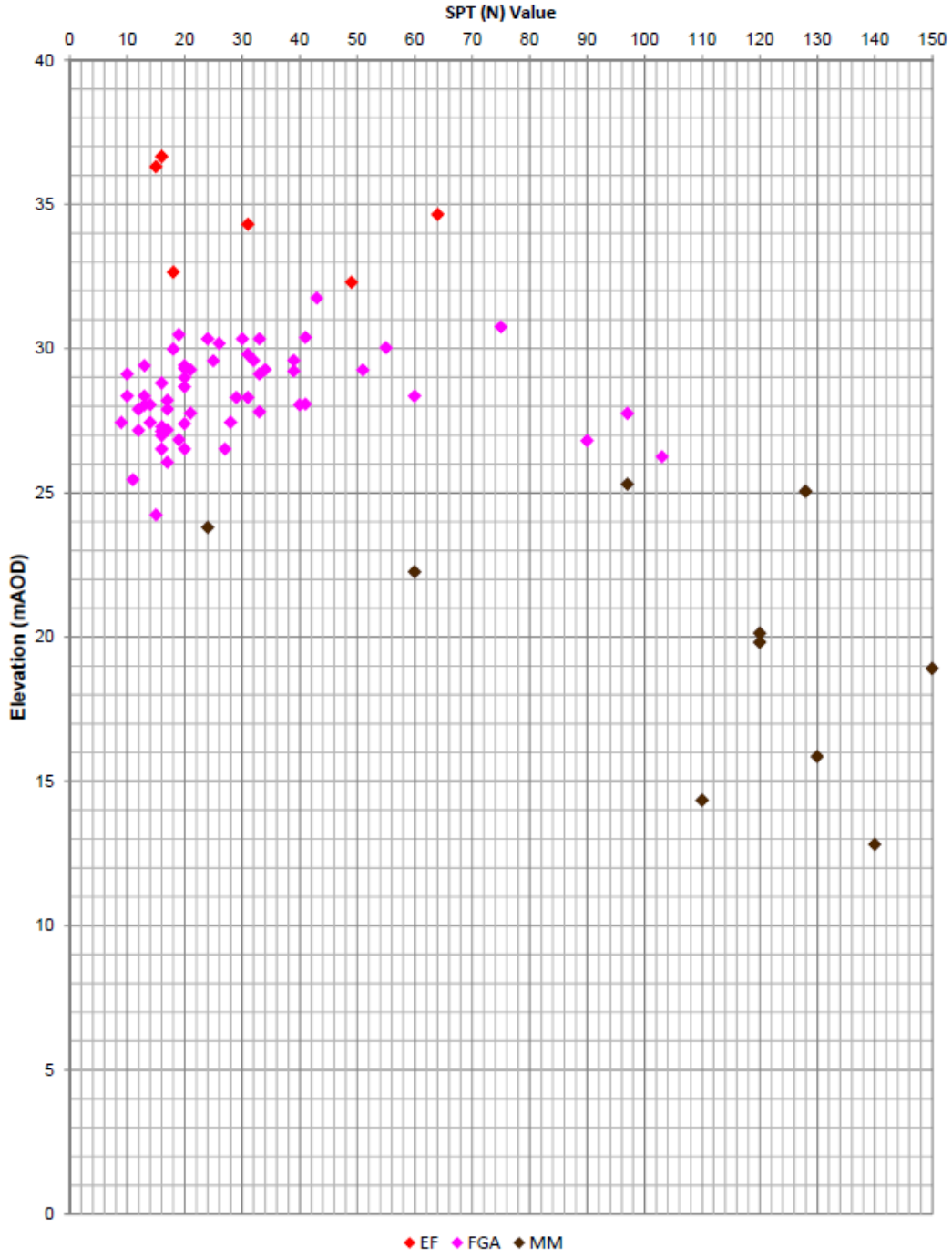
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PLOTS

SPT N Value vs Depth

Project ID: HA549342	Project Title: SMP - M1 J23A TO J25	Data Sheet: 189960-190370 SB
Client: Highways England	Borehole ID: CP1105, CP1108, HIS0001, HIS0002, HIS0003, HIS0004, HIS0005, HIS0006, HIS0007, HIS0008, HIS0009, HIS0010, HIS0011, HIS0012, HIS0013, HIS0014	



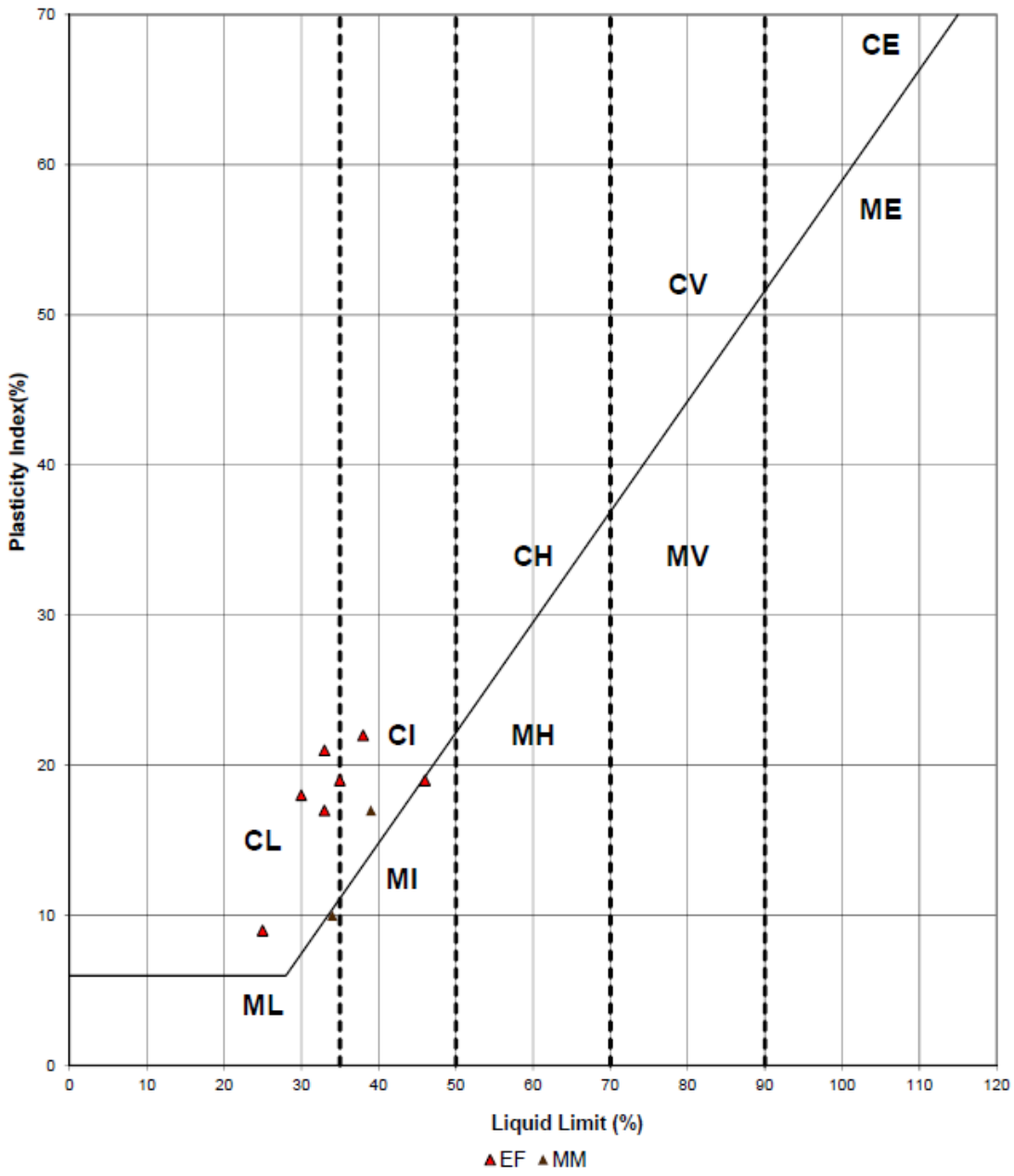
Extrapolated SPT (N) Values >150 have not been shown

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amey ARUP

A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **189960-190370 SB**
Client: **Highways England**	Borehole ID: **CP1105, TP1106, CP1107 and CP1108**	



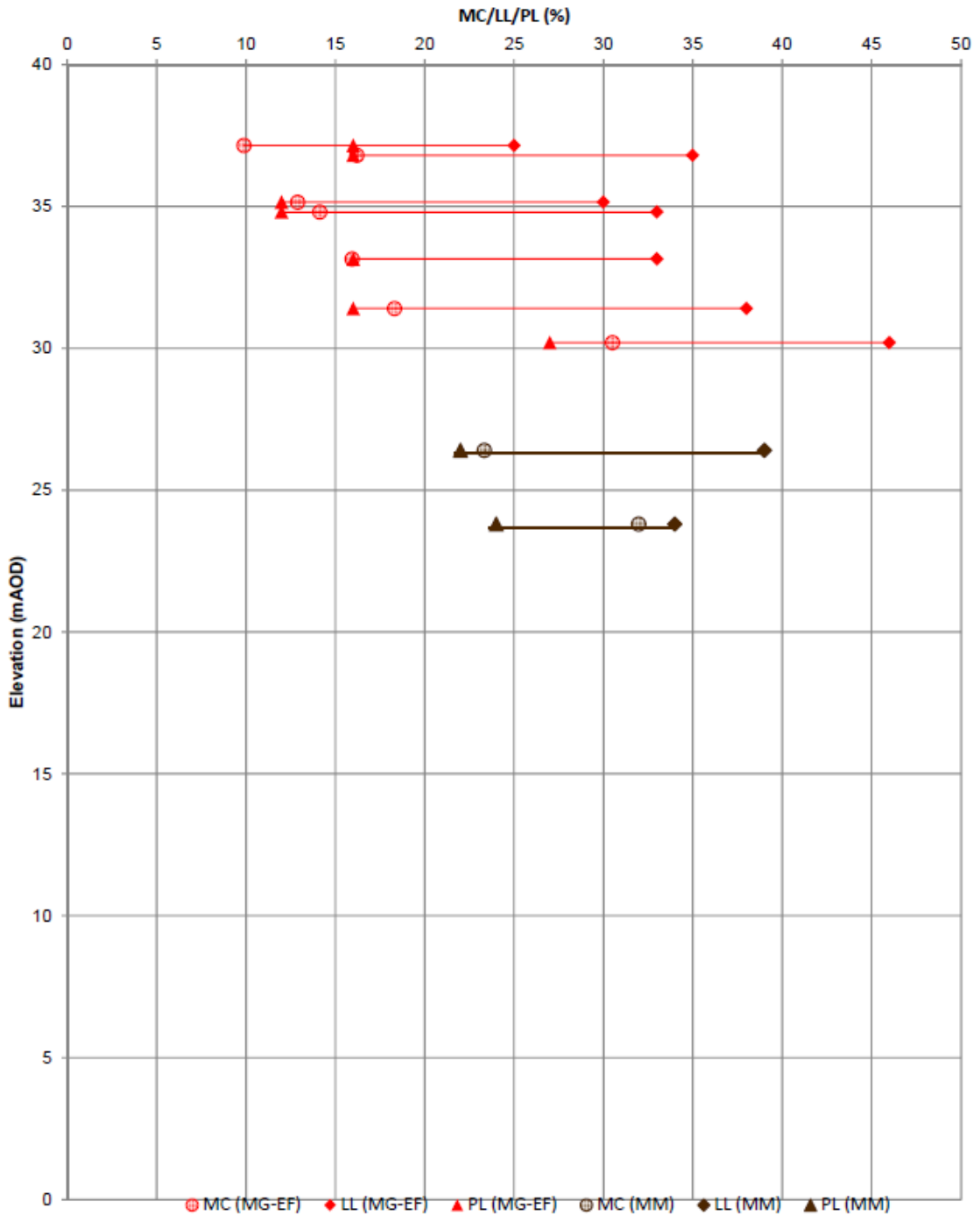
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

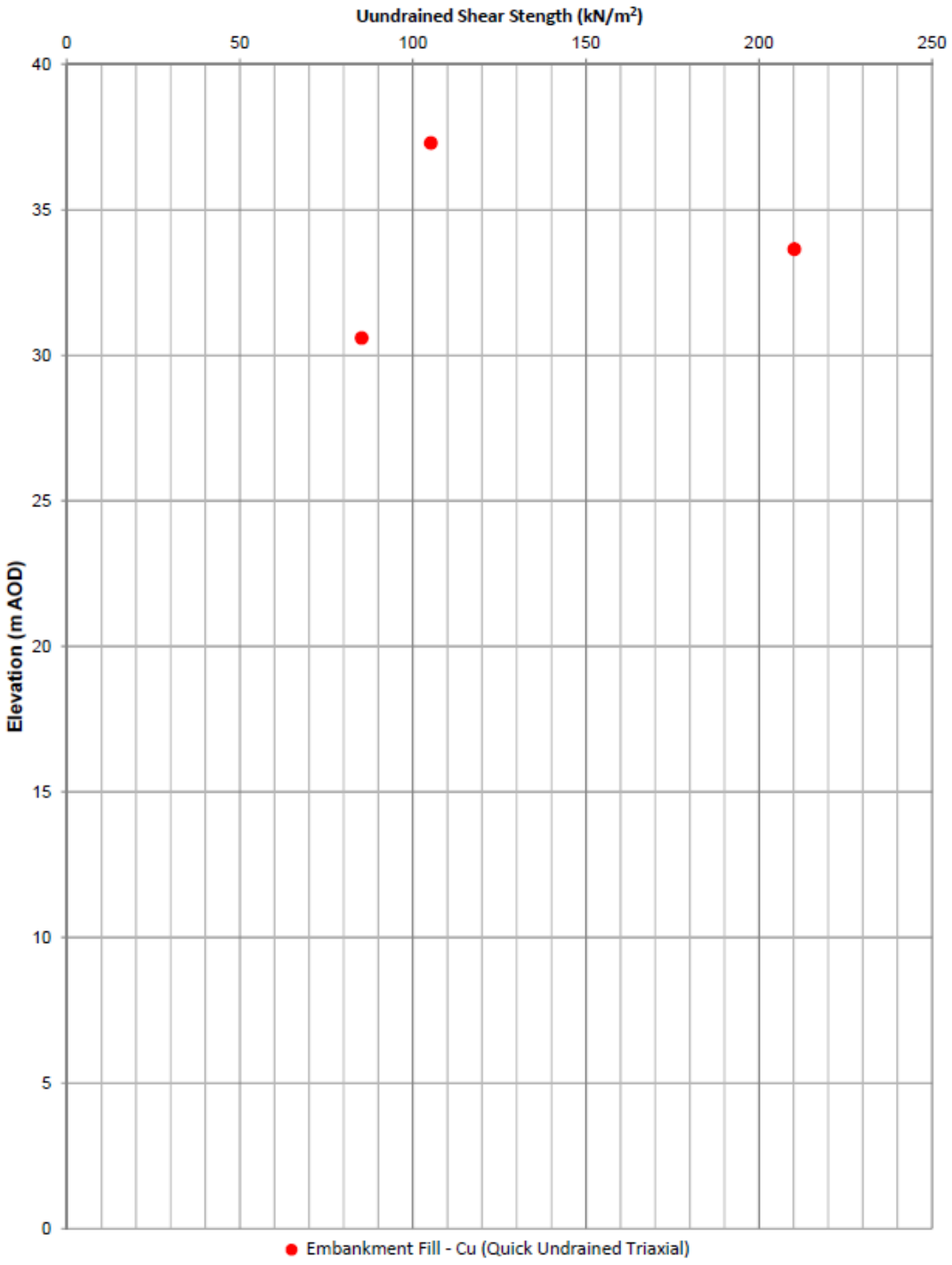
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **189960-190370 SB**
Client: **Highways England**	Borehole ID: **CP1105, TP1106, CP1107 and CP 1108**	



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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **189960-190370 SB**
Client: **Highways England**	Borehole ID: **CP1105, CP1107 and CP1108**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-190440-190650SB-GSS-000001		
Earthworks Widening Solution	Granular Wedge at Embankment Crest (1:2)		
Structure Number	Gantry 312, ERA E2-B2		
Structure Type	MS4 Cantilever, Emergency Refuge Area		
Design Chainage	190440-190650		
Carriageway	Southbound		
Marker Post	190/4+40 – 190/6+50		
National Grid Reference	E 446889,, N 332573 – E 447000, N 332751		
Existing Ground Level at Location	Carriageway	39.1mAOD - 36.8mAOD	
	Toe of Embankment	30.4mAOD-30.1mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_22134	HAGDMS designation
Maximum Earthwork Height	NB: N/A	SB: 6.7-8.7m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Typical Earthwork Angle	NB: N/A	SB: 21^{o}	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	21/03/2017	[redacted]
Checked	Alice Bazen	21/03/2017	
Reviewed	Gary Summerfield	21/04/2017	
Approved	Tom Bulteel	28/04/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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Figure 1: Location Plan

Proposed Earthworks Widening:

Within the chainage extents, the below earthworks widening solutions are to be constructed:

- Ch190440-190650, Granular Wedge at Embankment Crest (1:2.0);

Proposed Major Structures:

Within the chainage extents, the following major structures are to be constructed:

- Gantry, G312 (MS4), Ch190605;
- Emergency Refuge Area (ERA), E3-B2, Ch190465-190565.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is classified as an embankment. The embankment reduces in height from 6.7-8.7m with a typical slope angle of 21 degrees..

The critical cross section Ch190480 was chosen based on the granular wedge with the greatest vertical height.

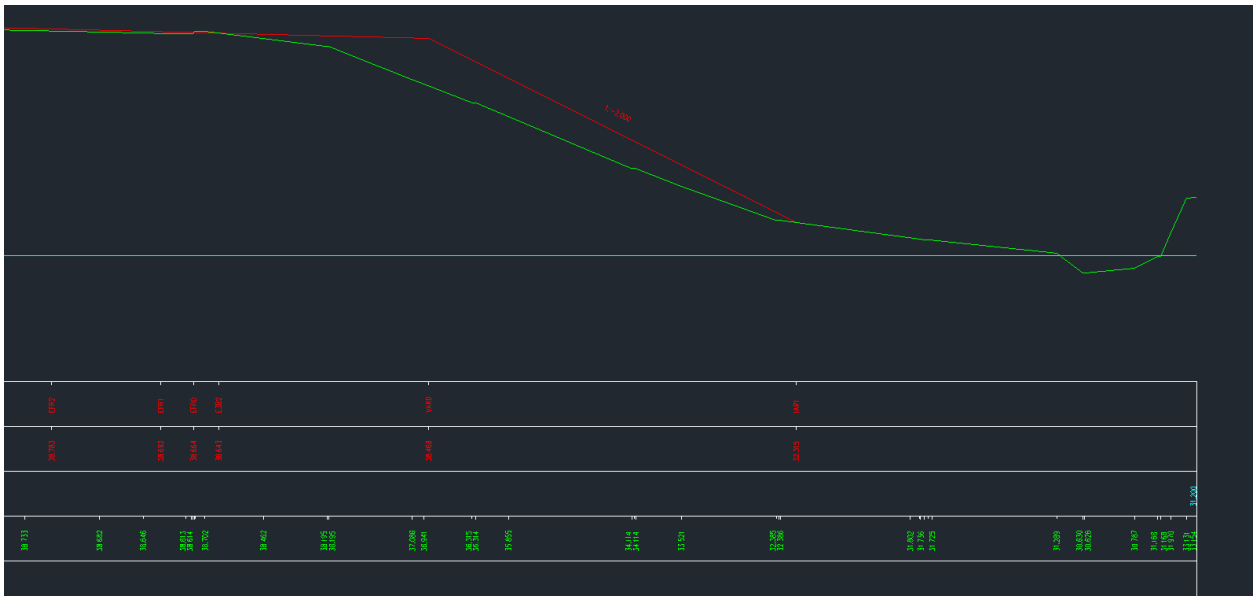


Figure 2: Topographic Critical Cross Section Ch190480

Utilities:

An overhead mid voltage Western Power cable is present at the embankment crest running parallel to the carriageway along the entirety of the chainage extents.



Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Hemington Member (Glaciofluvial Deposits)

Solid Deposits: Edwalton Member (Mercia Mudstone)

Ground Investigation:

There are 3 No. historical exploratory holes recorded within the design chainage, with additional 12 no. relevant exploratory holes considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000034, Rev P01.

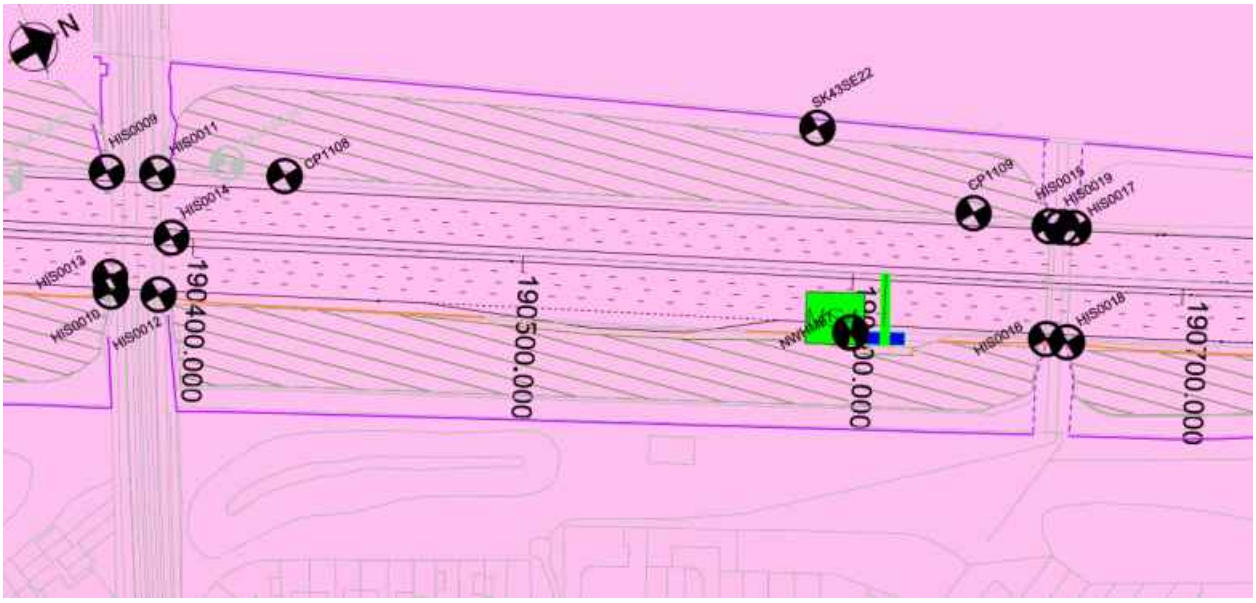


Figure 4: Borehole Location Plan

Flood Risk:

The design flood level for the chainage extents is 31.2mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR: Document Ref HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	HIS0012	HIS0016	NWHM67
Borehole Chainage	190391	190659	190600
Borehole Location	Southbound verge	Southbound verge	Southbound verge
National Grid Reference	E 446864, N 332532	E 447010, N 332758	E 446979, N 332708
Ground Level at Exploratory Hole	31.11mAOD (metres above Ordnance Datum)	30.80mAOD	37.38mAOD

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Date Drilled	12/06/1964 – 15/06/1964	17/06/1964 – 19/06/1964	01/09/1964 – 02/09/1964
Termination Depth	7.92m	8.69m	6.80m
Hole Category	Green	Amber	Green
Other suitable holes	HIS0009-HIS0019, CP1108, CP1109, NWHM67, SK43SE22		

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey data.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT (N) Value
Embankment Fill	7.9	30.6	12-49 (20)
Glaciofluvial Deposits (coarse grained)	12.6	25.9	12-120 (20)
Mercia Mudstone – III/IV	Not proven	Not proven	24-60 (25)

(1) Ground level is assumed to be at carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Mercia Mudstone – I/II, Mercia Mudstone - Siltstone and Mercia Mudstone – Sandstone are recorded at depth beneath Mercia Mudstone – III/IV in some of the historical exploratory holes. Due to the lack of historical exploratory holes undertaken within the footprint of the earthwork, as a conservative measure, only Mercia Mudstone – III/IV is included in the ground model.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in historical exploratory holes HIS0009-HIS0018, CP1108, CP1109, NWHM67 and SK43SE22 (none were recorded in HIS0019).

Groundwater:

The following groundwater strikes were recorded in the historical exploratory holes:

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Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
HIS0009	Glaciofluvial Deposits	3.35	28.05	-	-	-
HIS0010	Glaciofluvial Deposits	0.91	30.21	-	-	-
HSI0011	Mercia Mudstone	7.01	24.19	-	-	-
HIS0012	Glaciofluvial Deposits	0.61	30.50	-	-	-
HIS0013	Glaciofluvial Deposits	1.91	29.19	-	2.44	28.66
HIS0014	Glaciofluvial Deposits	1.83	29.57	-	-	-
HIS0015	Glaciofluvial Deposits	1.52	29.18	-	1.22	29.48
HIS0016	Glaciofluvial Deposits	1.83	28.97	-	-	-
HIS0017	Glaciofluvial Deposits	3.05	27.75	-	1.22	29.58
HIS0018	Glaciofluvial Deposits	1.83	28.97	-	1.22	29.58
HIS0019	Glaciofluvial Deposits	3.05	27.65	-	-	-
SK43SE22	Glaciofluvial Deposits	2.44	29.06	38 hours	0.76	30.74

Groundwater Design Level:

A design groundwater level of 31.20mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

6 No. Atterberg Limit Tests and 6 No. Moisture Content Tests were undertaken within historical exploratory holes with the following results for the strata noted in the ground model:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	2.0	16	35	16	19	CL/CI
Embankment Fill	3.7	14	32	14	18	CL
Embankment Fill	4.0	14	33	12	21	CL
Embankment Fill	5.7	17	34	17	17	CL
Mercia Mudstone – III/IV	12.2	22	33	19	14	CL
Mercia Mudstone – III/IV	15.0	32	34	24	10	ML

31 No. undrained triaxial tests were undertaken with the following results for the strata noted in the ground model (an additional 8 No. were undertaken within Glaciofluvial Deposits (fine grained), but these were not included as this stratum is not present within the ground model):

Stratum	No. of tests	Range of Undrained Shear Strength (kN/m^2)
Embankment Fill	3	12-145
Mercia Mudstone	28	19-350

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Lab Test Data – BRE Classification

The following pH testing data was available from the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Sulphate (Total) as SO4	Solid	3	0.02-0.08	%SO4
Embankment Fill	Water Soluble Sulphate as SO4	Water	1	0.08	g/l SO4
Embankment Fill	pH	Solid	3	8.6-9.4	-
Glaciofluvial Deposits	Sulphate (Total) as SO4	Solid	10	0.01-0.12	%SO4
Glaciofluvial Deposits	Water Soluble Sulphate as SO4	Water	3	0.20-0.61	g/l SO4
Glaciofluvial Deposits	pH	Solid	13	6.7-7.5	-
Mercia Mudstone –III/IV	Sulphate (Total) as SO4	Solid	24	0.02-0.35	%SO4
Mercia Mudstone- III/IV	Water Soluble Sulphate as SO4	Water	4	0.19-1.8	g/l SO4
Mercia Mudstone – III/IV	pH	Solid	27	7.0-8.5	-
Mercia Mudstone – I/II	Sulphate (Total) as SO4	Solid	-	-	%SO4
Mercia Mudstone – I/II	Water Soluble Sulphate as SO4	Water	2	0.73-1.36	g/l SO4
Mercia Mudstone – I/II	pH	Solid	10	7.0-7.3	-
Mercia Mudstone - Sandstone	Sulphate (Total) as SO4	Solid	-	-	%SO4
Mercia Mudstone - Sandstone	Water Soluble Sulphate as SO4	Water	2	1.06-1.64	g/l SO4
Mercia Mudstone - Sandstone	pH	Solid	2	7.5	-

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Assumed Ground Model For Design:

Ground model based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-CE-000034 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01. The below table outlines the assumed anticipated ground model:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0-7.9	38.5-30.6	7.9	21	27	0	100	7.8	6.2	-	0.50	0.20	-	DS-1 AC-1
Glaciofluvial Deposits (coarse grained)	7.9-12.6	30.6-25.9	4.7	21	33	-	-	-	25.2	-	-	0.25	-	DS-3 AC-3
Mercia Mudstone – III/IV	>12.6	>25.9	-	21	30	2	100	9.3	7.4	-	0.50	0.20	-	DS-4 AC4m

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Given the limited amount of local PI data, the ϕ' of Embankment Fill and Mercia Mudstone – III/IV was taken as the characteristic value given in the AMAR GIR.
(4) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a characteristic SPT 'N' value of 20, ϕ' was found to be 33°.
(5) c_u of Embankment Fill and Mercia Mudstone – III/IV was determined based on recorded undrained triaxial tests and c_u derived using the Stroud correlation. Due to the limited amount of local PI data, a typical f1 value of 5.0 was used.
(6) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the characteristic SPT 'N' value of 20, Eu = 7.8MN/m^2. Therefore E' = 6.2MN/m^2.
(7) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a characteristic SPT 'N' value of 20, E' = 25.2MN/m^2.
(8) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the characteristic SPT 'N' value of 25, Eu = 9.3MN/m^2. Therefore E' = 7.4MN/m^2.

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(9) BRE Classification is determined using criteria set out in BRE Special Digest 1. Note, BRE class for Mercia Mudstone incorporates results for Mercia Mudstone –I/II and Mercia Mudstone - Sandstone

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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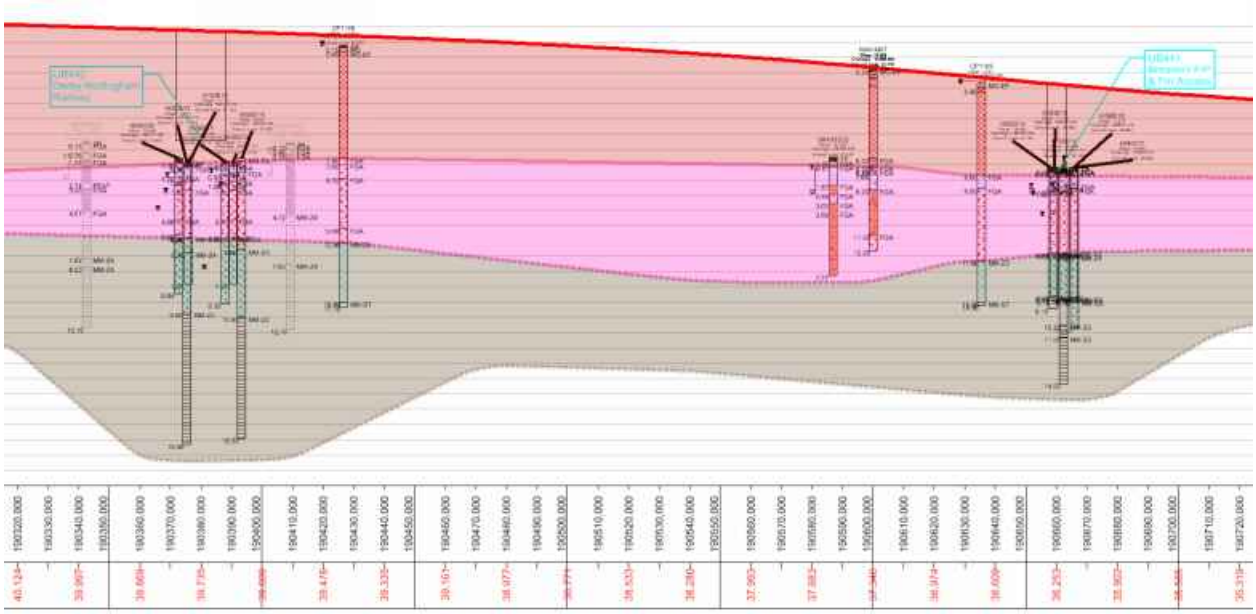


Figure 5: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Widening Solution:

Following design, the below earthworks widening solutions are proposed for these chainages extents:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
190440	190465	Granular Wedge at Embankment Crest (1:2.0)	3.9	26.6 (1V:2H)
190465	190565	Granular Wedge at Embankment Crest (1:2.0)	3.9	26.6 (1V:2H)
190565	190650	Granular Wedge at Embankment Crest (1:2.0)	3.9	26.6 (1V:2H)

Foundation Solutions:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	750	16.0	2.25	10	167	529

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-R-BB4_1m, Ch190541, Northbound, 13m deep dynamic sample / rotary follow on exploratory hole, located in southbound existing grass verge.
- BH-CPT-08, Ch190633, Southbound, 6m deep CPT exploratory hole, located in southbound existing grass verge.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **CP1108** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446852.00 - 332583.00	Hole Type CP
Location:		Level: 38.80	Scale 1:50
Client: Highways England		Dates: 01/10/2006 - 01/10/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.15	38.65		TOPSOIL. TP
		0.45 - 1.20	B				0.45	38.35		MADE GROUND. Hard core (driller's description). MG
		1.50 - 1.95	U							MADE GROUND. Firm to stiff becoming very stiff red brown gravelly clay with occasional gravel sized pockets of organic material. Gravel is subangular to subrounded, fine to coarse of mudstone, siltstone and sandstone. MG-EF
		2.00	D							
		2.50	D							From 2.50m, some grey mottling
		2.50 - 3.00	B							
		3.50 - 3.95	U							
		4.00	D							Between 4.00m to 5.50m, friable
		4.50	D							
		4.50 - 5.00	B							
		5.50 - 6.00	U#B							
		6.50	D							
		6.50 - 7.00	B							
		7.40	B				7.40	31.40		Grey brown clayey SAND. Possible FGA-SG
		7.50 - 7.95	U							
		8.00	D				7.80	31.00		Grey brown clayey slightly gravelly SAND. Gravel is subangular to subrounded, fine to coarse of sandstone and mudstone. FGA-SG
		9.00 - 9.50	B				8.70	30.10		Brown clayey SAND and subangular to subrounded, fine to coarse GRAVEL of mudstone and sandstone. FGA-SG

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.70m. The borehole was advanced by chiselling methods from 17.00m to 17.10m (1 hour). A hand held Photo-ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.

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Rotary Core Log

Borehole No. CP1108 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446852.00 - 332583.00	Hole Type CP
Location:		Level: 38.80	Scale 1:50
Client: Highways England		Dates: 01/10/2006 - 01/10/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 - 11.00	B							SAND and GRAVEL (as previous sheet)
		12.00 - 12.50	B				12.00	26.80		Brown grey gravelly SAND. Gravel is subrounded to rounded, fine to coarse of quartz. Sand is coarse. FGA-SG
		12.90	D				12.90	25.90		Firm red brown locally mottled grey green slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse possibly lithorelics of mudstone and siltstone. MM-Z4
		13.50 - 14.00	U#B							
		15.00	D							
		15.00 - 15.50	B							
		16.50 - 16.90	U#B							
		17.00	D				16.80	22.00		Recovered as grey subangular to subrounded, fine to coarse gravel sized fragments of weak SANDSTONE and SILTSTONE. MM-ST
							17.10	21.70		End of borehole at 17.10 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.70m. The borehole was advanced by chiselling methods from 17.00m to 17.10m (1 hour).A hand held Photo-ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.

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Rotary Core Log

Borehole No. **CP1109** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446966.00 - 332758.00	Hole Type CP
Location:		Level: 36.30	Scale 1:50
Client: Highways England		Dates: 02/11/2006 - 02/11/2006	Logged By RMS/OP

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	B				0.20	36.10		MADE GROUND. Light to medium brown slightly sandy, gravelly soft clay with occasional rootlets up to 20mm. Gravel is subrounded to rounded fine and medium of quartzite and angular to subangular fine and medium of limestone and mudstone. MG-EF
		0.45	B				0.40	35.90		
		0.60	B				0.60	35.70		
		1.20 - 1.65	U							MADE GROUND. Light brown very sandy gravel with frequent rootlets up to 100mm. Gravel is angular and subangular fine to coarse of sandstone, mudstone and limestone. MG-EF
		1.70	D							
		2.20 - 2.65	D							MADE GROUND. Light brown very gravelly, clayey fine and medium sand. Gravel is angular and subangular fine to coarse of sandstone. Possible MG-EF
		2.20 - 2.70	B							
		3.20 - 3.65	U							MADE GROUND. Firm to stiff red brown slightly gravelly clay. Gravel is subrounded and rounded fine to coarse of mudstone, sandstone and siltstone. Possible MG-EF
		3.70	D							*From 2.20m, slightly sandy.*
		4.20 - 4.65	D							*From 4.20m, slightly friable with some light green grey mottling*
		4.20 - 4.70	B							
		5.20 - 5.65	U							
		5.70	D							
		6.00	D				6.00	30.30		Stiff brown grey with black mottling, slightly sandy slightly gravelly CLAY. Gravel is subrounded and rounded, fine and medium of quartz with occasional gravel sized fragments of organic material. Possible FGA
		6.20 - 6.65	D							
		6.20 - 6.70	B							
		7.00 - 7.50	B				6.90	29.40		Very dense brown fine to coarse SAND and subrounded to rounded, fine to coarse GRAVEL of quartz, mudstone and sandstone. FGA-SG
		8.00 - 8.50	B							
		9.50 - 10.00	B							
										Continued on next sheet.

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.00m.;The borehole was advanced by chiselling methods from 14.30m to 14.60m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1109 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446966.00 - 332758.00	Hole Type CP
Location:		Level: 36.30	Scale 1:50
Client: Highways England		Dates: 02/11/2006 - 02/11/2006	Logged By RMS/OP

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										SAND and GRAVEL (as previous sheet)
		11.00 - 11.50	B							
		11.60	D				11.60	24.70		Stiff to very stiff red brown CLAY with pockets of fine to coarse sand. MM-Z3
		11.70 - 12.15	U							
		12.20	D							
		13.20 - 13.65	D							From 13.20m, mottled red brown and grey with some subangular to subrounded fine to coarse gravel sized fragments of siltstone. With white gypsum crystals
		13.20 - 13.70	B							
		14.30 - 14.50	B				14.30	22.00		Recovered as grey, clayey angular to subangular fine to coarse gravel sized fragments of SILTSTONE. MM-ST
							14.50	21.80		End of borehole at 14.50 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.00m.;The borehole was advanced by chiselling methods from 14.30m to 14.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. **HIS0009**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446824.00 - 332537.00	Hole Type CP
Location:		Level: 31.40	Scale 1:50
Client: Highways England		Dates: 08/06/1964 - 09/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	D				0.30	31.10		TOPSOIL TP
		0.46 - 0.91	U							Stiff brown silty CLAY FGA
		0.91	D				1.20	30.20		
		1.83 - 2.13	B							Medium dense to dense brown sandy fine to medium GRAVEL with occasional coarse gravel FGA-SG
		2.59 - 2.90	B							
	▼	3.51 - 3.96	B							
		4.42 - 4.88	B				4.00	27.40		Medium dense brown fine to medium SAND and GRAVEL with occasional cobbles FGA-SG
		5.03	D				5.00	26.40		Firm to stiff friable red-brown and grey silty CLAY (Keuper Marl) MM-Z4
		5.18 - 5.64	U							
		5.64	D							
		5.94	D							
		6.10 - 6.55	U							
		6.55	D							
		6.86	D							
		7.01 - 7.47	U							
		7.47	D							
		7.92	D							
		8.38 - 8.84	U							
		8.84	W				8.84	22.56		End of borehole at 8.80 m
		8.84	D							

Remarks
Ground-water stood at a depth of 3.35m below ground level on completion of boring and a sample was taken.

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Rotary Core Log

Borehole No. **HIS0010**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446856.00 - 332520.00	Hole Type CP
Location:		Level: 31.12	Scale 1:50
Client: Highways England		Dates: 10/06/1964 - 11/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	D							TOPSOIL TP
		0.30 - 0.76	U				0.30	30.82		Very stiff friable brown silty CLAY with occasional coal fragments. FGA
	▼	0.76	D							
							1.20	29.92		Brown fine to medium SAND and GRAVEL FGA-SG
		1.37 - 1.80	B							
							1.80	29.32		Medium dense to dense brown sandy fine to medium GRAVEL with occasional coarse gravel FGA-SG
		2.44 - 2.74	B							
		3.35 - 3.66	B							
		4.27 - 4.57	B							
							4.90	26.22		Soft grey-brown silty CLAY MM-Z4
		5.03 - 5.49	U							
		5.49	D							
		5.94 - 6.40	U				5.90	25.22		Stiff to very stiff friable red-brown silty CLAY (Keuper Marl). MM-Z4
		6.40	D							
		7.50 - 7.92	U							
		7.92	D				7.93	23.19		End of borehole at 7.93 m
		7.92	W							

Remarks
Ground-water was first encountered at a depth of 0.9m below ground level. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. **HIS0011**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446832.00 - 332550.00	Hole Type CP
Location:		Level: 31.20	Scale 1:50
Client: Highways England		Dates: 15/06/1964 - 17/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 0.76	U				0.20	31.00		TOPSOIL TP
		0.76	D							Stiff brown sandy CLAY with fragments of coal FGA
							0.90	30.30		Medium dense brown SAND and GRAVEL FGA-SG
							1.50	29.70		Medium dense to dense brown sandy fine to coarse GRAVEL with occasional cobbles. FGA-SG
		1.83 - 2.29	B							
		3.20 - 3.51	B							
		4.11 - 4.42	B							
							4.90	26.30		
		5.03 - 5.49	U							Firm to stiff friable red-brown and grey silty CLAY with mudstone fragements (Keuper Marl) MM-Z3
		5.49	D							
		6.10 - 6.55	U							
		6.55	D							
	▼									
		7.62 - 8.08	U							
		8.08	D							
		8.69	D							
		9.30	W				9.30	21.90		End of borehole at 9.29 m
		9.30	D							

Remarks
Ground-water was first encountered at a depth of 7m below ground level and rose to a depth of 1.22m. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. **HIS0012**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446864.00 - 332532.00	Hole Type CP
Location:		Level: 31.11	Scale 1:50
Client: Highways England		Dates: 12/06/1964 - 15/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 0.76	U				0.20	30.91		FILL MG-CL
	▼	0.61	W							Firm brown sandy CLAY with gravel FGA
		0.76	D							
							1.20	29.91		Dense fine to medium GRAVEL FGA-SG
		1.83 - 2.13	B				1.80	29.31		Medium dense brown slightly sandy fine to medium GRAVEL with occasional coarse gravel FGA-SG
		2.74 - 3.05	B							
		3.66 - 3.96	B				3.70	27.41		Medium dense brown medium to coarse GRAVEL FGA-SG
							4.90	26.21		
		5.03 - 5.49	U							Soft to firm, becoming stiff red-brown and brown clayey SILT or silty CLAY with mudstone (Keuper Marl) MM-Z3
		5.49	D							
		5.94 - 6.40	U							
		6.71 - 7.16	U							
		7.16	D							
		7.47 - 7.92	U							
		7.92	D				7.93	23.18		End of borehole at 7.92 m

Remarks
Ground-water was first encountered at a depth of 0.61m below ground level and a sample was taken.

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Rotary Core Log

Borehole No. HIS0013
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446852.00 - 332522.00	Hole Type CP
Location:		Level: 31.10	Scale 1:50
Client: Highways England		Dates: 10/08/1964 - 15/08/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	30.80		TOPSOIL TP
		0.46 - 0.91	U							Stiff mottled brown and grey silty CLAY FGA
		0.91	D							
							1.20	29.90		Dense brown medium to coarse GRAVEL FGA-SG
	▼	1.52 - 1.83	B							
		3.05 - 3.35	B							
							4.90	26.20		Firm to stiff, becoming very stiff to hard, friable mottled red-brown and grey silty CLAY with fragments of mudstone (Keuper Marl) MM-Z3
		5.18 - 5.64	U							
		5.64	D							
		6.71 - 7.16	U							
		7.16	D							
		8.23 - 8.26	U							
		8.26	D							
							9.80	21.30		Mottled grey and brown MUDSTONE with some
										Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 1.9m below ground level on the morning of 11.08.64 but had fallen to 2.4m below ground level by the morning of 15.08.64. Sample of ground-water taken. Full penetration of sampler not attained.

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Rotary Core Log

Borehole No. HIS0013
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446852.00 - 332522.00	Hole Type CP
Location:		Level: 31.10	Scale 1:50
Client: Highways England		Dates: 10/08/1964 - 15/08/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										gypsum MM-Z2
		10.97 - 11.23	D							
		12.19 - 12.22	D							
		13.41 - 13.59	D							
		15.24 - 15.34	D							
		16.76 - 16.84	D							
		18.29	W							
		18.29 - 18.36	D				18.40	12.70		End of borehole at 18.36 m

11 12 13 14 15 16 17 18 19 20

Remarks
Ground-water was first encountered at a depth of 1.9m below ground level on the morning of 11.08.64 but had fallen to 2.4m below ground level by the morning of 15.08.64. Sample of ground-water taken. Full penetration of sampler not attained.

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Rotary Core Log

Borehole No. HIS0014
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446851.00 - 332544.00	Hole Type CP
Location:		Level: 31.40	Scale 1:50
Client: Highways England		Dates: 04/08/1964 - 08/08/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 0.76	U				0.20	31.20		FILL (clay and gravel) MG-CL
		0.76	D							Firm brown and grey silty CLAY FGA
		1.07 - 1.37	B				0.90	30.50		Medium dense to dense medium to coarse GRAVEL; some cobbles at between 3m and 3.6m FGA-SG
	▼									
		3.66	B							
		6.25 - 6.71	U				6.00	25.40		Stiff friable red-brown and grey silty CLAY (Keuper Marl) MM-Z3
		6.71	D							
		7.32	D							
		7.92 - 8.08	U							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 1.83m below ground level on the morning of 5.08.64 and stood at this level on the mornings of 7.08.64 & 8.08.64. Sample of ground-water taken. Full penetration of sampler not attained. Unable to recover sample.

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Rotary Core Log

Borehole No. HIS0014
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446851.00 - 332544.00	Hole Type CP
Location:		Level: 31.40	Scale 1:50
Client: Highways England		Dates: 04/08/1964 - 08/08/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.40	21.00		Mottled brown and grey MUDSTONE with thin bands of hard friable clay. MM-Z2
		11.58 - 11.76	D							
		13.41 - 13.49	U							
		13.49	D							
		14.33	B							
		15.85	B							
		15.85 - 15.90	U							
		16.76	D							
		17.98 - 18.29	B							
		18.29	W				18.30	13.10		End of borehole at 18.29 m

Remarks
Ground-water was first encountered at a depth of 1.83m below ground level on the morning of 5.08.64 and stood at this level on the mornings of 7.08.64 & 8.08.64. Sample of ground-water taken. Full penetration of sampler not attained. Unable to recover sample.

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Rotary Core Log

Borehole No. **HIS0015**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446981.00 - 332776.00	Hole Type CP
Location:		Level: 30.70	Scale 1:50
Client: Highways England		Dates: 15/06/1964 - 17/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.50		TOPSOIL TP
		0.46 - 0.91	U							Stiff brown silty CLAY FGA
		0.91	D							
	▼	1.37	D				1.50	29.20		
		1.68 - 2.13	B							Medium dense brown sandy fine to medium GRAVEL FGA-SG
		2.59 - 3.05	B							
		3.51 - 3.96	B							
		4.45 - 4.88	B							
		5.79 - 6.25	U				5.60	25.10		Stiff to very stiff friable red-brown and grey silty CLAY (Keuper Marl) MM-Z4
		6.25	D							
		6.86	D							
		7.47 - 7.92	U							
		7.92	D							
		8.38 - 8.69	B				8.40	22.30		Light grey SANDSTONE MM-SS
		8.69	W							
							9.15	21.55		End of borehole at 9.14 m

Remarks
Ground-water was first encountered at a depth of 1.5m but subsequently rose to 1.2m below ground level. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. **HIS0016**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447010.00 - 332758.00	Hole Type CP
Location:		Level: 30.80	Scale 1:50
Client: Highways England		Dates: 17/06/1964 - 19/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.60		TOPSOIL TP
		0.46 - 0.91	U							Stiff brown silty CLAY with traces of organic matter FGA
		0.91	D							
							1.50	29.30		
	▼	1.68 - 2.13 1.83	B W							Medium dense brown slightly sandy fine to medium GRAVEL with occasional coarse gravel; becoming sandy with depth FGA-SG
		2.59 - 3.05	B							
		3.51 - 3.96	B							
		4.42 - 4.88	B							
							5.60	25.20		
		5.94 - 6.40	U							Stiff friable red-brown and grey silty CLAY or clayey SILT (Keuper Marl) MM-Z4
		6.40	D							
		7.01	D							
		7.47 - 7.92	U							
		7.92	D							
		8.38 - 8.69	B				8.40	22.40		Grey SANDSTONE MM-SS
							8.70	22.10		End of borehole at 8.69 m

Remarks
Water was added to assist boring. On completion of boring the water stood at a depth of 1.8m below ground level and a sample was taken.

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Rotary Core Log

Borehole No. HIS0017
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446985.00 - 332782.00	Hole Type CP
Location:		Level: 30.80	Scale 1:50
Client: Highways England		Dates: 09/06/1964 - 15/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.60		TOPSOIL TP
		0.61 - 1.07	U							Firm brown sandy CLAY with gravel FGA
	▼	1.07	D				1.10	29.70		
		1.22 - 1.68	B							Medium dense brown sandy fine to medium GRAVEL with occasional coarse gravel and cobbles; becoming more sandy with depth FGA-SG
		2.13 - 2.59	B							
	▽	3.05 - 3.51	B							
		3.96 - 4.42	B							
		4.88 - 5.33	B							
							5.80	25.00		
		6.10 - 6.55	U							Stiff to very stiff friable red-brown and grey silty CLAY (Keuper Marl) MM-Z4
		6.55	D							
		6.86	D							
		7.62 - 8.08	U							
		8.08	D							
		8.69	D				8.70	22.10		Grey SANDSTONE MM-SS
		9.14	W							
		9.14	D							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level and rose overnight to 1.22m depth. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No.
HIS0017
Sheet 2 of 2

Project Name:	SMP - M1 J23A TO J25	Project No.	COCDFL1SMP01	Co-ords:	446985.00 - 332782.00
Location:				Level:	30.80
Client:	Highways England			Dates:	09/06/1964 - 15/06/1964

Hole Type: CP
Scale: 1:50
Logged By:

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.52	20.28		End of borehole at 10.52 m

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level and rose overnight to 1.22m depth. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. **HIS0018**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447014.00 - 332763.00	Hole Type CP
Location:		Level: 30.80	Scale 1:50
Client: Highways England		Dates: 19/06/1964 - 20/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.60		TOPSOIL TP
										Firm brown silty CLAY with gravel FGA
		0.91 - 1.37	U							
	▼	1.22	W							
		1.37	D				1.40	29.40		
		1.52 - 1.98	B							Medium dense brown sandy fine to medium GRAVEL with occasional coarse gravel at depth FGA-SG
		2.44 - 2.90	B							
		3.35 - 3.81	B							
		4.27 - 4.72	B							
							5.50	25.30		Firm to stiff friable red-brown and grey silty CLAY or clayey SILT (Keuper Marl) MM-Z4
		5.79 - 6.25	U							
		6.25	D							
		6.71	D							
		7.47 - 7.92	U							
		7.92	D							
		8.53	D				8.50	22.30		
							8.70	22.10		Grey SANDSTONE MM-SS End of borehole at 8.69 m

Remarks
Ground-water was first encountered at a depth of 1.8m below ground level. Subsequently the water level rose to a depth of 1.22m and a sample was taken.

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Rotary Core Log

Borehole No. HIS0019
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446983.00 - 332779.00	Hole Type RC
Location:		Level: 30.70	Scale 1:50
Client: Highways England		Dates: 09/07/1964 - 11/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.50		TOPSOIL TP
										Brown silty CLAY FGA
							1.20	29.50		Sandy fine to medium GRAVEL FGA-SG
	▼									
							5.60	25.10		Stiff red-brown and grey silty CLAY (Keuper Marl) MM-Z4
							8.50	22.20		Grey medium SANDSTONE with veins of gypsum MM-SS
										Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level.

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Rotary Core Log

Borehole No. HIS0019
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446983.00 - 332779.00	Hole Type RC
Location:		Level: 30.70	Scale 1:50
Client: Highways England		Dates: 09/07/1964 - 11/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.20	20.50		Green-grey clayey sandy MUDSTONE MM-Z2
							11.00	19.70		Mottled red-brown and green-grey sandy MUDSTONE with fine sandstone and viens of gypsum MM-Z2
							14.03	16.67		End of borehole at 14.02 m

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level.

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Rotary Core Log

Borehole No. **NWHM67**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446978.66 - 332707.69	Hole Type CP
Location:		Level: 37.38	Scale 1:50
Client: Highways England		Dates: 01/09/1999 - 02/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	D				0.20	37.18		TOPSOIL. TP
							0.50	36.88		MADE GROUND: Very stiff desiccated marl fill. MG-EF
							0.70	36.68		MADE GROUND: Blue grey sandy fine to coarse angular gravel of limestone. (Hardcore) MG-EF
										MADE GROUND: Stiff red brown mottled/ dappled blue grey slightly sandy clay with a little, locally some fine to coarse subangular mudstone gravel (as lithorelicts). (Embankment Fill - Marl) MG-EF
		6.00	B							
							6.50	30.88		Very dense brown clayey medium and coarse SAND with much fine to coarse angular to rounded gravel of sandstone, limestone and quartz? (River Terrace Deposits?) FGA-SG
							6.80	30.58		at 6.80m possible obstruction/bowlder End of borehole at 6.80 m

Remarks

1. Hand excavated inspection pit to 1.20m. CAT scan at GL and 1.20m. 2. M67 commenced in 150mm - terminated at 6.80m - see M67A redrilled on sameposition with 200mm casing to start. 3. M67 backfilled with arisings tomake secure overnight. 4. Marker Post Ref 190/7 -50S.

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Rotary Core Log

Borehole No. **SK43SE22**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446920.00 - 332730.00	Hole Type CP
Location:		Level: 31.50	Scale 1:50
Client: Highways England		Dates: 03/03/1962 - 06/03/1962	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	D				0.30	31.20		Topsoil TP
		0.46	D				0.61	30.89		Subsoil FGA
	▼	0.76	W							Mottled clay FGA
		0.91	D							
							1.83	29.67		
		1.98 - 2.44	U							Sandy clay FGA
	▽	2.29	D							
		2.44 - 2.90	U				2.44	29.06		Grey silt FGA
		3.05	D				3.05	28.45		Gravel & silt FGA-SG
		3.35	D							
							3.66	27.84		Gravel & sand FGA-SG
		4.11 - 4.57	SPTL							
		4.11 - 4.57	S							
			B							
		4.88	D							
		5.64 - 6.10	SPTL							
		5.64 - 6.10	S							
			B							
		6.40	D							
		7.32 - 7.77	SPTL							
		7.32 - 7.77	S							
		7.62	B							
			D				7.77	23.73		End of borehole at 7.77 m

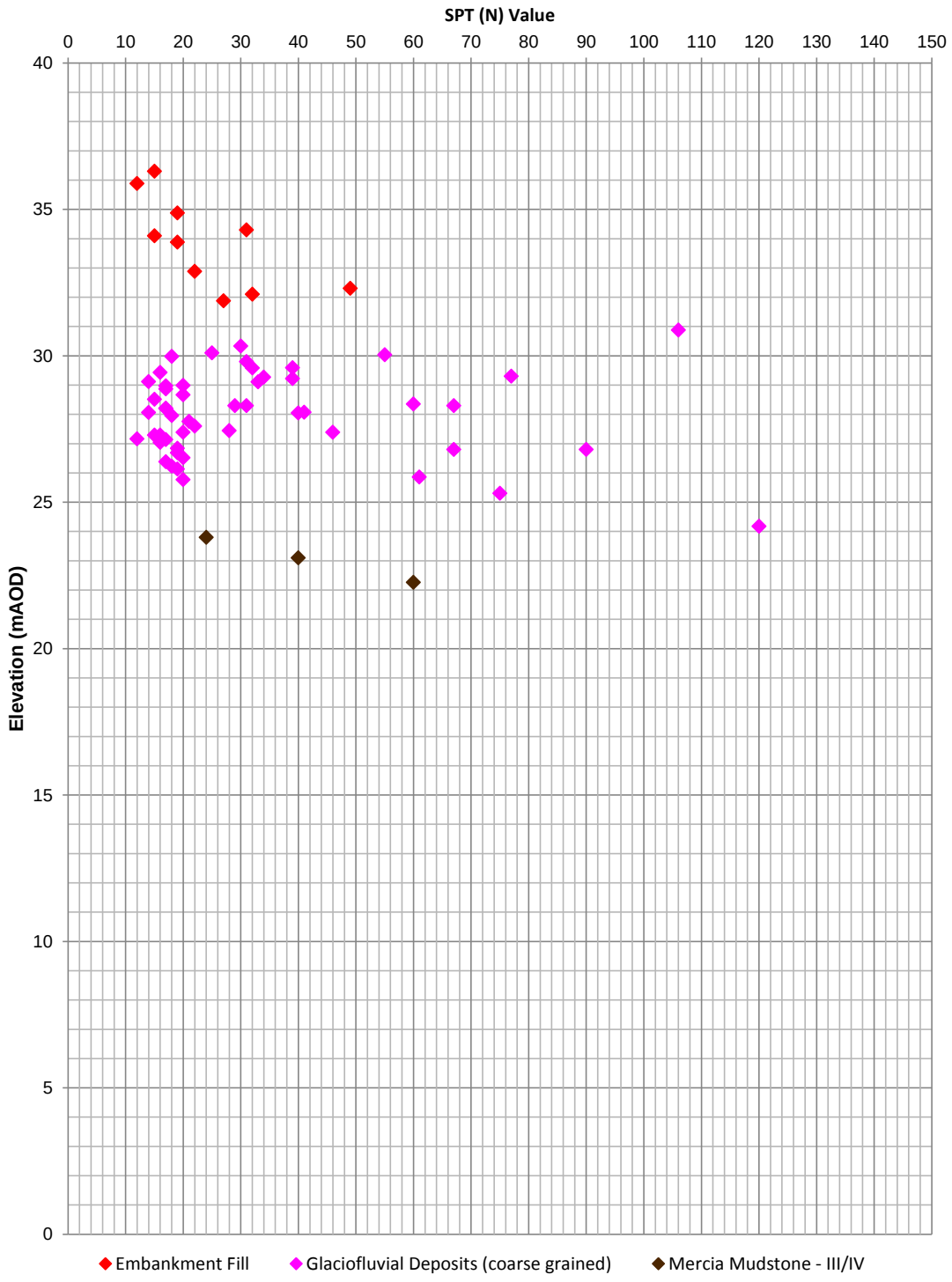
Remarks

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PLOTS

amey ARUP	SPT N Value vs Depth
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25** | Data Sheet: **190400-190620SB**
Client: **Highways England**	Borehole ID: **HIS0009-HIS0018, CP1108, CP1109, NWHM67, SK43SE22**



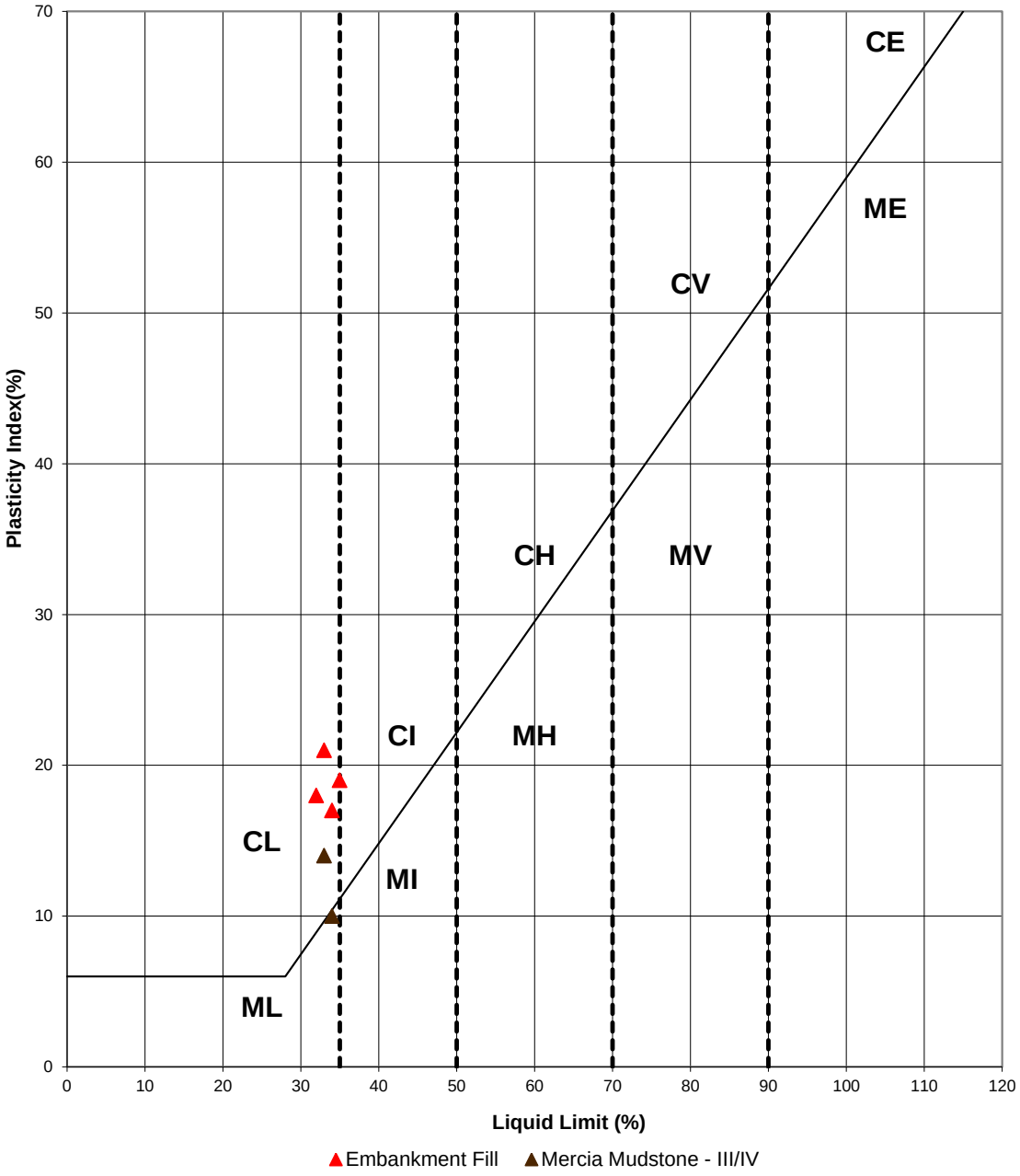
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 13/02/2017 Ref: HA549342-AMAR-HGT-190400-190620SB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **190400-190620SB**
Client: **Highways England**	Borehole ID: **CP1108 & CP1109**	



Key

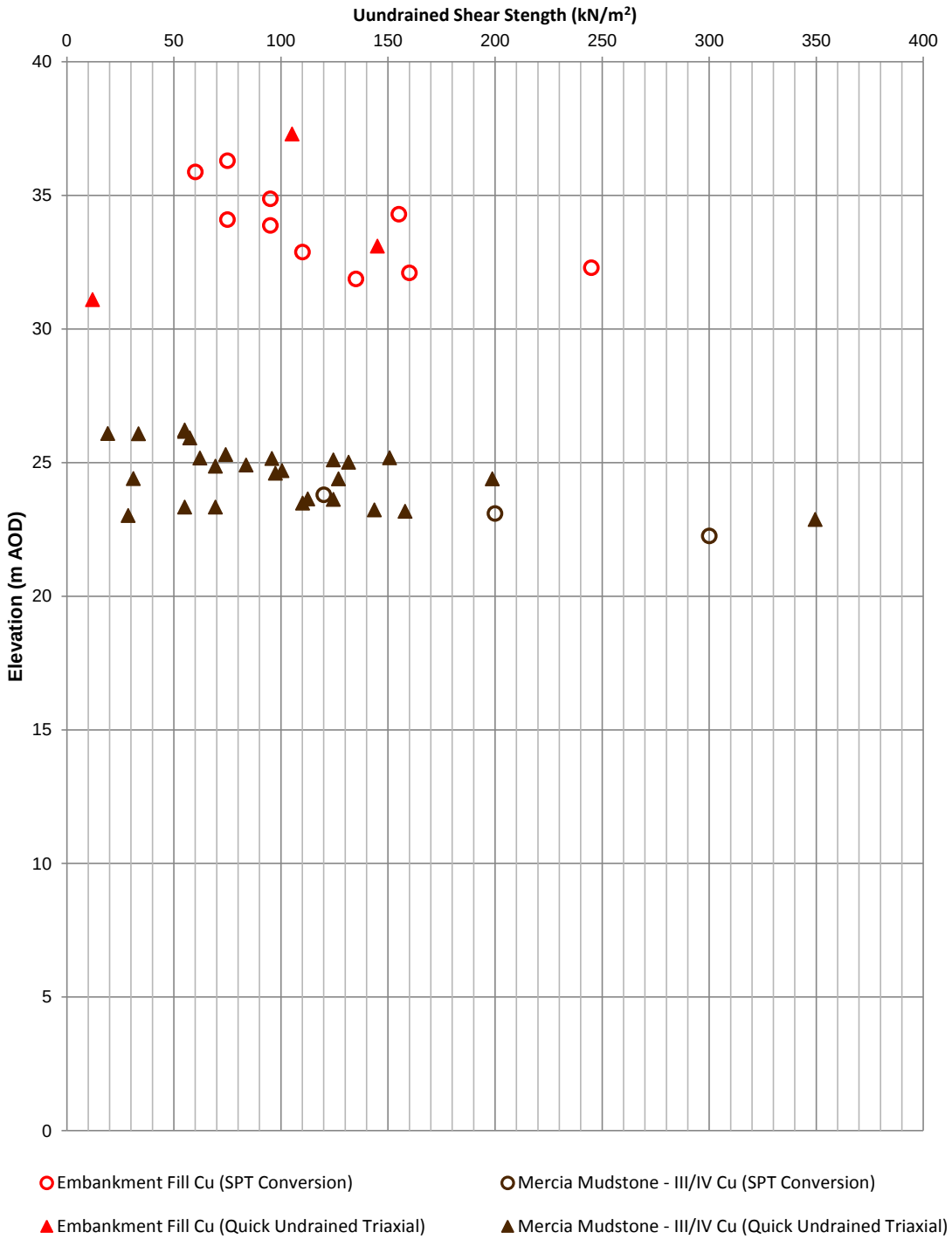
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 13/02/2017 Ref: HA549342-AMAR-HGT-190400-190620SB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **190400-190620SB**
Client: **Highways England**	Borehole ID: **HIS0009-HIS0018, CP1108, CP1109, NWHM67, SK43SE22**	



Rev: P01 Date: 13/02/2017 Ref: HA549342-AMAR-HGT-190400-190620SB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-190680-191040SB -GSS-000001		
Earthworks Widening Solution	Granular Wedge at Embankment Crest (1:2.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	190680-191040		
Carriageway	Southbound		
Marker Post	190/6+80 – 191/0+40		
National Grid Reference	E 447022, N 332777 – E 447150, N 333005		
Existing Ground Level at Location	Carriageway	36.1mAOD	
	Toe of Embankment	33.7mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_22134 & 7_M1_22054	HAGDMS designation
Maximum Earthwork Height	NB: N/A	SB: 3.4-6.5m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Typical Earthwork Angle	NB: N/A	SB: 27^{o}	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	10/02/2017	[redacted]
Checked	Alice Bazen	11/02/2017	
Reviewed	Gary Summerfield	13/02/2017	
Approved	Tom Bulteel	20/02/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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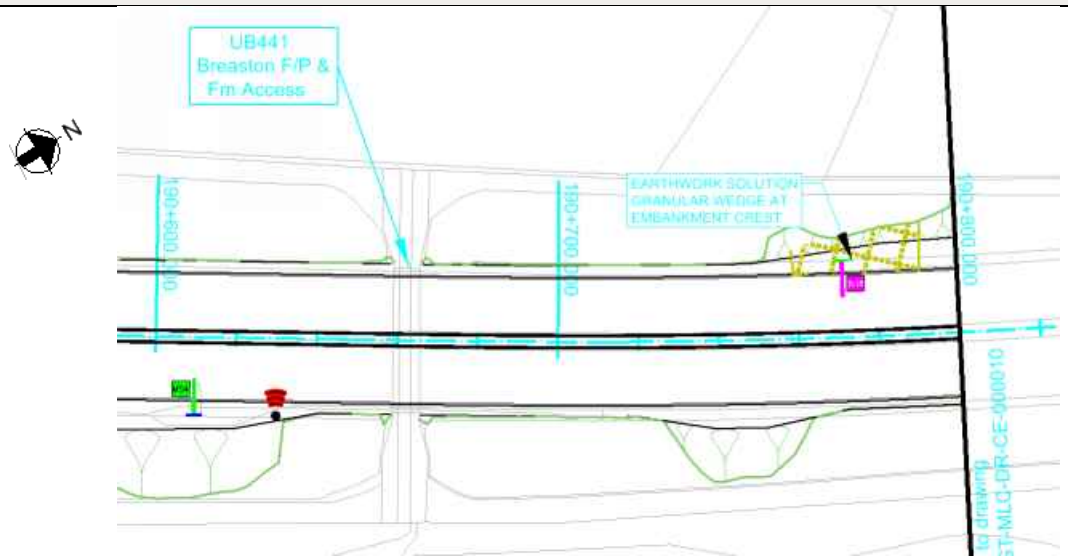


Figure 1.1: Location Plan 1 of 2

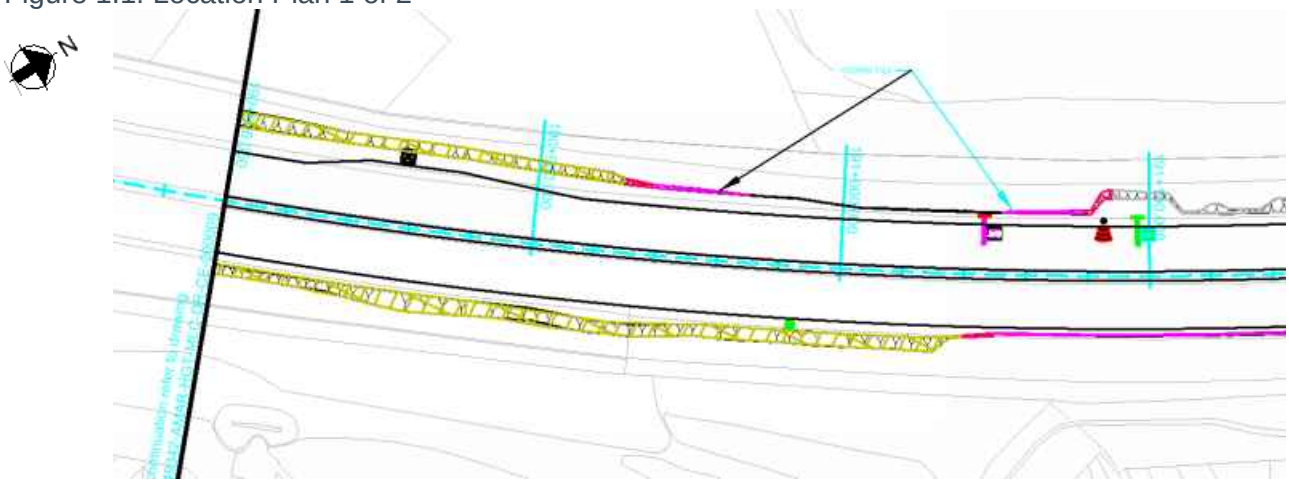


Figure 1.2: Location Plan 2 of 2

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Granular Wedge at Embankment Crest at 1 in 2 gradient.

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is classified as an embankment. The embankment reduces in height from 6.5m in the south to 3.4m in the north of the extents with a typical slope angle of 27^{o}.

The critical cross section Ch190860 was chosen based on the granular wedge with the greatest vertical height.

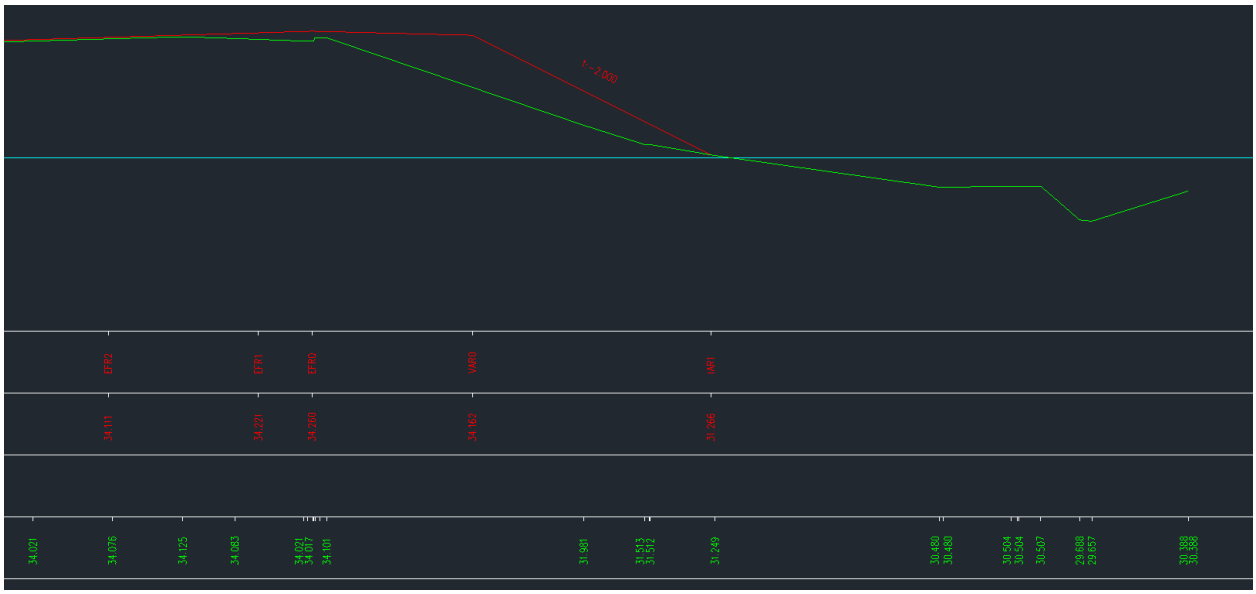


Figure 2: Topographic Critical Cross Section Ch190860

Utilities:

An overhead mid voltage Western Power cable is present at the embankment crest running parallel to the carriageway along the entirety of the chainage extents.

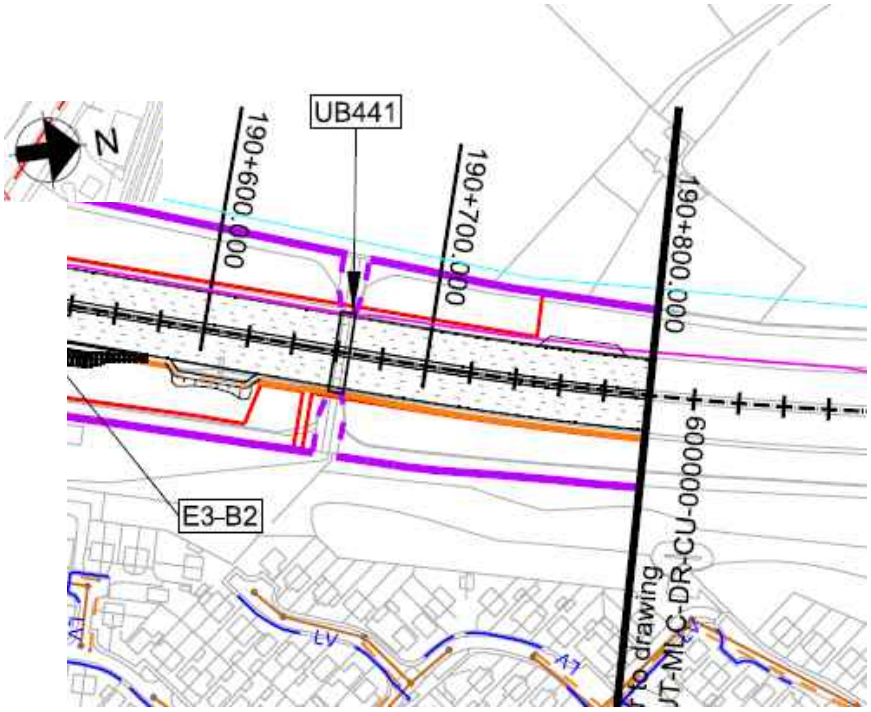


Figure 3.1: Utilities Location Plan – 190680-190800

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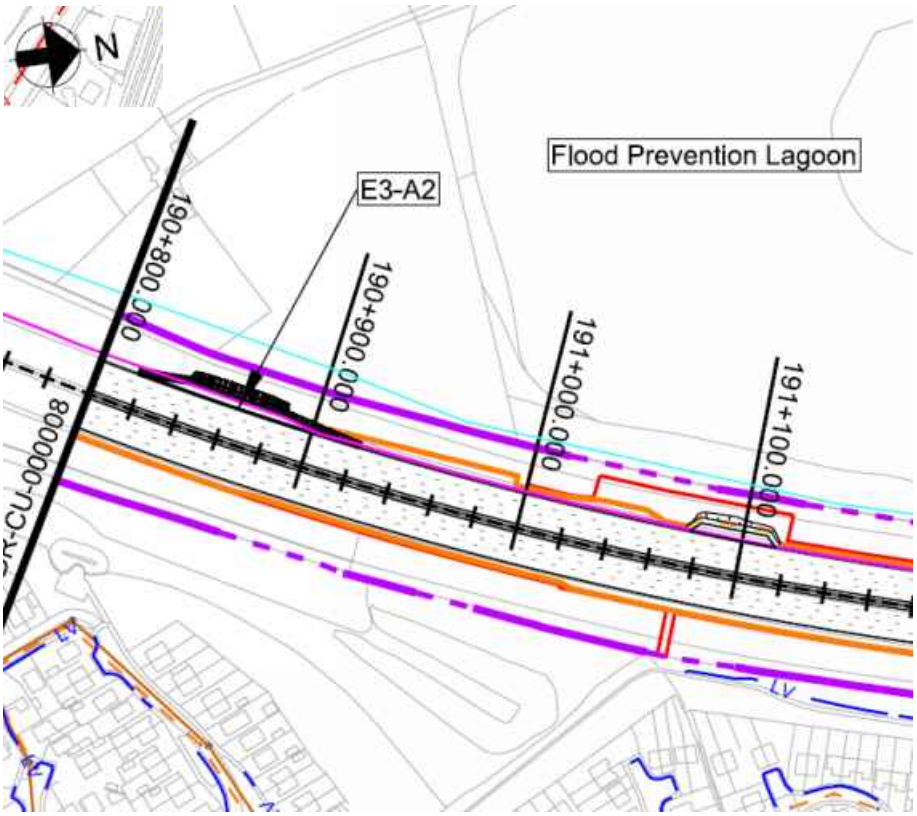


Figure 3.2: Utilities Location Plan – 190800-191040

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Ch190680-190790 & Ch190875-191040 Hemington Member (Glaciofluvial Deposits); Ch190790-190875 Alluvium

Solid Deposits: Edwalton Member (Mercia Mudstone)

Ground Investigation:

There are 2 No. historical exploratory holes recorded within the design chainage, with additional 7 no. relevant exploratory holes considered outside the design chainage; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000034-35, Rev P01.

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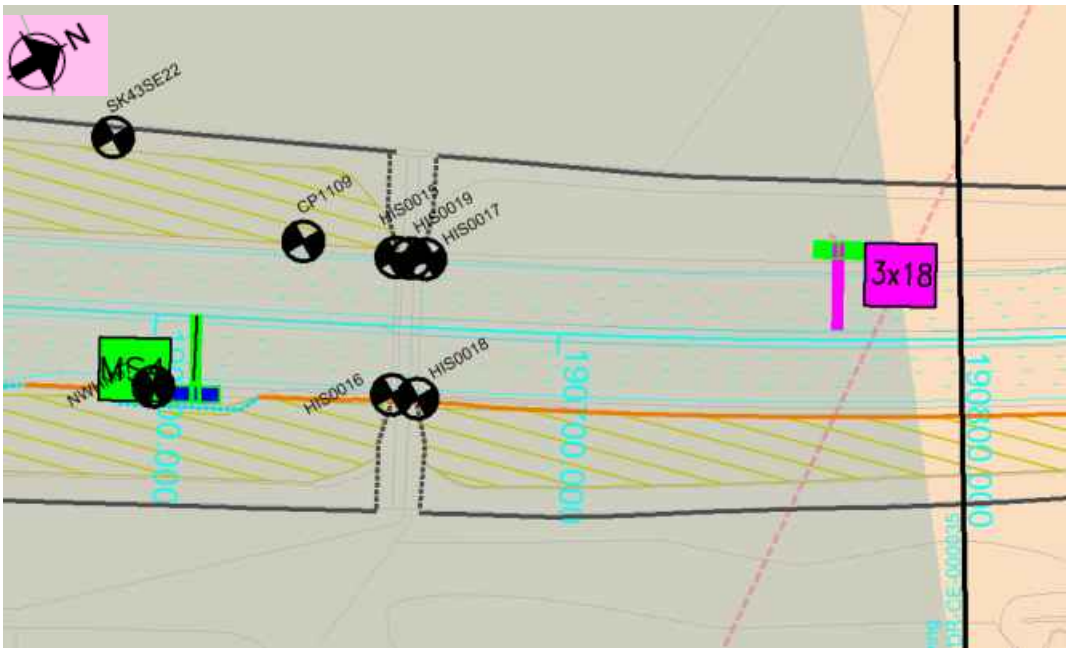


Figure 4.1: Borehole Location Plan 1 of 2

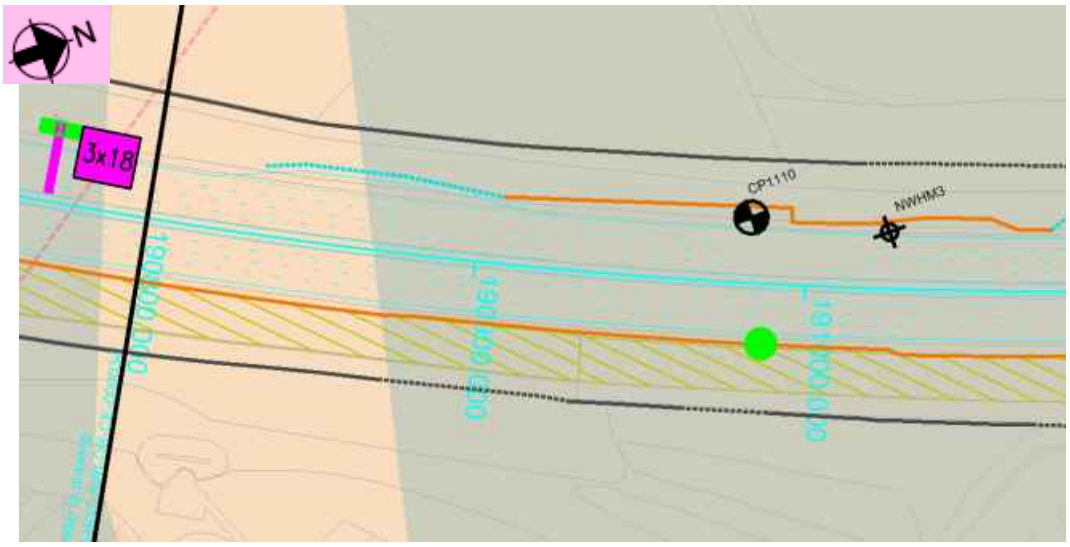


Figure 4.2: Borehole Location Plan 2 of 2

Flood Risk:

The embankment lies within the flood plain.

The assumed design flood level for the chainage extents is 31.2mAOD.

Baseline flood levels were provided by BWB Consulting and are detailed within the Environmental Study Report by AMAR, Document Ref. HA549342-AMAR-EG-SWI-RP-YE-000001, Rev P04.

Historical Boreholes:

Relevant Borehole Number	HIS0018
Borehole Chainage	190666
Borehole Location	Southbound verge
National Grid Reference	E 447014, N 332763
Ground Level at Exploratory Hole	30.8mAOD (above Ordnance Datum)
RAG Analysis	Amber
Date Drilled	19/06/1964 – 20/06/1964
Termination Depth	8.69m below ground level (mbgl)
Hole Category	Amber
Other suitable holes	CP1109, CP1110, HIS0015, HIS0016, HIS0017, HIS0019, NWHM3, NWHM67

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI and driven LiDAR Survey Data.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT (N) Value
Embankment Fill	4.5	29.7	12-103 (20)
Alluvium	6.5	27.7	--
Glaciofluvial Deposits (coarse grained)	9.2	25.0	9-106 (20)
Mercia Mudstone	Not proven	Not proven	19-214 (30)

(1) Ground level is assumed to be at carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in historical exploratory holes CP1109, CP1110, HIS0015, HIS0016, HIS0017, HIS0018, NWHM3 and NWHM67.

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Groundwater:

The following groundwater strikes were recorded in the historical exploratory holes:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
HIS0015	Glaciofluvial Deposits	1.52	29.18	-	1.22	29.48
HIS0016	Glaciofluvial Deposits	1.83	28.97	-	-	-
HIS0017	Glaciofluvial Deposits	3.05	27.75	-	1.22	29.58
HIS0018	Glaciofluvial Deposits	1.83	28.97	-	1.22	29.58
HIS0019	Glaciofluvial Deposits	3.05	27.65	-	-	-

Groundwater Design Level:

A design groundwater level of 31.20mAOD (Flood Risk Level) has been assumed within the embankment, with the piezometric line drawing down to ground level at the toe of the embankment.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

6 No. Atterberg Limit Tests and 6 No. Moisture Content Tests were undertaken within historical exploratory holes with the following results for the strata noted in the ground model:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	2.2	14.79	36	17	19	CI
Embankment Fill	3.7	14.00	32	14	18	CL
Embankment Fill	5.7	16.87	34	17	17	CL
Mercia Mudstone – III/IV	9.6	22.78	34	17	17	CL
Mercia Mudstone – III/IV	12.2	21.88	33	19	14	CL
Mercia Mudstone – III/IV	14.0	20.49	27	16	11	CL

12 No. undrained triaxial tests were undertaken with the following results for the strata noted in the ground model:

Stratum	Depth to Top of Test (mbgl)	Depth to Top of Test (mAOD)	Undrained Shear Strength (kN/m^2)
MG-EF	3.2	33.1	145.1
MM-Z3	11.7	24.6	97.5
MG-EF	5.2	31.1	12
MM-Z4	13.5	19.45	279.4
MM-Z4	5.79	24.91	83.79
MM-Z4	7.47	23.23	143.64
MM-Z4	7.47	23.33	69.426
MM-Z4	5.94	24.86	69.426
MM-Z4	6.1	24.7	100.548
MM-Z4	7.62	23.18	158.004
MM-Z4	5.79	25.01	131.67
MM-Z4	7.47	23.33	55.062

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Lab Test Data – BRE Classification:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Sulphate (Total) as SO4	Solid	2	0.01-0.05	%SO4
Embankment Fill	Water Soluble Sulphate as SO4	Water	1	0.05	g/l SO4
Embankment Fill	pH	Solid	3	8.6-8.9	-
Glaciofluvial Deposits (coarse grained)	Water Soluble Sulphate as SO4	Water	1	0.61	g/l SO4
Mercia Mudstone – III/IV	Sulphate (Total) as SO4	Solid	10	0.07-0.19	%SO4
Mercia Mudstone – III/IV	Water Soluble Sulphate as SO4	Water	1	1.06	g/l SO4
Mercia Mudstone – III/IV	pH	Solid	10	8.7-7.5	-

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Assumed Ground Model For Design:

Ground model based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-CE-000034 & HA549342-AMAR-HGT-SWI-DR-CE-000035 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01. The below table outlines the assumed anticipated ground model:

The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γ_b (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0-4.5	34.2-29.7	4.5	21	27	0	100	7.8	6.2	-	0.50	0.20	-	DS-1 AC-1
Alluvium	4.5-6.5	29.7-27.7	2.0	20	25	0	40	4.0	3.0	-	0.50	0.20	-	DS-1 AC-1s
Glaciofluvial Deposits (coarse grained)	6.5-9.2	27.7-25.0	2.7	21	33	-	-	-	31.2	-	-	0.25	-	DS-3 AC-3
Mercia Mudstone – III/IV	>9.2	<25.0	-	21	30	2	100	10.8	8.6	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Given the limited amount of local PI data, the ϕ' of Embankment Fill, Head Deposits and Mercia Mudstone – III/IV was taken as the characteristic value given in the AMAR GIR.
(4) c_u of Embankment Fill and Mercia Mudstone – III/IV was determined based on recorded undrained triaxial tests and c_u derived using the Stroud correlation. Due to the limited amount of local PI data, a typical f1 value of 5.0 was used.
(5) Given the lack of GI data for Alluvium, the characteristic c_u value given in the AMAR GIR was adopted.
(6) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a characteristic SPT 'N' value of 20, ϕ' was found to be 33^o.

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(7) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the characteristic SPT 'N' value of 20, Eu = 7.8MN/m^2. Therefore E' = 6.2MN/m^2.

(8) Given the lack of GI data for Alluvium, characteristic Eu and E' values given in the AMAR GIR were adopted.

(9) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a characteristic SPT 'N' value of 20, E' = 25.2MN/m^2.

(10) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the characteristic SPT 'N' value of 30, Eu = 10.8MN/m^2. Therefore E' = 8.6MN/m^2.

(11) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for Alluvium and Glaciofluvial Deposits the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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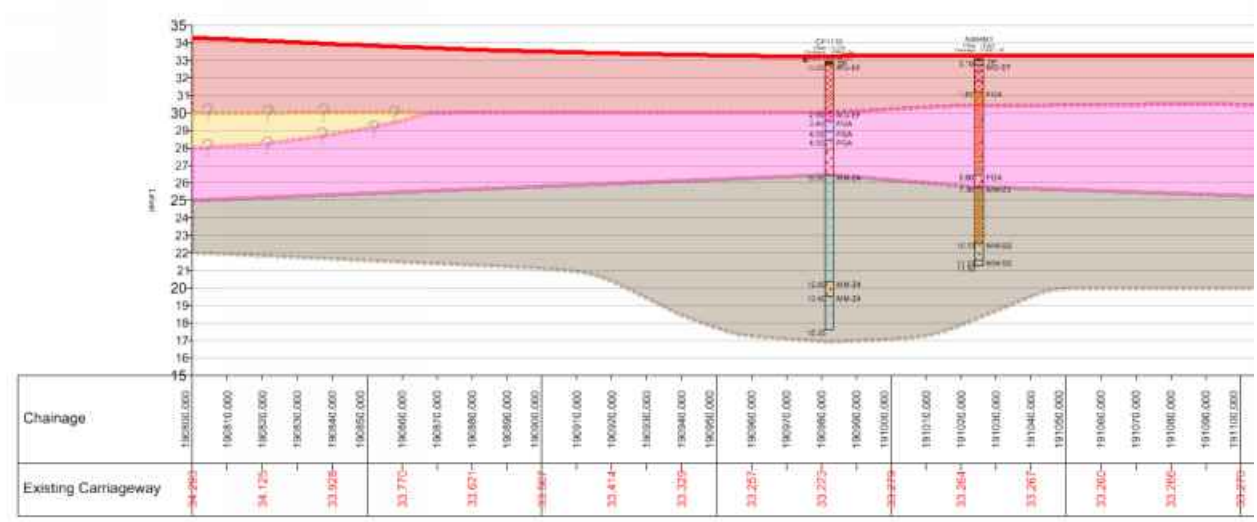


Figure 5.1: Geological Long Section 1 of 2

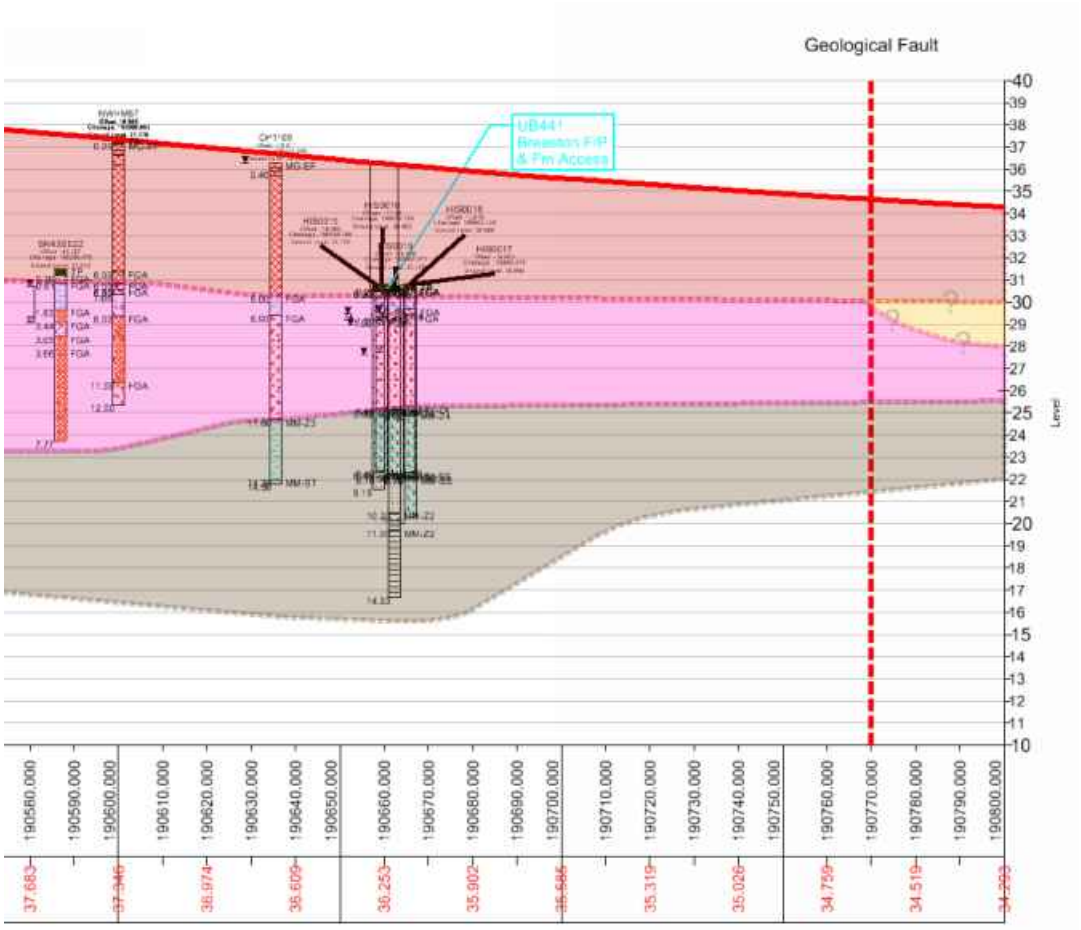


Figure 5.2: Geological Long Section 2 of 2

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
190680	191040	Granular Wedge at Embankment Crest (1:2.0)	3.8	26.6 (1V:2H)

Proposed Structural Solution:

N/A

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-R-FTPSB3_800y, Ch190932, Southbound, 6m deep CPT exploratory hole, located in southbound existing grass verge.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **CP1109** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446966.00 - 332758.00	Hole Type CP
Location:		Level: 36.30	Scale 1:50
Client: Highways England		Dates: 02/11/2006 - 02/11/2006	Logged By RMS/OP

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	B				0.20	36.10		MADE GROUND. Light to medium brown slightly sandy, gravelly soft clay with occasional rootlets up to 20mm. Gravel is subrounded to rounded fine and medium of quartzite and angular to subangular fine and medium of limestone and mudstone. MG-EF
		0.45	B				0.40	35.90		
		0.60	B				0.60	35.70		
		1.20 - 1.65	U							MADE GROUND. Light brown very sandy gravel with frequent rootlets up to 100mm. Gravel is angular and subangular fine to coarse of sandstone, mudstone and limestone. MG-EF
		1.70	D							
		2.20 - 2.65	D							MADE GROUND. Light brown very gravelly, clayey fine and medium sand. Gravel is angular and subangular fine to coarse of sandstone. Possible MG-EF
		2.20 - 2.70	B							
		3.20 - 3.65	U							MADE GROUND. Firm to stiff red brown slightly gravelly clay. Gravel is subrounded and rounded fine to coarse of mudstone, sandstone and siltstone. Possible MG-EF
		3.70	D							*From 3.20m, slightly sandy*
		4.20 - 4.65	D							*From 4.20m, slightly friable with some light green grey mottling*
		4.20 - 4.70	B							
		5.20 - 5.65	U							
		5.70	D							
		6.00	D				6.00	30.30		Stiff brown grey with black mottling, slightly sandy slightly gravelly CLAY. Gravel is subrounded and rounded, fine and medium of quartz with occasional gravel sized fragments of organic material. Possible FGA
		6.20 - 6.65	D							
		6.20 - 6.70	B							
		7.00 - 7.50	B				6.90	29.40		Very dense brown fine to coarse SAND and subrounded to rounded, fine to coarse GRAVEL of quartz, mudstone and sandstone. FGA-SG
		8.00 - 8.50	B							
		9.50 - 10.00	B							

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.00m.;The borehole was advanced by chiselling methods from 14.30m to 14.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1109 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446966.00 - 332758.00	Hole Type CP
Location:		Level: 36.30	Scale 1:50
Client: Highways England		Dates: 02/11/2006 - 02/11/2006	Logged By RMS/OP

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										SAND and GRAVEL (as previous sheet)
		11.00 - 11.50	B							
		11.60	D				11.60	24.70		Stiff to very stiff red brown CLAY with pockets of fine to coarse sand. MM-Z3
		11.70 - 12.15	U							
		12.20	D							
		13.20 - 13.65	D							From 13.20m, mottled red brown and grey with some subangular to subrounded fine to coarse gravel sized fragments of siltstone. With white gypsum crystals
		13.20 - 13.70	B							
		14.30 - 14.50	B				14.30	22.00		Recovered as grey, clayey angular to subangular fine to coarse gravel sized fragments of SILTSTONE. MM-ST
							14.50	21.80		End of borehole at 14.50 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 8.00m.;The borehole was advanced by chiselling methods from 14.30m to 14.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. **CP1110** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447131.00 - 333059.00	Hole Type CP
Location:		Level: 32.95	Scale 1:50
Client: Highways England		Dates: 03/11/2006 - 06/11/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	B				0.20	32.75		TOPSOIL. TP
		0.60	B							MADE GROUND. Firm, friable, red brown with some grey mottling, slightly gravelly clay. Gravel is subangular to subrounded, fine to coarse of siltstone and mudstone. MG-EF
		1.20 - 1.65	U							
		1.70	D							
		2.20 - 2.65	D							
		2.20 - 2.70	B							
		2.90 - 3.30	B				2.90	30.05		MADE GROUND. Very dense brown and grey rounded fine to coarse gravel of quartz. MG-EF
		3.40	D				3.40	29.55		Stiff dark green grey slightly gravelly CLAY. Gravel is subangular and subrounded, fine and medium of mudstone with pockets of brown sand. Sand is fine to coarse. FGA
		3.50 - 3.95	U							
		4.00	D				4.00	28.95		Firm light brown with light grey mottling slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded, fine and medium of quartz, with occasional gravel sized pockets of black organic matter. FGA
		4.50 - 5.00	B				4.50	28.45		Dense to very dense brown fine to coarse SAND, and subrounded and rounded fine to coarse GRAVEL of quartz, mudstone and sandstone. FGA-SG
		5.50 - 6.00	B							*Below 5.50m, sandy gravel*
		6.50	D				6.50	26.45		Firm red brown with some grey mottling, sandy slightly gravelly CLAY. Gravel is subangular to rounded, fine to coarse of quartz, mudstone and siltstone. MM-Z4
		6.60 - 7.05	U							
		7.10	D							
		7.60 - 8.05	D							
		7.60 - 8.10	B							
		8.30	W							
		9.10 - 9.55	U							
		9.60	D							*From 9.60m, friable.*
		9.60 - 10.05	D							
		9.60 - 10.10	B							

Continued on next sheet.

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.50m.;The borehole was advanced by chiselling methods from 14.90m to 15.20m (1 hour).;No visual or olfactory indication of contamination was observed.;The borehole was backfilled on completion with grout.;

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Rotary Core Log

Borehole No. CP1110 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447131.00 - 333059.00	Hole Type CP
Location:		Level: 32.95	Scale 1:50
Client: Highways England		Dates: 03/11/2006 - 06/11/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										CLAY (as previous sheet)
		11.10 - 11.55	U							
		11.55	D							
		12.60 - 13.05	D				12.60	20.35		
		12.60 - 13.10	B							Dense light grey fine and medium SAND, with pockets of firm green grey sandy clay and silt. MM-Z4
		13.50 - 13.95	U				13.40	19.55		
		14.00	D							Very stiff red brown CLAY with angular and subangular fine to coarse gravel sized weathered mudstone lithorelics. MM-Z4
		14.80 - 15.00	D							
		14.80 - 15.20	B							From 14.80m, sandy
		15.20 - 15.34	D				15.35	17.60		At 15.20m, recovered as red brown angular and subangular fine to coarse gravel sized fragments of mudstone and gypsum
										End of borehole at 15.35 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.50m.;The borehole was advanced by chiselling methods from 14.90m to 15.20m (1 hour).;No visual or olfactory indication of contamination was observed.;The borehole was backfilled on completion with grout.;

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Rotary Core Log

Borehole No. **HIS0015**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446981.00 - 332776.00	Hole Type CP
Location:		Level: 30.70	Scale 1:50
Client: Highways England		Dates: 15/06/1964 - 17/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.50		TOPSOIL TP
		0.46 - 0.91	U							Stiff brown silty CLAY FGA
		0.91	D							
	▼	1.37	D				1.50	29.20		
		1.68 - 2.13	B							Medium dense brown sandy fine to medium GRAVEL FGA-SG
		2.59 - 3.05	B							
		3.51 - 3.96	B							
		4.45 - 4.88	B							
		5.79 - 6.25	U				5.60	25.10		Stiff to very stiff friable red-brown and grey silty CLAY (Keuper Marl) MM-Z4
		6.25	D							
		6.86	D							
		7.47 - 7.92	U							
		7.92	D							
		8.38 - 8.69	B				8.40	22.30		Light grey SANDSTONE MM-SS
		8.69	W							
							9.15	21.55		End of borehole at 9.14 m

Remarks
Ground-water was first encountered at a depth of 1.5m but subsequently rose to 1.2m below ground level. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. **HIS0016** Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447010.00 - 332758.00	Hole Type CP
Location:		Level: 30.80	Scale 1:50
Client: Highways England		Dates: 17/06/1964 - 19/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.60		TOPSOIL TP
		0.46 - 0.91	U							Stiff brown silty CLAY with traces of organic matter FGA
		0.91	D							
							1.50	29.30		
	▼	1.68 - 2.13 1.83	B W							Medium dense brown slightly sandy fine to medium GRAVEL with occasional coarse gravel; becoming sandy with depth FGA-SG
		2.59 - 3.05	B							
		3.51 - 3.96	B							
		4.42 - 4.88	B							
							5.60	25.20		
		5.94 - 6.40	U							Stiff friable red-brown and grey silty CLAY or clayey SILT (Keuper Marl) MM-Z4
		6.40	D							
		7.01	D							
		7.47 - 7.92	U							
		7.92	D							
		8.38 - 8.69	B				8.40	22.40		Grey SANDSTONE MM-SS
							8.70	22.10		End of borehole at 8.69 m

Remarks
Water was added to assist boring. On completion of boring the water stood at a depth of 1.8m below ground level and a sample was taken.

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Rotary Core Log

Borehole No. **HIS0017** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446985.00 - 332782.00	Hole Type CP
Location:		Level: 30.80	Scale 1:50
Client: Highways England		Dates: 09/06/1964 - 15/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.60		TOPSOIL TP
		0.61 - 1.07	U							Firm brown sandy CLAY with gravel FGA
	▼	1.07	D				1.10	29.70		
		1.22 - 1.68	B							Medium dense brown sandy fine to medium GRAVEL with occasional coarse gravel and cobbles; becoming more sandy with depth FGA-SG
		2.13 - 2.59	B							
	▽	3.05 - 3.51	B							
		3.96 - 4.42	B							
		4.88 - 5.33	B							
							5.80	25.00		
		6.10 - 6.55	U							Stiff to very stiff friable red-brown and grey silty CLAY (Keuper Marl) MM-Z4
		6.55	D							
		6.86	D							
		7.62 - 8.08	U							
		8.08	D							
		8.69	D				8.70	22.10		Grey SANDSTONE MM-SS
		9.14	W							
		9.14	D							

Continued on next sheet

Remarks

Ground-water was first encountered at a depth of 3.05m below ground level and rose overnight to 1.22m depth. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No.
HIS0017
Sheet 2 of 2

Project Name:	SMP - M1 J23A TO J25	Project No.	COCDFL1SMP01	Co-ords:	446985.00 - 332782.00
Location:				Level:	30.80
Client:	Highways England			Dates:	09/06/1964 - 15/06/1964

Hole Type: CP
Scale: 1:50
Logged By:

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.52	20.28		End of borehole at 10.52 m

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level and rose overnight to 1.22m depth. On completion of boring a water sample was taken.

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Rotary Core Log

Borehole No. **HIS0018**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447014.00 - 332763.00	Hole Type CP
Location:		Level: 30.80	Scale 1:50
Client: Highways England		Dates: 19/06/1964 - 20/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.60		TOPSOIL TP
										Firm brown silty CLAY with gravel FGA
		0.91 - 1.37	U							
	▼	1.22	W							
		1.37	D				1.40	29.40		
		1.52 - 1.98	B							Medium dense brown sandy fine to medium GRAVEL with occasional coarse gravel at depth FGA-SG
		2.44 - 2.90	B							
		3.35 - 3.81	B							
		4.27 - 4.72	B							
							5.50	25.30		Firm to stiff friable red-brown and grey silty CLAY or clayey SILT (Keuper Marl) MM-Z4
		5.79 - 6.25	U							
		6.25	D							
		6.71	D							
		7.47 - 7.92	U							
		7.92	D							
		8.53	D				8.50	22.30		
							8.70	22.10		Grey SANDSTONE MM-SS End of borehole at 8.69 m

Remarks
Ground-water was first encountered at a depth of 1.8m below ground level. Subsequently the water level rose to a depth of 1.22m and a sample was taken.

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Rotary Core Log

Borehole No. HIS0019
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446983.00 - 332779.00	Hole Type RC
Location:		Level: 30.70	Scale 1:50
Client: Highways England		Dates: 09/07/1964 - 11/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	30.50		TOPSOIL TP
										Brown silty CLAY FGA
							1.20	29.50		Sandy fine to medium GRAVEL FGA-SG
	▼									
							5.60	25.10		Stiff red-brown and grey silty CLAY (Keuper Marl) MM-Z4
							8.50	22.20		Grey medium SANDSTONE with veins of gypsum MM-SS
										Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level.

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Rotary Core Log

Borehole No. HIS0019
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446983.00 - 332779.00	Hole Type RC
Location:		Level: 30.70	Scale 1:50
Client: Highways England		Dates: 09/07/1964 - 11/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.20	20.50		Green-grey clayey sandy MUDSTONE MM-Z2
							11.00	19.70		Mottled red-brown and green-grey sandy MUDSTONE with fine sandstone and viens of gypsum MM-Z2
							14.03	16.67		End of borehole at 14.02 m

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level.

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Rotary Core Log

Borehole No. **NWHM3** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447149.38 - 333096.71	Hole Type CP+RC
Location:		Level: 33.07	Scale 1:50
Client: Highways England		Dates: 20/09/1999 - 23/09/1999	Logged By NBR/BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.30	D				0.10	32.97		TOPSOIL.
		0.00 - 0.30	D							TP
		0.30 - 0.70	D				0.30	32.77		MADE GROUND: Brown sandy clay with much fine to coarse angular gravel sized fragments of limestone, sandstone and mudstone. MG-EF
		0.30 - 0.70	D							
		0.70	D				0.70	32.37		
		0.70 - 0.80	D							
		1.00 - 1.30	B							MADE GROUND: Light grey medium and coarse angular gravel sized fragments of limestone. MG-EF
		1.00 - 1.30	B	56	0	0	1.25	31.82		
		1.60 - 2.05	D							MADE GROUND: Brown very clayey sandy fine to coarse angular to subrounded gravel sized fragments of quartz, sandstone and limestone. MG-EF
		1.60 - 2.05	D				1.85	31.22		
		2.00 - 2.50	D							MADE GROUND: Reddish brown very silty clay with some fine and medium subangular gravel sized fragments of mudstone. (Reworked Mercia Mudstone) MG-EF
		2.00 - 2.50	D							
		2.05 - 2.60	98	91	0	0				
		3.00 - 3.50	B							Medium dense brown clayey sandy medium and coarse subrounded and rounded GRAVEL of quartz, sandstone and siltstone. (River Terrace Deposits) FGA-SG
		3.00 - 3.50	B							
		3.05 - 3.60	98	0	0	0				
		4.00 - 4.50	B							
		4.00 - 4.50	B							
		4.05 - 4.60	98	0	0	0				
										from 4.60m to 5.05m loose
		5.05 - 5.50	98	0	0	0				
		5.50	D							
		5.50	D							
		5.50 - 6.00	B							
		5.50 - 6.00	B							
		6.05 - 6.50	98	0	0	0				
		6.50 - 7.00	B							
		6.50 - 7.00	B				6.60	26.47		Medium dense brown SAND and GRAVEL: Gravel content fine to coarse subangular to rounded of sandstone, limestone and quartz. (River Terrace Deposits) FGA-SG
		7.30	D				7.30	25.77		
		7.30	D							Firm to stiff red brown (friable) sandy CLAY with some fine and medium subangular mudstone lithorelicts. (Mercia Mudstone - Zone III?) MM-Z3
		7.50 - 7.95	D							
		7.50 - 7.95	D							
		8.50	D							
		8.50	D							
		9.00 - 9.45	D							
		9.00 - 9.45	D							
		9.50 - 10.00	B							
		9.50 - 10.00	B							
										Continued on next sheet.

Remarks

1. Inspection pit excavated to 0.80m. 2. Rotary coring complete at 6.60m due to collapse. 3. Borehole completed by cablepercussive methods. 4. Borehole complete at 11.80m. 5. Boreholebackfilled with bentonite grout. 6. Marker post ref 191/0+30N.

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Rotary Core Log

Borehole No. NWHM3
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447149.38 - 333096.71	Hole Type CP+RC
Location:		Level: 33.07	Scale 1:50
Client: Highways England		Dates: 20/09/1999 - 23/09/1999	Logged By NBR/BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 - 10.95	D				10.50	22.57		
		10.50 - 10.95	D							Dense blue grey slightly clayey medium SAND with a little medium and coarse subangular gravel sized lithorelicts of sandstone. MM-SS
		11.50	D				11.50	21.57		
		11.50 - 11.52	D							Blue grey fine and medium grained slightly weathered SANDSTONE, moderately strong to strong. MM-SS.
		11.50 - 11.52	D				11.80	21.27		
										End of borehole at 11.80 m

Remarks
1. Inspection pit excavated to 0.80m. 2. Rotary coring complete at 6.60m due to collapse. 3. Borehole completed by cablepercussive methods. 4. Borehole complete at 11.80m. 5. Boreholebackfilled with bentonite grout. 6. Marker post ref 191/0+30N.

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Rotary Core Log

Borehole No. **NWHM67**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446978.66 - 332707.69	Hole Type CP
Location:		Level: 37.38	Scale 1:50
Client: Highways England		Dates: 01/09/1999 - 02/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	D				0.20	37.18		TOPSOIL. TP
							0.50	36.88		MADE GROUND: Very stiff desiccated marl fill. MG-EF
							0.70	36.68		MADE GROUND: Blue grey sandy fine to coarse angular gravel of limestone. (Hardcore) MG-EF
										MADE GROUND: Stiff red brown mottled/ dappled blue grey slightly sandy clay with a little, locally some fine to coarse subangular mudstone gravel (as lithorelicts). (Embankment Fill - Marl) MG-EF
		6.00	B							
							6.50	30.88		Very dense brown clayey medium and coarse SAND with much fine to coarse angular to rounded gravel of sandstone, limestone and quartz? (River Terrace Deposits?) FGA-SG
							6.80	30.58		at 6.80m possible obstruction/bowlder End of borehole at 6.80 m

Remarks

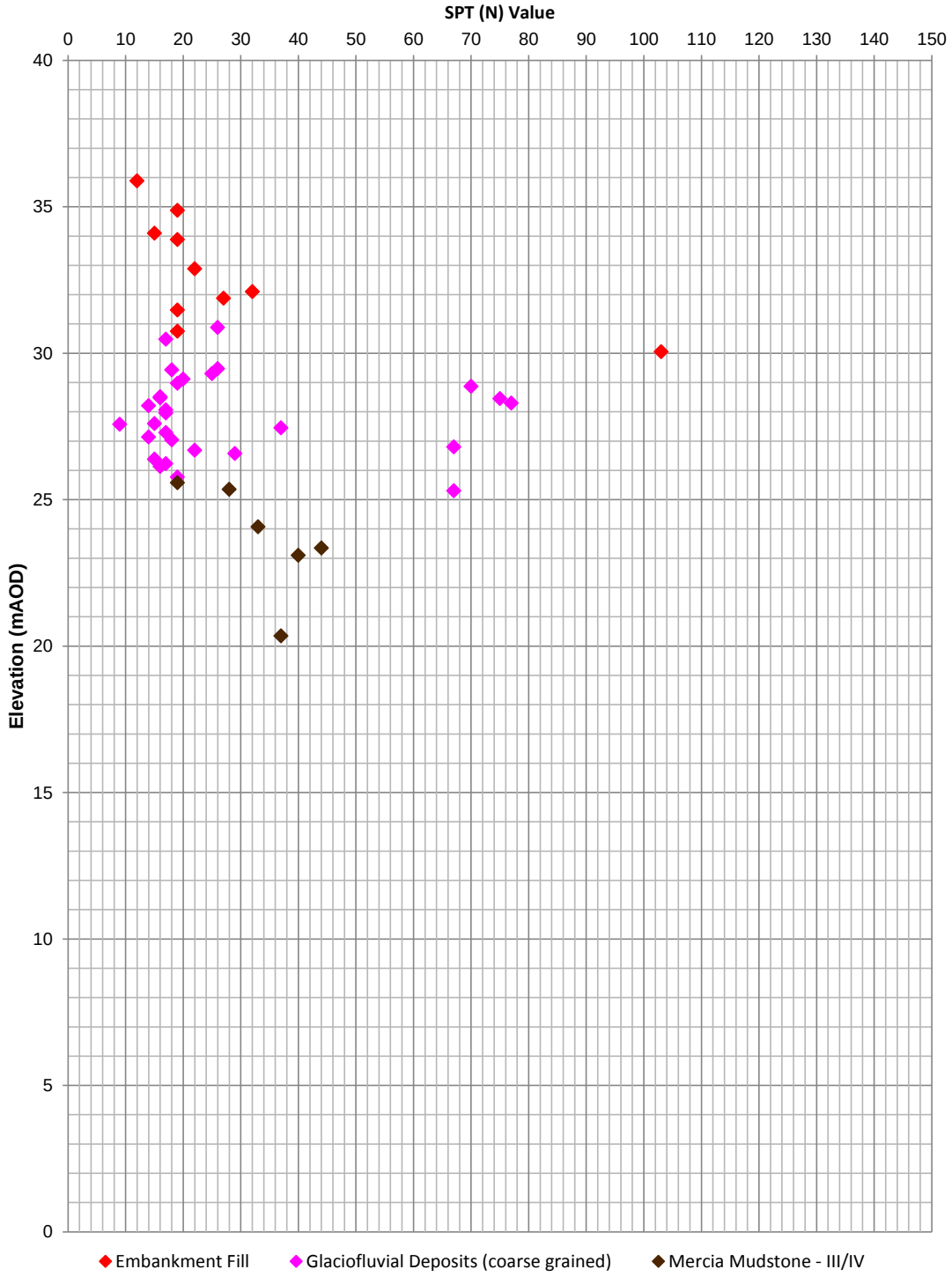
1. Hand excavated inspection pit to 1.20m. CAT scan at GL and 1.20m. 2. M67 commenced in 150mm - terminated at 6.80m - see M67A redrilled on sameposition with 200mm casing to start. 3. M67 backfilled with arisings tomake secure overnight. 4. Marker Post Ref 190/7 -50S.

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PLOTS

amey ARUP	SPT N Value vs Depth
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25** | Data Sheet: **190680-191040SB**
Client: **Highways England**	Borehole ID: **CP1109, CP1110, HIS0015, HIS0016, HIS0017, HIS0018, NWHM3, NWHM67**



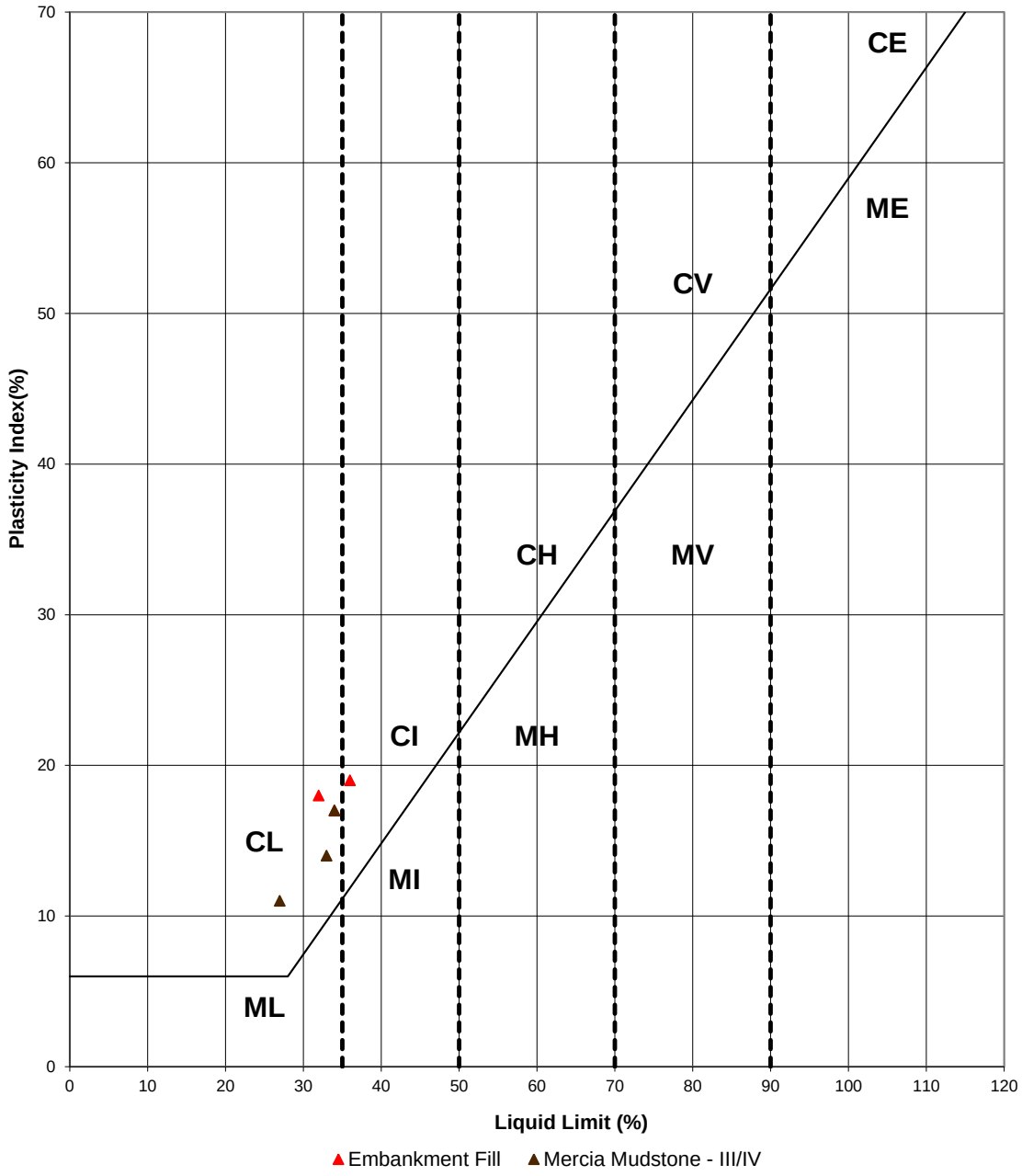
Extrapolated SPT (N) Values >150 have not been shown

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **190680-191040SB**
Client: **Highways England**	Borehole ID: **CP1109, CP1110**	



Key

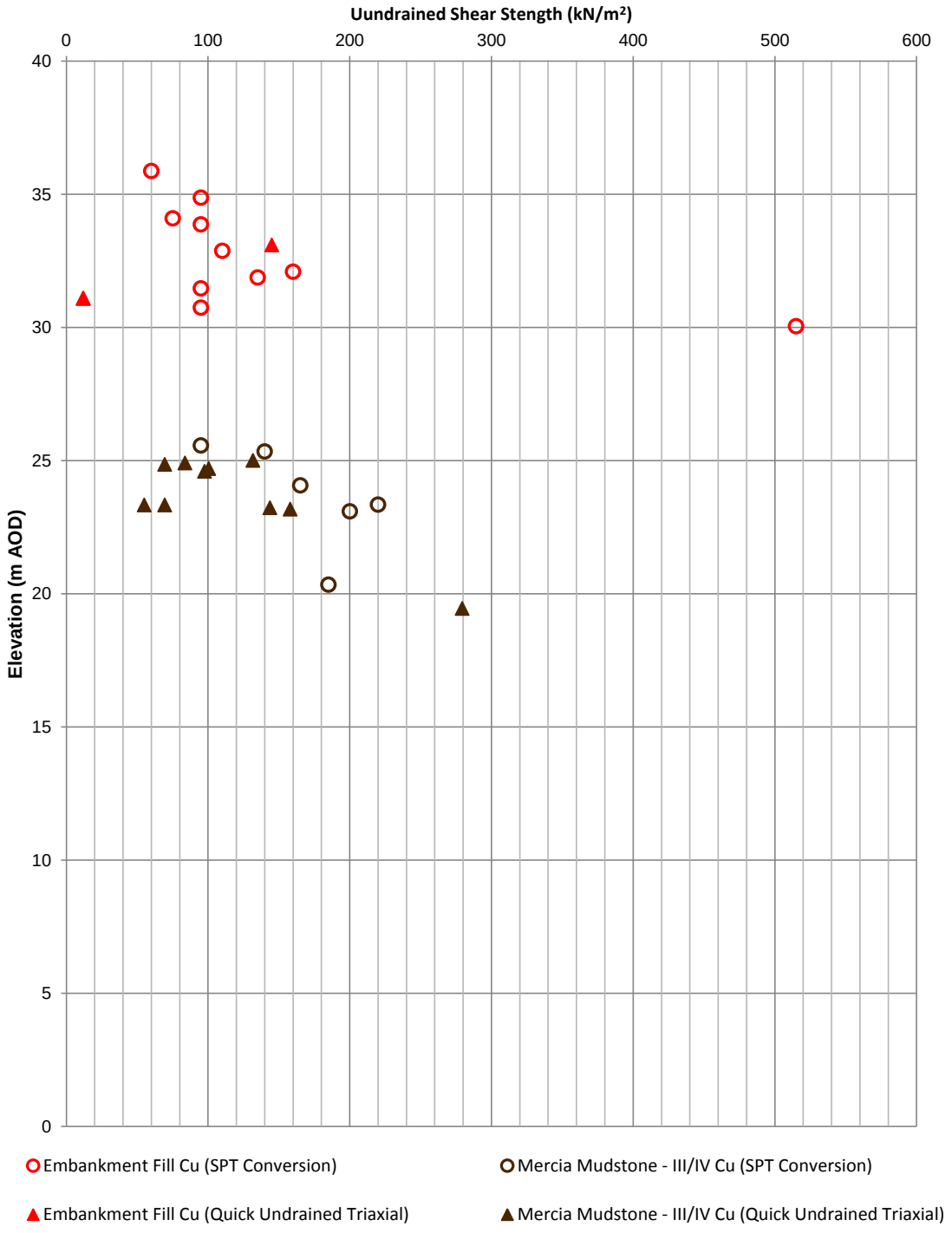
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **190680-191040SB**
Client: **Highways England**	Borehole ID: **CP1109, CP1110, HIS0015, HIS0016, HIS0017, HIS0018, NWHM3, NWHM67**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-191420-191450SB-GSS-000001		
Earthworks Widening Solution	Granular Wedge at Embankment Crest (1:2.0)		
Structure Number	GANTRY_316		
Structure Type	MS4 Cantilever Gantry;		
Design Chainage	191420-191450		
Carriageway	Southbound		
Marker Post	191/4+20 – 191/4+50		
National Grid Reference	E 447289, N 333469 – E 447293, N 333499		
Existing Ground Level at Location	Carriageway	33.4-33.6mAOD	
	Toe of embankment	29.6-30.2mOAD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_22139	HAGDMS designation
Maximum Earthwork Height	NB: N/A	SB: 3.4-4.0m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Typical Earthwork Angle	NB: N/A	SB: 27^{o}	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	17/02/2017	[redacted]
Checked	Roheel Masrat	10/03/2017	
Reviewed	Gary Summerfield	17/03/2017	
Approved			

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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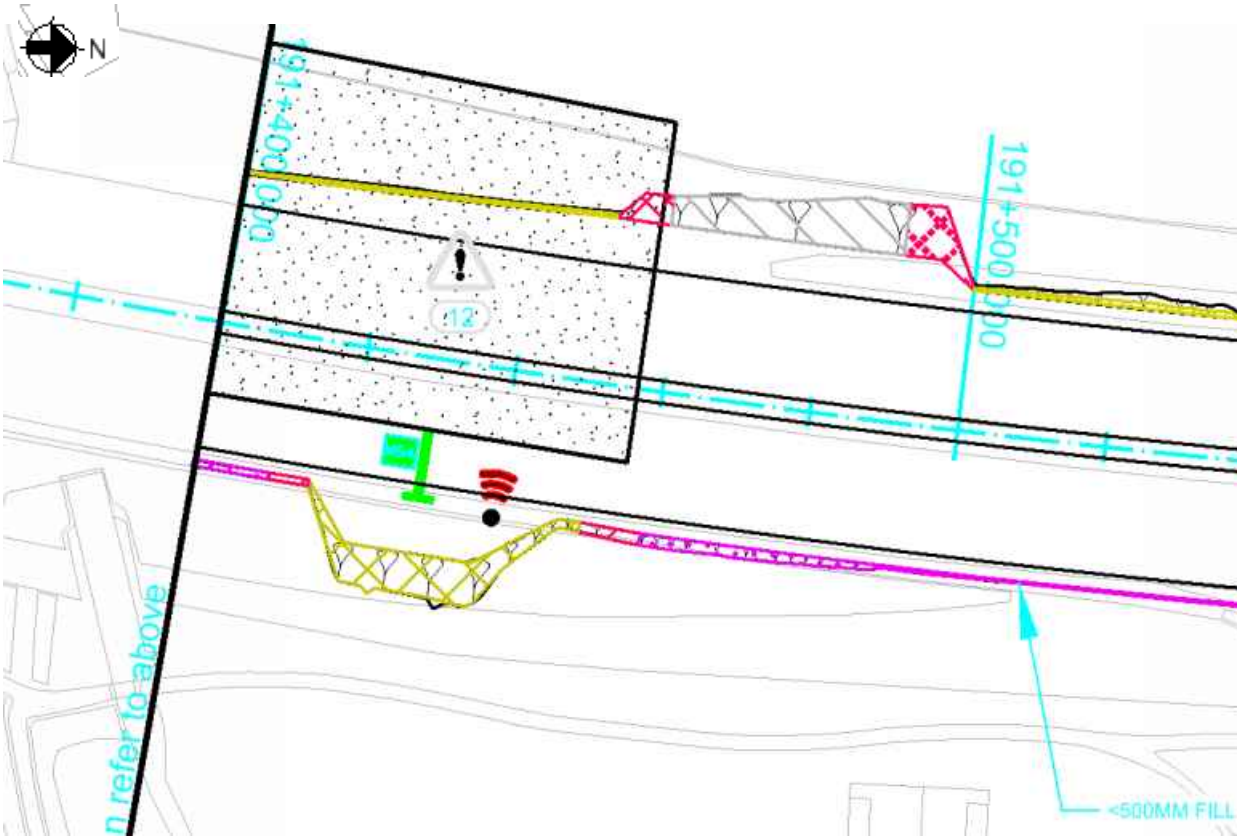


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Granular Wedge at Embankment Crest (1:2.0)

Proposed Major Structure:

A new MS4 cantilever gantry structure, Gantry 316, situated on the southbound carriageway at chainage 191430.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is classified as an embankment. The embankment reduces in height from 3.4-4.0m with a proposed slope gradient of 1V:2H (27°).

The critical cross section Ch191440 was chosen based on the granular wedge with the greatest vertical height.

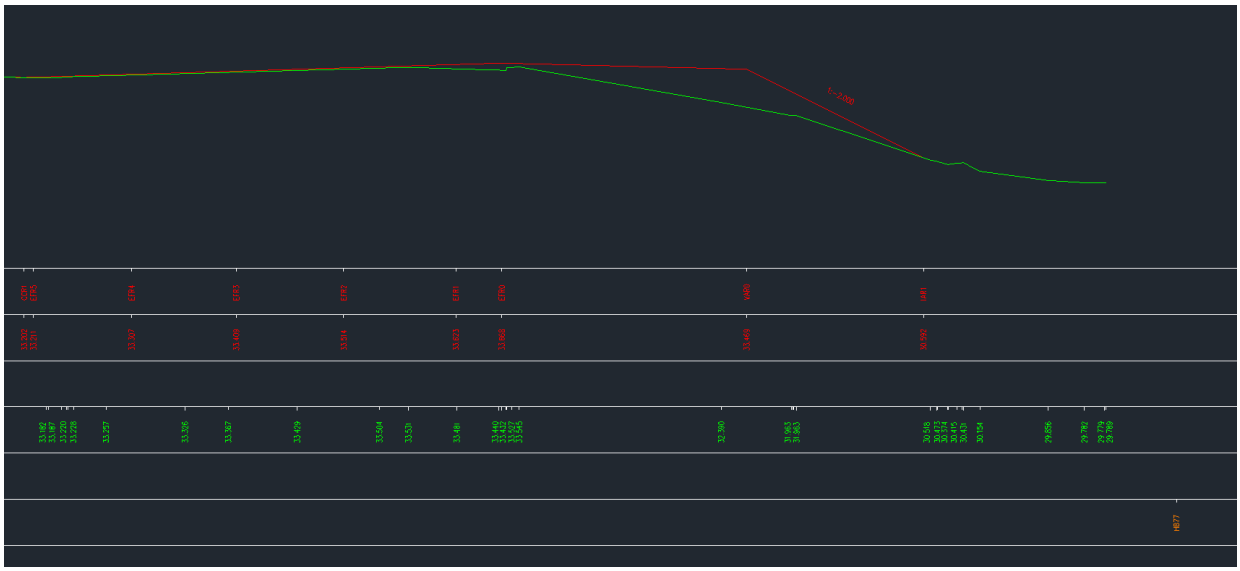


Figure 2: Topographic Critical Cross Section Ch191440

Utilities:

An overhead mid voltage Western Power cable is present at the embankment crest running parallel to the carriageway along the entirety of the chainage extents.

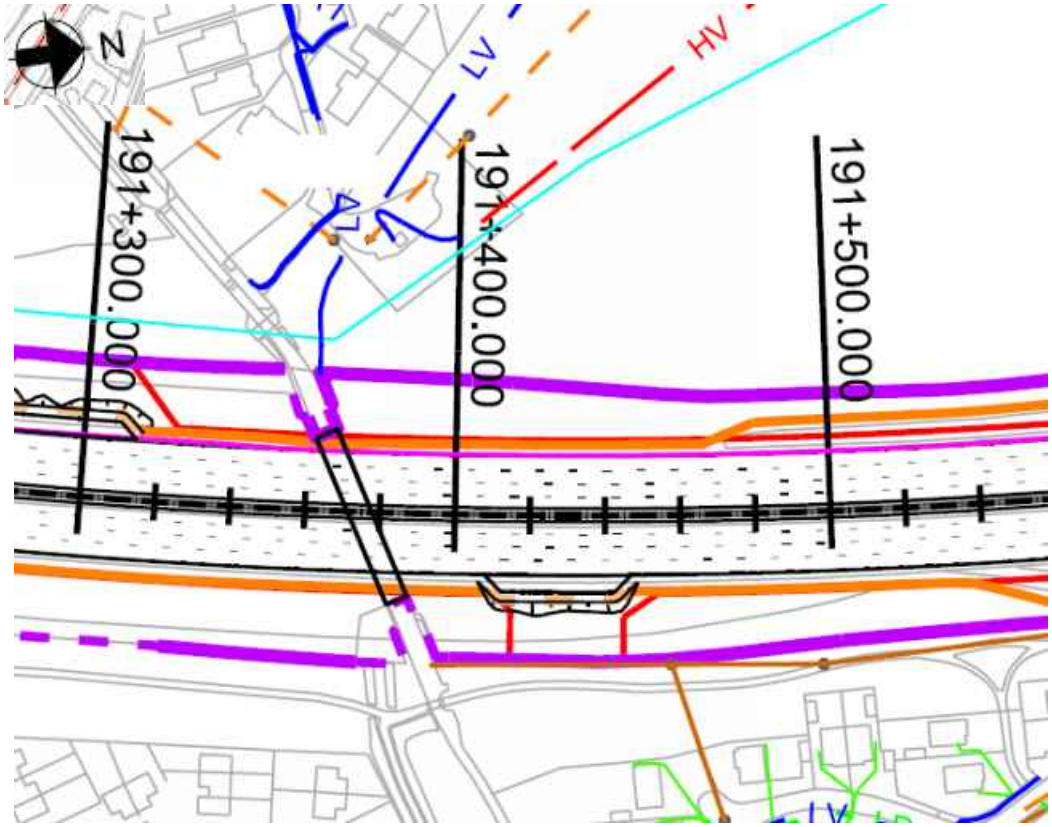


Figure 3: Utilities Location Plan

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Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Ch191420-191425 Alluvium (Fluvial Deposits); Ch191425-191450 Beeston Sand And Gravel Member (Glaciofluvial Deposits)

Solid Deposits: Cotgrave Sandstone Member (Mercia Mudstone)

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, but 1 no. relevant exploratory hole has been considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000036, Rev P01.



Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	CP1111
Borehole Chainage	191375
Borehole Location	Southbound (9m from VRS)
National Grid Reference	E 447287, N 333422
Ground Level at Exploratory Hole	32.05 metres Above Ordnance Datum (mAOD)
RAG Analysis	Green
Date Drilled	29/08/2006-30/08/2006
Termination Depth	12.61 metres below ground level (m bgl)
Other suitable holes	None

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey data.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT (N) Value
Embankment Fill	3.7	29.8	5
Glaciofluvial Deposits (coarse grained)	10.0	23.5	34-66 (34)
Mercia Mudstone – III/IV	Not proven	Not proven	49-100 (49)

(1) Ground level is assumed to be at carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) Depth of Embankment Fill is based on driven LiDAR survey data at the critical cross section location Ch191440.
(4) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(5) Historical exploratory hole CP1111 was used to determine depths of natural geological strata.
(6) Mercia Mudstone – I/II is recorded at depth beneath Mercia Mudstone – III/IV. Due to the lack of local historical exploratory holes, as a conservative measure, only Mercia Mudstone – III/IV is included in the ground model.
(7) SPTs undertaken within Mercia Mudstone – I/II were not included for Mercia Mudstone – III/IV.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within exploratory hole CP1111.

Groundwater:

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Groundwater was encountered in CP1111 at 4.6mbgl (27.5mAOD), this had risen to 3.1mbgl (29.0mAOD) after 20 minutes.

Groundwater Design Level:

Limited local groundwater level is available, therefore a groundwater level of 1.0m below toe of embankment has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

3 No. Atterberg Limit and 3 No. Natural Moisture Content test were undertaken within the Embankment Fill within CP1111 with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	0.50	10.64	36	16	20	ML
Glaciofluvial Deposits (coarse grained)*	4.00	39.33	31	23	8	CI
Glaciofluvial Deposits (coarse grained)	6.45	13.88	NP	NP	NP	NP

1. NP = Non-plastic.
2. *This test was undertaken within fine grained elements of a dominantly coarse grained material and therefore is not considered to be representative of the stratum as a whole. Therefore, this test has not been used to determine geotechnical parameters.

1 No. quick undrained triaxial test was completed in the Embankment Fill at 2.00mbgl (30.05mAOD) with a recorded undrained shear strength (c_u) of 85.3kN/m^2.

Lab Test Data – BRE Classification:

Chemical test data is presented in the table below:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Sulphate (Total) as SO4	Solid	2	0.01-0.02	%SO4
Embankment Fill	Water Soluble Sulphate as SO4	Water	-	-	g/l SO4
Embankment Fill	pH	Solid	1	7.9	-
Mercia Mudstone –I/II	Sulphate (Total) as SO4	Solid	-	-	%SO4
Mercia Mudstone –I/II	Water Soluble Sulphate as SO4	Water	2	0.05	g/l SO4
Mercia Mudstone –I/II	pH	Solid	1	8.5	-

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Assumed Ground Model For Design:

Ground model based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-CE-000036 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation::

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment Fill	0-3.7	33.5-29.8	3.7	21	27	0	100	7.8	6.2	-	0.50	0.20	-	2.60		-	6.2*	-	DS-2 AC-2
Glaciofluvial Deposits (coarse grained)	3.7-10.0	29.8-23.5	6.3	21	37	-	-	-	48.0	-	-	0.25	-	19.20	-	1.0	-	50	DS-3 AC-3
Mercia Mudstone – III/IV (>10mbgl)	>10.0	<23.5	-	21	30	2	100	16.5	13.2	-	0.50	0.20	-	5.50			9.0		DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Given the limited amount of local PI data, the ϕ' and c_u of Embankment Fill and Mercia Mudstone – III/IV was taken as the characteristic value given in the AMAR GIR.
(4) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a conservative SPT 'N' value of 34, ϕ' was found to be 37^o.
(5) Given the lack of test data available for Embankment Fill, geotechnical parameters derived in the AMAR GIR were adopted.
(6) E' of Embankment Fill can be based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the recorded SPT 'N' value of 5, Eu = 3.3MN/m^2. Therefore E' = 2.6MN/m^2. These values are below the range given in the AMAR GIR, therefore the lowerbound of the range given in the AMAR GIR was adopted.
(7) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a conservative SPT 'N' value of 34, E' = 25.2MN/m^2.
(8) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the conservative SPT 'N' value of 49, Eu = 16.5MN/m^2. Therefore E' = 13.2MN/m^2.
(9) Shear modulus is based on G = E/2(1+v).
(10) Adhesion Factor for Mercia Mudstone is based on BS8004 (equation 41).

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(11) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl
(12) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).
(13) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1). For sandstone, Nq is derived based on a very dense siliceous cohesionless soil (Tomlinson Table 7.1).
(14) BRE Classification is determined using criteria set out in BRE Special Digest 1. Due to the lack of BRE test data for all strata's, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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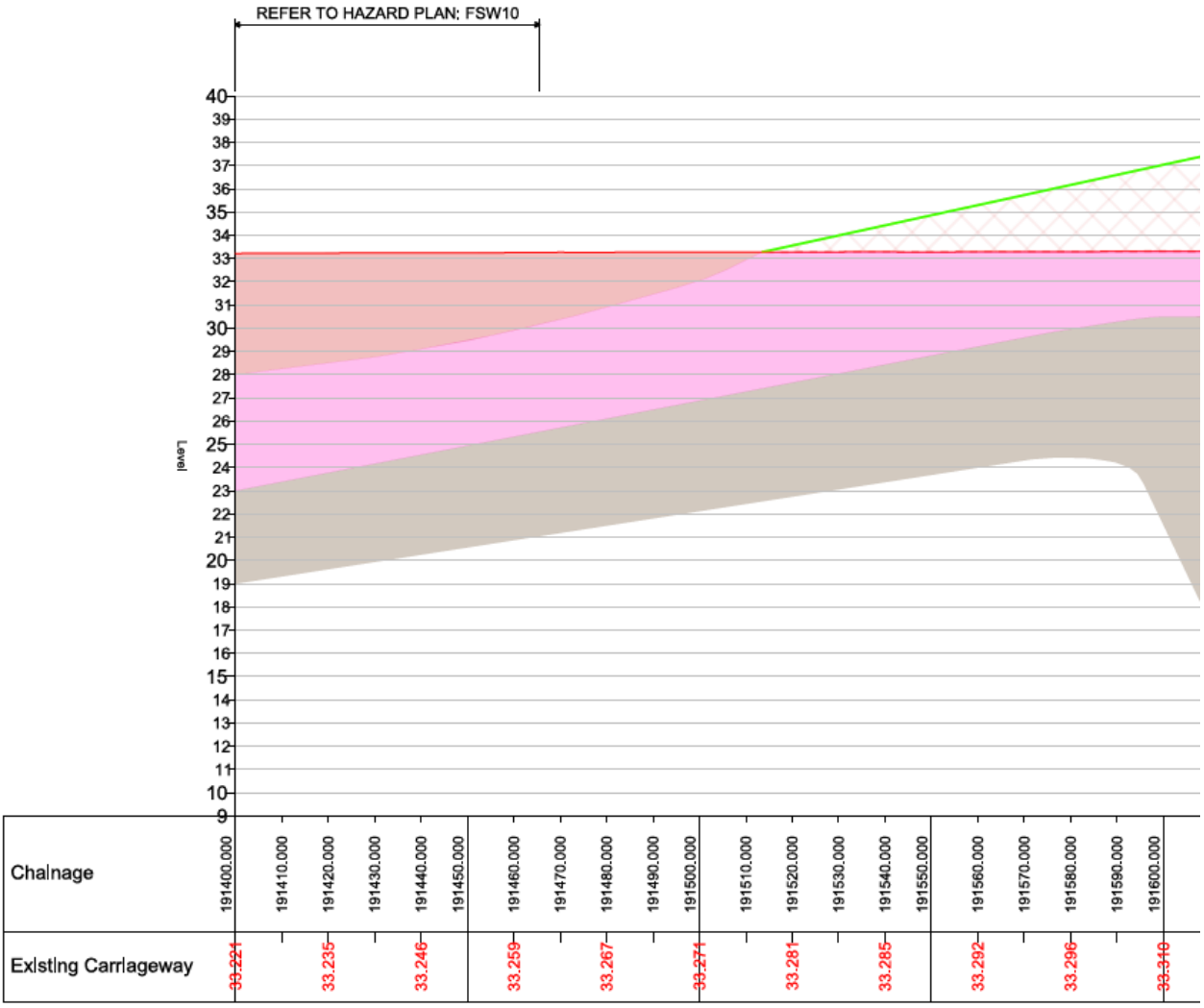


Figure 4.1: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
191420	191450	Granular Wedge at Embankment Crest (1:2.0)	3.0	26.6

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2 x 2)	750	10.5	2.25	10	194	678

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-G316, Ch191430, Southbound, 16m deep dynamic sample / rotary follow on exploratory hole, located in existing hard strip.

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HISTORICAL EXPLORATORY HOLES

Rotary Core Log

Borehole No. **CP1111** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447287.00 - 333422.00	Hole Type CP
Location:		Level: 32.05	Scale 1:50
Client: Highways England		Dates: 29/08/2006 - 30/08/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	31.85		TOPSOIL. TP
		0.50 0.50 - 1.00	D B							MADE GROUND. Firm to stiff red brown sandy gravelly clay. Gravel is coarse angular to subrounded of dolerite, quartz, mudstone and sandstone with frequent cobbles of the same. MG-EF
		1.20 - 1.70	U#B							*To 1.20m; with many rootlets.* *From 1.20m; red brown mottled grey slightly sandy clay.*
		1.70 - 2.00	B							
		2.00 - 2.40	U				2.00	30.05		MADE GROUND. Stiff dark grey/brown gravelly clay with some organic matter. Gravel is angular fine to coarse of red brick. MG-EF
		2.40	D							
	▼	3.00 - 3.45 3.00 - 3.50 3.10	D B W				3.00	29.05		MADE GROUND. Soft brown mottled grey slightly sandy clay with occasional gravel of quartz, brick and sandstone. With gravel size pockets of coal dust and occasional organic matter (grass). MG-EF
		3.70	D				3.70	28.35		(Soft) grey black organic CLAY with occasional plant matter. Possible FGA
		4.00 - 4.45	U				4.00	28.05		Dense brown grey slightly clayey sandy GRAVEL/gravelly SAND. Gravel is angular to rounded fine to coarse of sandstone, mudstone, dolerite, flint and quartz. FGA-SG
	▽	4.45	D							
		5.00 - 5.45 5.00 - 5.50	D B							
		5.80 6.00 - 6.45	D U				5.80	26.25		Soft blue grey sandy CLAY with occasional fine subrounded gravel of quartz and flint. FGA
		6.45	D				6.40	25.65		Very dense light grey/white fine to medium SAND with occasional angular to subrounded fine gravel of grey sandstone. Becoming gravelly with depth. FGA-SG
		7.00 - 7.45 7.00 - 7.50	D B							
		8.00 - 8.45 8.00 - 8.50	D B							
		8.60	D				8.60	23.45		Firm to stiff red brown mottled grey gravelly CLAY. Gravel is angular fine to coarse of friable mudstone. MM-Z3
		9.00 - 9.45 9.00 - 9.50	D B							*At 8.60m; becoming sandy silt/clay.*
		10.00	D							Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;A hand held Photo-Ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.;The borehole was advanced by chiselling methods from 1.70m to 2.00 (1.5hr) and 12.00m to 12.50m (1hr).;

AGS

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Rotary Core Log

Borehole No. **CP1111** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447287.00 - 333422.00	Hole Type CP
Location:		Level: 32.05	Scale 1:50
Client: Highways England		Dates: 29/08/2006 - 30/08/2006	Logged By RMS

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.00 - 10.50	B							CLAY (as previous sheet)
		11.00	D							
		11.00 - 11.50	B							
		12.00	D				12.00	20.05		MUDSTONE. Recovered as red brown clayey angular fine to coarse gravel sized fragments with pockets of blue grey slightly sandy fissile clay. MM-Z2
		12.00 - 12.50	B							
		12.50	D				12.61	19.44		End of borehole at 12.61 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;A hand held Photo-ionisation Detector (PID) was used to screen disturbed samples by measurements made in the head space above the sample in its container to give a semi-quantitative indication of the presence of volatile organic compounds. The results are given in ppm.;The borehole was advanced by chiselling methods from 1.70m to 2.00 (1.5hr) and 12.00m to 12.50m (1hr).;

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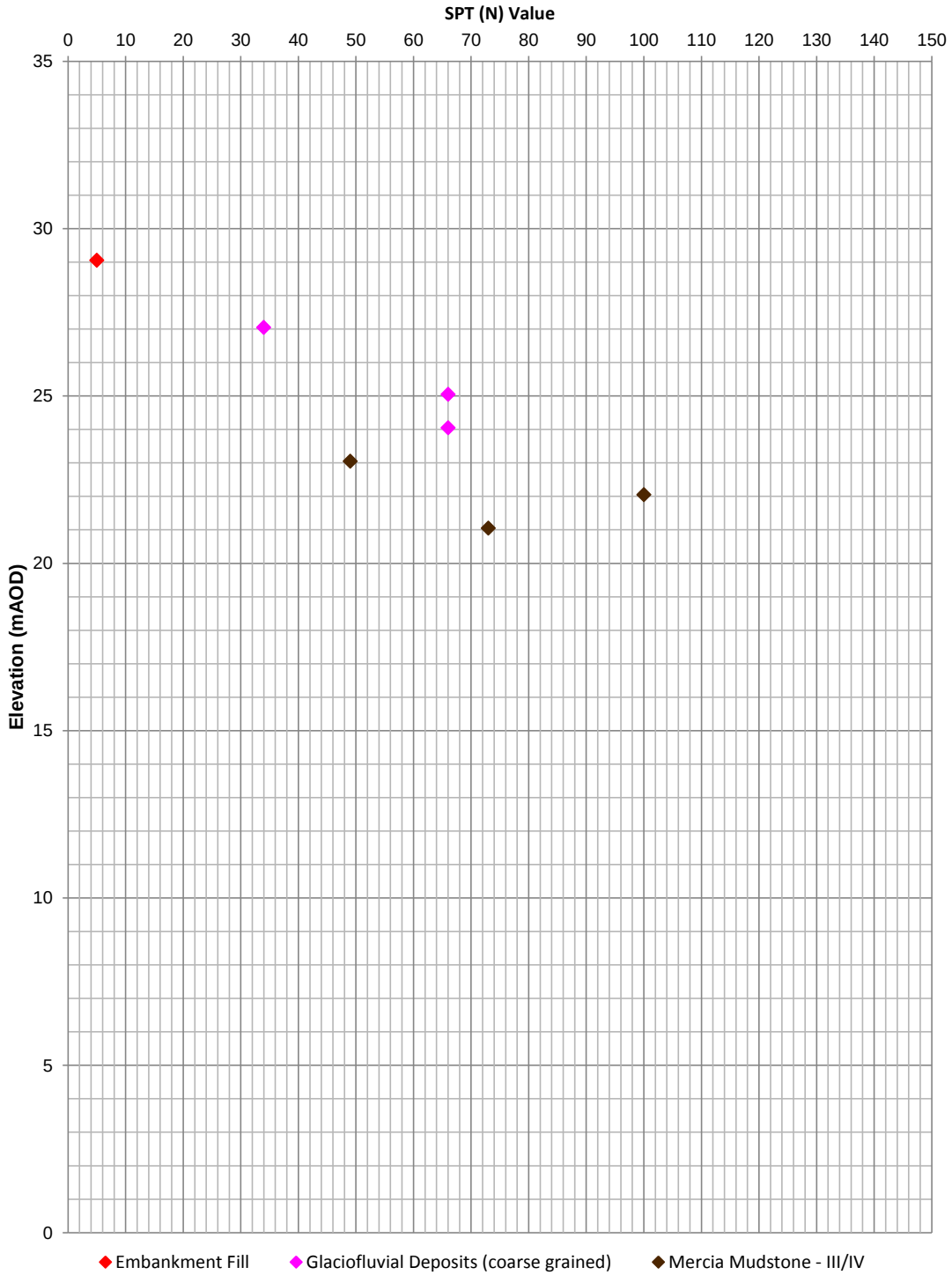
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PLOTS

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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **191420-191450SB**
Client: **Highways England**	Borehole ID: **CP1111**	



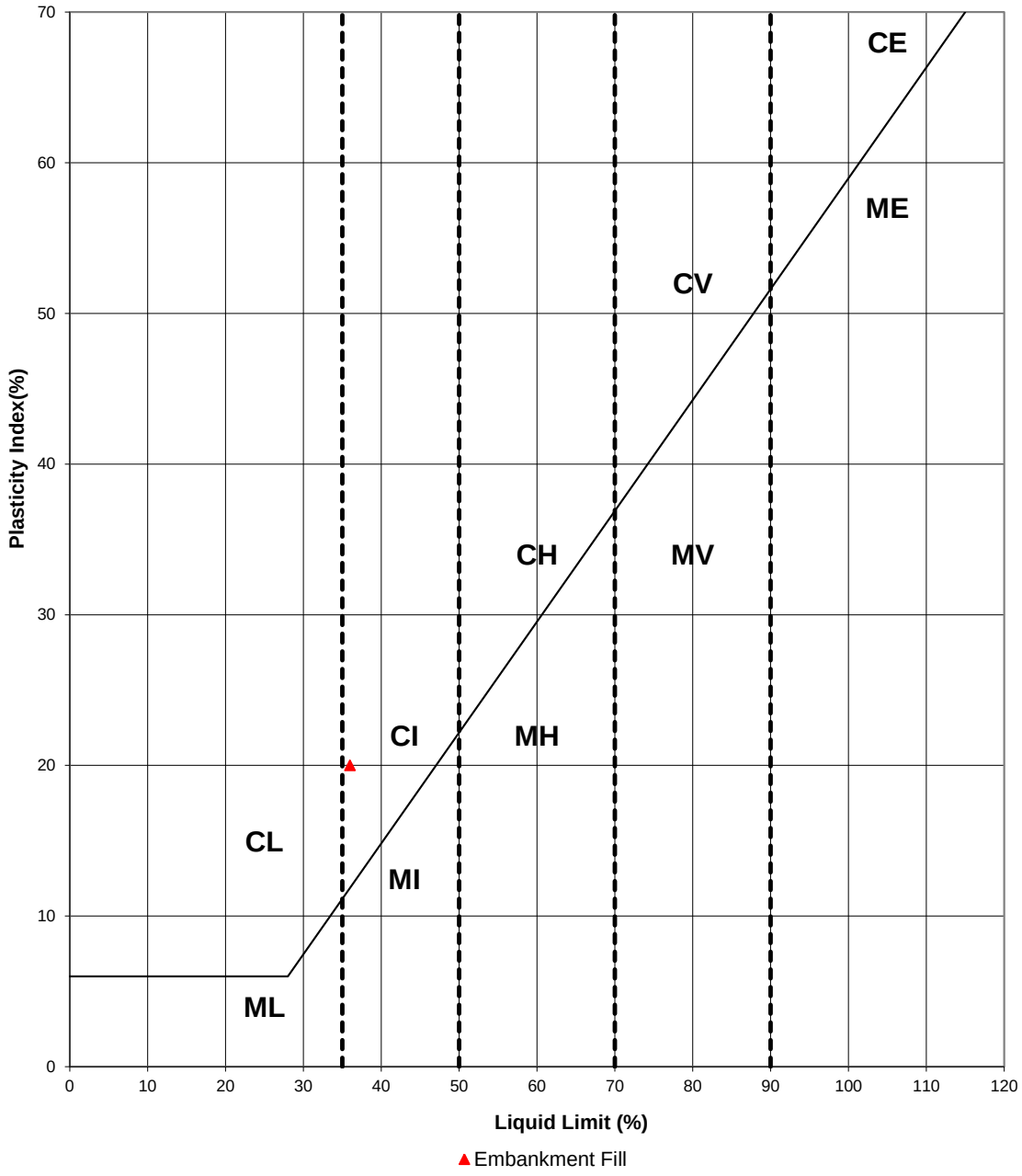
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 14/02/2017 Ref: HA549342-AMAR-HGT-191420-191450SB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **191420-191450SB**
Client: **Highways England**	Borehole ID: **CP1111**	



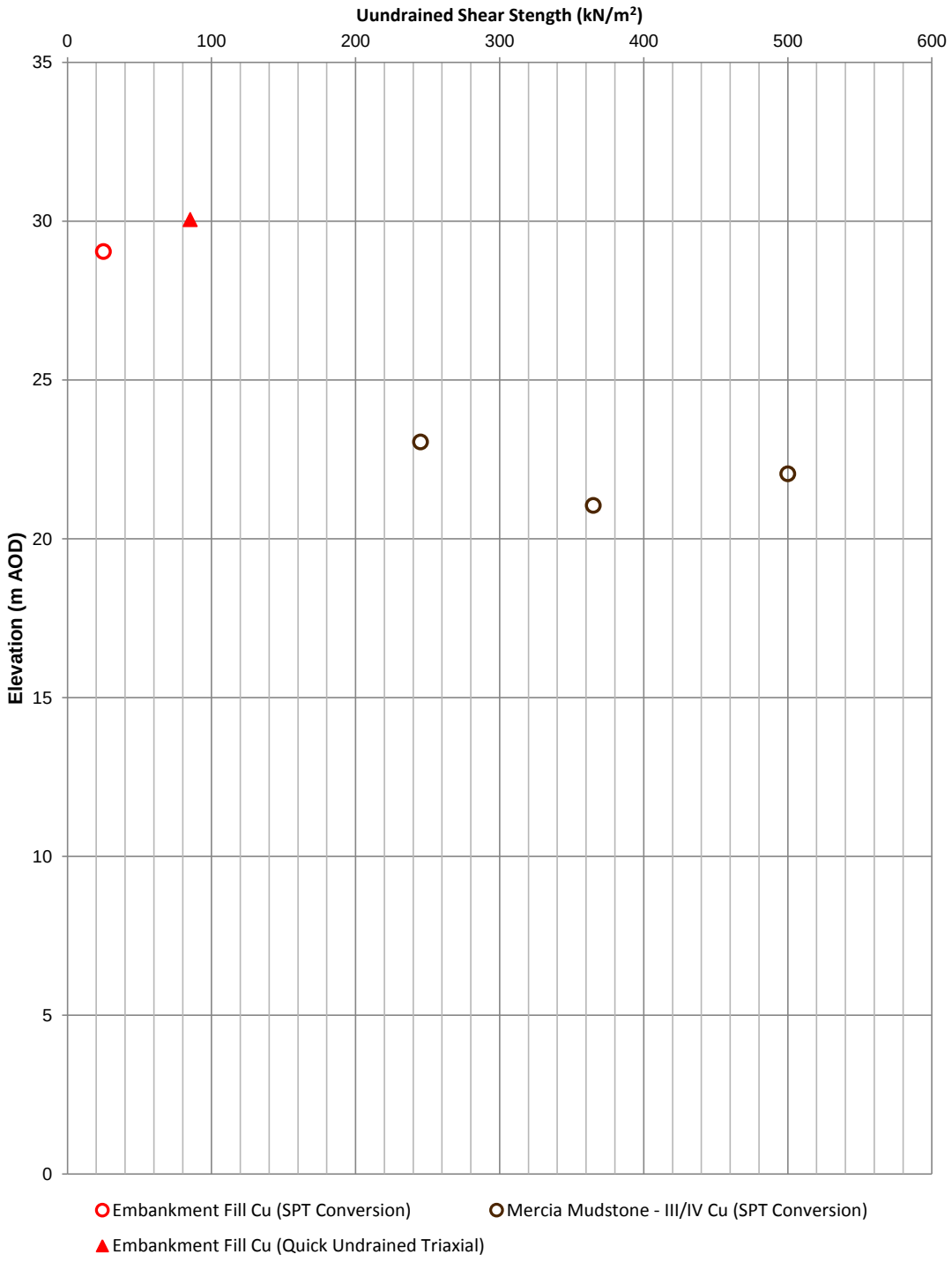
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **191420-191450SB**
Client: **Highways England**	Borehole ID: **CP1111**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-191560-191570SB-GSS-000001		
Earthwork Widening Solution	Regrade Full Height 1:3.0		
Structure	N/A		
Structure Chainage	N/A		
Design Chainage	191560-191570		
Carriageway	Southbound		
Marker Post	MP191/5B+60 – MP191/5B+70		
National Grid Reference	E 447301, N 333608 – E 447302, N 333618		
Existing Ground Level at Location	Crest of cutting	34.61mAOD	
	Carriageway	33.45mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_24508	HAGDMS designation
Earthwork Height	NB: N/A	SB: 0.9m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB:18°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	13/02/2017	[redacted]
Checked	Alice Bazen	17/03/2017	
Reviewed	Gary Summerfield	20/03/2017	
Approved	Tom Bulteel	27/03/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this earthwork. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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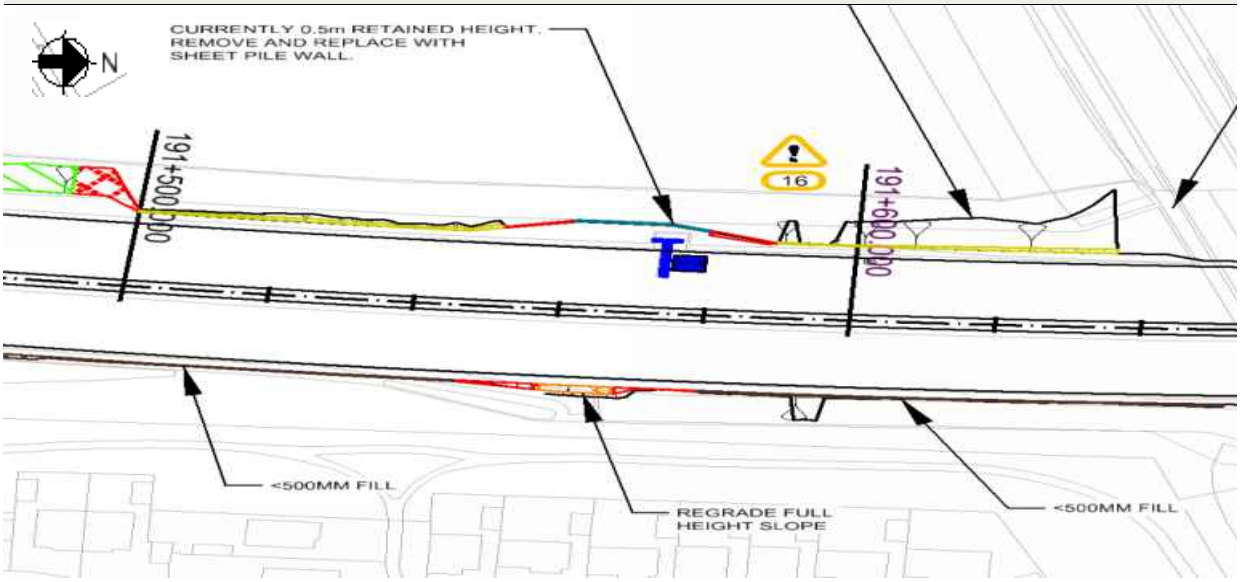


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Regrade Full Height at 1:3.0 gradient.

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a cutting ranging in height from 0.8m to 0.9m with a typical slope angle of 18 degrees.

The critical cross section is based on the section with the greatest earthwork height and is at Ch. 191570.

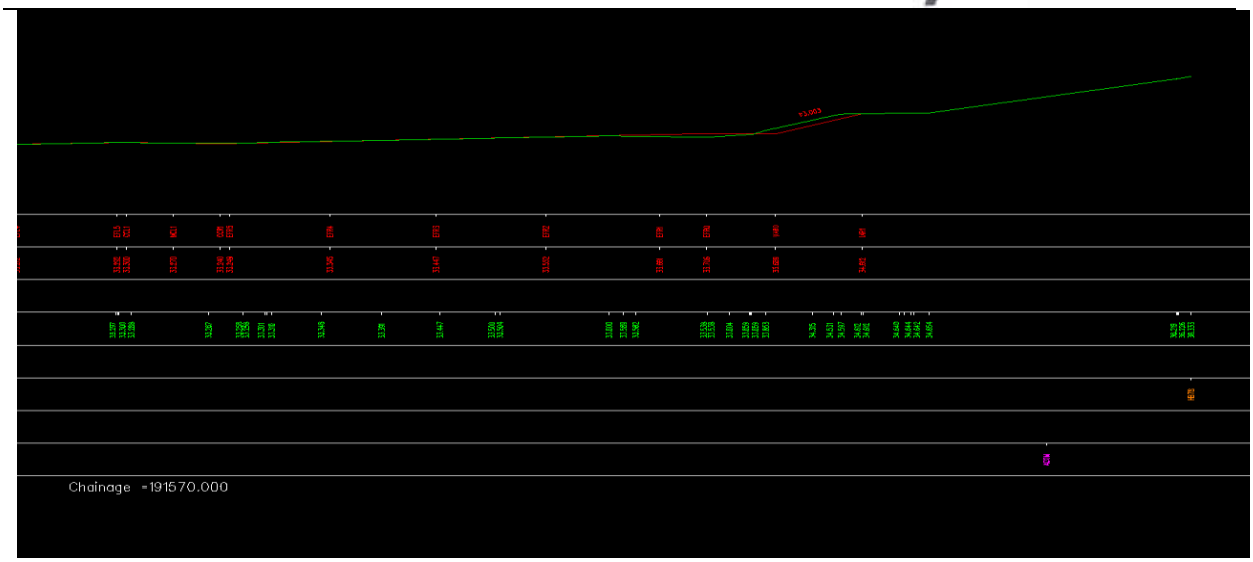


Figure 2: Topographic Critical Cross Section Chainage 191570

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: - Beeston Sand and Gravel Member – Sand and Gravel.

Solid Deposits: Gunthorpe Member - Mudstone

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however 1 no. relevant exploratory hole was considered outside the design chainage; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000036, Rev P01.



Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK43SE25
Borehole Chainage	191619
Borehole Location	Northbound
National Grid Reference	E 446856, N 332520
Ground Level at Exploratory Hole	31.12mAOD
RAG Analysis	Amber
Date Drilled	10/06/1964 – 11/06/1964
Termination Depth	7.93 metres below ground level (mbgl)
Other suitable holes	None

Existing Ground Level:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
River Terrace Deposits	5.61	29.00	67-68 (67)
Mercia Mudstone – III-IV <10mbgl	10.00	24.61	-
Mercia Mudstone – III-IV >10mbgl	>10.00	<24.61	-

(1) Ground level is assumed to be at the crest of the cutting.
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken in exploratory holes SK43SE25.

Groundwater:

Groundwater strike are presented in the table below:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
SK43SE25	River Terrace Deposits	2.13	33.27	-	1.52	33.88

Groundwater Design Level:

Limited local groundwater level is available and therefore a design groundwater level of 1.0m below ground level throughout cutting has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

No geotechnical laboratory testing data is available between chainage 191560-191570.

Lab Test Data – BRE Classification:

No chemical testing data is available between chainage 191560-191570.

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000016 – HA549342-AMAR-HGT-SWI-DR-CE-000042 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002.

The below table outlines the assumed anticipated ground model:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
River Terrace Deposits	0 –5.61	34.61 – 29.00	5.61	20	38	-	-	-	43.0	-	-	0.35	-	DS-3 AC-3
Mercia Mudstone – III/IV <10mbgl	5.61-10.00	29.00 – 24.61	4.39	21	30	2	100	10.8	8.6	-	0.50	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV >10mbgl	>10.00	<24.61	-	21	30	2	150	16.8	13.4	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Stratum types and depths are derived from the interpreted geological long section.
(3) Due to limited localised GI data, typical values for bulk density, ϕ', cohesion, and Poisson's ratio derived in the AMAR GIR are used.
(4) Due to limited localised GI data, E' for River Terrace deposits have been based on values derived from the AMAR GIR.
(5) Due to limited localised GI data, Eu and E' for Mercia Mudstone have been based on values derived from the AMAR GIR.
(6) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for River Terrace Deposits and Mercia Mudstone-III/IV, the classification used for the strata in the AMAR GIR was adopted.

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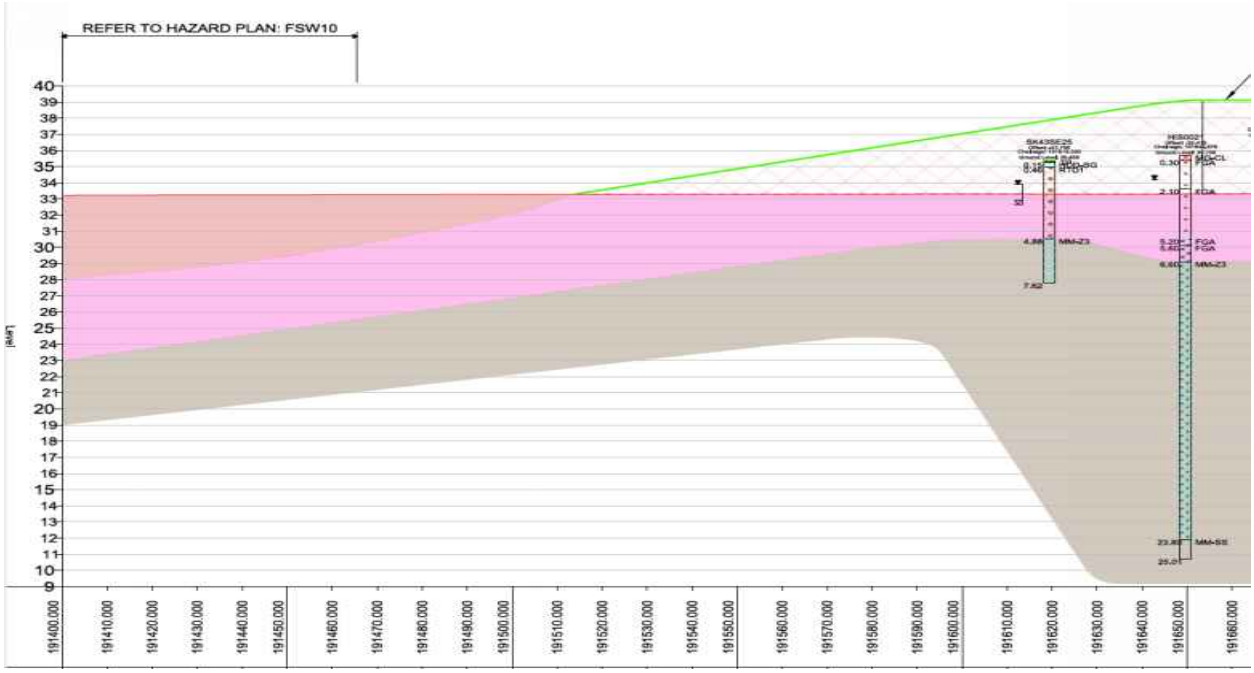


Figure 5 : Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
191560	191570	Full Height Regrade 1:3.0

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FURTHER GROUND INVESTIGATION

'Just In Time' Validation Ground Investigation has not been proposed at this location.

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HISTORICAL EXPLORATORY HOLES

Borehole Log

Borehole No. **SK43SE25** HISTORIC Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447240.00 - 333670.00	Hole Type CP
Location:		Level: 35.40mbgl	Scale 1:50
Client: Highways England		Dates: 28/02/1962 - 01/03/1962	Logged By

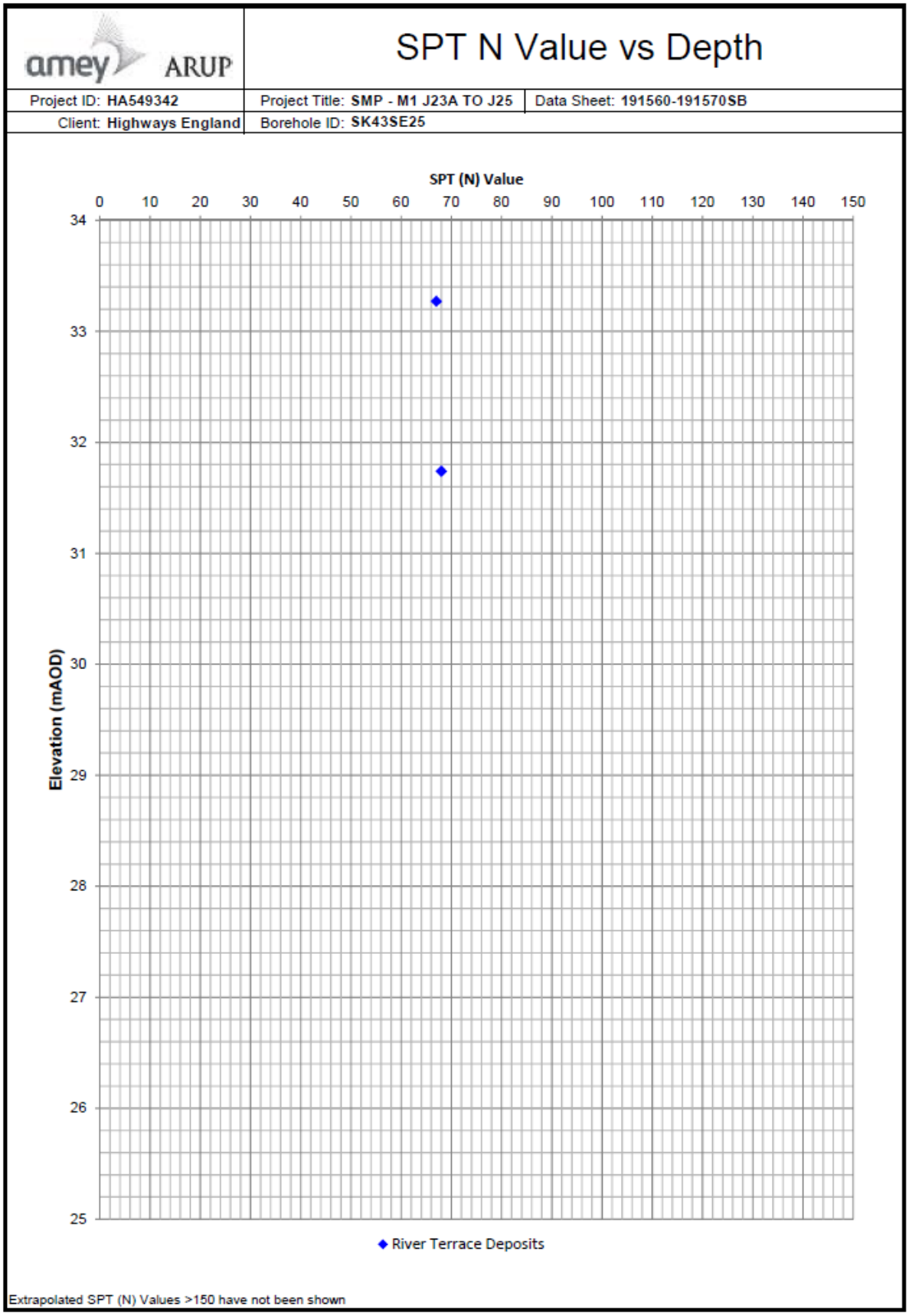
Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	1D			0.15	35.25		Topsoil TP
		0.30	2D						
						0.46	34.94		Subsoil HDD-SG
									Gravel & sand RTD1
		1.52	3D						
		2.13	SPT (S)	N=67 (75,12/14,16,17,20)	Water=-				
		2.13 - 2.59	10B						
		2.13 - 2.59	15SP TLS						
		2.74	12W						
		3.05	4D						
		3.66	SPT (S)	N=68 (75,10/13,17,17,21)	Water=-				
		3.66 - 4.11	11B						
		3.66 - 4.11	16SP TLS						
		4.57	5D						
						4.88	30.52		Red marl & decomposed grey sandstone MM-Z3
		5.18	6D						
		5.33 - 5.64	13U	91blows					
		5.64	7D						
		6.40	8D						
		7.32 - 7.62	14U	83blows					
		7.62	9D			7.62	27.78		End of borehole at 7.62 m

Remarks

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PLOTS



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-192030-192080SB-GSS-000001		
Earthworks Widening Solution	Granular Wedge at Embankment Crest (1:2.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	192030-192080SB		
Carriageway	Southbound		
Marker Post	192/0+30 – 192/0+80		
National Grid Reference	E 447275, N 334083 – E 447264, N 334130		
Existing Ground Level at Location	Carriageway	37.5-38.4mAOD	
	Toe of embankment	35.6-35.9mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_22149	HAGDMS designation
Maximum Earthwork Height	NB: N/A	SB: 1.9-2.8m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Typical Earthwork Angle	NB: N/A	SB: 27^{o}	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	13/02/2017	[redacted]
Checked	Alice Bazen	17/02/2017	
Reviewed	Gary Summerfield	17/02/2017	
Approved	Tom Bulteel	24/02/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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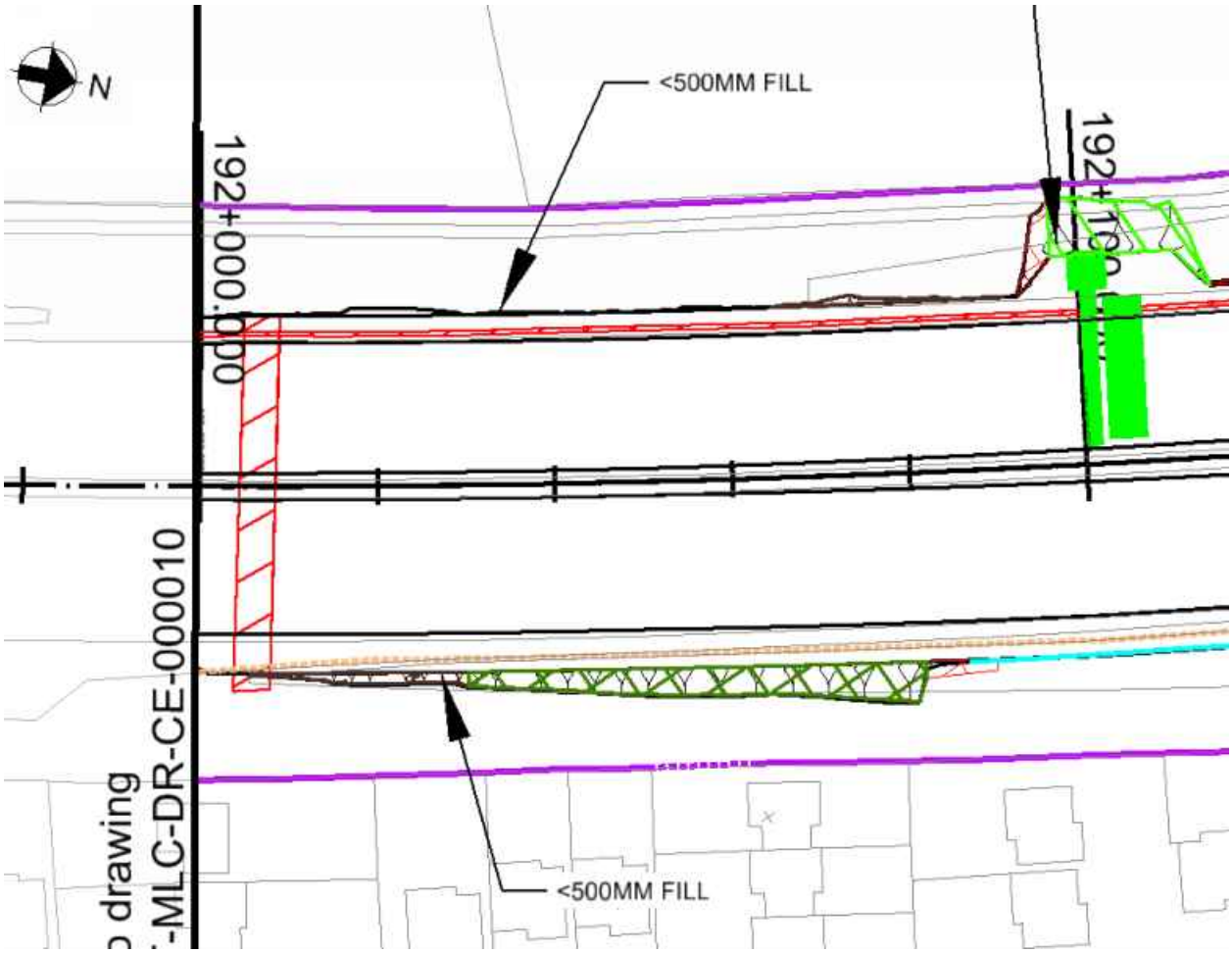


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Granular Wedge at Embankment Crest (1:2.0)

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is classified as an embankment. The embankment varies in height from 1.9-2.8m with a typical slope gradient of 27°.

The critical cross section Ch192080 was chosen based on the granular wedge with the greatest vertical height.

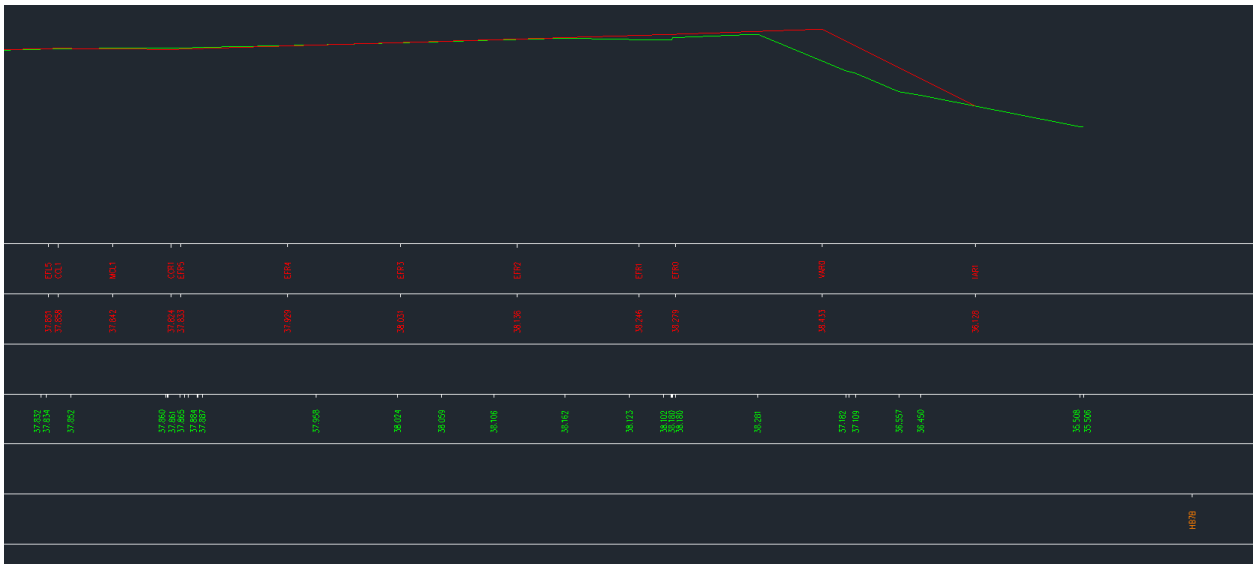


Figure 2: Topographic Critical Cross Section Ch192080

Utilities:

An overhead mid voltage Western Power cable is present at the embankment crest running parallel to the carriageway along the entirety of the chainage extents.



Figure 3: Utilities Location Plan

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Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Beeston Sand and Gravel Member (Glaciofluvial Deposits)

Solid Deposits: Gunthorpe Member (Mercia Mudstone)

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, however 1 no. relevant exploratory holes was considered was considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000037 Rev P01.

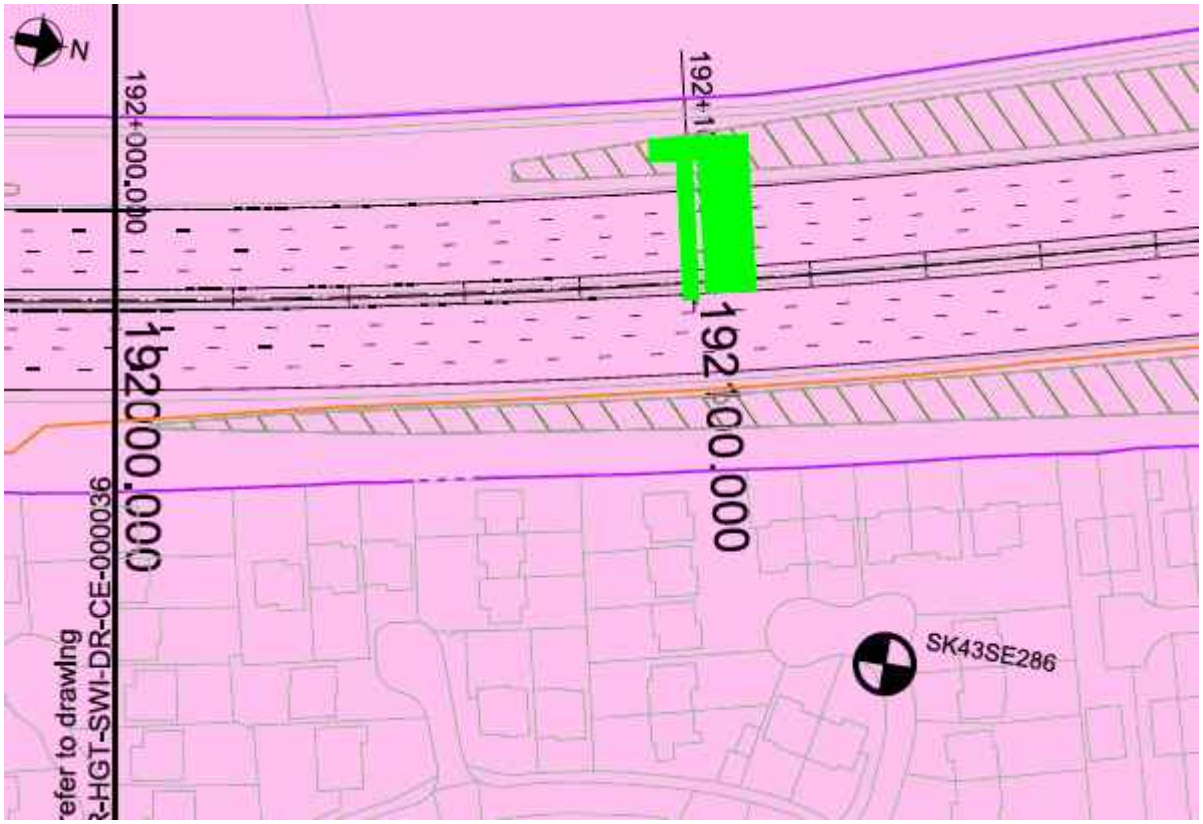


Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

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Historical Boreholes:

Relevant Borehole Number	SK43SE286
Borehole Chainage	192122
Borehole Location	Adjacent housing estate
National Grid Reference	E 447300, N 334190
Ground Level at Exploratory Hole	36.27mAOD (metres above Ordnance Datum)
Date Drilled	18/11/1975
Termination Depth	11.00mbgl (metres below ground level)
Hole Category	Amber
Other suitable holes	None

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey data.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT (N) Value
Embankment Fill	2.9	35.5	--
Glaciofluvial Deposits (fine grained)	3.3	35.1	--
Glaciofluvial Deposits (coarse grained)	6.7	31.7	16-21 (16)
Mercia Mudstone – III/IV	Not proven	Not proven	--

(1) Ground level is assumed to be at carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in historical exploratory hole SK43SE286.

Groundwater:

The following groundwater strikes were recorded in the historical exploratory holes:

- SK43SE286 – Groundwater strike at 2.50mbgl (33.77mAOD) within the Glaciofluvial Deposits.

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Groundwater Design Level:

Due to the lack of local groundwater level available, a design groundwater level 1.0m below toe of embankment has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

No local geotechnical lab data was available.

Lab Test Data - BRE Classification:

No local chemical lab data was available.

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Assumed Ground Model For Design:

Ground model based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-CE-000037 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01.

The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0-2.9	38.4-35.5	2.9	21	27	0	100	7.8	6.2	-	0.50	0.20	-	DS-2 AC-2
Glaciofluvial Deposits (fine grained)	2.9-3.3	35.5-35.1	0.4	21	26	0	150	10.8	6.2	-	0.50	0.20	-	DS-3 AC-3
Glaciofluvial Deposits (coarse grained)	3.3-6.7	35.1-31.7	3.4	21	32	-	-	-	26.4	-	-	0.25	-	DS-3 AC-3
Mercia Mudstone – III/IV	>6.7	>31.7	-	21	30	2	100	10.8	8.6	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Given the limited amount of local GI data, the ϕ', c_u, Eu and E' of Embankment Fill, Glaciofluvial Deposits (fine grained) and Mercia Mudstone – III/IV was taken as the characteristic value given in the AMAR GIR.

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(4) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a conservative SPT 'N' value of 16, ϕ' was found to be 32°.

(5) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a conservative SPT 'N' value of 16, E' = 26.4MN/m^2.

(6) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata's, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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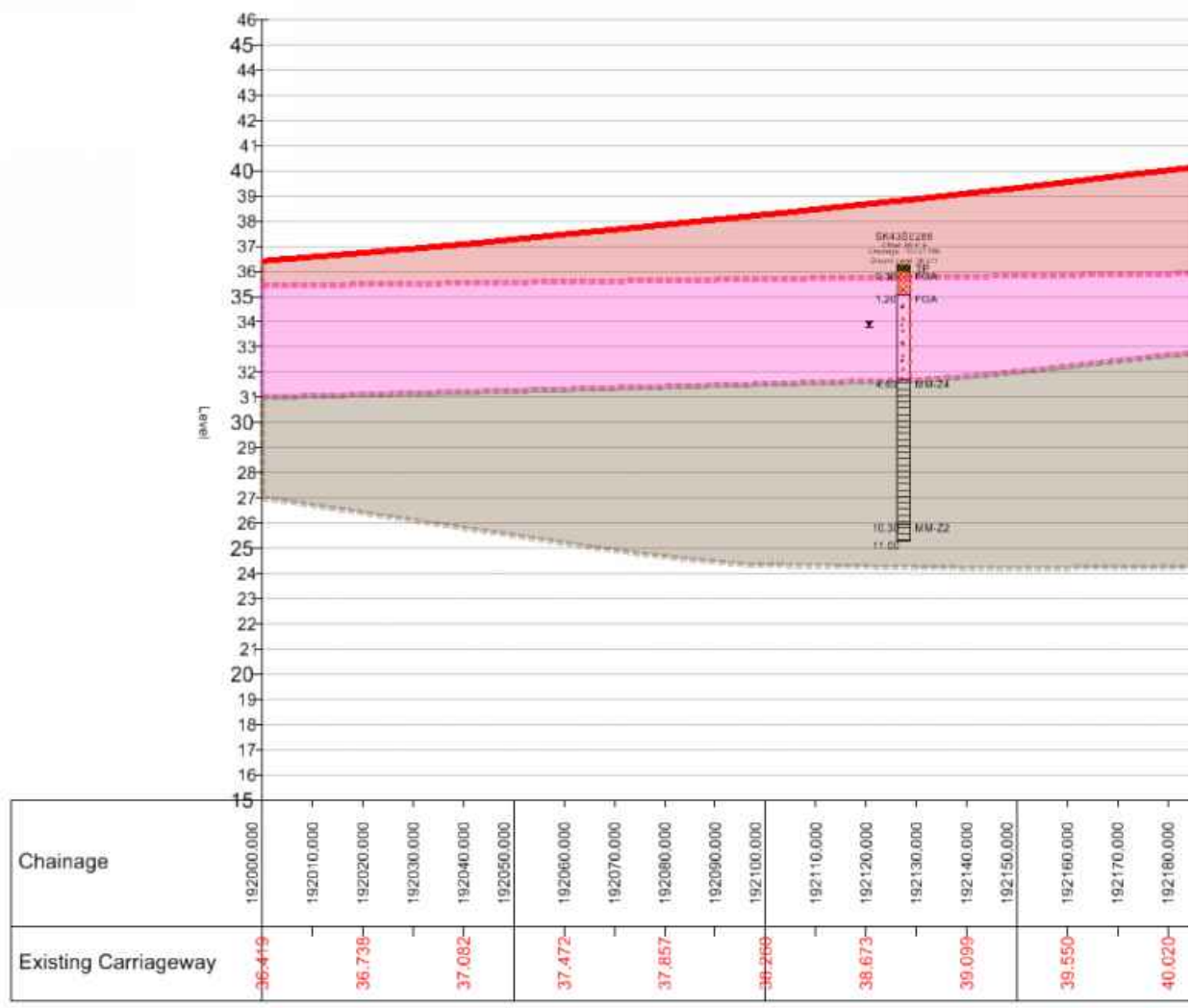


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
186800	186830	Granular Wedge at Embankment Crest (1:2.0)	2.40	27

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FURTHER GROUND INVESTIGATION

The following additional GI will be undertaken within 100m of the chainage extents:

- BH-G319, Ch192101 - 30m deep dynamic sample / rotary follow on exploratory hole, located in southbound existing grass verge.

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HISTORICAL EXPLORATORY HOLES

Rotary Core Log

Borehole No. **SK43SE286** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447300.00 - 334190.00	Hole Type CP
Location:		Level: 36.27	Scale 1:50
Client: Highways England		Dates: 18/11/1975 - 18/11/1975	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	35.97		TOPSOIL TP
										Grey brown very stony sandy CLAY FGA
							1.20	35.07		Medium compact medium grained SAND and GRAVEL. FGA-SG
	▼									
							4.60	31.67		Highly weathered red/brown silty MARL with occasional bands of green marl MM-Z4
		5.00	U							
		6.50	U							
		8.00	U							
		9.50	U							
										Continued on next sheet

Remarks
Water struck at 2.50m. Water standing level 2.50m.

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447300.00 - 334190.00	Borehole No. SK43SE286 Sheet 2 of 2
Location:		Level: 36.27	Hole Type CP
Client: Highways England		Dates: 18/11/1975 - 18/11/1975	Scale 1:50
			Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.30	25.97		Moderately weathered hard MARL MM-Z2
							11.00	25.27		End of borehole at 11.00 m

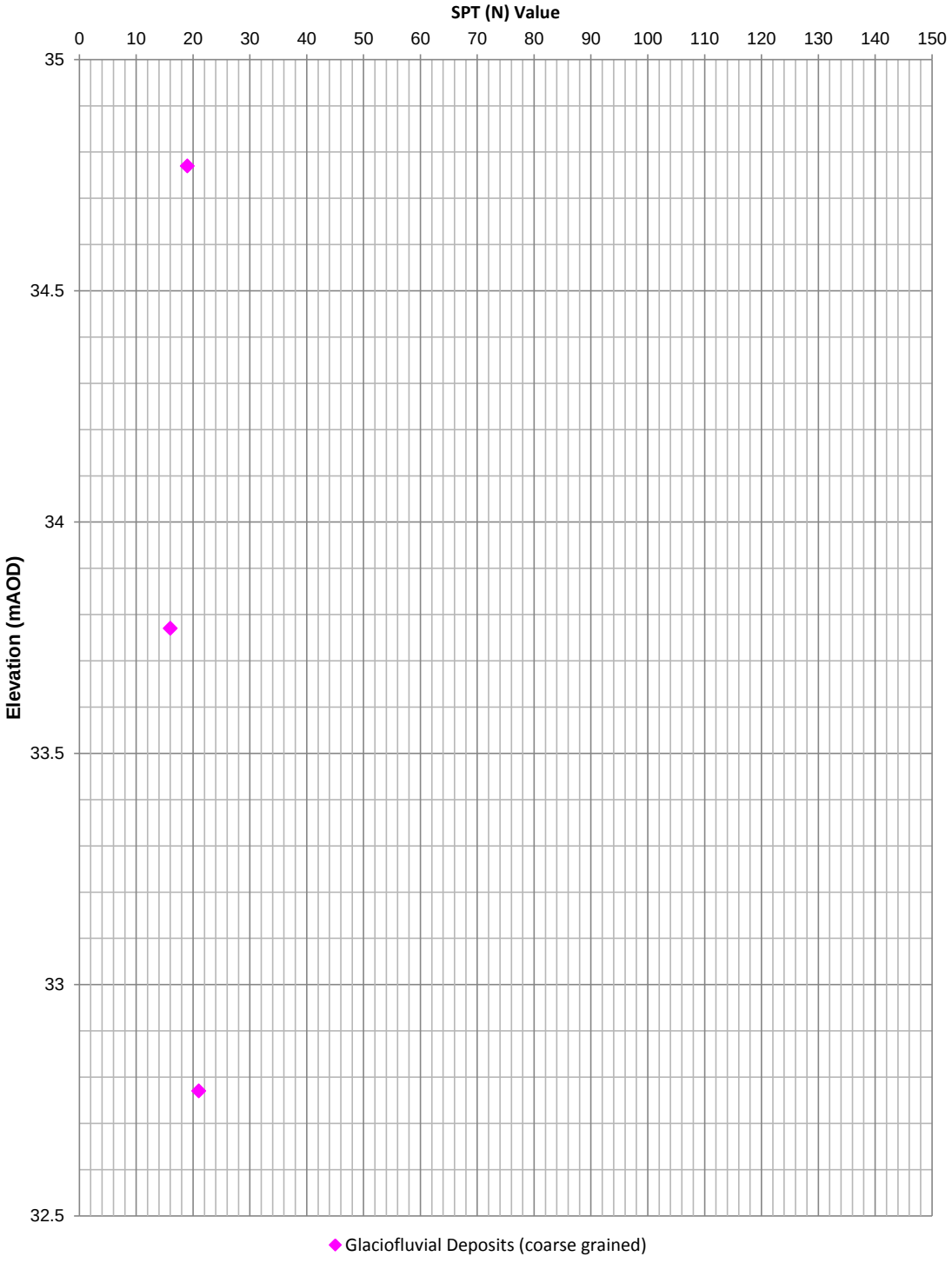
Remarks
Water struck at 2.50m. Water standing level 2.50m.

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PLOTS

amey ARUP	SPT N Value vs Depth
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25** | Data Sheet: **192030-192080SB**
Client: **Highways England**	Borehole ID: **SK43SE286**



Rev: P01 Date: 13/02/2017 Ref: HA549342-AMAR-HGT-192030-192080SB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-192090-192520-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	Gantry 320		
Structure Type	Supercantilever Gantry		
Design Chainage	192090-192520		
Carriageway	Southbound		
Marker Post	192/0+90 – 192/5+20		
National Grid Reference	E 447260, N 334142 – E 447169, N 334558		
Existing Ground Level at Location	Carriageway	43.0 – 45.4mAOD	
	Toe of Embankment	37.0 – 37.2mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: N/A	HAGDMS designation
Maximum Earthwork Height	NB: N/A	SB: 6.0-8.2m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Typical Earthwork Angle	NB: N/A	SB: 26^{o}	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Roheel Masrat	16/02/2017	[redacted]
Checked	Alice Bazen	18/02/2017	
Reviewed	Gary Summerfield	21/02/2017	
Approved	Tom Bulteel	28/02/2017	

[1] Structure numbers in accordance with Drawing Sequence HA549342-AMAR-HML-MLC-DR-CH-000001 to HA549342-AMAR-HML-MLC-DR-CH-000025

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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DESK STUDY



Figure 1.1: Location Plan 1 of 2

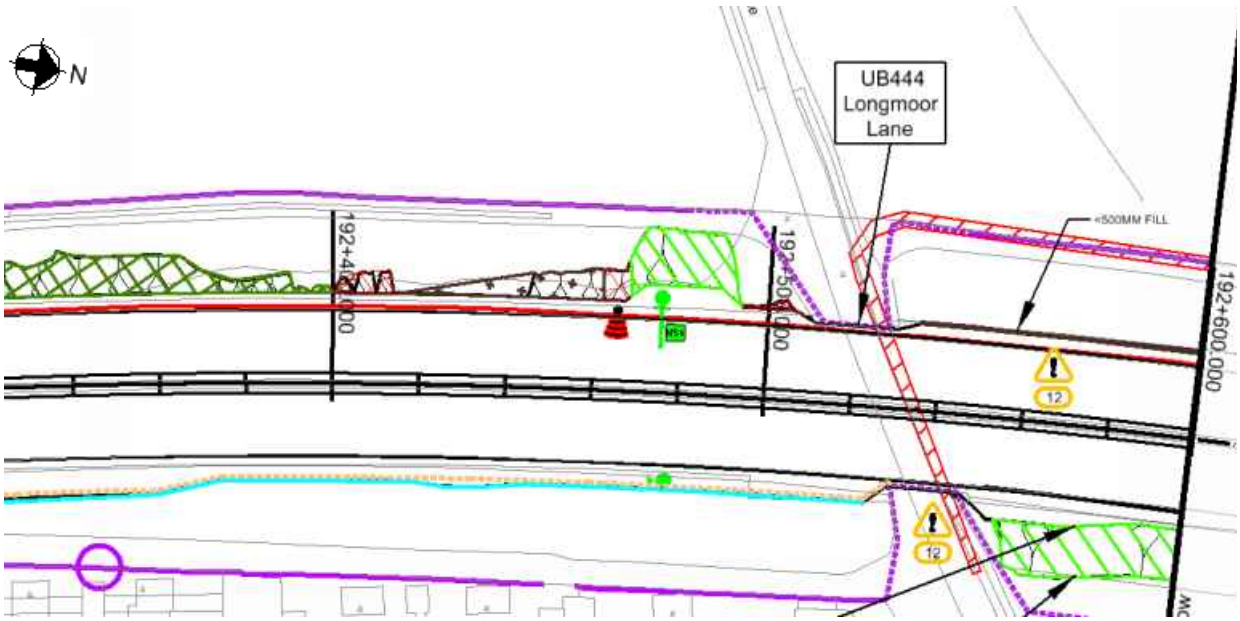


Figure 1.2: Location Plan 2 of 2

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- King Sheet Pile Retaining Wall
  - Ch192090-192140, maximum retained height 2.0m;
  - Ch192140-192190, maximum retained height 3.9m;
  - Ch192190-192250, maximum retained height 3.1m;

- Ch192250-192260, maximum retained height 2.0m;
- Ch192260-192300, maximum retained height 3.1m;
- Ch192300-192370, maximum retained height 3.9m;
- Ch192370-192400, maximum retained height 3.1m.
- Ch192400-192480, maximum retained height 2.4m
- Ch192480-192520, maximum retained height 2.5m.

Proposed Major Structures:

A new Super Cantilever Gantry structure (Gantry 320), is proposed at Ch.192285.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is classified as an embankment. Two ground models have been produced due to the varying ground conditions between Ch192090-192520, the topographic survey recorded the following embankment geometries:

- Ch192090-192400 – 2.8-7.0m height and typical 26° slope gradient;
- Ch192400-192520 – 7.0-8.2m height and typical 26° slope gradient.

The critical cross sections at chainage at ch192250, 192270, 192330 and 192520 are based on the sections with the greatest retained height.

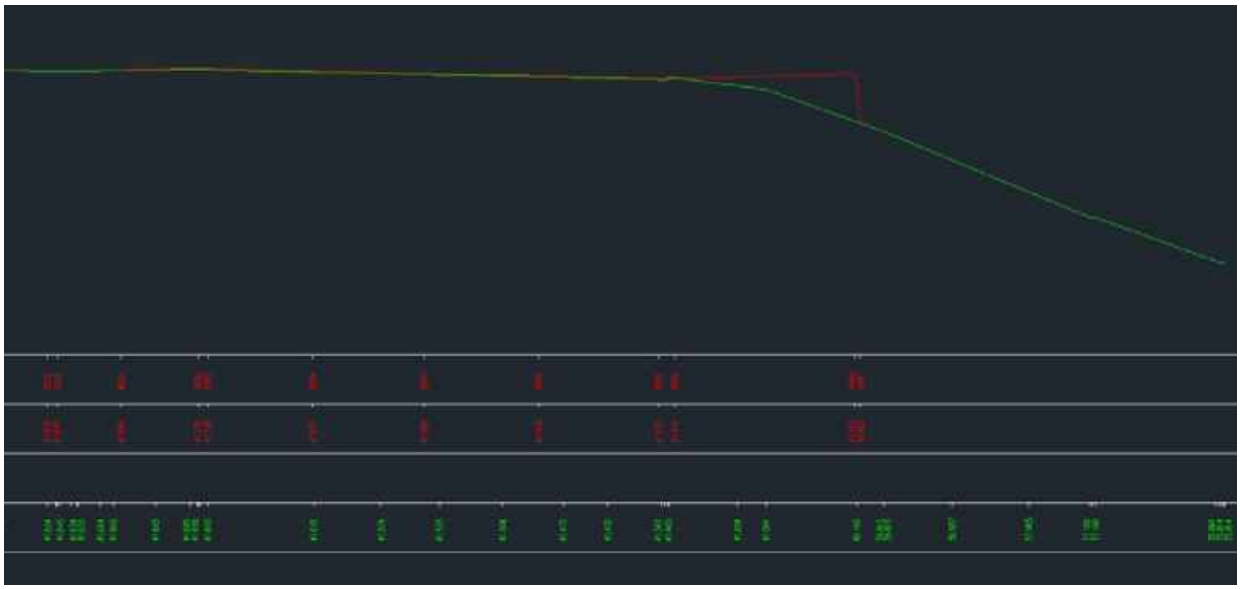


Figure 2.1: Topographic Critical Cross Section Ch192400 for a maximum retained height of 2.0m

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Figure 2.2: Topographic Critical Cross Section Ch192270 for a maximum retained height of 3.1m



Figure 2.3: Topographic Critical Cross Section Ch192330 for a maximum retained height of 3.9m

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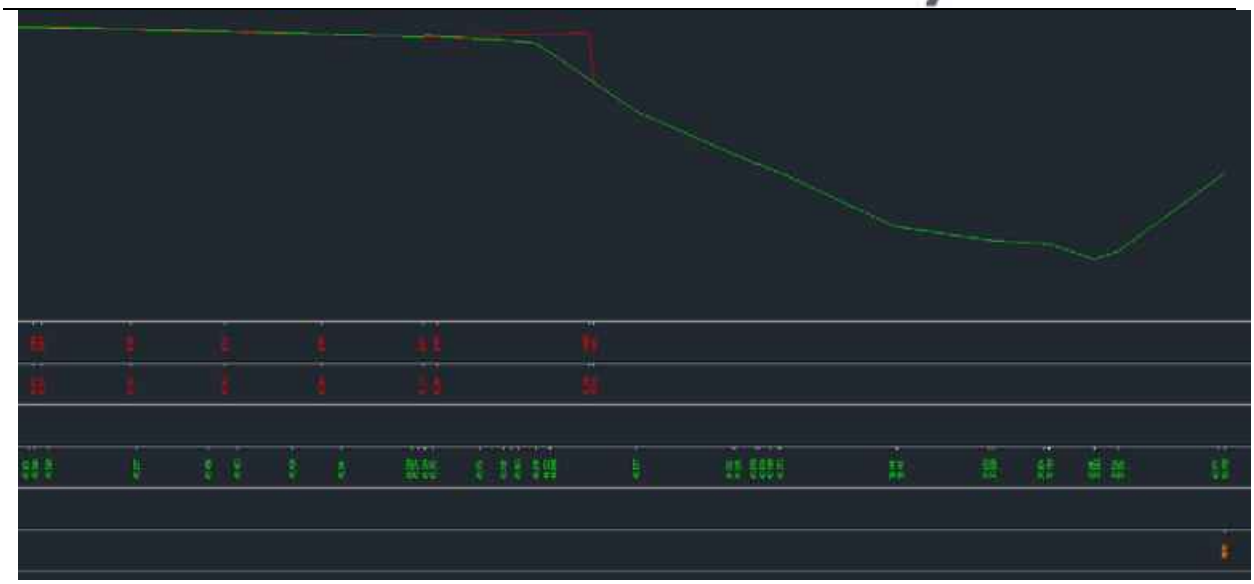


Figure 2.4: Topographic Critical Cross Section Ch19252 for a maximum retained height of 2.5m and due to change in ground conditions.

Utilities:

Western Power Overhead Mid Voltage cable present at embankment crest Ch192090-192520.

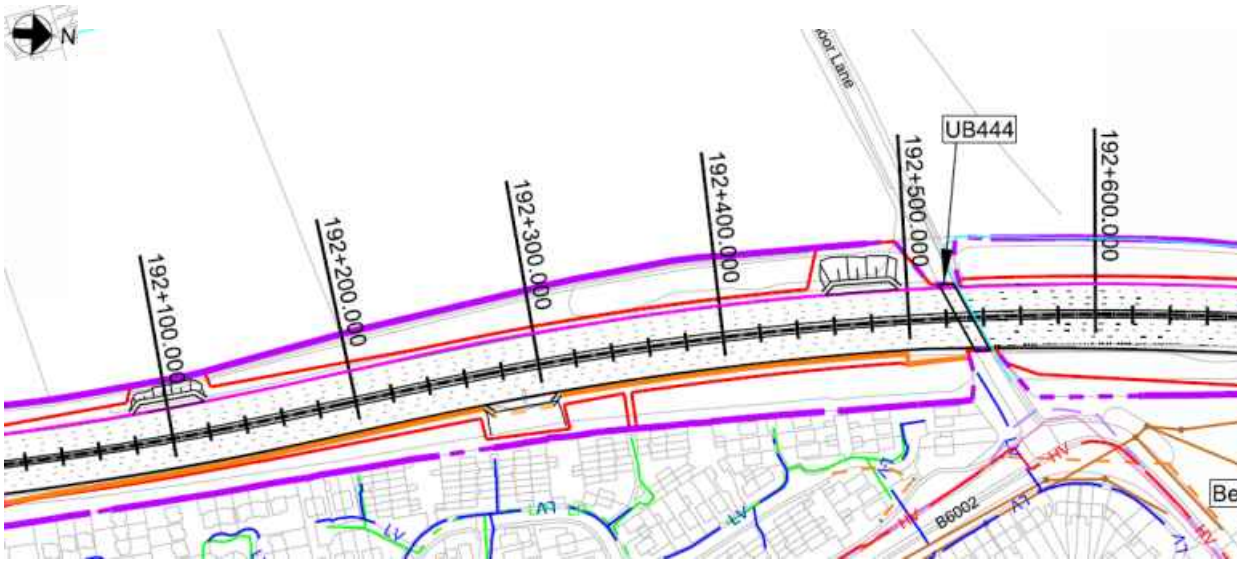


Figure 3: Utilities location plan.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Beeston Sand and Gravel Member (Glaciofluvial Deposits)

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Solid Deposits: Gunthorpe Member (Mercia Mudstone)

Ground Investigation:

There are 4 No. historical exploratory holes recorded within the design chainage, with additional 3 no. relevant exploratory holes considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000037, Rev P01.

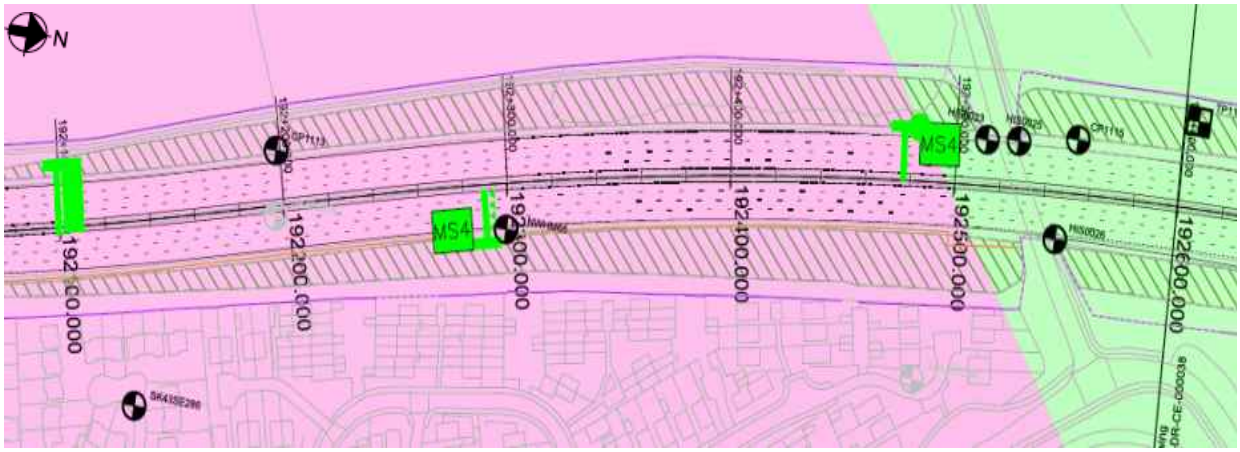


Figure 4: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	NWHM66	SK43SE286	CP1113	HIS0023
Borehole Chainage	192298	192128	192199	192513
Borehole Location	Southbound	Southbound	Northbound	Northbound
National Grid Reference	E 447207, N 334342	E 447300, N 334190	E 447196, N 334236	E 447137, N 334548
Ground Level at Exploratory Hole	42.62mAOD	36.27mAOD	40.05mOAD	39.20mAOD
RAG Analysis	Green	Amber	Green	Green
Date Drilled	04/09/1999	18/11/1975	03/11/2006-06/11-2006	23/06/1964–29/06/1964

Termination Depth	15.00mbgl	11.00mbgl	14.60mbgl	18.59mbgl
Other suitable holes	CP1115, HIS0025, HIS0026			

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR Survey. Two ground models have been produced due to the varying ground conditions between Ch192090-192520.

Ground conditions: 192090-192400

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT (N) Value
Embankment Fill	7.1	37.0	7-150 (19)
Glaciofluvial Deposits (coarse grained)	10.9	33.2	15-49 (15)
Mercia Mudstone – III/IV	-	-	21-150 (28)

(1) Ground level is assumed to be at carriageway level.
(2) Note that the Embankment height will vary per location analysed, therefore the above elevation/depth of Embankment Fill may vary.
(3) Maximum 'N' Value capped at 150. Characteristic SPT 'N' values are given in brackets.
(4) Although Mercia Mudstone – I/II was recorded at depth within some historical exploratory holes, as a conservative measure given the uncertainty in ground conditions, only Mercia Mudstone – III/IV has been used in the ground model. This is pertinent considering that Mercia Mudstone is modelled as a soil rather than a rock in geotechnical analyses. SPT 'N' values derived in Mercia Mudstone – I/II were not used for derivation of soil parameters.

Ground conditions: 192400-192520

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT (N) Value
Embankment Fill	8.2	37.2	7-150 (19)
Head Deposits	10.0	35.4	10-23 (10)
Glaciofluvial Deposits (fine grained)	11.6	33.8	29 (29)
Mercia Mudstone – III/IV	-	-	21-150 (28)

(1) Ground level is assumed to be at carriageway level.
(2) Note that the Embankment height will vary per location analysed, therefore the above elevation/depth of Embankment Fill may vary.
(3) Maximum 'N' Value capped at 150. Characteristic SPT 'N' values are given in brackets.
(4) Depths to base are derived from topographic data for Embankment Fill, and from historical exploratory hole CP1115 for natural strata
(5) Although a 0.8m layer of Glaciofluvial Deposits (coarse grained) was recorded in historical exploratory hole CP1115 at 35.4-34.9mAOD, this has been modelled as Glaciofluvial Deposits (fine grained) as a conservative measure given the uncertainty in local ground conditions.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in boreholes CP1113, CP1115, HIS0023, HIS0025, HIS0026, NWHM66 and SK43SE286.

Groundwater:

The following groundwater strikes were recorded in the historical exploratory holes:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
HIS0023		1.98	37.22	-	1.52	37.68
HIS0025		3.05	35.55	-	2.13	36.47
HIS0026		1.52	36.68	-	1.22	36.98
NWHM66		14.80	27.82	-	-	-
SK43SE286		2.50	33.77	-	-	-

Groundwater Design Level:

A groundwater level of 1.0m below toe of embankment has been assumed for WALLAP analysis for king and intermediate sheet piles. When checking the global stability check of the earthwork and king and intermediate sheet pile (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

9 No. Atterberg Limit Tests and 9 No. Moisture Content Tests were undertaken within historical exploratory holes with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	2.7	19.17	33	16	17	CL
Embankment Fill	4.0	11.76	36	14	22	CL
Embankment Fill	4.7	15.52	31	13	18	CL
Head Deposits	6.7	11.93	26	14	12	CL
Head Deposits	8.7	20.34	46	17	29	CI
Glaciofluvial Deposits (fine grained)	4.5	16.19	39	19	20	CI
Glaciofluvial Deposits (fine grained)	11.8	18.74	34	17	17	CL
Mercia Mudstone – III/IV	12.5	27.0	36	19	17	CL
Mercia Mudstone – III/IV	13.5	16.99	40	17	23	CI

31 No. undrained triaxial tests were undertaken with the following results:

Stratum	Depth to Top of Test (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	3.50	139
Embankment Fill	6.20	138
Embankment Fill	2.20	116
Head Deposits	1.20	60
Head Deposits	0.90	115
Head Deposits	0.50	77
Glaciofluvial Deposits (fine grained)	2.74	55
Glaciofluvial Deposits (fine grained)	4.27	127
Glaciofluvial Deposits (fine grained)	2.44	60
Mercia Mudstone – III/IV	5.79	172
Mercia Mudstone – III/IV	11.89	151
Mercia Mudstone – III/IV	13.41	180

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Mercia Mudstone – III/IV	10.36	302
Mercia Mudstone – III/IV	7.32	110
Mercia Mudstone – III/IV	8.84	172
Mercia Mudstone – III/IV	10.82	110
Mercia Mudstone – III/IV	12.34	180
Mercia Mudstone – III/IV	5.03	79
Mercia Mudstone – III/IV	13.87	172
Mercia Mudstone – III/IV	9.30	103
Mercia Mudstone – III/IV	6.25	103
Mercia Mudstone – III/IV	7.77	62
Mercia Mudstone – III/IV	15.39	117
Mercia Mudstone – III/IV	6.10	165
Mercia Mudstone – III/IV	4.57	91
Mercia Mudstone – III/IV	7.62	134
Mercia Mudstone – III/IV	18.29	144
Mercia Mudstone – III/IV	9.14	110
Mercia Mudstone – III/IV	17.07	144
Mercia Mudstone – III/IV	15.54	53
Mercia Mudstone – III/IV	10.67	153

Lab Test Data – BRE Classification:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Sulphate (Total) as SO4	Solid	1	0.08	%SO4
Embankment Fill	Water Soluble Sulphate as SO4	Water	2	1.7	g/l SO4
Embankment Fill	pH	Solid	5	7.8 – 8.6	-
Head Deposits	Sulphate (Total) as SO4	Solid	4	0.04	%SO4
Head Deposits	pH	Solid	4	7.0 – 7.2	-
Glaciofluvial Deposits (fine grained)	Sulphate (Total) as SO4	Solid	3	0.01 – 0.37	%SO4
Glaciofluvial Deposits (fine grained)	Water Soluble Sulphate as SO4	Water	1	0.05	g/l SO4
Glaciofluvial Deposits (fine grained)	pH	Solid	3	4.6 – 7.0	-
Mercia Mudstone – III/IV	Sulphate (Total) as SO4	Solid	17	0.02 – 0.25	%SO4
Mercia Mudstone – III/IV	Water Soluble Sulphate as SO4	Water	3	0.18-0.55	g/l SO4
Mercia Mudstone – III/IV	pH	Solid	17	7.2 – 8.4	-

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Assumed Ground Model For Design (192090-192400):

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000037 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Embankment Fill	0.0 – 7.1	44.1 – 37.0	7.1	21	26	0	95	7.5	6.0	-	0.5	0.2	-	2.50	0.47	-	6.2*	-	DS-2 AC-2
Glaciofluvial Deposits (coarse grained)	7.1 – 10.9	37.0 – 33.2	3.8	21	32	-	-	-	25.2	-	-	0.25	-	10.08	-	1.0	-	50	DS-3 AC-3
Mercia Mudstone – III/IV	>10.9	<33.2	-	21	26	2	140	10.2	8.2	-	0.5	0.2	-	3.42	0.40	-	9	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Note that the Embankment height will vary per location analysed, therefore the above elevation/depth of Embankment Fill may vary.
(3) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(4) ϕ' of Embankment Fill was determined using Table 2 in BS8002:2015 using the recorded PI of 22% gives 26°.
(5) c_u of Embankment Fill was derived using the Stroud correlation. The recorded PI of 22% gives an f1 value of 5, using a recorded SPT of 19, Cu= 95kN/m^2.
(6) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the characteristic SPT 'N' value of 19, Eu = 7.5MN/m^2. Therefore E' = 6.0MN/m^2.
(7) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a conservative SPT 'N' value of 15, ϕ' was found to be 32^o.
(8) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a conservative SPT 'N' value of 15, E' = 25.2MN/m^2.

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(9) ϕ' of Mercia Mudstone – III/IV was determined using Table 2 in BS8002:2015 using the recorded PI of 23% gives 26°.
(10) c_u of Mercia Mudstone – III/IV was derived using the Stroud correlation. A recorded PI of 23% gives an f1 value of 5.0, with a characteristic SPT of 28, c_u= 140kN/m^2.
(11) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the characteristic SPT 'N' value of 28, Eu = 10.2MN/m^2. Therefore E' = 8.2MN/m^2.
(12) Adhesion was based on equation 41 of BS8004 (2015).
(13) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl
(14) K_s/K_0 is presumed to be 1.0 for a bored pile (see Tomlinson and Woodward Table 4.10).
(15) Nq is based on relationship with ϕ' as shown in Tomlinson (Table 7.1). For sandstone, Nq is derived based on a very dense siliceous cohesionless soil (Tomlinson Table 7.1).
(16) BRE Classification is determined using criteria set out in BRE Special Digest 1. . In the absence of BRE test data for Glaciofluvial Deposits, the classification used for the strata in the AMAR GIR was adopted.

Assumed Ground Model For Design (192400-192520):

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000037 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0.0-8.2	45.4-37.2	8.2	21	26	0	95	7.5	6.0	-	0.5	0.2	-	DS-2 AC-2
Head Deposits	8.2-10.0	37.2-35.4	1.8	20	24	0	45	4.8	3.8	-	0.5	0.2	-	DS-1 AC-1
Glaciofluvial Deposits (fine grained)	10.0-11.6	35.4-33.8	1.6	21	26	0	160	10.5	8.4	-	0.5	0.2	-	DS-3 AC-3
Mercia Mudstone – III/IV	>11.6	<33.8	-	21	26	2	140	10.2	8.2	-	0.5	0.2	-	DS-2 AC-2

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(17) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(18) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(19) ϕ' of Embankment Fill was determined using Table 2 in BS8002:2015 using the recorded PI of 22% gives 26°.
(20) c_u of Embankment Fill was derived using the Stroud correlation. The recorded PI of 22% gives an f1 value of 5, using a recorded SPT of 19, Cu= 95kN/m^2.
(21) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the characteristic SPT 'N' value of 19, Eu = 7.5MN/m^2. Therefore E' = 6.0MN/m^2.
(22) ϕ' of Head Deposits was determined using Table 2 in BS8002:2015 using the recorded PI of 29% gives 24°.
(23) c_u of Head Deposits can be derived using the Stroud correlation. Assuming a PI of 29% gives an f1 value of 4.5, using a characteristic SPT 'N' value of 10, Cu= 45kN/m^2.
(24) E' of Head Deposits was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the characteristic SPT 'N' value of 10, Eu = 4.8MN/m^2. Therefore E' = 3.8MN/m^2.
(25) ϕ' of Glaciofluvial Deposits (fine grained) was determined using Table 2 in BS8002:2015 using the recorded PI of 20% gives 26°.
(26) c_u of Glaciofluvial Deposits (fine grained) was derived using the Stroud correlation. Using the recorded PI of 20% gives an f1 value of 5.5, using a recorded SPT 'N' value of 29, Cu= 160kN/m^2.
(27) E' of Glaciofluvial Deposits (fine grained) is based relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the recorded SPT 'N' value of 29, Eu = 10.5MN/m^2. Therefore E' = 8.4MN/m^2.
(28) ϕ' of Mercia Mudstone – III/IV was determined using Table 2 in BS8002:2015 using the recorded PI of 23% gives 26°.
(29) c_u of Mercia Mudstone – III/IV was derived using the Stroud correlation. A recorded PI of 23% gives an f1 value of 5.0, with a characteristic SPT of 28, c_u= 140kN/m^2.
(30) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the characteristic SPT 'N' value of 28, Eu = 10.2MN/m^2. Therefore E' = 8.2MN/m^2.
(31) BRE Classification is determined using criteria set out in BRE Special Digest 1. . In the absence of BRE test data for Head Deposits and Glaciofluvial deposits, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of king and intermediate sheet piles in embankments; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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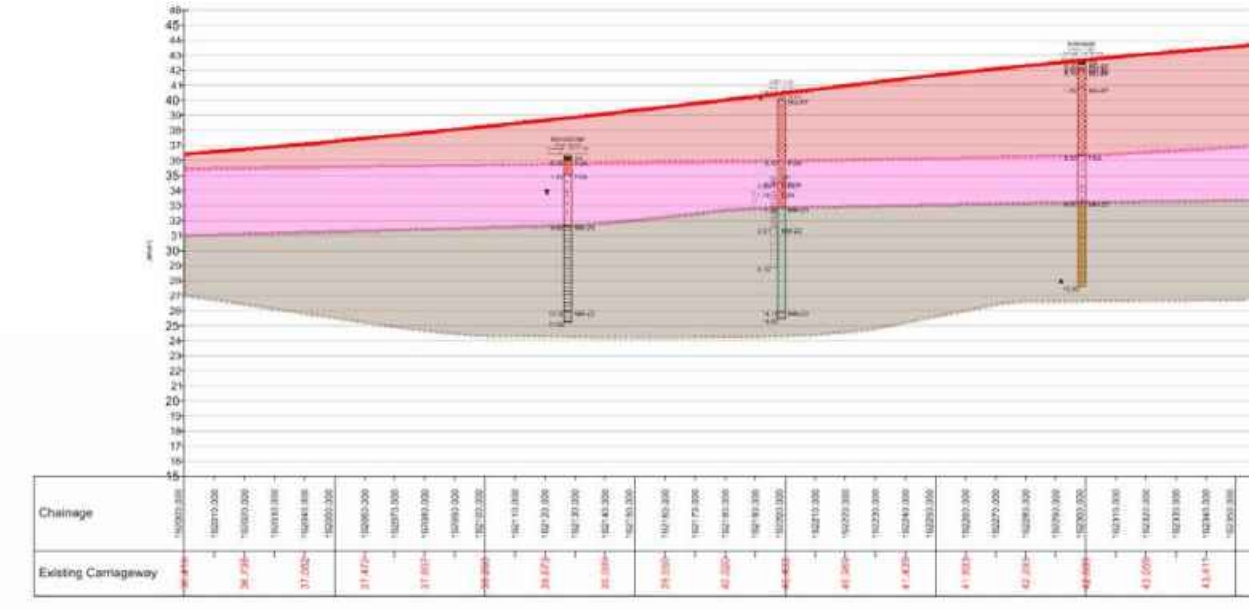


Figure 4.1: Geological Long Section 1 of 2

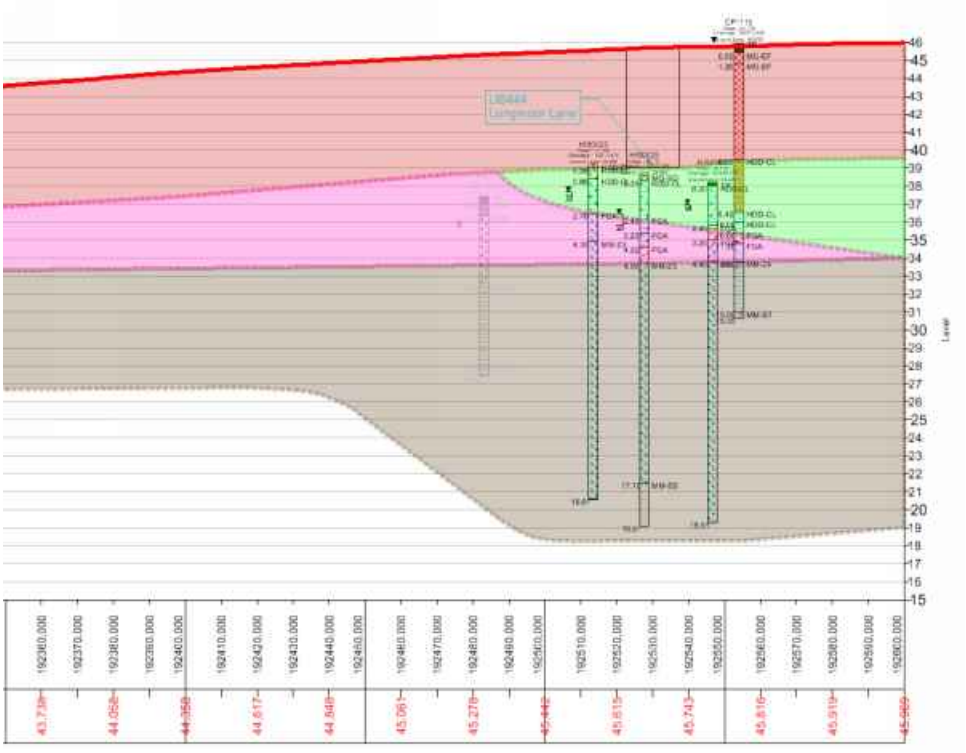


Figure 4.2: Geological Long Section 2 of 2

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to restrictions due to the highway boundary, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Sheet Pile wall Type	Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
192090	192140	King	AZ-36 S 390 GP	2.0	6.0	8.0	87	69	21	77.5
192150	192190	Continuous Sheet	AZ-50 S 390 GP	3.9	9.1	13	88	63	76.0	371.6
192190	192250	King	AZ-36 S 390 GP	3.1	7.9	11.0	89	60	49.0	232.2
192250	192260	King	AZ-36 S 390 GP	2.0	6.0	8.0	87	69	21.0	77.5
192260	192300	King	AZ-36 S 390 GP	3.1	7.9	11.0	89	60	49.0	232.2
192300	192370	Continuous Sheet	AZ-50 S 390 GP	3.9	9.1	13	88	63	76.0	371.6
192370	192400	King	AZ-36 S 390 GP	3.1	7.9	11.0	89	60	49.0	232.2
192400	192480	King	AZ-36 S 390 GP	2.4	9.6	12.0	86	74	33.0	129.1
192480	192520	King	AZ-36 S 390 GP	2.3	9.7	12.0	86	74	33.0	129.1

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Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	900	12.5	2.7	4	451	1779

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FURTHER GROUND INVESTIGATION

Additional GI for this location will be undertaken to confirm ground conditions. The following is scheduled:

- BH-G320 at chainage 192290, Southbound - 18m deep dynamic sample / rotary core follow on exploratory hole, located in southbound existing hardstrip.
- BH-CPT-11 at chainage 192344 - 5m deep CPT exploratory hole, located in southbound grass verge using excavator mounted equipment.
- BH-CPT-12 at chainage 192502 - 5m deep CPT exploratory hole, located in southbound grass verge using excavator mounted equipment.

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HISTORICAL EXPLORATORY HOLES

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Rotary Core Log

Borehole No. **CP1113** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447196.00 - 334236.00	Hole Type CP
Location:		Level: 40.05	Scale 1:50
Client: Highways England		Dates: 03/11/2006 - 06/11/2006	Logged By SM

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.50	B							MADE GROUND. Stiff red brown slightly sandy slightly gravelly clay with occasional pockets of light grey silt. Sand is fine. Gravel is subangular and subrounded fine to coarse of sandstone, mudstone and coal. MG-EF
		1.50 - 1.95	U							
		2.00	D							
		2.50	D							
		2.50 - 3.00	B							
		3.50 - 3.95	U							
		4.00	D							
		4.10	D				4.10	35.95		Stiff dark grey brown sandy slightly gravelly CLAY with occasional rootlets. Sand is fine to coarse. Gravel is subangular to rounded fine to coarse flint and sandstone. FGA
		4.50	D							
		4.50 - 5.00	B							
		5.50 - 6.00	U#B				5.50	34.55		Dense brown sandy GRAVEL. Gravel is subangular to rounded fine to coarse of sandstone, siltstone and flint. Sand is fine to coarse. FGA-SG
		6.50	B							
		7.50	D				7.20	32.85		Red brown CLAY with subangular and subrounded fine and medium gravel sized lithorelics of mudstone. With occasional pockets of light grey green silt/siltstone. MM-Z3
		7.50 - 8.00	U#B							
		9.00	D							
		9.00 - 9.50	B							

Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.50m.;The borehole was advanced by chiselling methods from 14.10m to 14.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1113 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447196.00 - 334236.00	Hole Type CP
Location:		Level: 40.05	Scale 1:50
Client: Highways England		Dates: 03/11/2006 - 06/11/2006	Logged By SM

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										CLAY (as previous sheet)
		10.50 - 11.00	U#B							
		12.00	D							
		12.00 - 12.50	B							
		13.50	D							
		13.50 - 14.00	B							
		14.10	D				14.10	25.95		
		14.10 - 14.50	B							Weak red brown MUDSTONE recovered as red brown clay with fine to coarse gravel sized fragments. MM-Z2
		14.50	D				14.60	25.45		End of borehole at 14.60 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring and to maintain a positive hydrostatic head in granular strata from 5.50m.;The borehole was advanced by chiselling methods from 14.10m to 14.50m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1115
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447130.00 - 334588.00	Hole Type CP
Location:		Level: 46.00	Scale 1:50
Client: Highways England		Dates: 13/11/2006 - 14/11/2006	Logged By OP

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										TOPSOIL TP
		0.50	B				0.60	45.40		MADE GROUND. Dark brown sandy gravelly clay. Sand is predominantly fine and medium. Gravel is subangular fine to coarse of siltstone. MG-EF
		1.00	B							
		1.20 - 1.70	B				1.20	44.80		MADE GROUND. Stiff red brown with occasional grey mottling slightly gravelly clay with occasional pockets of silt. Gravel is subangular to rounded fine to coarse of claystone, siltstone and quartzite. Possible MG-EF
		2.20 - 2.65	U							
		2.70	D							
		3.20 - 3.65	D							
		3.20 - 3.70	B							
		4.20 - 4.65	U							
		4.70	D							
		5.20	D							
		5.20 - 5.70	B							
		6.20 - 6.65	U							
							6.50	39.50		
		6.70	D							Stiff friable red brown sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to rounded fine to coarse of quartzite. Possible HDD-CL
		7.20 - 7.65	D							
		7.20 - 7.70	B							*Between 7.20m and 7.70m; orange brown with occasional light grey and red brown mottling.*
		8.20 - 8.65	U							
		8.34	W							
		8.70	D							*At 8.70m, slightly sandy.*
		9.40	D				9.40	36.60		Stiff red brown slightly sandy CLAY. Sand is fine and medium. Possible HDD-CL
		9.70 - 10.15	D							
		9.70 - 10.20	B				10.00	36.00		
										Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 10.60m.;The borehole was advanced by chiselling methods from 15.00m to 15.30m (1 hour) ;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1115 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447130.00 - 334588.00	Hole Type CP
Location:		Level: 46.00	Scale 1:50
Client: Highways England		Dates: 13/11/2006 - 14/11/2006	Logged By OP

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Dark grey slightly organic slightly sandy CLAY. Sand is fine. HDD-CL
		10.60 - 11.10	B				10.60	35.40		Dense brown, white and grey SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to rounded of quartzite, sandstone and siltstone. FGA-SG
		11.20	D				11.20	34.80		Firm and stiff brown and orange brown slightly sandy slightly gravelly CLAY with occasional partings of silt. Sand is fine. Gravel is subangular and subrounded fine of mudstone. Possible FGA
		11.30 - 11.75	U							
		11.80	D							
		12.20 - 12.65	D				12.20	33.80		Stiff red brown slightly sandy CLAY. Sand is fine. MM-Z4
		12.20 - 12.70	B							
		13.70 - 14.15	D							
		13.70 - 14.20	B							
		15.00 - 15.07	D				15.00	31.00		Weak light grey SILTSTONE recovered as light grey subangular fine to coarse gravel and cobble sized fragments. MM-ST
		15.00 - 15.30	B				15.35	30.65		End of borehole at 15.35 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 10.60m.;The borehole was advanced by chiselling methods from 15.00m to 15.30m (1 hour) ;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. HIS0023
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447137.00 - 334548.00	Hole Type CP
Location:		Level: 39.20	Scale 1:50
Client: Highways England		Dates: 23/06/1964 - 29/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.61	B				0.20	39.00		Brown CLAY HDD-CL
										Medium dense brown clayey coarse GRAVEL HDD-CL
							0.80	38.40		Firm red-brown silty CLAY with occasional gravel HDD-CL
		1.22 - 1.68	U							
	▼	1.68	D							
	▽									
		2.29	B							
		2.74 - 3.20	U				2.70	36.50		Firm grey-blue silty CLAY FGA
		3.20	D							
		3.66	D							
		4.27 - 4.72	U				4.30	34.90		Stiff to very stiff, becoming hard, friable mottled red-brown and grey silty CLAY, with bands of mudstone and sandstone (Keuper Marl) MM-Z3
		4.72	D							
		5.33	D							
		5.79 - 6.25	U							
		6.25	D							
		6.86	D							
		7.32 - 7.77	U							
		7.77	D							
		8.38	D							
		8.84 - 9.30	U							
		9.30	D							
		9.75	B							

Continued on next sheet

Remarks
Ground-water was first observed at a depth of 1.98m below ground level on the morning of 24.06.64 but had risen to 1.52m below ground level on the morning of 27.06.64. Water samples were taken.

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Rotary Core Log

Borehole No. HIS0023
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447137.00 - 334548.00	Hole Type CP
Location:		Level: 39.20	Scale 1:50
Client: Highways England		Dates: 23/06/1964 - 29/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.36 - 10.82	U							
		10.82	D							
		11.43	D							
		11.89 - 12.34	U							
		12.34	D							
		12.95	D							
		13.41 - 13.87	U							
		13.87	D							
		14.48	D							
		14.94	D							
		16.46	B							
		17.37	D							
		18.29 - 18.59	B							
		18.59	W				18.61	20.59		End of borehole at 18.59 m

11 12 13 14 15 16 17 18 19 20

Remarks
Ground-water was first observed at a depth of 1.98m below ground level on the morning of 24.06.64 but had risen to 1.52m below ground level on the morning of 27.06.64. Water samples were taken.

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Rotary Core Log

Borehole No. **HIS0025**
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447135.00 - 334562.00	Hole Type CP
Location:		Level: 38.60	Scale 1:50
Client: Highways England		Dates: 09/07/1964 - 13/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	38.30		FILL (Brick rubble and gravel) MG-SG
		0.61	D							Stiff mottled blue and brown silty CLAY with occasional fine to medium gravel HDD-CL
		0.91 - 1.37	U							
		1.37	D							
		1.98	D							
		2.44 - 2.90	U				2.40	36.20		
		2.90	D							Firm brown sandy CLAY FGA
		3.51	D				3.20	35.40		Firm grey silty CLAY FGA
		4.11 - 4.57	B				4.00	34.60		Medium dense brown fine to medium GRAVEL FGA-SG
		5.03 - 5.49	U				4.90	33.70		Stiff to very stiff friable red-brown and grey silty CLAY and clayey SILT with occasional mudstone fragments; thin bands of sandstone below 8.2m (Keuper Marl) MM-Z3
		5.49	D							
		5.94	D							
		6.25 - 6.71	U							
		6.71	D							
		7.16	D							
		7.77 - 8.23	U							
		8.23	D							
		8.69	D							
		9.30 - 9.75	U							
		9.75	D							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level but had risen to 2.13m below ground level on the morning of 13.07.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. **HIS0025**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447135.00 - 334562.00	Hole Type CP
Location:		Level: 38.60	Scale 1:50
Client: Highways England		Dates: 09/07/1964 - 13/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.21	D							
		10.82 - 11.28	U							
		11.28	D							
		11.73	D							
		12.34 - 12.80	U							
		12.80	D							
		13.26	D							
		13.87 - 14.33	U							
		14.33	D							
		14.78	D							
		15.39 - 15.85	U							
		15.85	W							
							17.10	21.50		Grey SANDSTONE MM-SS
							19.51	19.09		End of borehole at 19.51 m

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level but had risen to 2.13m below ground level on the morning of 13.07.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. HIS0026
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447168.00 - 334584.00	Hole Type CP
Location:		Level: 38.20	Scale 1:50
Client: Highways England		Dates: 06/07/1964 - 08/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.46 - 0.91	U				0.20	38.00		TOPSOIL TP Stiff friable brown silty sandy CLAY with roots. HDD-CL
		0.91	D							
	▼	1.52	D							
		2.44 - 2.90	B				2.40	35.80		Medium dense brown sandy fine to medium GRAVEL FGA-SG
		3.51 - 3.96	B				3.20	35.00		Medium dense brown clayey fine to medium GRAVEL FGA-SG
		4.57 - 5.03	U				4.40	33.80		Stiff to very stiff friable mottled red-brown and grey clayey SILTY or silty CLAY; thin bands of sandstone and mudstone below 4.7m. MM-Z3
		5.03	D							
		5.64	D							
		6.10 - 6.55	U							
		6.55	D							
		7.16	D							
		7.62 - 8.08	U							
		8.08	D							
		8.69	D							
		9.14 - 9.60	U							
		9.60	D							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 1.53m below ground level on the morning of 7.07.64 but had risen to 1.22m below ground level by the following morning. Sample of ground-water taken.

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Rotary Core Log

Borehole No. **HIS0026**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447168.00 - 334584.00	Hole Type CP
Location:		Level: 38.20	Scale 1:50
Client: Highways England		Dates: 06/07/1964 - 08/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.21	D							
		10.67 - 11.13	U							
		11.13	D							
		11.73	D							
		12.19 - 12.65	U							
		12.65	D							
		13.26	D							
		13.72 - 14.17	U							
		14.17	D							
		14.78	D							
		15.54 - 16.00	U							
		16.00	D							
		16.46	D							
		17.07 - 17.53	U							
		17.53	D							
		17.98	D							
		18.29 - 18.75	U							
		18.75	D							
		18.75	W				18.91	19.29		End of borehole at 18.91 m

Remarks
Ground-water was first encountered at a depth of 1.53m below ground level on the morning of 7.07.64 but had risen to 1.22m below ground level by the following morning. Sample of ground-water taken.

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Rotary Core Log

Borehole No. **NWHM66**

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447206.93 - 334342.18	Hole Type CP
Location:		Level: 42.62	Scale 1:50
Client: Highways England		Dates: 04/09/1999 - 04/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00	D				0.20	42.42		TOPSOIL. TP
		0.00	D							
		0.20	D				0.50	42.12		MADE GROUND: Hardcore of limestone. MG-EF
		0.20	D							
		0.50	D				0.70	41.92		MADE GROUND: Concrete. (Backfill) MG-EF
		0.50	D							
		0.70	D							MADE GROUND: Dark grey fine to coarse angular gravel of limestone. Occasional cobble. (Hardcore) MG-EF
		0.70	D							
		1.00	D							
		1.00	D							
		1.80	D				1.80	40.82		MADE GROUND: Firm to stiff occasionally stiff red brown dappled blue grey sandy clay with some fine to coarse subangular gravel of mudstone and very occasionally sandstone. (Backfill Embankment of Mercia Mudstone) MG-EF
		1.80	D							
		2.00 - 2.50	B							
		2.00 - 2.50	B							
		3.00 - 3.50	B							
		3.00 - 3.50	B							
		4.00 - 4.50	B							
		4.00 - 4.50	B							
		5.00 - 5.50	B							
		5.00 - 5.50	B							
		6.00 - 6.50	B							
		6.00 - 6.50	B							
		6.30	D				6.30	36.32		Dense brown slightly silty medium and coarse SAND and GRAVEL - gravel content fine to coarse subangular to rounded of sandstone, limestone and quartz. (River Terrace Deposits?) - Driller notes sand and gravel to be bound in clay matrix. FGA-SG
		6.30	D							
		6.50	B							
		6.50 - 7.00	B							
		7.50 - 8.00	B							
		7.50 - 8.00	B							
		8.00	B							
		8.00 - 8.50	B							
		9.00 - 9.80	B							
		9.00 - 9.80	B							
		9.40	D				9.40	33.22		Stiff red brown mottled/dappled blue grey slightly sandy CLAY with some fine to coarse subangular gravel sized lithorelicts of mudstone
		9.40	D							

Continued on next sheet

Remarks

1. Hand dug pit GL-1.20m. 2. End of drilling borehole grouted up to 0.50m topsoil replaced. 3. Marker Post Ref 192/4 -50S.

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Rotary Core Log

Borehole No. NWHM66
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447206.93 - 334342.18	Hole Type CP
Location:		Level: 42.62	Scale 1:50
Client: Highways England		Dates: 04/09/1999 - 04/09/1999	Logged By BS

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										(up to 40mm). (Mercia Mudstone - Zone III/IVa?) MM-Z3
		10.50 - 11.00	B							
		10.50 - 11.00	B							
		11.50	D							—from 11.50m to 12.00m locally grading to grade III/II with thin interbeds of siltstone/mudstone (note slow boring/ chiselling)
		11.50	D							
		12.40 - 13.50	B							
		12.40 - 13.50	B							
		12.50	B							
		14.00 - 15.00	B							
		14.00 - 15.00	B							
	▼						15.00	27.62		End of borehole at 15.00 m

Remarks
1. Hand dug pit GL-1.20m. 2. End of drilling borehole grouted up to 0.50m topsoil replaced. 3. Marker Post Ref 192/4 -50S.

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Rotary Core Log

Borehole No. SK43SE286
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447300.00 - 334190.00	Hole Type CP
Location:		Level: 36.27	Scale 1:50
Client: Highways England		Dates: 18/11/1975 - 18/11/1975	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	35.97		TOPSOIL TP Grey brown very stony sandy CLAY FGA
							1.20	35.07		Medium compact medium grained SAND and GRAVEL FGA-SG
	▼									
							4.60	31.67		Highly weathered red/brown silty MARL with occasional bands of green marl MM-Z4
		5.00	U							
		6.50	U							
		8.00	U							
		9.50	U							
										Continued on next sheet

Remarks
Water struck at 2.50m. Water standing level 2.50m.

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Rotary Core Log

Borehole No. **SK43SE286**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447300.00 - 334190.00	Hole Type CP
Location:		Level: 36.27	Scale 1:50
Client: Highways England		Dates: 18/11/1975 - 18/11/1975	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.30	25.97		Moderately weathered hard MARL MM-Z2
							11.00	25.27		End of borehole at 11.00 m

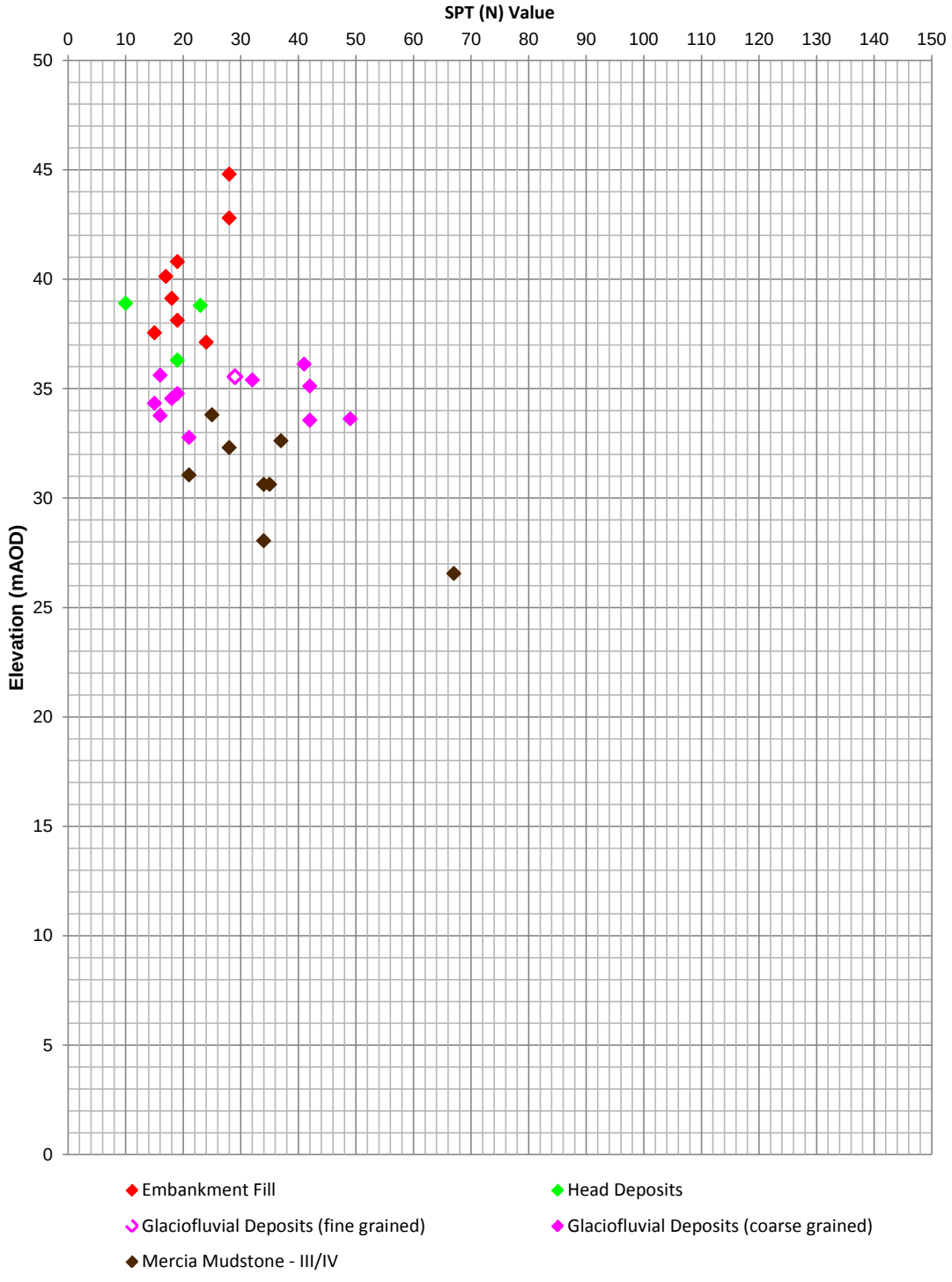
Remarks
Water struck at 2.50m. Water standing level 2.50m.

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PLOTS

amey ARUP	**SPT N Value vs Depth**
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25** | Data Sheet: **192090-192520SB**
Client: **Highways England**	Borehole ID: **CP1113, CP1115, HIS0023, HIS0025, HIS0026, NWHM66, SK43SE286**



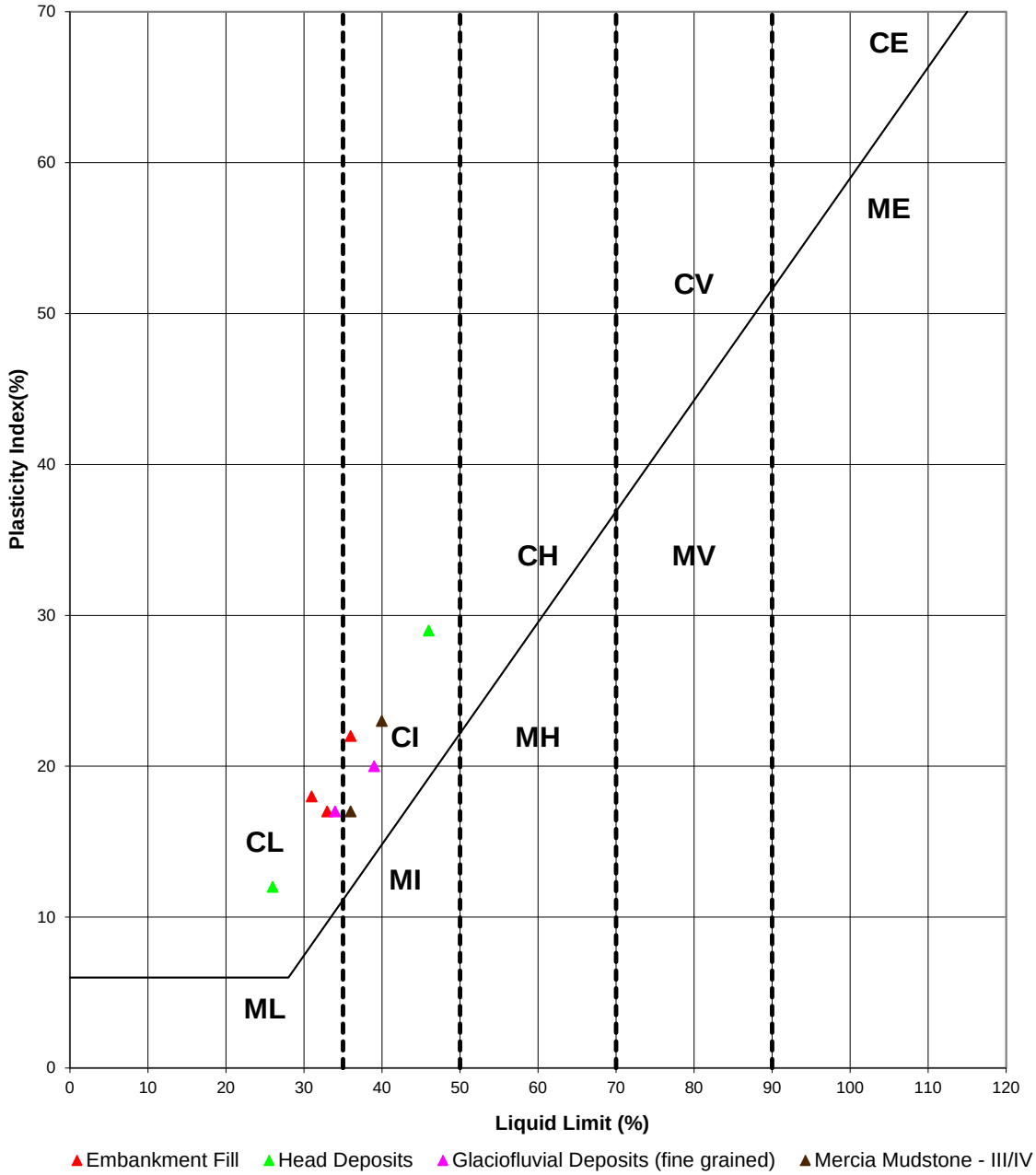
Extrapolated SPT (N) Values >150 have not been shown

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **192090-192520SB**
Client: **Highways England**	Borehole ID: **CP1113, CP1115, NWHM66**	



Key

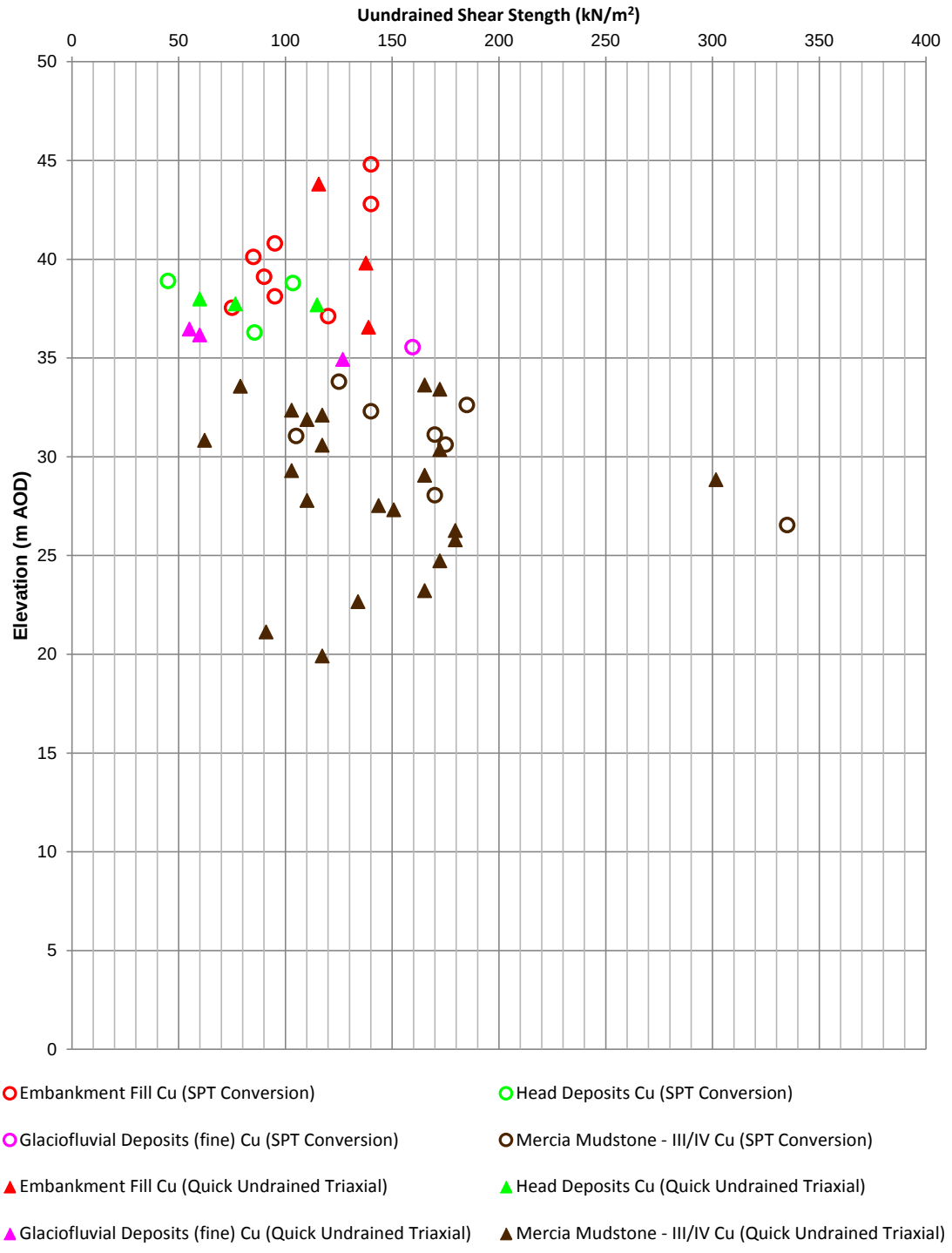
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **192090-192520SB**
Client: **Highways England**	Borehole ID: **CP1113, CP1115, HIS0023, HIS0025, HIS0026, NWHM66, SK43SE286**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-192560-192710SB-GSS-000001		
Earthworks Widening Solution	Full Height Embankment Widening (1:2.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	192560-192710		
Carriageway	Southbound		
Marker Post	192/5+60 – 192/7+10		
National Grid Reference	E 447166, N 334587 – E 447163, N 334746		
Existing Ground Level at Location	Carriageway	45.7mAOD	
	Toe of embankment	39.5mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_21148	HAGDMS designation
Maximum Earthwork Height	NB: N/A	SB: 6.2m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Typical Earthwork Angle	NB: N/A	SB: 27^{o}	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Scott Bishton	09/02/2017	[redacted]
Checked	Roheel Masrat	10/03/2017	
Reviewed	Gary Summerfield	10/03/2017	
Approved	Tom Bulteel	17/03/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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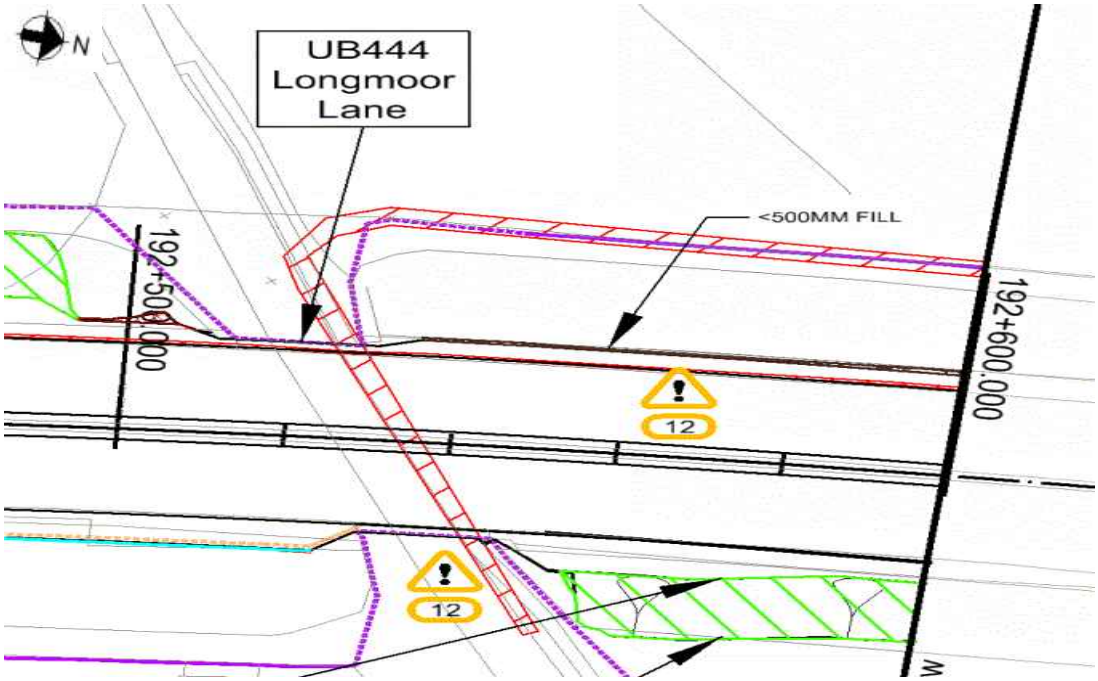


Figure 1.1: Location Plan 1 of 2 – 192560-192600

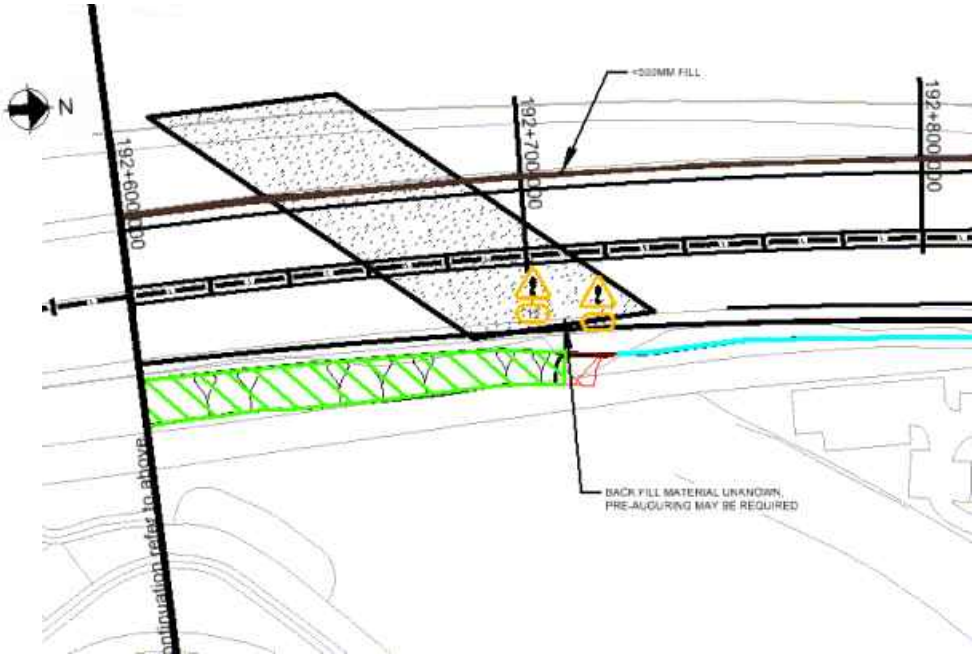


Figure 1.2: Location Plan 2 of 2 – 192600-192710

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch192560-192710 – Full Height Embankment Widening (1:2.0)

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is classified as an embankment. The embankment reduces in height from 6.2m in the south to 4.3m in the north of the extents with a proposed slope gradient of 1V:2H.

The cross section with the greatest earthwork height is used as the critical cross section at Ch192560.

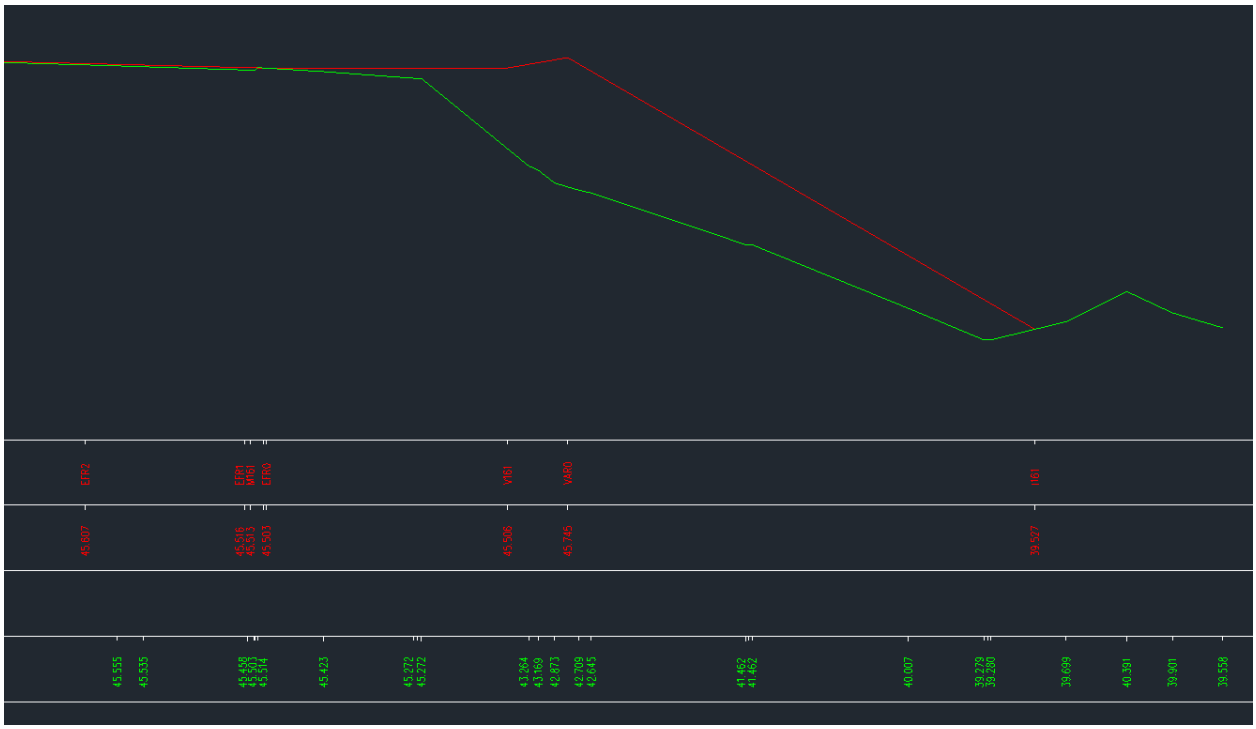


Figure 2: Topographic Critical Cross Section Ch192560

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough indicates that the site is underlain by:

Superficial Deposits: Head Deposits

Solid Deposits: Gunthorpe Member (Mercia Mudstone)

Ground Investigation:

There are 2 No. historical exploratory holes recorded within the design chainage, with additional 4 no. relevant exploratory holes considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000028, Rev P01.

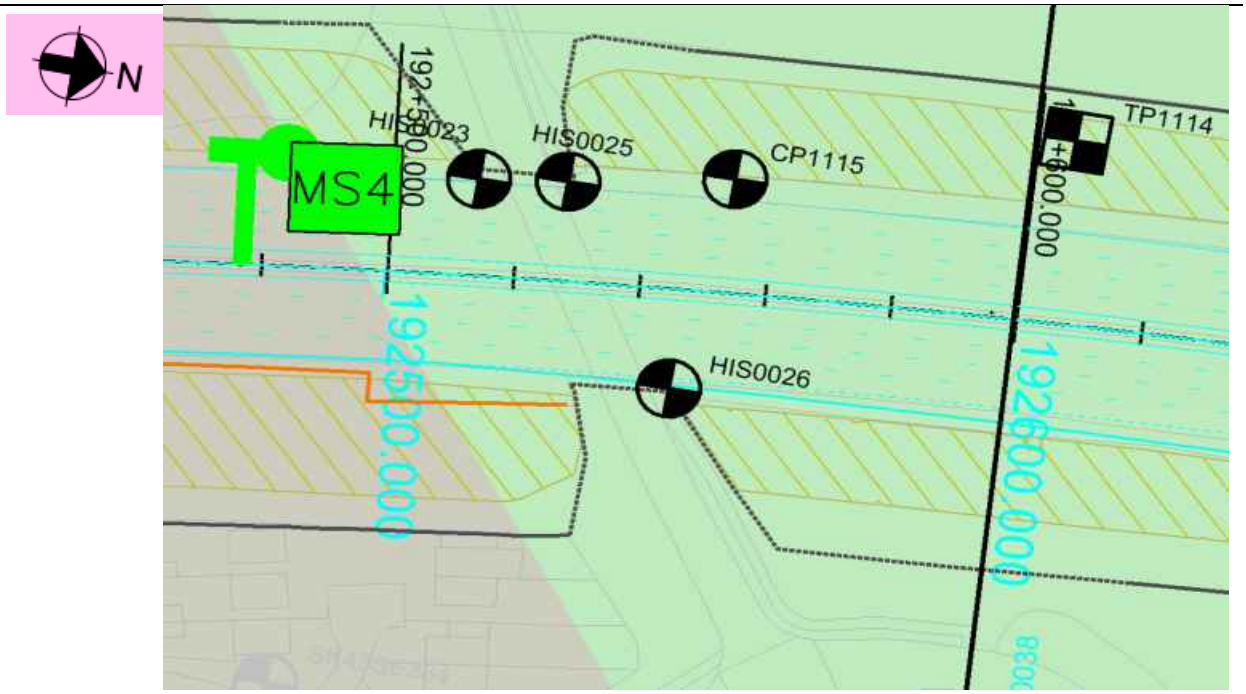


Figure 3.1: Borehole Location Plan 1 of 2

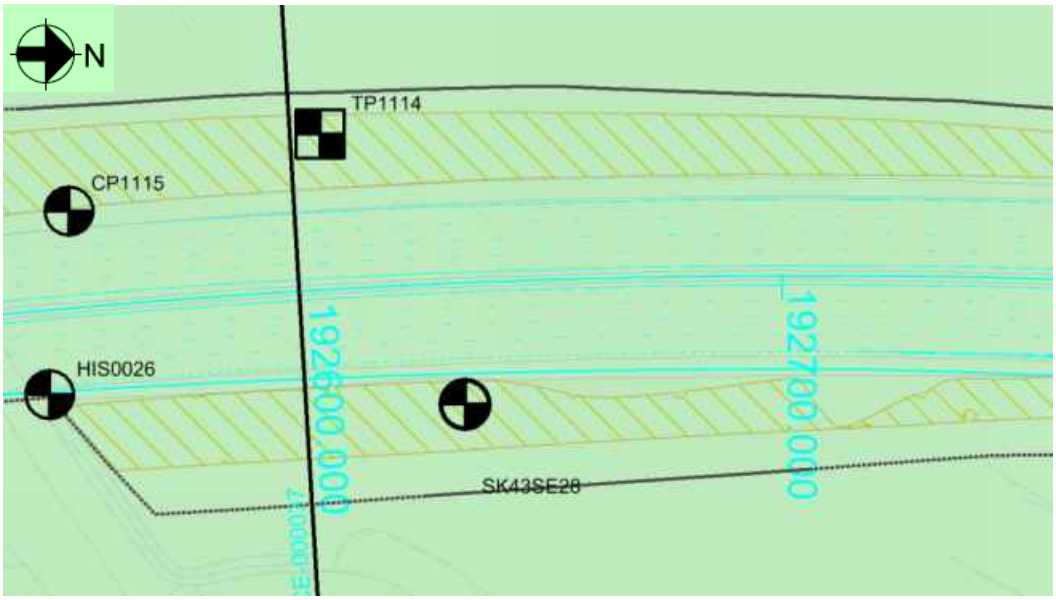


Figure 3.2: Borehole Location Plan 2 of 2

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	HIS0026
Borehole Chainage	192546
Borehole Location	Southbound verge
National Grid Reference	E 447168, N 334584
Ground Level at Exploratory Hole	38.2mAOD (above Ordnance Datum)
RAG Analysis	Green
Date Drilled	06/07/1964 – 08/07/1964
Termination Depth	18.89m below ground level (mbgl)
Other suitable holes	HIS0023, HIS0025, CP1115, TP1114

Existing Ground Conditions:

The following ground conditions are assumed based on previous GI data and driven LiDAR survey data.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT (N) Value
Embankment Fill	6.2	39.5	19-28 (19)
Head Deposits	9.9	35.8	10-23 (10)
Glaciofluvial Deposits (coarse grained)	11.9	33.8	15-32 (15)
Mercia Mudstone – III/IV	Not proven	Not proven	25-28 (25)

(1) Ground level is assumed to be at the carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary. SPT capped at 150. Characteristic 'N' Values are given in brackets
(3) 2 No. SPTs were undertaken within Mercia Mudstone – Siltstone and experienced refusal; these have not been considered further.
(4) Mercia Mudstone – Siltstone was recorded in CP1115 and Mercia Mudstone – Sandstone was recorded in HIS0025, both at depth beneath Mercia Mudstone – III/IV. Given that the closest historical exploratory hole HIS0026 does not contain these strata, they have been excluded from the ground model.

In Situ Testing:

Standard Penetration Tests (SPT's) were undertaken in historical exploratory holes HIS0023, HIS0025, HIS0026 and CP1115.

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Groundwater:

The following groundwater strikes were recorded in the historical exploratory holes:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
HIS0023	Head Deposits	1.92	37.22	-	1.52	37.68
HIS0025	Glaciofluvial Deposits rising into Head Deposits	3.05	35.55	-	2.13	36.47
HIS0026	Head Deposits	1.52	36.68		1.22	36.98

Groundwater Design Level:

Due to the lack of local groundwater data available, a design groundwater level of 1.0m below toe of embankment has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

6 No. Atterberg Limit Tests and 6 No. Moisture Content Tests were undertaken within historical exploratory holes with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	1.30	23	46	15	31	CI
Embankment Fill	2.70	19	33	16	17	CL
Head Deposits	3.80	20	33	13	20	CL
Embankment Fill	4.70	16	31	13	18	CL
Head Deposits	6.70	12	26	14	12	CL
Head Deposits	8.70	20	46	17	29	CI

30 No. undrained triaxial tests were undertaken with the following results:

Stratum	No. of tests	Undrained Shear Strength Range (kN/m^2)
Embankment Fill	2	116-138
Head Deposits	3	60-115
Glaciofluvial Deposits	3	55-127
Mercia Mudstone – III/IV	22	53-302

Lab Test Data - BRE Classification:

The table below presents the chemical test data undertaken within the exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	Sulphate (Total) as SO4	Solid	-	-	%SO4
Embankment Fill	Water Soluble Sulphate as SO4	Water	-	-	g/l SO4
Embankment Fill	pH	Solid	1	8.5	-
Head Deposits	Sulphate (Total) as SO4	Solid	4	0.04	%SO4

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Head Deposits	Water Soluble Sulphate as SO4	Water	-	-	g/l SO4
Head Deposits	pH	Solid	5	7.2-8.5	-
Glaciofluvial Deposits	Sulphate (Total) as SO4	Solid	3	0.01-0.37	%SO4
Glaciofluvial Deposits	Water Soluble Sulphate as SO4	Water	1	0.05	g/l SO4
Glaciofluvial Deposits	pH	Solid	3	7.0-7.2	-
Mercia Mudstone – III/IV	Sulphate (Total) as SO4	Solid	17	0.02-0.25	%SO4
Mercia Mudstone – III/IV	Water Soluble Sulphate as SO4	Water	3	0.18-0.55	g/l SO4
Mercia Mudstone – III/IV	pH	Solid	20	4.6-8.4	-

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000037 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0-6.2	45.7-39.5	6.2	21	27	0	115	7.5	6.0	-	0.50	0.20	-	DS-2 AC-2
Head Deposits	6.2-9.9	39.5-35.8	3.7	20	27	0	75	4.8	3.8	-	0.50	0.20	-	DS-1 AC-1
Glaciofluvial Deposits (coarse grained)	9.9-11.9	35.8-33.8	2.0	21	32	-	-	-	25.2	-	-	0.25	-	DS-2 AC-2
Mercia Mudstone – III/IV	>11.9	<33.8	-	21	30	2	110	9.3	7.4	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Given the limited amount of local PI data, the ϕ' of Embankment Fill, Head Deposits and Mercia Mudstone – III/IV was taken as the characteristic value given in the AMAR GIR.
(4) c_u of Embankment Fill, Head Deposits and Mercia Mudstone – III/IV was determined based on recorded undrained triaxial tests and c_u derived using the Stroud correlation. Due to the limited amount of local PI data, a typical f1 value of 5.0 was used.
(5) ϕ' of Glaciofluvial Deposits (coarse grained) was determined using the relationship between SPT 'N' value and ϕ' (Peck 1989, from Tomlinson Foundation Design and Construction 7th Edition). For a conservative SPT 'N' value of 15, ϕ' was found to be 32^o.
(6) E' of Embankment Fill was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the conservative SPT 'N' value of 19, Eu = 7.5MN/m^2. Therefore E' = 6.0MN/m^2.
(7) E' of Head Deposits was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); using the conservative SPT 'N' value of 10, Eu = 4.8MN/m^2. Therefore E' = 4.8MN/m^2.
(8) E' of Glaciofluvial Deposits (coarse grained) was based on the relationship where E'= 1200 (N+6) for sands and gravels (from Bowles 5th Edition). Therefore for a conservative SPT 'N' value of 15, E' = 25.2MN/m^2.
(9) E' of Mercia Mudstone – III/IV was based on the relationship by Wroth (1972) where E' = 2/3 (1+v)Eu. Eu = 300(N+6) as shown in Bowles (1988); therefore using the conservative SPT 'N' value of 25, Eu = 9.3MN/m^2.

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Therefore E' = 7.4MN/m^2.

(10) BRE Classification is determined using criteria set out in BRE Special Digest 1. Due to the limited available BRE test data for Embankment Fill and Head Deposits, the classification used for the strata in the AMAR GIR was adopted

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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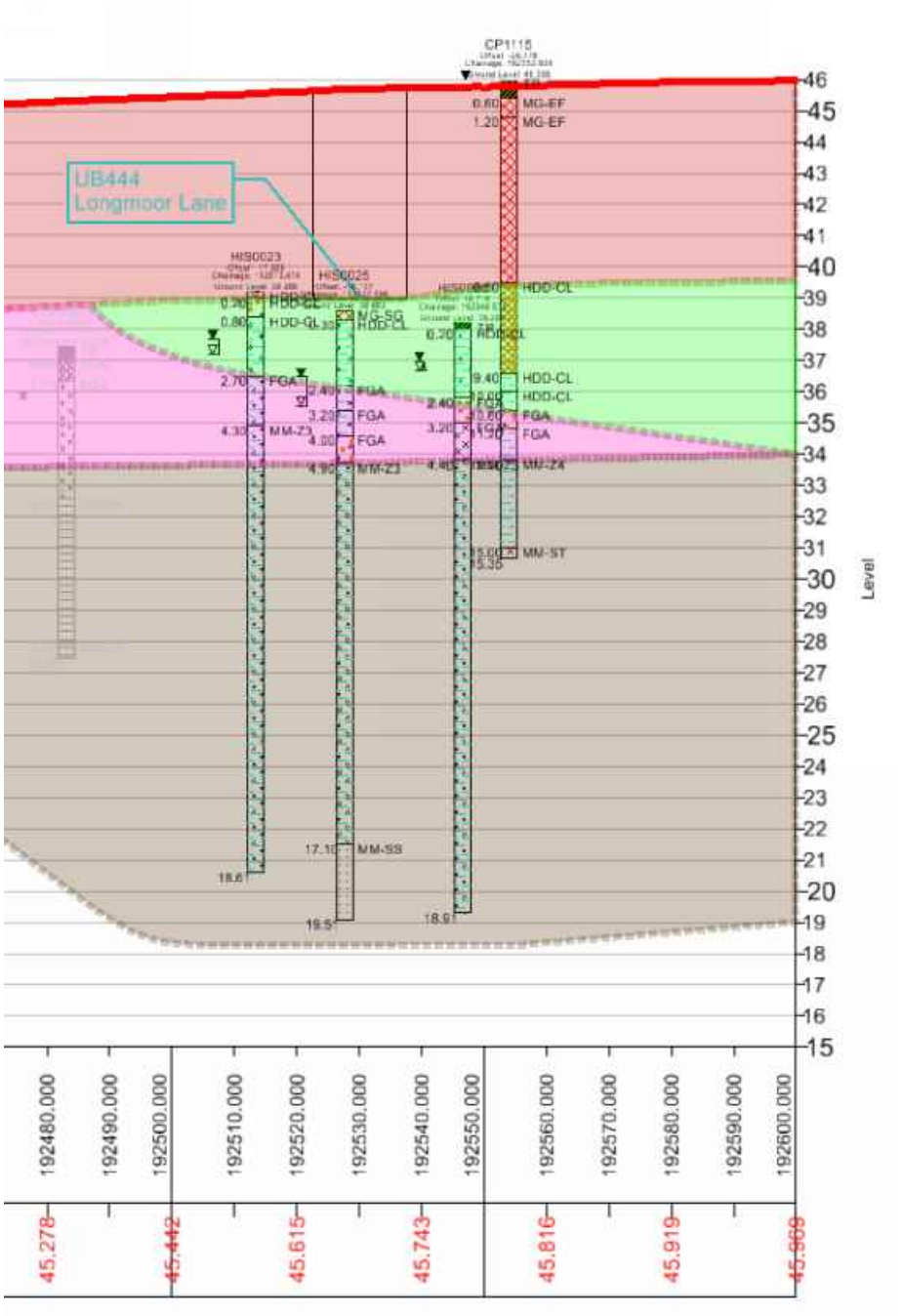


Figure 4.1: Geological Long Section 1 of 2

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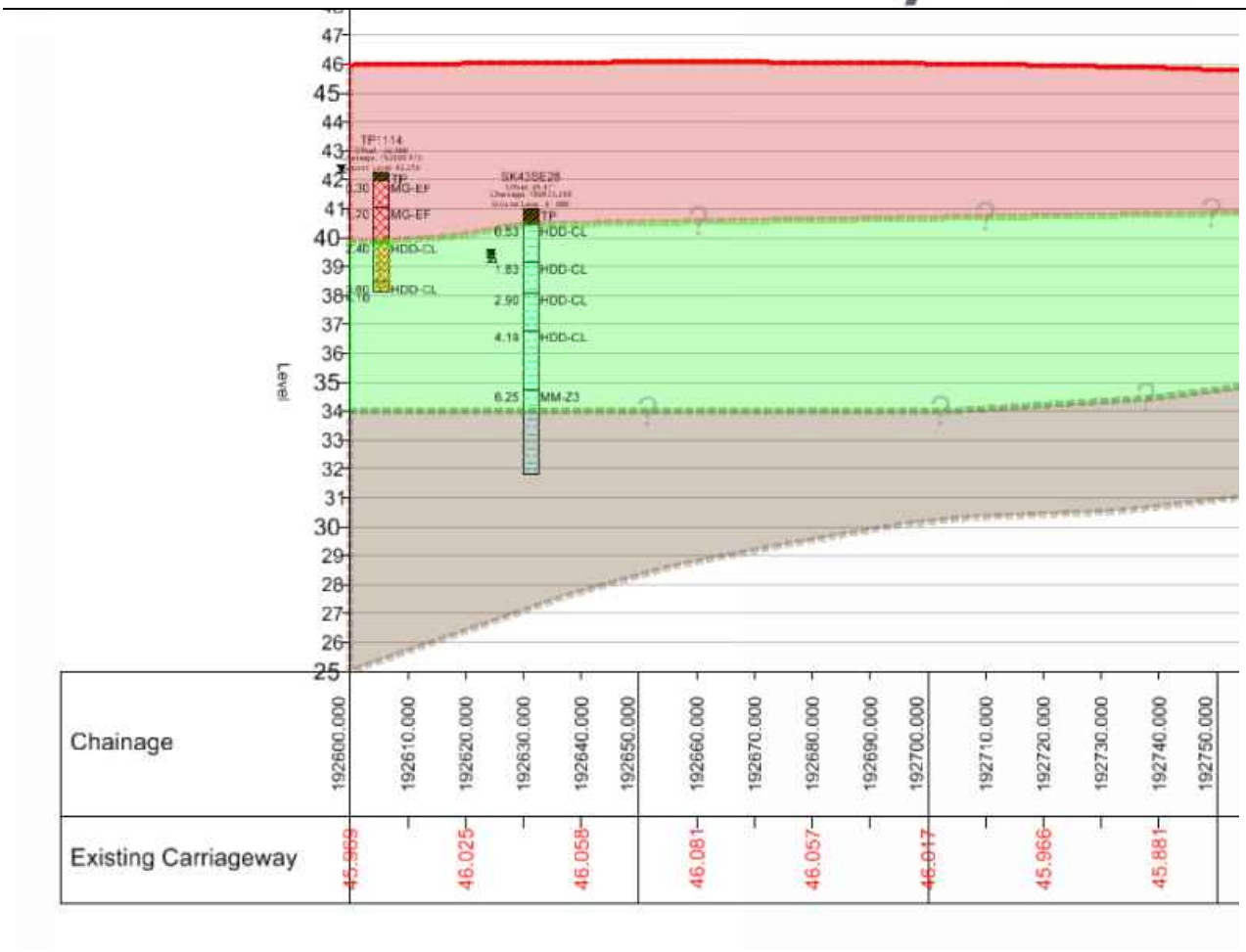


Figure 4.2: Geological Long Section 2 of 2

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
192560	192710	Full Height Embankment Widening (1:2.0)	5m	26.6 (1V:2H)

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-CPT-12, Ch192502, Southbound - 5m deep CPT exploratory hole, location in southbound grass verge using excavator mounted equipment.
- BH-R-SB2-800y, Ch192722, Southbound - 13m deep dynamic sample / rotary core follow on exploratory hole, located in southbound existing hardstrip.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **CP1115** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447130.00 - 334588.00	Hole Type CP
Location:		Level: 46.00	Scale 1:50
Client: Highways England		Dates: 13/11/2006 - 14/11/2006	Logged By OP

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										TOPSOIL TP
		0.50	B				0.60	45.40		MADE GROUND. Dark brown sandy gravelly clay. Sand is predominantly fine and medium. Gravel is subangular fine to coarse of siltstone. MG-EF
		1.00	B							
		1.20 - 1.70	B				1.20	44.80		MADE GROUND. Stiff red brown with occasional grey mottling slightly gravelly clay with occasional pockets of silt. Gravel is subangular to rounded fine to coarse of claystone, siltstone and quartzite. Possible MG-EF
		2.20 - 2.65	U							
		2.70	D							
		3.20 - 3.65	D							
		3.20 - 3.70	B							
		4.20 - 4.65	U							
		4.70	D							
		5.20	D							
		5.20 - 5.70	B							
		6.20 - 6.65	U							
		6.70	D				6.50	39.50		Stiff friable red brown sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to rounded fine to coarse of quartzite. Possible HDD-CL
		7.20 - 7.65	D							
		7.20 - 7.70	B							*Between 7.20m and 7.70m, orange brown with occasional light grey and red brown mottling.*
		8.20 - 8.65	U							
		8.34	W							
		8.70	D							*At 8.70m, slightly sandy*
		9.40	D				9.40	36.60		Stiff red brown slightly sandy CLAY. Sand is fine and medium. Possible HDD-CL
		9.70 - 10.15	D							
		9.70 - 10.20	B							
							10.00	36.00		Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 10.60m.;The borehole was advanced by chiselling methods from 15.00m to 15.30m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. CP1115 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447130.00 - 334588.00	Hole Type CP
Location:		Level: 46.00	Scale 1:50
Client: Highways England		Dates: 13/11/2006 - 14/11/2006	Logged By OP

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Dark grey slightly organic slightly sandy CLAY. Sand is fine. HDD-CL
		10.60 - 11.10	B				10.60	35.40		Dense brown, white and grey SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular to rounded of quartzite, sandstone and siltstone. FGA-SG
		11.20	D				11.20	34.80		Firm and stiff brown and orange brown slightly sandy slightly gravelly CLAY with occasional partings of silt. Sand is fine. Gravel is subangular and subrounded fine of mudstone. Possible FGA
		11.30 - 11.75	U							
		11.80	D							
		12.20 - 12.65	D				12.20	33.80		Stiff red brown slightly sandy CLAY. Sand is fine. MM-Z4
		12.20 - 12.70	B							
		13.70 - 14.15	D							
		13.70 - 14.20	B							
		15.00 - 15.07	D				15.00	31.00		Weak light grey SILTSTONE recovered as light grey subangular fine to coarse gravel and cobble sized fragments. MM-ST
		15.00 - 15.30	B				15.35	30.65		End of borehole at 15.35 m

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;An amount of water was added to facilitate boring from 10.60m.;The borehole was advanced by chiselling methods from 15.00m to 15.30m (1 hour).;No visual or olfactory indication of contamination was observed.;

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Rotary Core Log

Borehole No. HIS0023
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447137.00 - 334548.00	Hole Type CP
Location:		Level: 39.20	Scale 1:50
Client: Highways England		Dates: 23/06/1964 - 29/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.61	B				0.20	39.00		Brown CLAY HDD-CL
										Medium dense brown clayey coarse GRAVEL HDD-CL
							0.80	38.40		Firm red-brown silty CLAY with occasional gravel HDD-CL
		1.22 - 1.68	U							
	▼	1.68	D							
		2.29	B							
		2.74 - 3.20	U				2.70	36.50		Firm grey-blue silty CLAY FGA
		3.20	D							
		3.66	D							
		4.27 - 4.72	U				4.30	34.90		Stiff to very stiff, becoming hard, friable mottled red-brown and grey silty CLAY, with bands of mudstone and sandstone (Keuper Marl) MM-Z3
		4.72	D							
		5.33	D							
		5.79 - 6.25	U							
		6.25	D							
		6.86	D							
		7.32 - 7.77	U							
		7.77	D							
		8.38	D							
		8.84 - 9.30	U							
		9.30	D							
		9.75	B							

Continued on next sheet

Remarks
Ground-water was first observed at a depth of 1.98m below ground level on the morning of 24.06.64 but had risen to 1.52m below ground level on the morning of 27.06.64. Water samples were taken.

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Rotary Core Log

Borehole No. HIS0023 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447137.00 - 334548.00	Hole Type CP
Location:		Level: 39.20	Scale 1:50
Client: Highways England		Dates: 23/06/1964 - 29/06/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.36 - 10.82	U							
		10.82	D							
		11.43	D							
		11.89 - 12.34	U							
		12.34	D							
		12.95	D							
		13.41 - 13.87	U							
		13.87	D							
		14.48	D							
		14.94	D							
		16.46	B							
		17.37	D							
		18.29 - 18.59	B							
		18.59	W				18.61	20.59		End of borehole at 18.59 m

Remarks
Ground-water was first observed at a depth of 1.98m below ground level on the morning of 24.06.64 but had risen to 1.52m below ground level on the morning of 27.06.64. Water samples were taken.

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Rotary Core Log

Borehole No. HIS0025
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447135.00 - 334562.00	Hole Type CP
Location:		Level: 38.60	Scale 1:50
Client: Highways England		Dates: 09/07/1964 - 13/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	38.30		FILL (Brick rubble and gravel) MG-SG
		0.61	D							Stiff mottled blue and brown silty CLAY with occasional fine to medium gravel HDD-CL
		0.91 - 1.37	U							
		1.37	D							
		1.98	D							
		2.44 - 2.90	U				2.40	36.20		Firm brown sandy CLAY FGA
		2.90	D							
							3.20	35.40		Firm grey silty CLAY FGA
		3.51	D							
		4.11 - 4.57	B				4.00	34.60		Medium dense brown fine to medium GRAVEL FGA-SG
							4.90	33.70		Stiff to very stiff friable red-brown and grey silty CLAY and clayey SILT with occasional mudstone fragments; thin bands of sandstone below 8.2m (Keuper Marl) MM-Z3
		5.03 - 5.49	U							
		5.49	D							
		5.94	D							
		6.25 - 6.71	U							
		6.71	D							
		7.16	D							
		7.77 - 8.23	U							
		8.23	D							
		8.69	D							
		9.30 - 9.75	U							
		9.75	D							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level but had risen to 2.13m below ground level on the morning of 13.07.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No.	HIS0025	Sheet 2 of 2	
Project Name:	SMP - M1 J23A TO J25	Project No.	COCDFL1SMP01
Co-ords:	447135.00 - 334562.00	Hole Type	CP
Location:		Level:	38.60
Scale	1:50		
Client:	Highways England	Dates:	09/07/1964 - 13/07/1964
Logged By			

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.21	D							
		10.82 - 11.28	U							
		11.28	D							
		11.73	D							
		12.34 - 12.80	U							
		12.80	D							
		13.26	D							
		13.87 - 14.33	U							
		14.33	D							
		14.78	D							
		15.39 - 15.85	U							
		15.85	W							
							17.10	21.50		Grey SANDSTONE MM-SS
							19.51	19.09		End of borehole at 19.51 m

Remarks
Ground-water was first encountered at a depth of 3.05m below ground level but had risen to 2.13m below ground level on the morning of 13.07.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. HIS0026
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447168.00 - 334584.00	Hole Type CP
Location:		Level: 38.20	Scale 1:50
Client: Highways England		Dates: 06/07/1964 - 08/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.46 - 0.91	U				0.20	38.00		TOPSOIL TP
		0.91	D							Stiff friable brown silty sandy CLAY with roots. HDD-CL
	▼	1.52	D							
		2.44 - 2.90	B				2.40	35.80		Medium dense brown sandy fine to medium GRAVEL FGA-SG
		3.51 - 3.96	B				3.20	35.00		Medium dense brown clayey fine to medium GRAVEL FGA-SG
		4.57 - 5.03	U				4.40	33.80		Stiff to very stiff friable mottled red-brown and grey clayey SILTY or silty CLAY; thin bands of sandstone and mudstone below 4.7m. MM-Z3
		5.03	D							
		5.64	D							
		6.10 - 6.55	U							
		6.55	D							
		7.16	D							
		7.62 - 8.08	U							
		8.08	D							
		8.69	D							
		9.14 - 9.60	U							
		9.60	D							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 1.53m below ground level on the morning of 7.07.64 but had risen to 1.22m below ground level by the following morning. Sample of ground-water taken.

AGS

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Rotary Core Log

Borehole No. HIS0026 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447168.00 - 334584.00	Hole Type CP
Location:		Level: 38.20	Scale 1:50
Client: Highways England		Dates: 06/07/1964 - 08/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.21	D							
		10.67 - 11.13	U							
		11.13	D							
		11.73	D							
		12.19 - 12.65	U							
		12.65	D							
		13.26	D							
		13.72 - 14.17	U							
		14.17	D							
		14.78	D							
		15.54 - 16.00	U							
		16.00	D							
		16.46	D							
		17.07 - 17.53	U							
		17.53	D							
		17.98	D							
		18.29 - 18.75	U							
		18.75	D							
		18.75	W				18.91	19.29		End of borehole at 18.89 m

Remarks
Ground-water was first encountered at a depth of 1.53m below ground level on the morning of 7.07.64 but had risen to 1.22m below ground level by the following morning. Sample of ground-water taken.

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Trial Pit Log

Trialpit No: TP1114
Sheet 1 of 1

Project Name:	SMP - M1 J23A TO J25	Project No.: COCDFL1SMP01	Co-ords: 447114.00 - 334640.00 Level: 42.25
Date	19/10/2006		
Location:		Dimensions (m): 2.8 x 1.8 Depth 4.10	
Scale	1:25		
Client:	Highways England		
Logged	RMS		

Water Strike	Samples and In Situ Testing: Depth	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
							Brown slightly sandy clayey TOPSOIL (Stratum I) TP
				0.30	41.95		MADE GROUND. Red brown slightly sandy slightly gravelly clay. Gravel is fine to coarse subangular to subrounded mudstone. Locally mottled grey with gravel of siltstone. (Stratum II) MG-EF
	0.50	B					
	1.00	B					
				1.20	41.05		MADE GROUND: Brown mottled grey gravelly clay. Gravel is fine to coarse subangular to subrounded coal, mudstone, quartz and sandstone. (Stratum III) MG-EF *At 1.50m, blocks of dark grey slate*
	1.30	B					
				2.40	39.85		Light brown sandy CLAY with occasional rounded fine to coarse gravel of quartz, mudstone and sandstone. (Stratum IV) Possible HDD-CL *At 2.60m, rootlets* *Below 2.90m, very sandy with gravel of weak sandstone*
	2.50	B					
	3.10	B					
	3.80	B		3.80	38.45		Firm to stiff orange brown mottled grey sandy CLAY with occasional fine to coarse subrounded to rounded gravel sized fragments of quartz, siltstone, coal, sandstone and chalk. (Stratum V) Possible HDD-CL
				4.10	38.15		*End of pit at 4.10 m*

Remarks: Prior to excavation a Cable Avoidance Tool (CAT) survey was carried out. Services were not encountered.;On completion the trial pit was backfilled with compacted arisings.;No visual or olfactory indication of contamination was observed.;

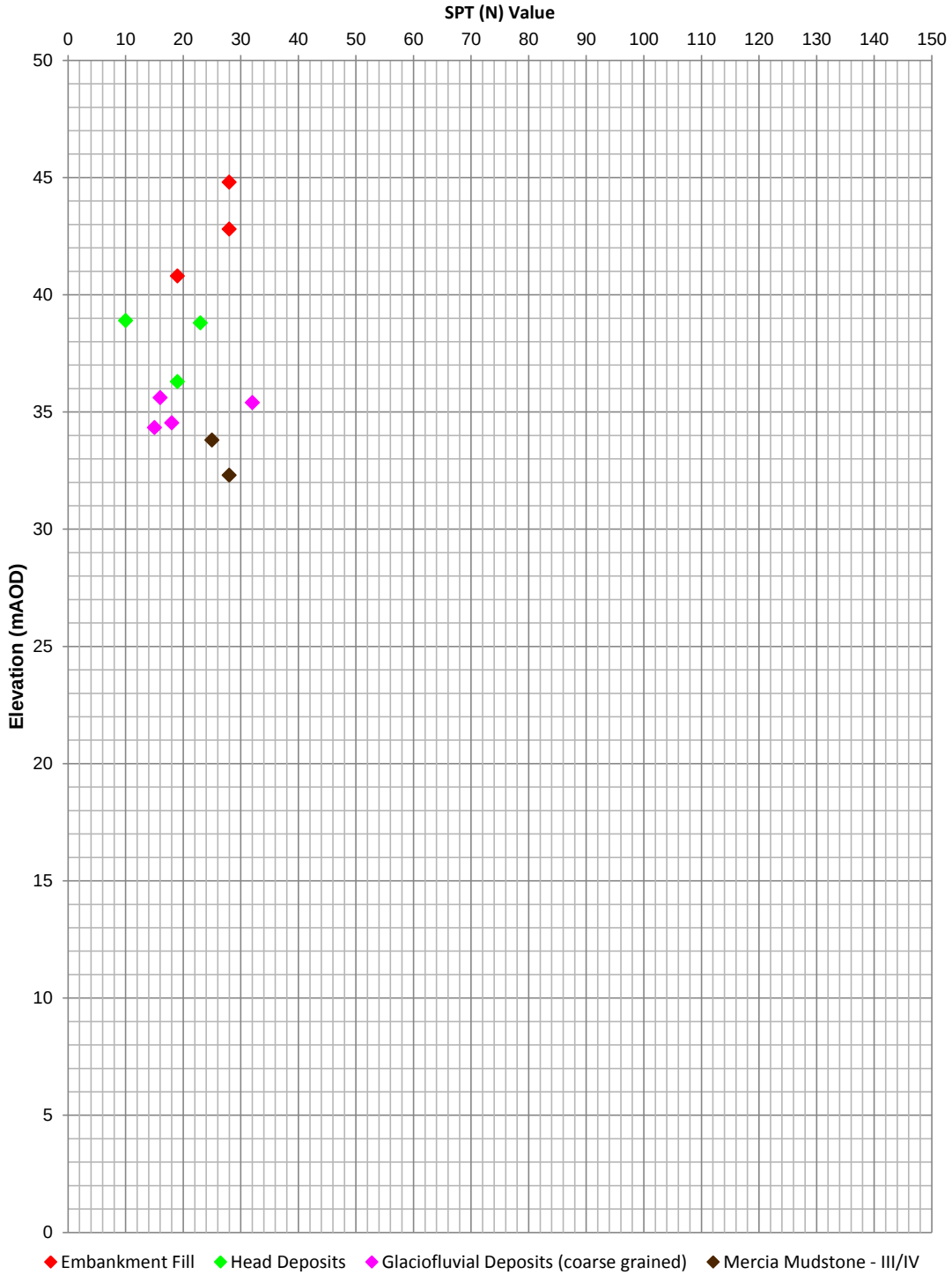
Stability: The walls of the pit were stable during excavation.

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PLOTS

amey ARUP	**SPT N Value vs Depth**
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25** | Data Sheet: **192560-192710SB**
Client: **Highways England**	Borehole ID: **HIS0023, HIS0025, HIS0026, CP1115**



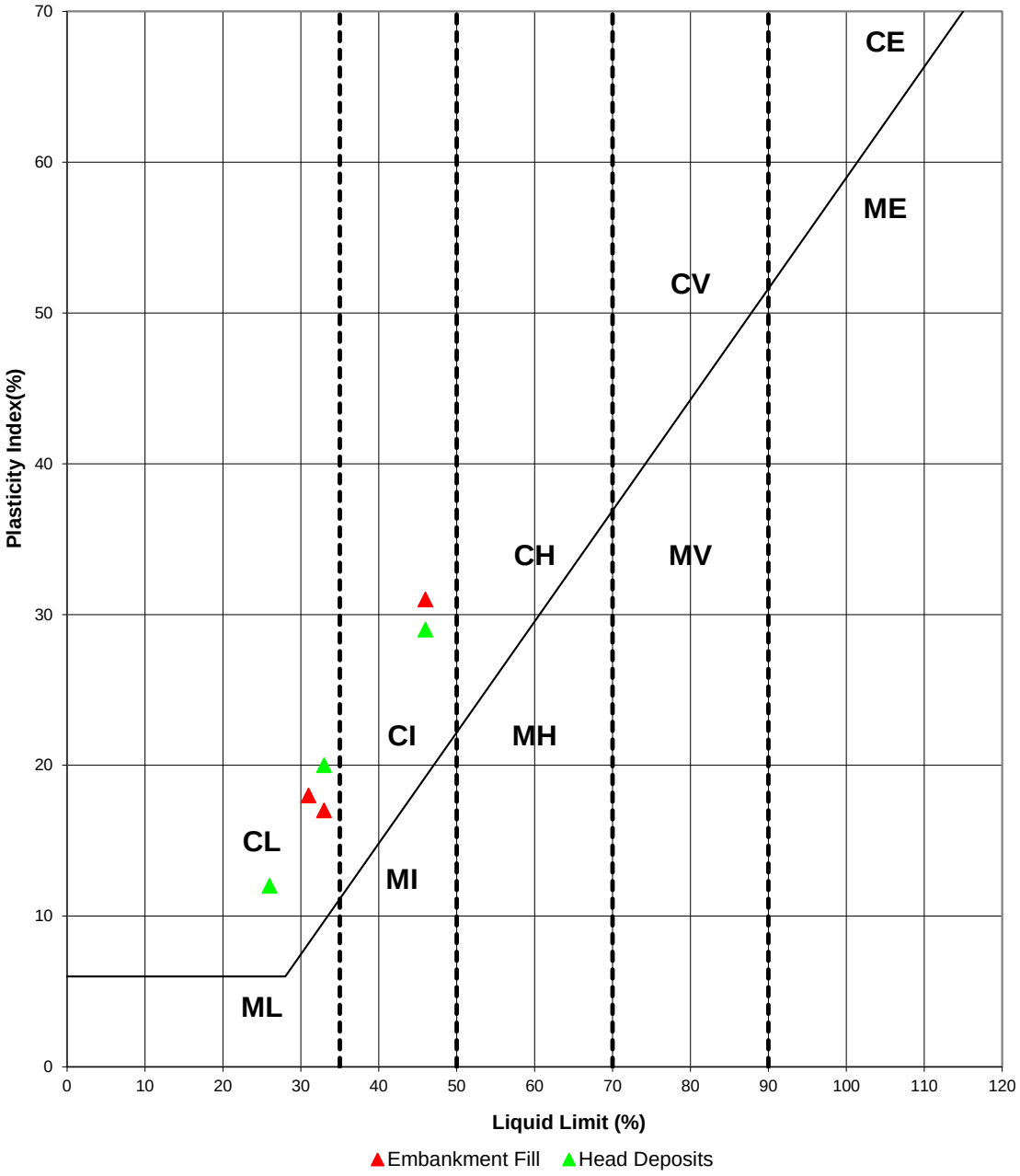
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 08/02/2017 Ref: HA549342-AMAR-HGT-192560-192710SB-GSS-CE-000001 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **Ch192560-192710SB**
Client: **Highways England**	Borehole ID: **CP1115, TP1114**	



Key

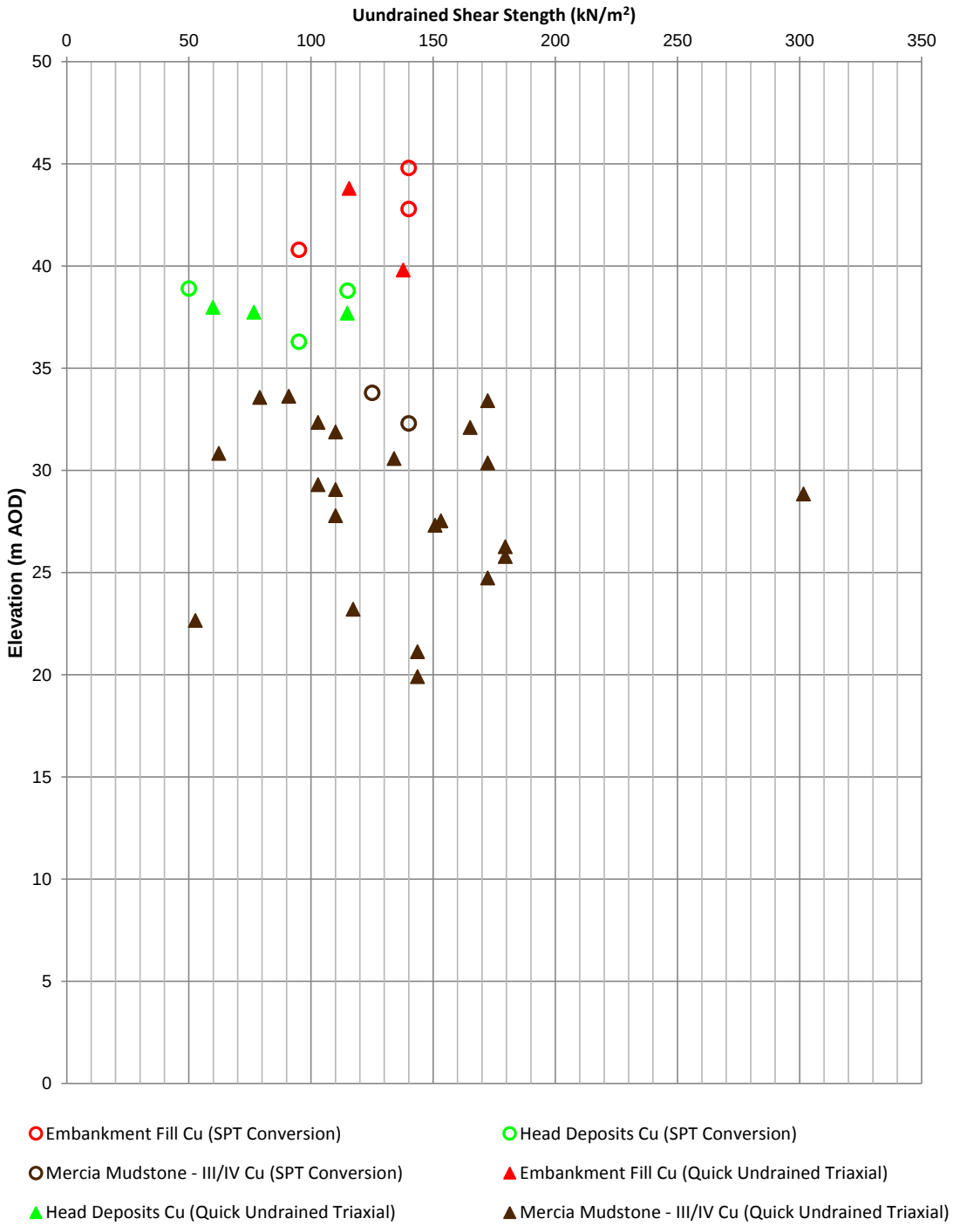
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 09/02/2017 ef: HA549342-AMAR-HGT-Ch192560-192710SB-GSS-CE-0000(Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **Ch192560-192710SB**
Client: **Highways England**	Borehole ID: **CP1115, HIS0023, HIS0025, HIS0026**	



Rev: P01 Date: 23/02/2016 ef: HA549342-AMAR-HGT-Ch192560-192710SB-GSS-CE-0000C Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-192710-192840-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	192710-192840		
Carriageway	Southbound		
Marker Post	192/7B+10 – 192/8B+40		
National Grid Reference	E 447158, N 334747 – E 447161, N 334875		
Existing Ground Level at Carriageway	Carriageway	45.5mAOD	
	Toe of Embankment	39.5mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_221148 & 7_M1_22180	HAGDMS designation
Earthwork Height	NB: N/A	SB: 5.7-6.0m	HAGDMS designation
Earthwork Angle	NB: N/A	SB: 23°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Simon Arinze	16/02/2017	[redacted]
Checked	Alice Bazen	18/02/2017	
Reviewed	Gary Summerfield	21/02/2017	
Approved	Tom Bulteel	28/02/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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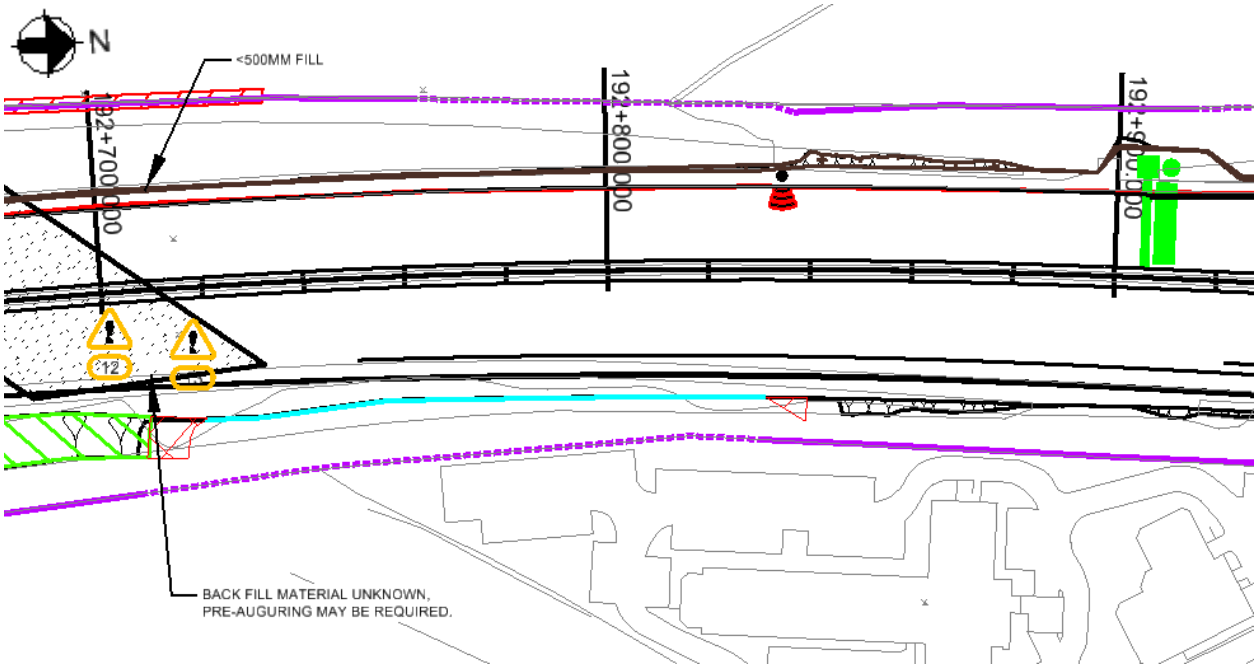


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- A king sheet pile retaining wall, situated on the southbound carriageway was proposed. The king sheet pile wall varies in retained height across its extents; therefore it was subdivided into the following sections for design and construction purposes:
  - Ch192720-192770 – retained height up to 3.4m;
  - Ch192770-192830 – retained height up to 2.5m.

Proposed Major Structures

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130) has been supplied to AMAR indicating that the location is at an earthwork classified as an embankment. The Lidar survey does not pick up the full extents of the embankment; therefore information available on HAGDMS has been used for the earthworks heights. The following have been assumed for design:

- Ch192720-192770 – embankment height 5.7-5.8m and slope gradient of 23°;
- Ch192770-192830 – embankment height 6.0m and slope gradient of 23°.

The critical cross sections at chainage 192730 and 192770 are based on sections with the greatest retained height.

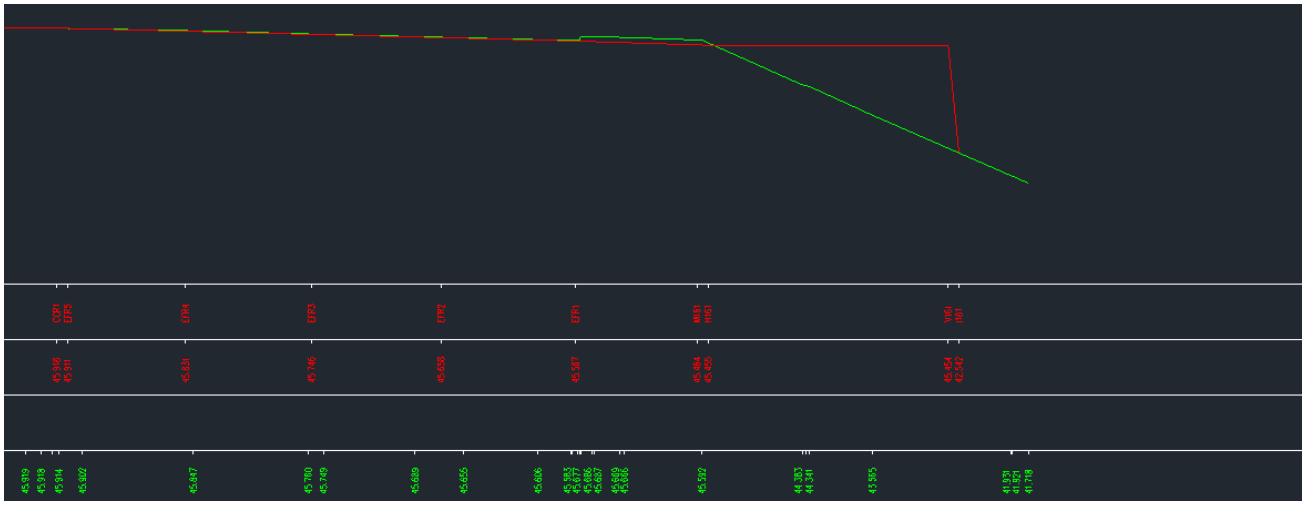


Figure 2.1: Topographic Critical Cross Section Chainage 192730 (for 3.4m retained height)

The above cross section shows a retained height of 2.9m; however, this does not include for a 1m wide walkway in front of the wall. Therefore, a further 0.5m of retained height was added to compensate for construction of the walkway, making the total retained height 3.4m.

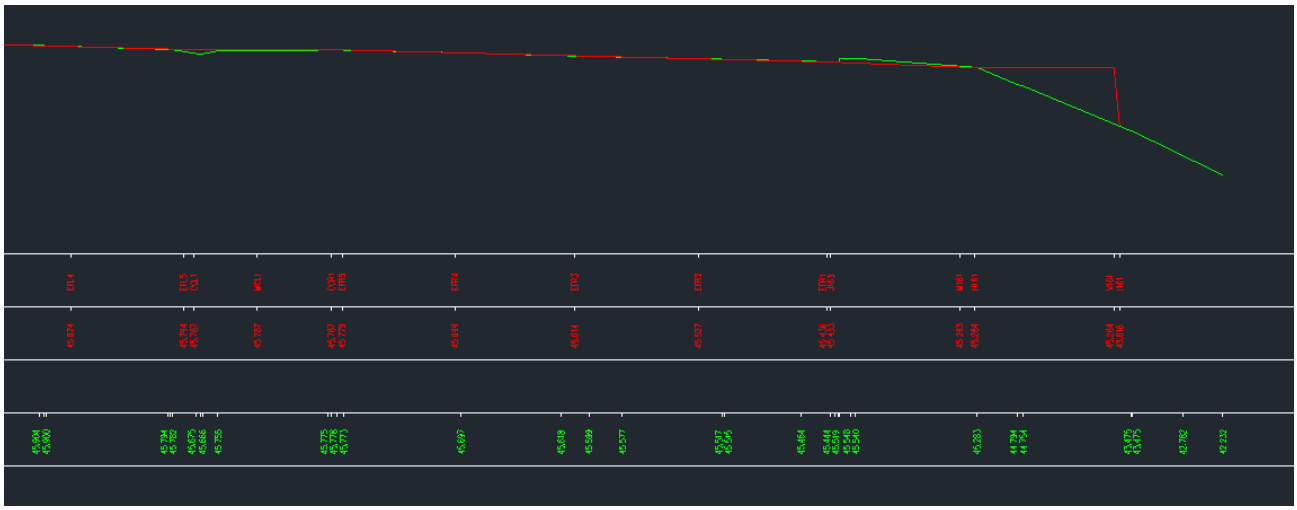


Figure 2.2: Topographic Critical Cross Section Chainage 192770 (for 2.5m retained height)

The above cross section shows a retained height of 2.0m; however, this does not include for a 1m wide walkway in front of the wall. Therefore, a further 0.5m of retained height was added to compensate for construction of the walkway, making the total retained height 2.5m.

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Head Deposits

Solid Deposits: Gunthorpe Member (Mercia Mudstone Group)

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Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, with no additional relevant exploratory holes considered. Ground model has been assumed based on LiDAR Survey and Geological Long Section Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000038, Rev P01



Figure 3: Borehole Location Plan

Flood Risk:

This earthwork is not in an area at risk from flooding.

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey

The critical cross sections for 3.4m and 2.5m retained height are only 30m apart and do not contain the full earthwork due to a lack of topographic data; therefore the same ground model has been adopted for them both (but with differing retained heights). The following ground conditions are assumed, based on topographic and historical exploratory hole data, at carriageway level:

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*
Embankment Fill	6.0	39.5	None recorded
Head Deposits	12.5	33.0	None recorded
Mercia Mudstone – III/IV	>12.5	<33.0	None recorded

The area is within a zone of back-fill material, therefore there may be coarse grained artificial materials present beneath the Embankment Fill; however this has been omitted from the ground model for a conservative design. The ground conditions will be confirmed by a 'Just in Time' Validation Ground Investigation before construction.

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Groundwater:

No groundwater data was available.

Groundwater Design Level:

No local groundwater data is available and therefore a groundwater level of 1.0m below toe of embankment has been assumed for WALLAP analysis for king and intermediate sheet piles. When checking the global stability check of the earthwork and king and intermediate sheet piles (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

No local lab test data was available.

Lab Test Data – BRE Classification:

No local lab test data was available.

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Assumed Ground Model For Design:

Ground model based on geological long section HA549342-AMAR-HGT-SWI-DR-CE-000038 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outlines the assumed anticipated ground model from carriageway level:

The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0-6.0	45.5-39.5	6.0	21	27	0	100	7.8	6.2	-	0.5	0.2	-	DS-2 AC-2
Head Deposits	6.0-12.5	39.5-33.0	6.5	20	27	0	100	7.8	6.2	-	0.5	0.2	-	DS-1 AC-1
Mercia Mudstone – III/IV	>12.5	<33.0	-	21	30	2	100	16.8	13.4	-	0.5	0.2	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are for the proposed location only.
(2) Due to the lack of localised GI data, typical values for parameters derived in the AMAR GIR were used.
(3) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for all strata's, the classification used for the strata in the AMAR GIR was adopted.

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Imported Granular Fill (Class 6N) was included as backfill to the king sheet pile wall in the design calculations; the granular material was assumed to have the following properties:

:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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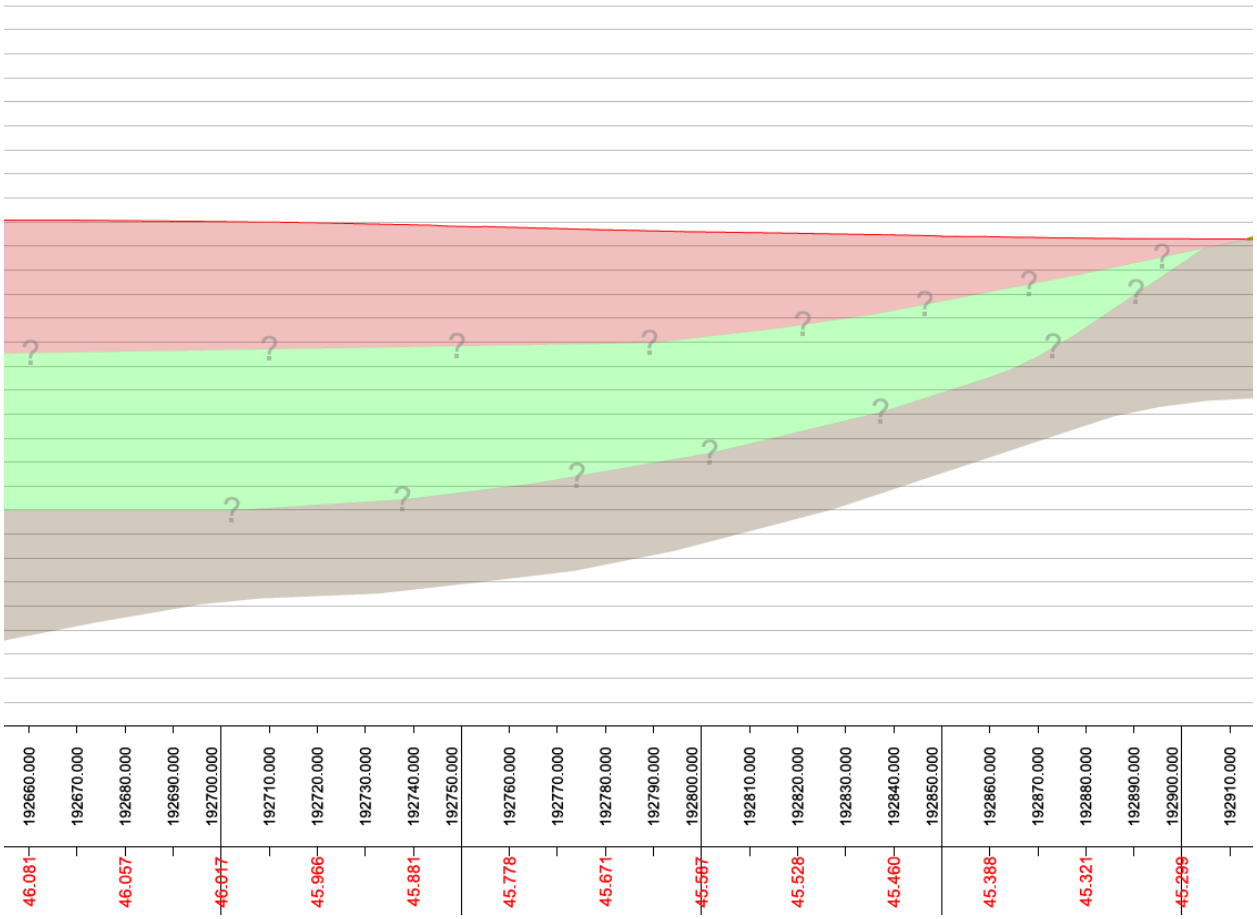


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Earthwork regrade was considered at this location, however due to highway boundary, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
192710	192770	AZ-50 S 390 GP	3.4	9.1	12.5	81	50	58	193.3
192770	192840	AZ-36 S 390 GP	2.5	6.0	8.5	88	50	36.0	89.2

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH-CPT13 at chainage 192790, Southbound - CPT hole to 20m depth.
- BH-R-SB2_800y at chainage 192722, dynamic sample with rotary core exploratory hole to 13m depth.

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HISTORICAL EXPLORATORY HOLES

None due to lack of local GI data.

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PLOTS

None

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-193300-193490SB-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall & Gabion Wall		
Structure Number	Gantry 323		
Structure Type	MS4 Cantilever Gantry		
Design Chainage	193300-193490		
Carriageway	Southbound		
Marker Post	193/3+00 – 193/4+90		
National Grid Reference	E 447211, N 335365 – E 447214, N 335525		
Existing Ground Level	Crest of Cutting	54.7mAOD	
	Carriageway	48.9mAOD	
Earthwork Type	NB: N/A	SB: Cutting	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_22232; 7_M1_22154; 7_M1_22179; 7_M1_21996	HAGDMS designation
Earthwork Height	NB: N/A	SB: 5.8m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 27°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Scott Bishton	14/02/2017	[redacted]
Checked	Alice Bazen	17/02/2017	
Reviewed	Gary Summerfield	21/02/2017	
Approved	Tom Bulteel	28/02/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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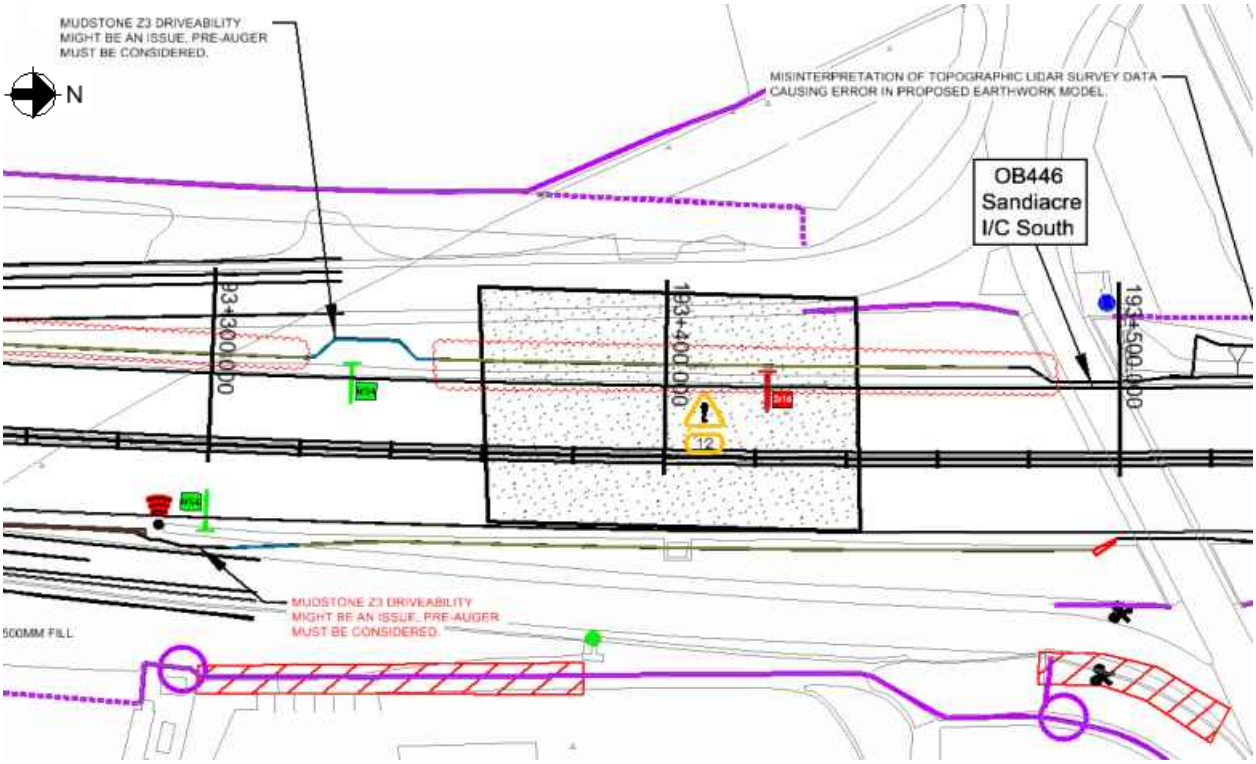


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch193300-193320: King Sheet Pile Retaining Wall;
- Ch193320-193490: Gabion Wall.

Proposed Major Structures:

MS4 Cantilever Gantry (Gantry 323) proposed on the southbound carriageway/verge at chainage 193300.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a cutting. The cutting ranges approximately from 1.1m to 5.8m (south to north) in height and has a typical slope angle of 27°.

The critical cross sections are based on the sections with the greatest retained height located on an onslip.

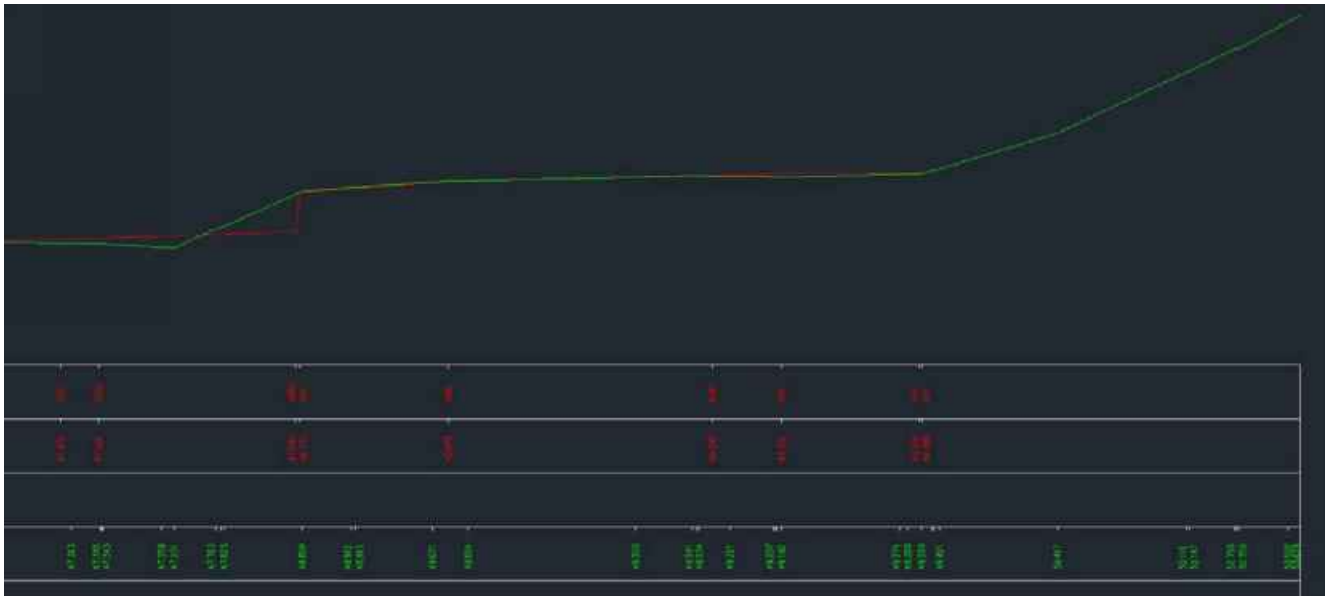


Figure 2.1: Topographic Critical Cross Section Chainage 193320 – King Sheet Pile Wall

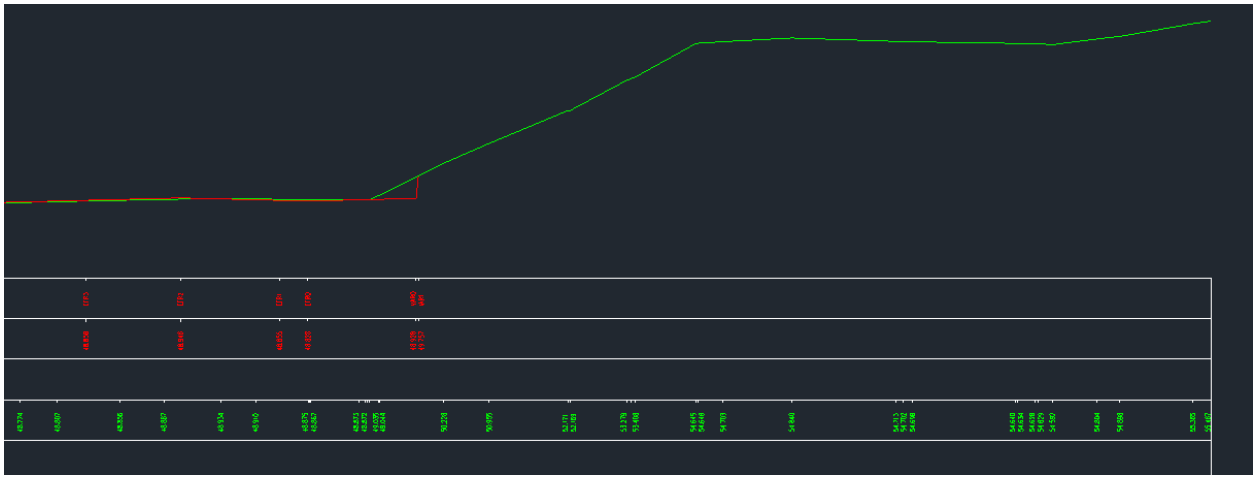


Figure 2.2: Topographic Critical Cross Section Chainage 193480 – Gabion Wall

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 125, Derby and Map Sheet 141 Loughborough indicates that the site is underlain by:

Superficial Deposits: Eagle Moor Sand and Gravel Member* (Glaciofluvial Deposits)

Solid Deposits: Gunthorpe Member** (Mercia Mudstone Group)

*between Ch193300-193350 only

**Undifferentiated between Ch193430-193490

Ground Investigation:

There are 5 No. historical exploratory holes recorded within the design chainage, with additional 3 no. relevant exploratory holes considered outside the design chainage as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000039, Rev P01.

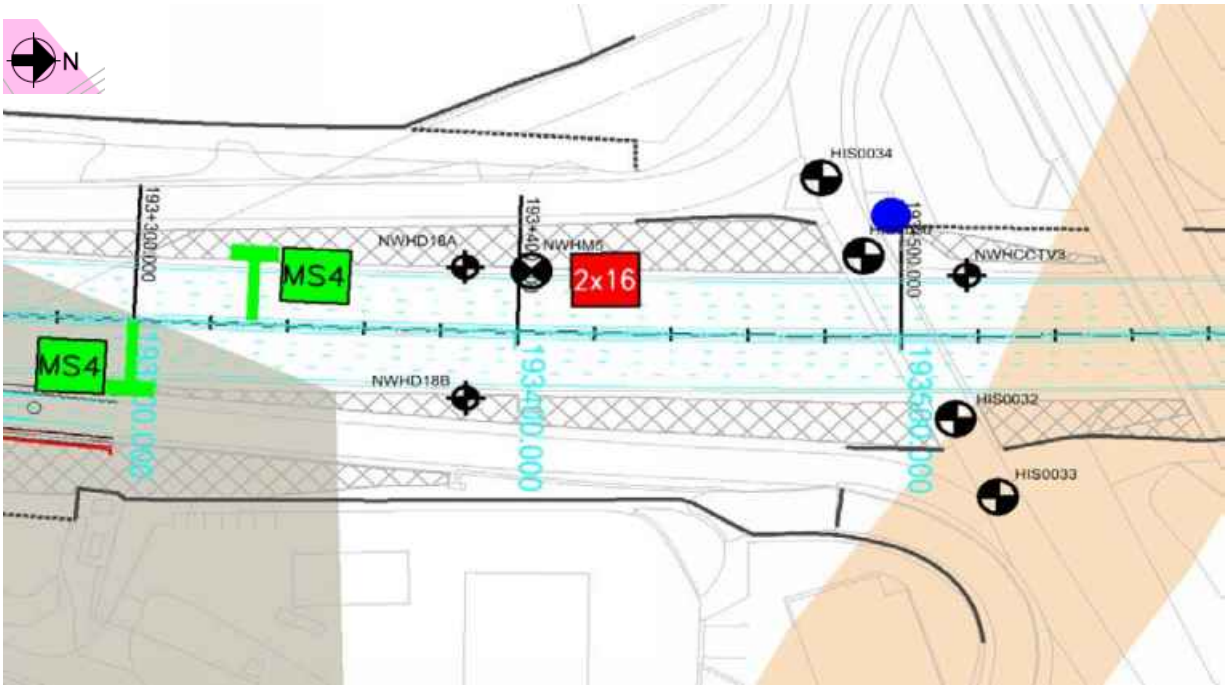


Figure 3: Borehole Location Plan

Flood Risk:

This earthwork is not in an area at risk from flooding.

Historical Boreholes:

Relevant Borehole Number	NWHD18B	HIS0032
Borehole Chainage	193388	193515
Borehole Location	Southbound (in existing soft verge)	Southbound (beneath overbridge, prior to motorway construction)
National Grid Reference	E 447213, N 335420	E 447219, N 335548
Ground Level at Exploratory Hole	48.5	51.2
RAG Analysis	Amber	Green

Date Drilled	09/09/1999	15/07/1964-27/07/1964
Termination Depth	2.20mbgl	10.52mbgl
Other suitable holes	HIS0030, HIS0033, HIS0034, NWHCCTV3, NWHM5, NWHD18A	

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range
Mercia Mudstone – III/IV	>0	<54.7	>150*

(1) Ground level is assumed to be at the crest of the cutting.
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(3) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.
(4) Within historical exploratory hole NWHM5 beneath carriageway level there is Made Ground (coarse grained) with an approximate thickness of 1.10m. As a conservative design assumption, as there is insufficient evidence to show that the Made Ground is continuous across the earthworks extents, Made Ground is not included in the ground model and Mercia Mudstone – III/IV is assumed instead.

In Situ Testing:

7 No. Standard Penetration Tests (SPTs) were undertaken within historical exploratory hole NWHM5 within Mercia Mudstone – III/IV only; all of these tests gave results >50 (of which were extrapolated to >150). These results were considered to be unreliable due to the amount of extrapolation required to produce an SPT 'N' value based on the small amount of penetration recorded from the in situ tests, therefore have not been considered further.

Groundwater:

The following groundwater strikes were recorded in historical exploratory holes for this location:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
HIS0030	Mercia Mudstone	3.81	49.10	-	2.44	50.47
HIS00032	Mercia Mudstone	3.51	47.69	-	2.13	49.07
HIS0033	Mercia Mudstone	2.13	48.37	-	-	-
HIS0034	Mercia Mudstone	3.05	50.45	-	-	-

Groundwater Design Level:

A groundwater level of 1.0m below carriageway level has been assumed for WALLAP analysis for king and intermediate sheet piles and assessment of gabion walls. When checking the global stability check of the earthwork and king and intermediate sheet pile (analysed using SLOPE W) a Ru value of 0.2 for has been used for all strata.

GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

32 No. undrained triaxial tests were undertaken within the Mercia Mudstone – III/IV within historical exploratory holes HIS0030, HIS0032, HIS0033 and HIS0034. Results are presented in the table below:

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Mercia Mudstone	0.15	117
Mercia Mudstone	0.15	218
Mercia Mudstone	0.46	158
Mercia Mudstone	1.68	110
Mercia Mudstone	1.68	96
Mercia Mudstone	1.98	187
Mercia Mudstone	1.98	117
Mercia Mudstone	3.05	124
Mercia Mudstone	3.2	65
Mercia Mudstone	3.35	165
Mercia Mudstone	3.51	103
Mercia Mudstone	4.42	31
Mercia Mudstone	4.57	194
Mercia Mudstone	5.03	139
Mercia Mudstone	5.64	96
Mercia Mudstone	5.64	201
Mercia Mudstone	6.55	103
Mercia Mudstone	7.32	244
Mercia Mudstone	7.62	141
Mercia Mudstone	7.62	180
Mercia Mudstone	8.08	69
Mercia Mudstone	9.14	180
Mercia Mudstone	9.14	77
Mercia Mudstone	9.14	89
Mercia Mudstone	9.6	180
Mercia Mudstone	10.06	139
Mercia Mudstone	10.67	153
Mercia Mudstone	10.67	139
Mercia Mudstone	11.13	26
Mercia Mudstone	12.19	184
Mercia Mudstone	12.19	302
Mercia Mudstone	12.8	86

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Mercia Mudstone	13.72	139

Lab Test Data – BRE Classification:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Mercia Mudstone – III/IV	Sulphate (Total) as SO4	Solid	11	0.01 – 0.16	%SO4
Mercia Mudstone – III/IV	Water Soluble Sulphate as SO4	Water	2	0.16-0.22	g/l SO4
Mercia Mudstone – III/IV	pH	Solid	13	7.1-8.7	-

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Assumed Ground Model For Design:

Ground model based on geological long section HA549342-AMAR-HGT-SWI-DR-CE-000039 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outlines the assumed anticipated ground model from cutting crest:

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that road level on the base of the cutting is straight on to the Mercia Mudstone III/IV at this location. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			Shear Modulus (MN/m^2)	Adhesion Factor α	K_s/K_0	Nc	Nq	BRE Classification
								E_u	E'	E	V_u	v'	v						
Mercia Mudstone – III/IV	>0	<54.7	-	21	30	2	130	10.80	8.60	-	0.50	0.20	-	3.60	0.44	-	6.2*	-	DS-1 AC-1[d]

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, values for bulk density, friction angle, cohesion, Young's Modulus and Poisson's ratio derived in the AMAR GIR are used as a basis for the parameters above.
(3) For a conservative design, Made Ground is not included in the ground model and Mercia Mudstone – III/IV is assumed rather than Mercia Mudstone – I/II.
(4) Based on recorded undrained triaxial tests within Mercia Mudstone – III/IV, a typical c_u value of $130kN/m^2$ was adopted for Mercia Mudstone – III/IV.
(5) Shear modulus is based on G = E/2(1+v).
(6) Adhesion Factor for Mercia Mudstone is based on BS8004 (equation 41).
(7) Nc is based on CIRIA C570. * Nc increases to '9' from 3.6m bgl
(8) BRE Classification is determined using criteria set out in BRE Special Digest 1.

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Imported Granular Fill (Class 6N) was included in the design of a gabion wall alternative solution. The fill was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25
Gabion Fill (Class 6G)	24	-	-	-

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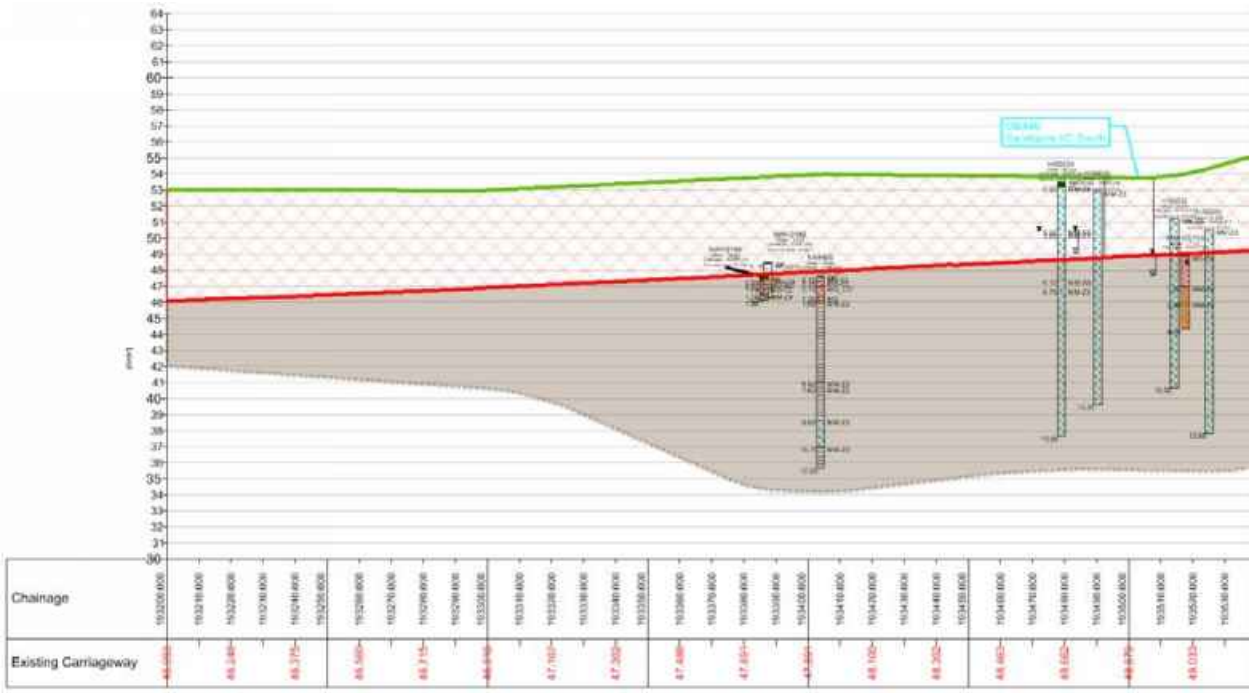


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to a slip road in close proximity, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
193300	199320	AZ-12 S 390 GP	0.8	2.4	20	72	44	5.0	8.4

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

Start Chainage	End Chainage	Carriageway	Solution	Layers	Gabion Wall Dimensions			
					Width (m)	Length (m)	Height (m)	Benching Batter Angle (°)
193320	193490	southbound	Gabion Wall	Lower	1.0	1.0	1.0	45
				Upper	1.0	1.0	1.0	45

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Proposed Structural Solution:

Following single pile analysis using an in-house spreadsheet and group pile analysis using Piglet software, the following foundations were determined in accordance with EC7:

Number of Piles	Pile Diameter (mm)	Pile Length (m)	Pile Spacing – Centre to Centre (m)	Maximum Deflection (mm)	Maximum Bending Moment (kNm)	Pile Working Load (kN)
4 (2x2)	750	6.0	2.25	8	242	398

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is required at this location to confirm the ground conditions: The following GI has been proposed:

- BH–G323 at chainage 193300, Southbound, 11m dynamic sample with rotary follow.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **HIS0030** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447171.00 - 335524.00	Hole Type CP
Location:		Level: 52.91	Scale 1:50
Client: Highways England		Dates: 22/07/1964 - 25/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.46 - 0.91	U							Stiff to very stiff friable mottled red-brown and gery silty CLAY with bands of sandstone and mudstone (Keuper Marl) MM-Z3
		0.91	D							
		1.37	D							
		1.98 - 2.44	U							
	▼	2.44	D							
		2.90	D							
		3.51 - 3.96	U							
	▽	3.96	D							
		4.42	D							
		5.03 - 5.49	U							
		5.49	D							
		5.94	D							
		6.55 - 7.01	U							
		7.01	D							
		7.47	D							
		8.08 - 8.53	U							
		8.53	D							
		9.30	D							
		9.60 - 10.06	U							

1 2 3 4 5 6 7 8 9 10

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.81m below ground level but had risen to 2.44m below ground level on the morning of 25.07.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. HIS0030
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447171.00 - 335524.00	Hole Type CP
Location:		Level: 52.91	Scale 1:50
Client: Highways England		Dates: 22/07/1964 - 25/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.06	D							
		11.13 - 11.58	U							
		11.58	D							
		12.80 - 13.26	U							
		13.26	D				13.30	39.61		End of borehole at 13.26 m
		13.26	W							

Remarks
Ground-water was first encountered at a depth of 3.81m below ground level but had risen to 2.44m below ground level on the morning of 25.07.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. HIS0032

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447219.00 - 335548.00	Hole Type CP
Location:		Level: 51.20	Scale 1:50
Client: Highways England		Dates: 15/07/1964 - 27/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.15 - 0.61	U							Stiff to very stiff friable mottled red-brown and gery silty CLAY; bands of mudstone and sandstone below 2.6m MM-Z3
		0.61	D							
		1.68 - 2.13	U							
	▼	2.13	D							
		2.59	D							
		3.05 - 3.51	U							
	▽	3.51	D							
		4.42 - 4.88	U							
		4.88	D							
		5.64 - 6.10	U							
		6.10	D							
		7.62 - 8.08	U							
		8.08	D							
		9.14 - 9.60	U							
		9.60	D							

Continued on next sheet

Remarks

Ground-water was first encountered at a depth of 3.51m below ground level but had risen to 2.13m below ground level by the morning of 27.07.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. **HIS0032**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447219.00 - 335548.00	Hole Type CP
Location:		Level: 51.20	Scale 1:50
Client: Highways England		Dates: 15/07/1964 - 27/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.06 - 10.52	U							
		10.52	D				10.52	40.68		End of borehole at 10.52 m
		10.52	W							

Remarks
Ground-water was first encountered at a depth of 3.51m below ground level but had risen to 2.13m below ground level by the morning of 27.07.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. HIS0033
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447242.00 - 335559.00	Hole Type CP
Location:		Level: 50.50	Scale 1:50
Client: Highways England		Dates: 16/07/1964 - 29/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.15 - 0.61	U							Stiff becoming very stiff, friable mottled red-brown and grey silty CLAY with bands of sandstone and mudstone MM-Z3
		0.61	D							
		1.68 - 2.13	U							
	▼	2.13	D							
		3.20 - 3.66	U							
		3.96	D							
		4.42 - 4.88	U							
		4.88	D							
		5.64 - 6.10	U							
		6.10	D							
		7.32 - 7.77	U							
		7.77	D							
		9.14 - 9.60	U							
		9.60	D							

1 2 3 4 5 6 7 8 9 10

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 2.13m below ground level.

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Rotary Core Log

Borehole No. HIS0033
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447242.00 - 335559.00	Hole Type CP
Location:		Level: 50.50	Scale 1:50
Client: Highways England		Dates: 16/07/1964 - 29/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.67 - 11.13	U							
		11.13	D							
		12.19 - 12.65	U							
		12.65	D				12.68	37.84		End of borehole at 12.65 m

Remarks
Ground-water was first encountered at a depth of 2.13m below ground level.

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Rotary Core Log

Borehole No. **HIS0034**
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447148.00 - 335513.00	Hole Type CP
Location:		Level: 53.50	Scale 1:50
Client: Highways England		Dates: 17/07/1964 - 21/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	D				0.30	53.20		TOPSOIL TP
		0.46 - 0.91	U							Very stiff friable red-brown silty CLAY (Keuper Marl) MM-Z4
		0.91	D							
		1.52	D							
		1.98 - 2.44	U							
		2.44	D							
	▼	3.05	D				3.00	50.50		
							3.20	50.30		Grey SANDSTONE MM-SS
		3.35 - 3.81	U							Very stiff mottled red-brown and grey silty CLAY with mudstone (Keuper Marl) MM-Z3
		3.81	D							
		4.27	D							
		4.57 - 5.03	U							
		5.03	D							
		5.64 - 6.10	U							
		6.10	D				6.10	47.40		Grey SANDSTONE MM-SS
		6.71	B				6.70	46.80		Stiff to very stiff, becoming hard friable mottled red-brown and grey silty CLAY with bands of sandstone and mudstone (Keuper Marl) MM-Z3
		7.62 - 8.08	U							
		8.08	D							
		8.53	D							
		9.14 - 9.60	U							
		9.60	D							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.1m below ground level.

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Rotary Core Log

Borehole No. HIS0034
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447148.00 - 335513.00	Hole Type CP
Location:		Level: 53.50	Scale 1:50
Client: Highways England		Dates: 17/07/1964 - 21/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.06	D							
		10.67 - 11.13	U							
		11.13	D							
		11.58	D							
		12.19 - 12.65	U							
		12.65	D							
		13.11	D							
		13.72 - 14.17	U							
		14.17	D							
		14.63	D							
		15.24 - 15.70	U							
		15.70	D				15.86	37.64		End of borehole at 15.85 m

11 12 13 14 15 16 17 18 19 20

Remarks
Ground-water was first encountered at a depth of 3.1m below ground level.

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Borehole Log

Borehole No. NWHCCTV3
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447176.66 - 335550.93	Hole Type WS
Location:		Level: 48.89	Scale 1:50
Client: Highways England		Dates: 17/09/1999 - 17/09/1999	Logged By NBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.00	D					MADE GROUND: Reddish brown friable clay with a little fine coarse subrounded gravel sized fragments of sandstone with occasional sandstone cobbles. MG-CL
		0.00 - 1.90	D	Ublow=0				
		1.90 - 2.90	D	Ublow=0	1.90	46.99		Stiff reddish brown slightly sandy CLAY with occasional grey pockets (<50mm) of completely weathered mudstone. (Mercia Mudstone - Grade III?) MM-Z4
		1.90 - 2.90	D	Ublow=0				
		2.90 - 4.55	D	Ublow=0	2.90	45.99		Firm to stiff brownish red slightly sandy CLAY. (Mercia Mudstone - Grade III/IVa?) MM-Z4
		2.90 - 4.55	D	Ublow=0				
					4.55	44.34		End of borehole at 4.55 m

Remarks
1. Hand excavated inspection pit to 0.70m (0.40m x 0.50m). 2. Hole complete at 4.55m. 3. Hole dry. 4. Hole backfilled with grout. 5.Marker Post Ref 193/5

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Borehole Log

Borehole No. **NWHD18A**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447174.27 - 335420.31	Hole Type WS
Location:		Level: 47.60	Scale 1:50
Client: Highways England		Dates: 07/09/1999 - 07/09/1999	Logged By NBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20	47.40		TOPSOIL. TP
		0.60	D	Ublow=0	0.50	47.10		MADE GROUND: Yellow brown medium and coarse gravel of limestone. (Hardcore) MG-SG
		0.60	D	Ublow=0				
								MADE GROUND: Red brown sandy clay with some medium and coarse gravel of mudstone. MG-CL
		1.10 - 1.50	D	Ublow=0	1.10	46.50		
		1.10 - 1.50	D	Ublow=0				Red brown mottled blue grey highly locally completely weathered MUDSTONE, weak and very weak. (Mercia Mudstone - Grade IVa?) MM-Z4
					1.50	46.10		End of borehole at 1.50 m

Remarks
1. Hand excavated inspection pit to 1.00m (0.50m x 0.50m). 2. Hole dry. 3. Marker Post Ref 193/3 +80. 4. Hole backfilled with grout.

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Borehole Log

Borehole No. **NWHD18B**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447212.87 - 335420.34	Hole Type WS
Location:		Level: 48.50	Scale 1:50
Client: Highways England		Dates: 09/09/1999 - 09/09/1999	Logged By NBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.10 - 1.10	D	Ublow=0	0.10	48.40		TOPSOIL. TP. Red fine grained, moderately weathered SANDSTONE, weak. (Possible Made Ground) MG-SG
		0.10 - 1.10	D	Ublow=0				
		1.10 - 2.20	D	Ublow=0	1.10	47.40		Soft to firm red slightly sandy CLAY with a little fine to coarse gravel sized mudstone lithorelicts. MM-Z4
		1.10 - 2.20	D	Ublow=0				
					1.60	46.90		Firm red mottled greenish grey CLAY. MM-Z4
					2.20	46.30		End of borehole at 2.20 m

Remarks
1. Hand excavated to 0.70m (0.50m x 0.50m). 2. Hole terminated at 2.20m due to no penetration. 3. Hole dry. 4. Marker Post Ref 193/3+80. 5. Hole backfilled with grout.

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Rotary Core Log

Borehole No. **NWHM5** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447175.38 - 335437.53	Hole Type RC
Location:		Level: 47.67	Scale 1:50
Client: Highways England		Dates: 03/09/1999 - 04/09/1999	Logged By NBR

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.35	D				0.10	47.56		TOPSOIL. TP
		0.00 - 0.35	D				0.35	47.32		MADE GROUND: Brownish grey slightly clayey medium and coarse angular gravel sized fragments of limestone. MG-CL
		0.35	D							
		0.35 - 0.70	D				0.70	46.96		MADE GROUND: Reddish brown very silty clay with some fine and medium subangular gravel sized fragments of mudstone and siltstone. MG-CL
		0.70 - 1.30		0	0	0	1.30	46.36		MADE GROUND: Ballast fill. (Driller's description) Openholed from 0.70m to 1.30m. MG_CO
			98				1.60	46.06		MADE GROUND: Grey concrete. MG
			99							Reddish brown moderately weathered very silty MUDSTONE weak and very weak with extremely closely spaced random fractures tight smooth irregular. (Mercia Mudstone - Zone IIIa/II) MM-Z2
		1.70 - 2.70	25	40	0	0				
		2.70 - 3.00	25	50	0	0				
		3.00 - 3.70	97	0	0	0				
		3.70	D							
		3.92 - 4.40	25	42	0	0				
		4.40	D							
		4.60	C							
		4.62 - 5.40	97	0	0	0				
		5.62 - 6.40	97	0	0	0				
		6.65	C				6.62	41.04		Reddish brown very thinly bedded subhorizontal slightly to moderately weathered very silty MUDSTONE, weak with very closely spaced subhorizontal open rough planar. (Mercia Mudstone - Zone II) MM-Z2
		6.62 - 7.40	9	100	38	0	7.00	40.66		Reddish brown moderately weathered very silty MUDSTONE weak and very weak with extremely closely spaced random fractures tight smooth irregular. (Mercia Mudstone - Zone IIIa/II) MM-Z2
			25							
		7.62 - 8.00	97	0	0	0				
		8.00 - 9.00	25	33	0	0				
							9.00	38.66		Firm reddish brown very silty CLAY with much fine subangular lithorelicts up to 20mm. (Mercia Mudstone - Zone IIIa) MM-Z3
		9.22 - 10.00	98	25	0	0				
										Continued on next sheet

Remarks
1. Inspection pit excavated to 0.70m. 2. Borehole openholed to 1.30m. 3. Borehole complete at 12.00m. 4. Borehole backfilled with grout. 5. Marker Post Ref 193/4N.

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Rotary Core Log

Borehole No. **NWHM5**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447175.38 - 335437.53	Hole Type RC
Location:		Level: 47.67	Scale 1:50
Client: Highways England		Dates: 03/09/1999 - 04/09/1999	Logged By NBR

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.00 - 10.70	98	28	0	0				
							10.70	36.97		Reddish brown very thinly and thinly bedded subhorizontal slightly weathered very silty MUDSTONE, moderately weak and weak with very closely and closely spaced subhorizontal fractures open smooth and rough planar. (Mercia Mudstone Zone II) MM-Z2
		10.92 - 12.00	10	100	76	9				—from 11.65m vertical fracture open smooth planar
							12.00	35.66		End of borehole at 12.00 m

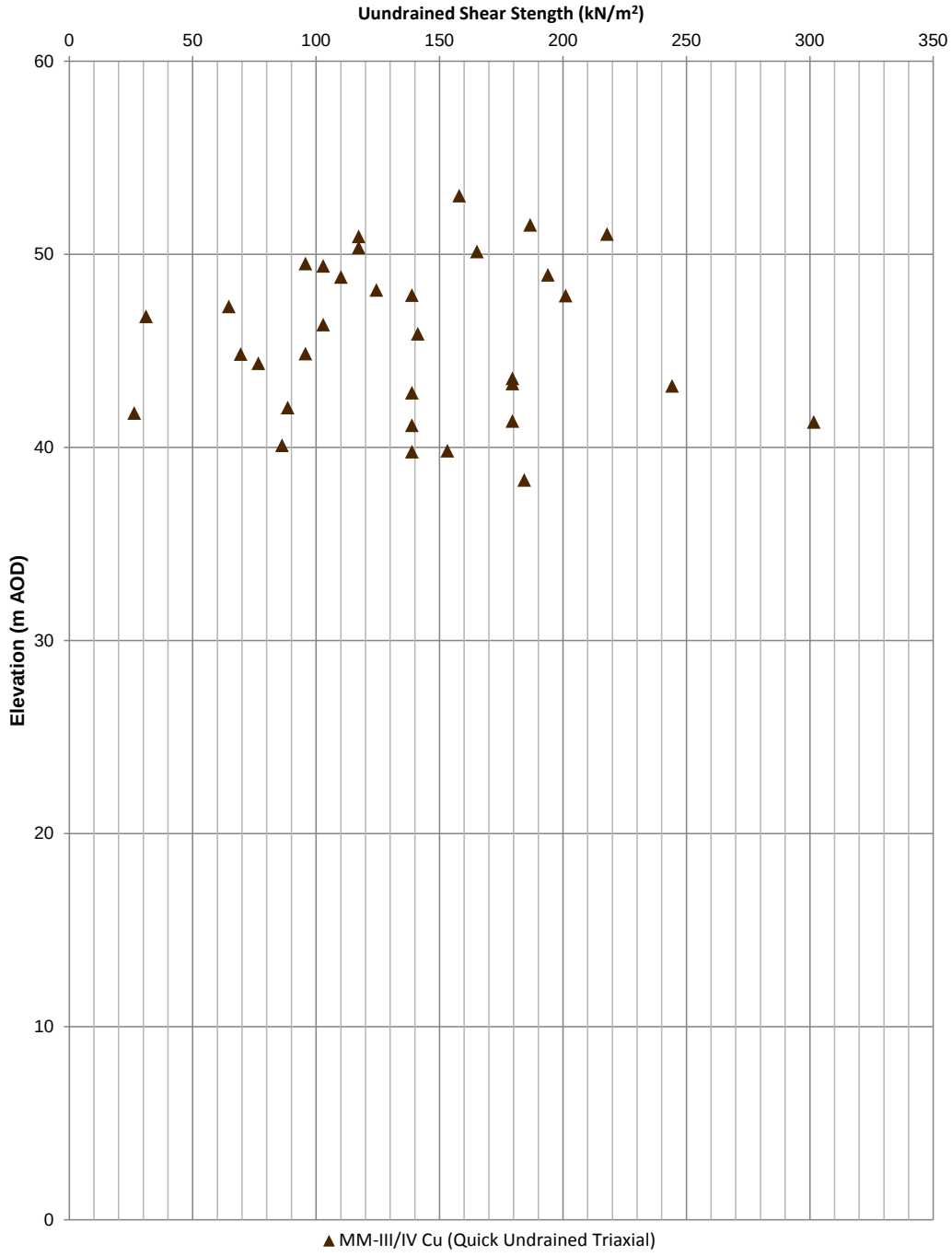
Remarks
1. Inspection pit excavated to 0.70m. 2. Borehole openholed to 1.30m. 3. Borehole complete at 12.00m. 4. Borehole backfilled with grout. 5. Marker Post Ref 193/4N.

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PLOTS

amey ARUP	Undrained Shear Strength vs Elevation
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25** | Data Sheet: **193300-193490**
Client: **Highways England**	Borehole ID: **HIS0030, HIS0032, HIS0033, HIS0034**



Rev: P01 Date: 20/12/2016 Ref: HA549342-AMAR-HGT-193300-193490-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-193680-193690SB-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	193680-193690		
Carriageway	Southbound		
Marker Post	193/6B+80 – 193/6B+90		
National Grid Reference	E 447211, N 335714 – E 447207, N 335726		
Existing Ground Level	Carriageway	50.9mAOD	
	Crest of Cutting	56.3mAOD	
Earthwork Type	NB: N/A	SB: Cutting	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_22152	HAGDMS designation
Earthwork Height	NB: N/A	SB: 5.4m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 26°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Scott Bishton	06/01/2017	[redacted]
Checked	Roheel Masrat	09/03/2017	
Reviewed	Gary Summerfield	10/03/2017	
Approved	Tom Bulteel	17/03/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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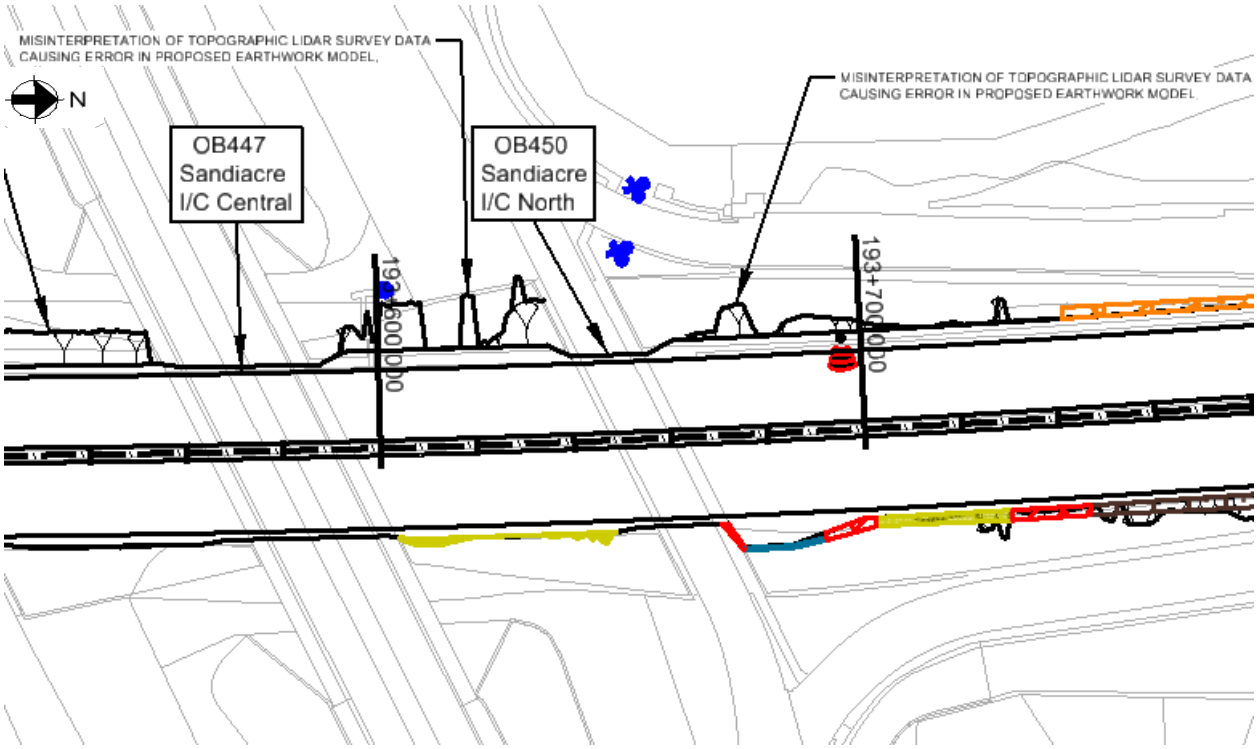


Figure 1: Location Plan

Proposed Earthwork Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed :

- King sheet pile retaining wall, situated on the southbound carriageway.

Proposed Major Structures:

No major structures are proposed within the design chainage.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the structure is located on an earthwork classified as a cutting. The cutting ranges from approximately 5.0-5.4m in height and has a typical slope angle of 26°.

The cross section with the greatest retained height has been used as the critical cross section. This is at Ch193680.

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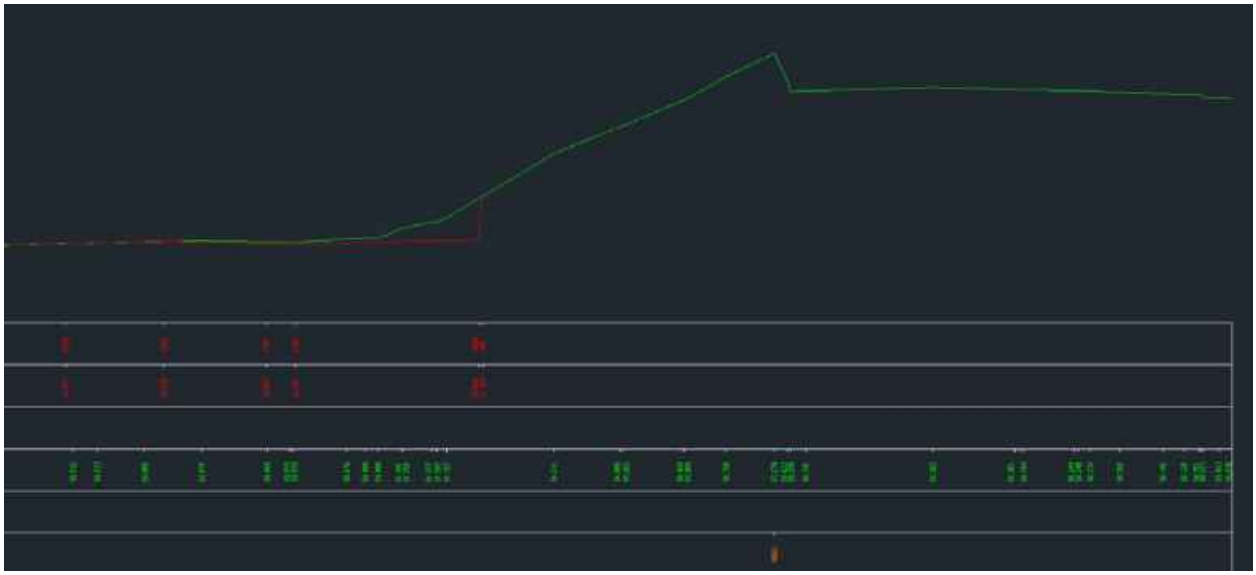


Figure 2: Topographic Critical Cross Section Chainage 193680

Utilities:

There is a gas mainline pipeline located at the crest of the cutting.

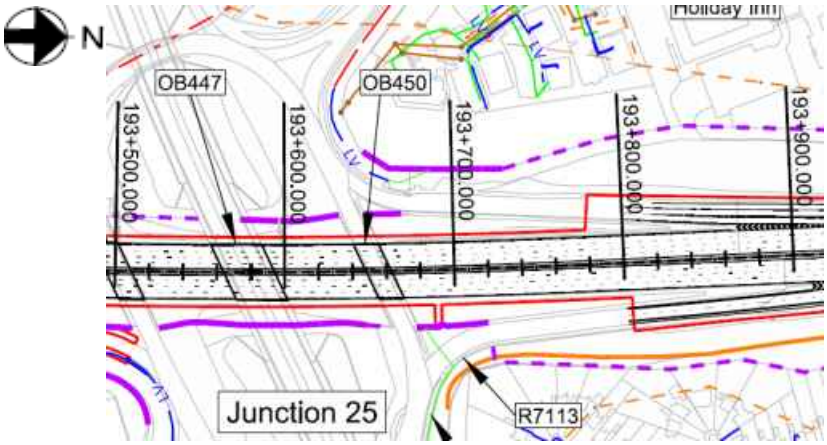


Figure 3: Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 125, Derby indicates that the site is underlain by:

Superficial Deposits: None recorded

Solid Deposits: Mercia Mudstone Group (Undifferentiated)

Ground Investigation:

There are no borehole located within the design chainage but 6 additional boreholes located outside the design chainage has been considered, as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000028, Rev P01.

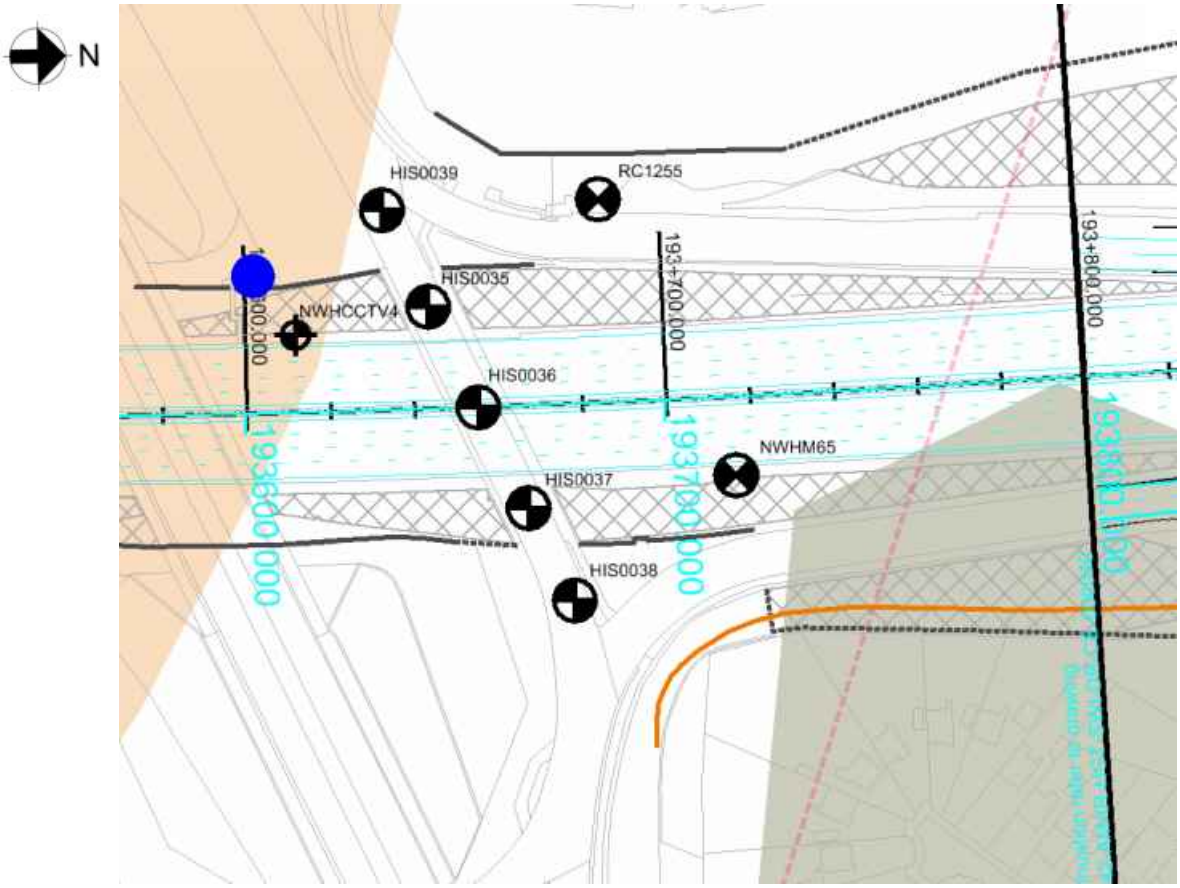


Figure 4: Borehole Location Plan

Flood Risk:

This earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	HIS0037	NWHM65	
Borehole Chainage	193668	193717	
Borehole Location	Southbound (beneath overbridge, completed before motorway construction)	Southbound (existing soft verge)	
National Grid Reference	E 447216, N 335701	E 447208, N 335750	
Ground Level at Exploratory Hole	55.80mAOD	51.32mAOD	
RAG Analysis	Green	Green	

Date Drilled	29/07/1964 – 30/07/1964	03/09/1999 – 04/09/1999	
Termination Depth	13.30 metres below ground level (mbgl)	12.00 metres below ground level (mbgl)	
Other suitable holes	RC1255, HIS0035-HIS0039, NHHCCTV4		

Existing Ground itions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range	Hand Vane Strength Range (kN/m^2)
Mercia Mudstone – III/IV (>50mAOD)	6.3	50.0	7-13 (10)	-
Mercia Mudstone – III/IV (<50mAOD)	>6.3	<50.0	33-143 (40)	-

(1) Ground level is assumed to be at the crest of the cutting
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(3) Given the uncertainties on ground conditions, only Mercia Mudstone – III/IV has been used in the ground model

The Mercia Mudstone – III/IV has been split at elevation 50.0mAOD based on historical GI data that shows a distinct increase in SPT 'N' values and undrained shear strength test results below 50.0mAOD.

Within historical exploratory hole NWHM65 beneath carriageway level there is Made Ground (coarse grained) with an approximate thickness of 0.70m. As a conservative design assumption, as there is insufficient evidence to show that the Made Ground is continuous across the earthworks extents, Made Ground is not included in the ground model and Mercia Mudstone – III/IV is assumed instead.

In Situ Testing:

13 No. Standard Penetration Tests (SPTs) were undertaken within historical exploratory holes NWHM65 and RC1255 within the Mercia Mudstone, the results are shown in the SPT plot appended to this document.

Groundwater:

The following groundwater strikes were recorded in historical exploratory holes for this location:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		m bgl	m AOD	Time	m bgl	m AOD
HIS0035		4.60	49.90	-	3.1m	51.30
HIS0036		1.80	53.20	-	-	-
HIS0037		4.60	51.20	-	-	-
HIS0038		3.50	53.20	-	-	-
HIS0039		4.40	49.60	-	3.40	50.60
NWHM65		9.00	42.32	-	-	-

Groundwater Design Level:

A groundwater level of 1.0m below carriageway level has been assumed for WALLAP analysis for king and intermediate sheet piles. When checking the global stability check of the earthwork and king and intermediate sheet piles (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

44 No. undrained triaxial tests were undertaken within the Mercia Mudstone – III/IV within historical exploratory holes HIS0035-HIS0039.

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Mercia Mudstone – III/IV	0.3	72
Mercia Mudstone – III/IV	0.3	139
Mercia Mudstone – III/IV	1.68	69
Mercia Mudstone – III/IV	1.83	55
Mercia Mudstone – III/IV	1.83	55
Mercia Mudstone – III/IV	1.98	53
Mercia Mudstone – III/IV	2.59	84
Mercia Mudstone – III/IV	3.2	43
Mercia Mudstone – III/IV	3.35	93
Mercia Mudstone – III/IV	3.35	67
Mercia Mudstone – III/IV	3.66	55
Mercia Mudstone – III/IV	4.72	89
Mercia Mudstone – III/IV	4.88	235
Mercia Mudstone – III/IV	4.88	57
Mercia Mudstone – III/IV	5.03	156
Mercia Mudstone – III/IV	5.18	84
Mercia Mudstone – III/IV	6.4	139
Mercia Mudstone – III/IV	6.4	48
Mercia Mudstone – III/IV	6.55	144
Mercia Mudstone – III/IV	6.71	132
Mercia Mudstone – III/IV	6.86	55
Mercia Mudstone – III/IV	7.92	165
Mercia Mudstone – III/IV	7.92	86
Mercia Mudstone – III/IV	8.08	139
Mercia Mudstone – III/IV	8.23	134
Mercia Mudstone – III/IV	8.23	235

Mercia Mudstone – III/IV	8.69	158
Mercia Mudstone – III/IV	9.45	69
Mercia Mudstone – III/IV	9.45	55
Mercia Mudstone – III/IV	9.6	192
Mercia Mudstone – III/IV	9.75	196
Mercia Mudstone – III/IV	10.21	306
Mercia Mudstone – III/IV	10.97	14
Mercia Mudstone – III/IV	10.97	55
Mercia Mudstone – III/IV	11.13	225
Mercia Mudstone – III/IV	11.28	158
Mercia Mudstone – III/IV	11.73	139
Mercia Mudstone – III/IV	12.19	29
Mercia Mudstone – III/IV	12.19	151
Mercia Mudstone – III/IV	12.34	69
Mercia Mudstone – III/IV	12.8	105
Mercia Mudstone – III/IV	13.41	45
Mercia Mudstone – III/IV	14.33	96
Mercia Mudstone – III/IV	15.85	29

Lab Test Data - BRE Classification:

The following pH testing data was available from the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Mercia Mudstone – III/IV	Sulphate (Total) as SO4	Solid	15	0.01-0.17	%SO4
Mercia Mudstone – III/IV	Water Soluble Sulphate as SO4	Water	2	0.24-0.3	g/l SO4
Mercia Mudstone – III/IV	pH	Solid	14	6.2-7.3	-
Mercia Mudstone – III/IV	pH	Water	2	6.9-7.1	-

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Assumed Ground Model For Design:

Ground model based on geological long section HA549342-AMAR-HGT-SWI-DR-CE-000039 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic borehole it is assumed that road level on the base of the cutting is straight on to the Mercia Mudstone III/IV at this location.

The below table outlines the assumed anticipated ground model:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Mercia Mudstone – III/IV (>50.0mAOD)	0-6.3	56.3-50.0	6.3	21	30	2	70	4.8	3.8	-	0.5	0.2	-	DS-1 AC-1
Mercia Mudstone – III/IV (<50.0mAOD)	>6.3	<50.0	-	21	30	2	150	13.8	11.0	-	0.5	0.2	-	DS-1 AC-1

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.

(2) Due to limited localised GI data, values for bulk density, friction angle, cohesion, Young's Modulus and Poisson's ratio derived in the AMAR GIR are used as a basis for the parameters above.

(3) The Mercia Mudstone – III/IV has higher recorded SPT 'N' values and undrained shear strength values from historical GI data below 50.0mAOD, and therefore has been subdivided as shown above.

(4) Based on SPT converted c_u values (using the formula by Stroud, 1975, and a typical f1 value of 5.0 after guidance in CIRIA C570 for Mercia Mudstone) and recorded undrained triaxial tests, a typical c_u value of 70kN/m^2 was adopted for Mercia Mudstone – III/IV (>50.0mAOD) and 150kN/m^2 for Mercia Mudstone – III/IV (<50.0mAOD).

(5) Eu for Mercia Mudstone – III/IV (within cutting) can be derived using N values (Bowles) where Eu = 300 (N+6); using a typical N value of 10 gives Eu = 4.8MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 3.8MN/m^2.

(6) Eu for Mercia Mudstone – III/IV (below carriageway level) can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 40 gives Eu = 13.8MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 11.0MN/m^2.

(7) BRE Classification is determined using criteria set out in BRE Special Digest 1.

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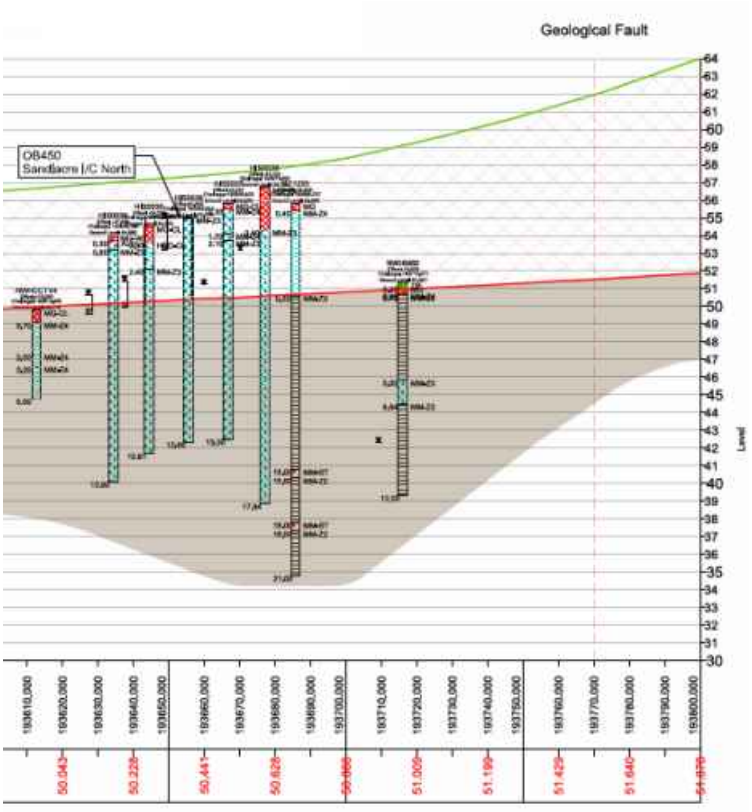


Figure 5: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Earthwork regrade was considered at this location, however due this impeding on the highway boundary, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
193680	193690	AZ-24 S 390 GP	1.5	5.5	4.5	61	49	18.0	64.6

Intermediate sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.
Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

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FURTHER GROUND INVESTIGATION

No further ground investigation is proposed at this location due to sufficient historical borehole data.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **RC1255** Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447142.40 - 335717.50	Hole Type RC
Location:		Level: 55.80	Scale 1:50
Client: Highways England		Dates: 08/01/2005 - 08/01/2005	Logged By SMCH

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.40	55.40		MADE GROUND (Drillers description) MG
										Soft to firm red brown slightly sandy fissured CLAY with extremely closely spaced very thin laminae up to 2mm of very weak dark red brown calcareous mudstone. Sand is fine. MM-Z4
		1.50 - 3.00		37						*At 1.80m; with some angular coarse lithorelics of weak mudstone*
		3.00 - 4.50		93						*Between 3.70m and 3.75m; with some very closely spaced thin laminae of weak grey green mudstone* *Between 3.70m and 3.75m; with some very closely spaced thin laminae of weak grey green mudstone* *Between 3.85m and 3.90m; with some very closely spaced thin laminae of weak grey green mudstone* *Between 3.85m and 3.90m; with some very closely spaced thin laminae of weak grey green mudstone* *Below 4.50m; with very closely spaced thick laminae up to 15mm of weak red brown calcareous mudstone*
		4.50 - 6.00 5.50 - 5.80	C	100	53		5.20	50.60		Very weak to weak, thickly laminated to thinly bedded locally calcareous red brown MUDSTONE. With occasional bands up to 100mm of moderately strong grey green siltstone. Fractures are extremely closely to closely spaced, subhorizontal and subvertical, tight, planar and smooth. With occasional black speckling on fracture surfaces (Mercia Mudstone). MM-Z3
		6.00 - 9.00		77	63	10				*Between 7.05m and 7.15m; moderately weak indistinctly laminated grey green siltstone* *Between 7.05m and 7.15m; moderately weak indistinctly laminated grey green siltstone* *Between 7.30m and 7.40m; becoming highly weathered recovered as soft red brown and grey green sandy clay with occasional fine to coarse lithorelics of mudstone* *Between 7.30m and 7.40m; becoming highly weathered recovered as soft red brown and grey green sandy clay with occasional fine to coarse lithorelics of mudstone* *Between 7.40m and 7.50m; strong thinly laminated grey green siltstone* *Between 7.40m and 7.50m; strong thinly laminated grey green siltstone* *Between 7.80m and 7.90m; strong thinly laminated grey green siltstone* *Between 7.80m and 7.90m; strong thinly laminated grey green siltstone* *At 9.20m; 60 degrees incipient fracture, tight, planar* *At 9.40m; 60 degrees incipient fracture, tight, planar*
										Continued on next sheet

Remarks
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ,The borehole was backfilled on completion with grout.:

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Rotary Core Log

Borehole No. **RC1255** Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447142.40 - 335717.50	Hole Type RC
Location:		Level: 55.80	Scale 1:50
Client: Highways England		Dates: 08/01/2005 - 08/01/2005	Logged By SMCH

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 - 10.75	C							At 10.20m, 60 degrees incipient fracture, tight, planar
		9.00 - 12.00		100	93	22				Between 10.60m and 10.63m, strong thinly laminated grey green siltstone Between 10.60m and 10.63m, strong thinly laminated grey green siltstone Between 10.65m and 10.70m, strong thinly laminated grey green siltstone Between 10.65m and 10.70m, strong thinly laminated grey green siltstone
		12.00 - 15.00		100	93	55				Between 12.35m and 12.40m, strong thinly laminated grey green siltstone Between 12.35m and 12.40m, strong thinly laminated grey green siltstone Below 12.70m, becoming locally moderately strong Between 13.40m and 13.45m, moderately strong thinly laminated grey green siltstone Between 13.40m and 13.45m, moderately strong thinly laminated grey green siltstone Between 13.60m and 13.65m, moderately strong thinly laminated grey green siltstone Between 13.60m and 13.65m, moderately strong thinly laminated grey green siltstone Between 14.10m and 14.30m, moderately strong thinly laminated grey green siltstone Between 14.10m and 14.30m, moderately strong thinly laminated grey green siltstone
		15.00 - 18.00		87	67	17	15.00 15.50	40.80 40.30		Between 14.80m and 15.00m, becoming highly weathered hard sandy clay with some subangular, fine to coarse lithorelics of mudstone Between 14.80m and 15.00m, becoming highly weathered hard sandy clay with some subangular, fine to coarse lithorelics of mudstone **Moderately strong thickly laminated to thinly bedded red brown SILTSTONE with occasional black speckling. Recovered non-intact, fracturing indistinct.** **MM-ST** Below 15.40m, becoming thinly interbedded with thick laminae of soft red brown sandy clay **Weak to moderately weak thickly laminated to very thinly bedded red brown locally calcareous MUDSTONE. With occasional bands of strong grey green thinly laminated siltstone. Fractures are horizontal and vertical closely spaced, generally planar, tight and smooth with a trace of fine sand and silt infill.** **MM-Z2**
		18.00 - 21.00		100	90	0	18.00 18.50	37.80 37.30		Between 16.45m and 16.65m, with very closely spaced thin to thick laminae, up to 15mm of soft red brown slightly sandy clay Between 16.45m and 16.65m, with very closely spaced thin to thick laminae, up to 15mm of soft red brown slightly sandy clay Between 16.65m and 16.85m, with bands of strong grey green thinly laminated siltstone Between 16.65m and 16.85m, with bands of strong grey green thinly laminated siltstone Between 16.85m and 16.90m, becoming highly weathered soft red brown slightly sandy clay with some randomly orientated fine to coarse angular lithorelics of mudstone Between 16.85m and 16.90m, becoming highly weathered soft red brown slightly sandy clay with some randomly orientated fine to coarse angular lithorelics of mudstone Between 17.00m and 17.60m, thinly interbedded with bands Continued on next sheet

Remarks

Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ;The borehole was backfilled on completion with grout.:

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Rotary Core Log

Borehole No. **RC1255** Sheet 3 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447142.40 - 335717.50	Hole Type RC
Location:		Level: 55.80	Scale 1:50
Client: Highways England		Dates: 08/01/2005 - 08/01/2005	Logged By SMCH

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							21.00	34.80		*Between 17.00m and 17.60m; thinly interbedded with bands up to 90mm of strong thinly laminated grey green siltstone.* *Between 17.00m and 17.60m; thinly interbedded with bands up to 90mm of strong thinly laminated grey green siltstone.* Moderately strong thickly laminated to thinly bedded red brown SILTSTONE with occasional black speckling. Fractures are horizontal and vertical very closely to closely spaced, generally tight, planar and smooth. MM-ST Weak to moderately weak thickly laminated to very thinly bedded red brown locally calcareous MUDSTONE. With occasional bands of strong grey green thinly laminated siltstone. Fractures are horizontal and vertical closely spaced, generally planar, tight and smooth with a trace of fine sand and silt infill. (Mercia Mudstone) MM-Z2 *Between 18.50m and 18.55m; strong thinly laminated grey green siltstone.* *Between 18.50m and 18.55m; strong thinly laminated grey green siltstone.* *Between 19.60m and 19.70m; strong thinly cross laminated grey green and white siltstone.* *Between 19.60m and 19.70m; strong thinly cross laminated grey green and white siltstone.* *Between 20.200m and 21.00m; subvertical, undulating fracture, tight and smooth.* *Between 20.200m and 21.00m; subvertical, undulating fracture, tight and smooth.* *At 20.05m; 60 degree fracture, planar, slightly rough with up to 1mm of fine sand and silt infill.* End of borehole at 21.00m

Remarks
Prior to boring a Cable Avoidance Tool (CAT) survey was carried out. An inspection pit was hand-dug to 1.20m depth and rescanned using the CAT to check for services. Services were not located. ,The borehole was backfilled on completion with grout.:

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Rotary Core Log

Borehole No. **NWHM65** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447208.16 - 335750.45	Hole Type RC
Location:		Level: 51.32	Scale 1:50
Client: Highways England		Dates: 03/09/1999 - 04/09/1999	Logged By NBR

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 0.60	D							TOPSOIL.
		0.00 - 0.60	D				0.20	51.12		TP
										MADE GROUND: Brownish grey very clayey medium to coarse angular gravel sized fragments of limestone.
		0.60	D				0.60	50.72		MG
		0.60 - 0.70	D				0.70	50.62		Firm reddish brown very silty CLAY with occasional fine sand sized mudstone lithorelicts (upto 3mm). (Mercia Mudstone - Zone IVa)
		0.70 - 1.70	25	49	0	0				MM-Z4
										Reddish brown moderately weathered MUDSTONE, very weak with extremely closely and very closely spaced random fractures tight smooth irregular. (Mercia Mudstone - Zone II)
		2.11 - 2.70	25	97	0	0				MM-Z2
		3.15 - 3.70	25	100	0	0				—from 3.20m to 3.70m becomes thinly laminated suorizontal
		4.15 - 4.70	99 25	85	0	0				
		5.15 - 5.50	99	66	0	0				
							5.50	45.82		Stiff reddish brown indistinctly thinly laminated subhorizontal very silty CLAY with some fine gravel sized lithorelicts (upto 6mm). (Mercia Mudstone - Zone IIIb)
		5.50 - 6.00	98	82	0	0				MM-Z3
		6.32 - 7.00	98 3	51	23	0	6.84	44.48		Reddish brown thinly laminated subhorizontal very thinly and thinly bedded subhorizontal slightly weathered MUDSTONE, moderately weak to weak with very closely and closely spaced subhorizontal fractures open smooth planar. (Mercia Mudstone - Zone I/II)
		7.31 - 7.50	99 3	100	42	0				MM-Z2
		7.75 - 8.00	4	100	100	80				—from 7.00m to 7.48m non intact very weak
		8.00 - 9.50	7 99 3 99 97	68	44	20				—from 8.35m to 8.40m greyish green thinly laminated suorizontal slightly weathered siltstone, weak (Mercia Mudstone - Zone I/II)
										—from 9.50m to 9.67m non intact mottled greenish grey
			99 2							Continued on next sheet

Remarks
1. Inspection pit excavated to 0.70m. 2. Borehole complete at 12.00m. 3. Borehole backfilled with grout. 4. Marker Post Ref 193/7 S.

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Rotary Core Log

Borehole No. **NWHM65**

Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447208.16 - 335750.45	Hole Type RC
Location:		Level: 51.32	Scale 1:50
Client: Highways England		Dates: 03/09/1999 - 04/09/1999	Logged By NBR

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.80 - 10.50	1	100	57	36				
		10.50 - 12.00	99	90	53	27				
			5							—from 10.80m to 11.40m with closely spaced subhorizontal to inclined open smooth planar and irregular
			25							—from 11.40m to 11.60m extremely closely spaced random fractures open smooth irregular clay smeared
			2							—from 11.60m to 12.00m extremely closely spaced random fractures open smooth irregular clay smeared
			25				12.00	39.32		End of borehole at 12.00 m

Remarks
1. Inspection pit excavated to 0.70m. 2. Borehole complete at 12.00m. 3. Borehole backfilled with grout. 4. Marker Post Ref 193/7 S.

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Borehole Log

Borehole No. NWHCCTV4
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447174.82 - 335645.42	Hole Type WS
Location:		Level: 49.78	Scale 1:50
Client: Highways England		Dates: 17/09/1999 - 17/09/1999	Logged By NBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.00	D					MADE GROUND: Reddish brown sandy clay with a little fine to coarse subangular gravel sized fragments of sandstone. MG-CL
		0.00 - 0.70	D	Ublow=0				
		0.70 - 2.50	D	Ublow=0	0.70	49.08		Firm brownish red CLAY. MM-Z4
		0.70 - 2.50	D	Ublow=0				
		2.50 - 3.20	D	Ublow=0	2.50	47.28		Soft yellowish grey CLAY. MM-Z4
		2.50 - 3.20	D	Ublow=0				
		3.20 - 5.00	D	Ublow=0	3.20	46.58		Soft to firm brownish red CLAY with a little fine subrounded mudstone lithorelicts. (Mercia Mudstone - Grade IVa?) MM-Z4
		3.20 - 5.00	D	Ublow=0				
					5.00	44.78		End of borehole at 5.00 m

Remarks
1. Hand excavated inspection pit to 0.90m (0.50m x 0.50m). 2. Hole complete at 5.00m. 3. Hole dry. 4. Hole backfilled with grout. 5.Marker Post Ref 193/6

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Rotary Core Log

Borehole No. HIS0039
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447145.00 - 335666.00	Hole Type CP
Location:		Level: 54.00	Scale 1:50
Client: Highways England		Dates: 30/07/1964 - 01/08/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 0.76	U				0.30	53.70		FILL (refuse) MG-WT
		0.76	D				0.80	53.20		Stiff brown silty CLAY with organic matter ALV
		1.68 - 2.13	U							Firm to stiff becoming very stiff, friable mottled red-brown and grey silty CLAY; bands of sandstone and mudstone below 3m MM-Z3
		2.13	D							
	▼	3.20 - 3.66	U							
		3.66	D							
		4.72 - 5.18	U							
		5.18	D							
		6.40 - 6.86	U							
		6.86	D							
		7.92 - 8.38	U							
		8.38	D							
		9.45 - 9.91	U							
		9.91	D							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 4.42m below ground level but had risen to 3.35m below ground level by the morning of 01.08.64.

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Rotary Core Log

Borehole No. HIS0039
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447145.00 - 335666.00	Hole Type CP
Location:		Level: 54.00	Scale 1:50
Client: Highways England		Dates: 30/07/1964 - 01/08/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.97 - 11.43	U							
		11.43	D							
		12.19 - 12.65	U							
		12.65	D							
		13.41 - 13.87	U							
		13.87	D				13.90	40.10		End of borehole at 13.87 m

Remarks
Ground-water was first encountered at a depth of 4.42m below ground level but had risen to 3.35m below ground level by the morning of 01.08.64.

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Rotary Core Log

Borehole No.	HIS0038	Sheet 1 of 2	
Project Name:	SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447238.00 - 335712.00
Hole Type	CP		
Location:		Level: 56.70	Scale 1:50
Client:	Highways England	Dates: 20/07/1964 - 23/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.61 - 1.07	U							FILL (clay) MG-CL
		1.07	D							
		1.52	D							
		2.29	D							
		2.59 - 3.05	U				2.40	54.30		Firm to stiff, becoming very stiff to hard friable mottled red-brown and grey silty CLAY with mudstone (Keuper Marl) MM-Z3
		3.05	D							
	▼									
		3.66 - 4.11	U							
		4.11	D							
		4.57	D							
		5.18 - 5.64	U							
		5.64	D							
		5.94	D							
		6.71 - 7.16	U							
		7.16	D							
		7.62	D							
		8.23 - 8.69	U							
		8.69	D							
		9.14	D							
		9.75 - 10.21	U							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 3.51m below ground level on the morning of 22.07.64

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Rotary Core Log

Borehole No. HIS0038
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447238.00 - 335712.00	Hole Type CP
Location:		Level: 56.70	Scale 1:50
Client: Highways England		Dates: 20/07/1964 - 23/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.21	D							
		10.67	D							
		11.28 - 11.73	U							
		11.73	D							
		12.19	D							
		12.80 - 13.26	U							
		13.26	D							
		13.72	D							
		14.33 - 14.78	U							
		14.78	D							
		15.24	D							
		15.85 - 16.31	U							
		16.31	D							
		16.76	D							
		17.37 - 17.83	U							
		17.83	D				17.84	38.86		End of borehole at 17.83 m

11 12 13 14 15 16 17 18 19 20

Remarks
Ground-water was first encountered at a depth of 3.51m below ground level on the morning of 22.07.64

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Rotary Core Log

Borehole No. HIS0037
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447216.00 - 335701.00	Hole Type CP
Location:		Level: 55.80	Scale 1:50
Client: Highways England		Dates: 29/07/1964 - 30/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 0.76	U				0.30	55.50		FILL (brick rubble and clay) MG-CL
		0.76	D							Stiff brown silty CLAY MM-Z4
		1.83 - 2.29	U				1.70	54.10		Firm grey silty CLAY MM-Z4
		2.29	D				2.10	53.70		Firm to stiff, becoming very stiff to hard friable mottled red-brown and grey silty CLAY; bands of sandstone below 7.9m MM-Z3
		3.35 - 3.81	U							
		3.81	D							
	▼									
		4.88 - 5.33	U							
		5.33	D							
		6.86 - 7.32	U							
		7.32	D							
		8.23 - 8.69	U							
		8.69	D							
		8.69 - 10.21	U							
		9.75	D							

Continued on next sheet

Remarks
Groundwater was first encountered at a depth of 4.57m below ground level. Sample of ground-water taken.

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Rotary Core Log

Borehole No. **HIS0037**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447216.00 - 335701.00	Hole Type CP
Location:		Level: 55.80	Scale 1:50
Client: Highways England		Dates: 29/07/1964 - 30/07/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.21 - 11.73	U							
		11.28	D							
		11.73 - 13.26	U							
		13.26	W				13.30	42.50		End of borehole at 13.26 m
		13.28	D							

Remarks
Groundwater was first encountered at a depth of 4.57m below ground level. Sample of ground-water taken.

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Rotary Core Log

Borehole No. **HIS0036**
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447192.00 - 335689.00	Hole Type CP
Location:		Level: 55.00	Scale 1:50
Client: Highways England		Dates: 07/08/1964 - 08/08/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30 - 0.76	U							Firm to stiff, becoming very stiff friable mottled red-brown and grey silty CLAY with bands of sandstone and mudstone (Keuper Marl) MM-Z3
		0.76	D							
		1.83 - 2.29	U							
		2.29	D							
		3.35 - 3.81	U							
		3.81	D							
		4.88 - 5.33	U							
		5.33	D							
		6.40 - 6.86	U							
		6.86	D							
		7.92 - 8.38	U							
		8.38	D							
		9.45 - 9.91	U							
		9.91	D							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 1.83m below ground level but had risen to ground level by the morning of 08.08.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. **HIS0036**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447192.00 - 335689.00	Hole Type CP
Location:		Level: 55.00	Scale 1:50
Client: Highways England		Dates: 07/08/1964 - 08/08/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.97 - 11.43	U							
		11.43	D							
		12.19 - 12.65	U							
		12.65	D				12.68	42.34		End of borehole at 12.65 m

Remarks
Ground-water was first encountered at a depth of 1.83m below ground level but had risen to ground level by the morning of 08.08.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. HIS0035
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447168.00 - 335677.00	Hole Type CP
Location:		Level: 54.50	Scale 1:50
Client: Highways England		Dates: 30/07/1964 - 01/08/1964	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.46 - 0.91	U				0.90	53.60		FILL (red-brown silty clay) MG-CL
		1.98 - 2.44	U				2.40	52.10		Firm to stiff brown silty sandy CLAY HDD-CL
		3.51 - 3.96	U							Stiff to very stiff friable mottled red-brown and grey silty CLAY with bands of sandstone and mudstone (Keuper Marl) MM-Z3
		3.96	D							
		5.03 - 5.49	U							
		5.49	D							
		6.55 - 7.01	U							
		7.01	D							
		8.08 - 8.53	U							
		8.53	D							
		9.60 - 10.06	U							

Continued on next sheet

Remarks
Ground-water was first encountered at a depth of 4.6m below ground level but had risen to 3.1m below ground level on the morning of 01.08.64. Sample of ground-water taken.

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Rotary Core Log

Borehole No. HIS0035
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447168.00 - 335677.00	Hole Type CP
Location:		Level: 54.50	Scale 1:50
Client: Highways England		Dates: 30/07/1964 - 01/08/1964	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		11.13 - 11.58	U							
		12.34 - 12.80	U							
		12.80	W				12.81	41.69		End of borehole at 12.80m

Remarks
Ground-water was first encountered at a depth of 4.6m below ground level but had risen to 3.1m below ground level on the morning of 01.08.64. Sample of ground-water taken.

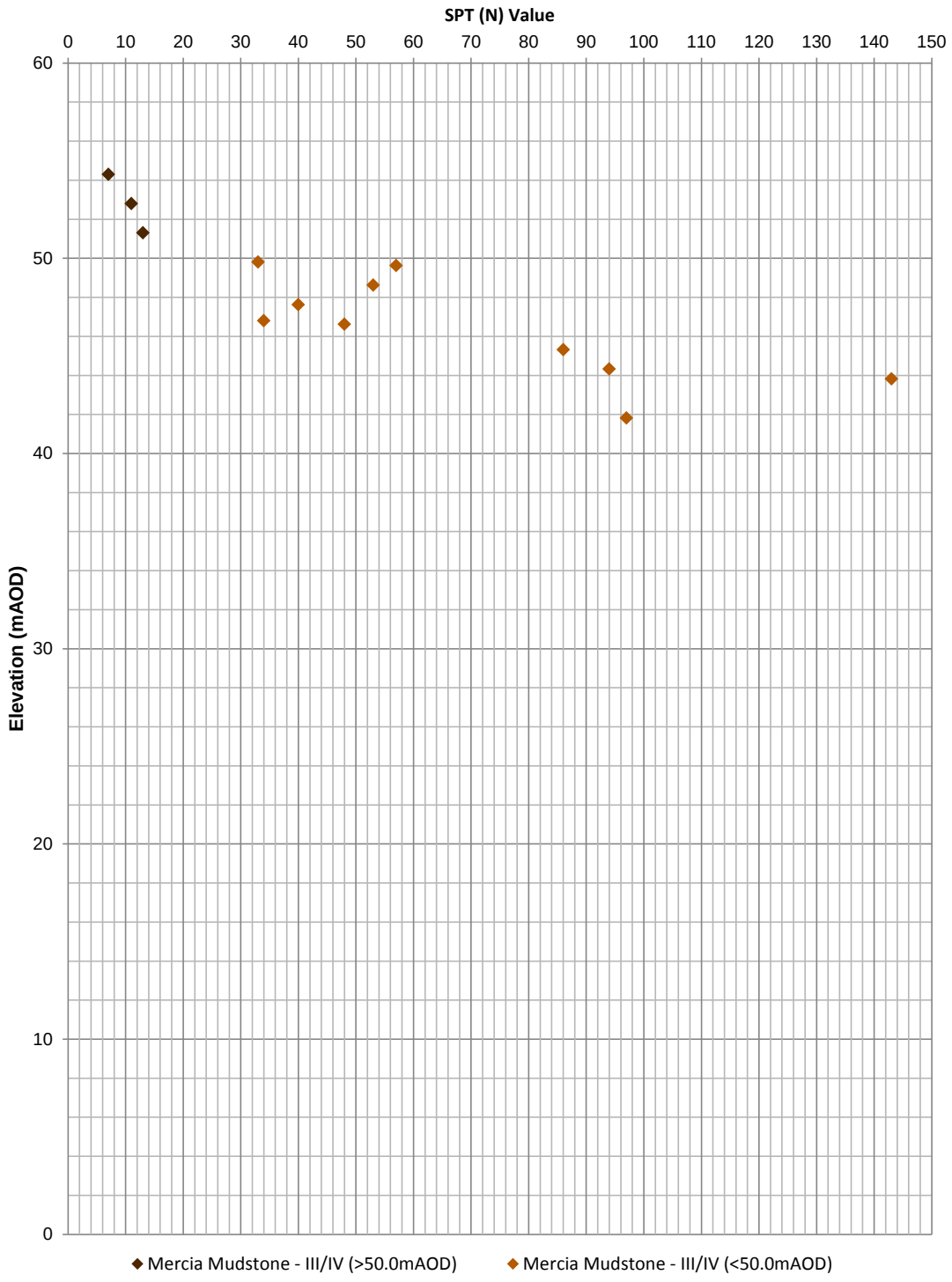
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PLOTS

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **193680-193690**
Client: **Highways England**	Borehole ID: **NWHM65, RC1255**	

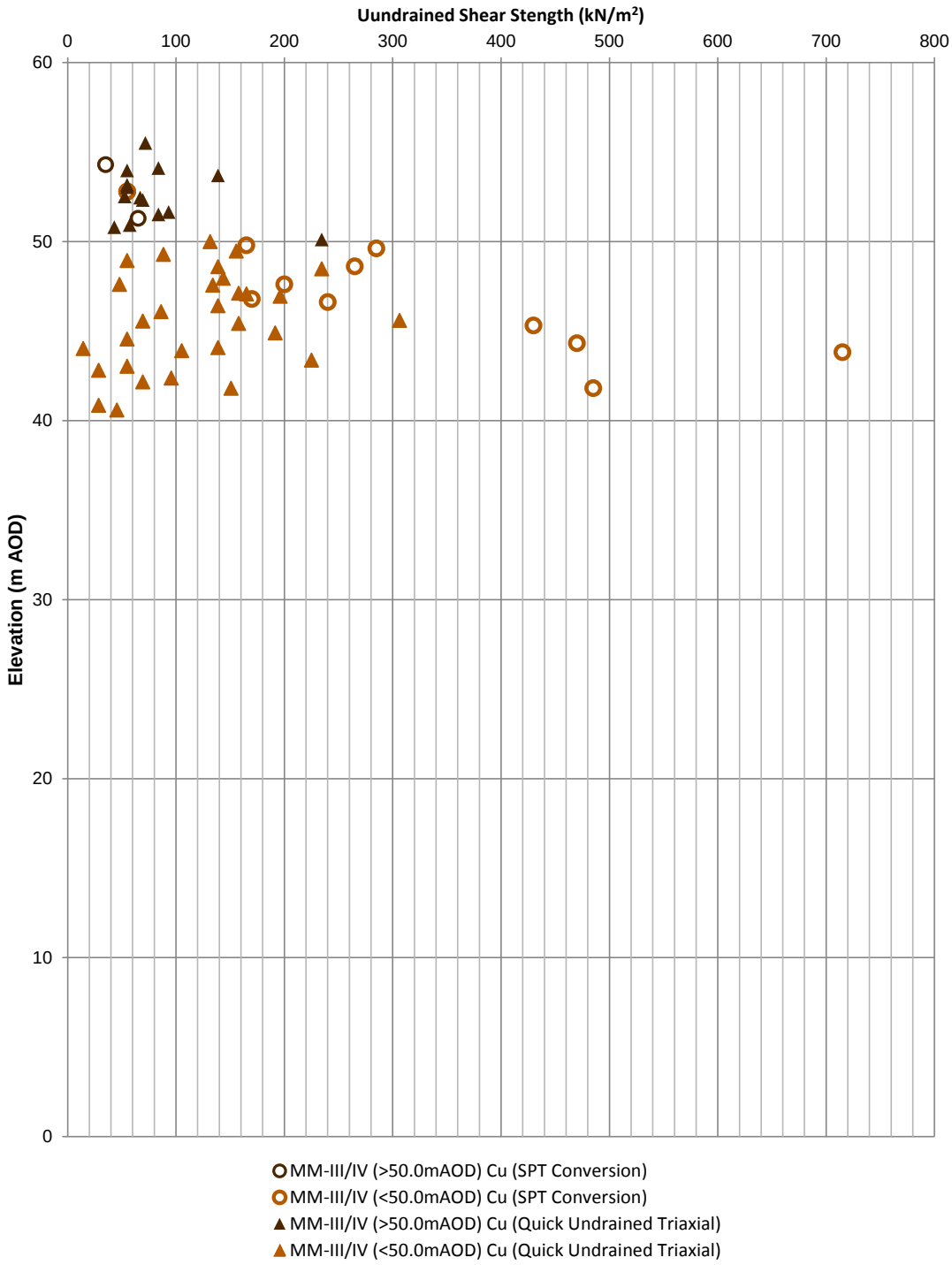


Rev: P01 Date: 21/12/2016 Ref: HA549342-AMAR-HGT-193680-193690-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **193680-193690**
Client: **Highways England**	Borehole ID: **NWHM65, RC1255, HIS0035-HI0039**	



Rev: P01 Date: 21/12/2016 Ref: HA549342-AMAR-HGT-193680-193690-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-186760-187070NB-GSS-000001		
Earthworks Widening Solution	Full Height Embankment Widening (1:2.0) / Granular Wedge at Embankment Crest (1:2.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	186760-187070		
Carriageway	Northbound – Jct 24a Merge (A50-M1 Onslip – west)		
Marker Post	186/7A+60 – 187/0A+70		
National Grid Reference	E 447098, N 329095 – E 447089, N 329317		
Existing Ground Level at Location	Carriageway	35.4-38.5mAOD	
	Toe of embankment	31.1-32.6mAOD	
Earthwork Type	NB: Embankment	SB: Embankment	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: 7_M1_24428	SB: N/A	HAGDMS designation
Earthwork Height	NB: 4.1-7.1m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 21-36°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Simon Arinze	12/04/2017	[redacted]
Checked	Roheel Masrat	03/05/2017	
Reviewed	Gary Summerfield	31/05/2017	
Approved	Tom Bulteel	07/06/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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DESK STUDY

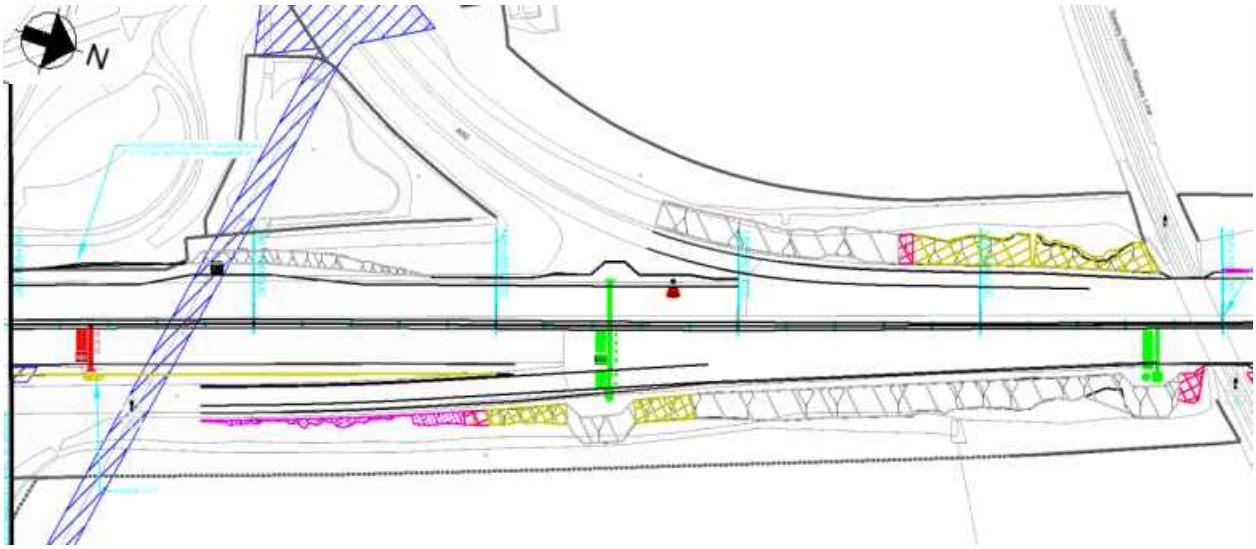


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch186760-186960, Full Height Embankment Widening (1:2);
- Ch186670-187070, Granular Wedge at Embankment Crest (1:2)

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that location comprises and embankment of 4.1-7.1m height (increasing in height from south to north) and a proposed slope gradient of 27°.

The critical cross section used is Ch186900 (Ch250).

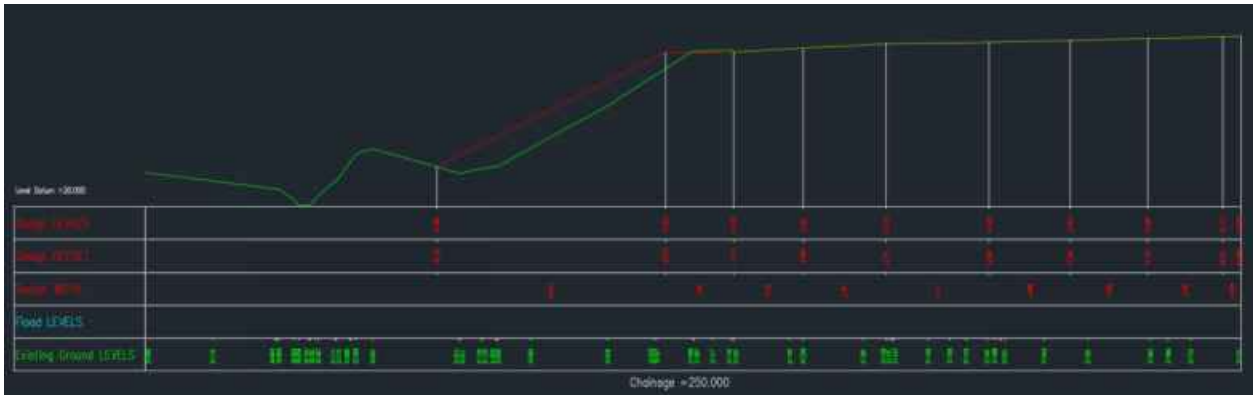


Figure 2 Topographic Critical Cross Section Chainage 186900 (Ch250)

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Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough, indicates that the site is underlain by:

Superficial Deposits: Holme Pierrepont Sand and Gravel Member (Sand and Gravel)

Solid Deposits: Branscombe Mudstone Formation (Mudstone – Mercia Mudstone Group)

Ground Investigation:

There are 2 No. historical exploratory holes recorded within the design chainage; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000028, Rev P01.

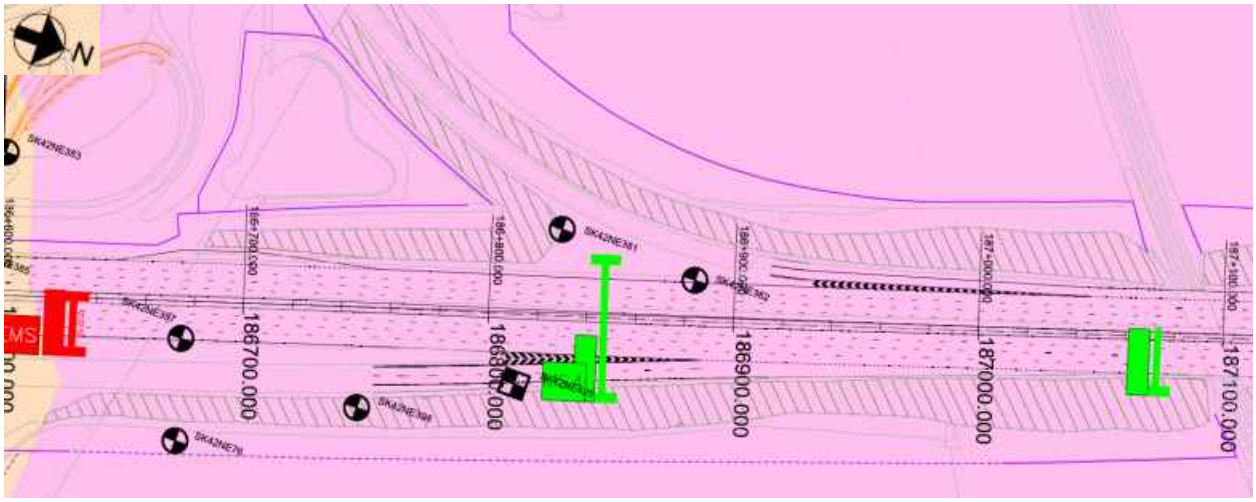


Figure 3: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42NE381	SK2NE382
Borehole Chainage	186830	186884
Borehole Location	Northbound	Northbound
National Grid Reference	E 447131, N 329149	E 447132, N 329207
Ground Level at Exploratory Hole	31.26m AOD	37.16mAOD
RAG Analysis	Green	Green

Date Drilled	09/06/1992	09/06/1992
Termination Depth	9.95m bgl	15.00m bgl
Other Suitable Holes	None	

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (m bgl)	Depth to Base (m AOD)	SPT 'N' Value Range*	Hand Vane Strength Range (kN/m^2)
Embankment Fill	6.6	30.56	17-21 (20)	-
River Terrace Deposits	5.80	24.76	15-107 (30)	-
Mercia Mudstone – III/IV	>3.45	<21.31	20-109 (23)	-

(1) Ground level is assumed to be at the carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within historical exploratory holes SK42NE381 and SK42NE382.

Groundwater:

No ground water encountered within the exploratory boreholes

Groundwater Design Level:

No local groundwater level is available and therefore a design groundwater level of 1.0m below toe of embankment has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

5 No. Atterberg Limit Test and 13 No. Natural Moisture Content tests were undertaken within the Embankment Fill and the Mercia mudstone III/IV with the following results:

Stratum	Depth (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Embankment Fill	0.8	22	-	-	-	-
Embankment Fill	1.0	16	-	-	-	-
Embankment Fill	1.2	17	36	16	20	CI
Embankment Fill	1.8	16	-	-	-	-
Embankment Fill	2.3	18	34	14	20	CL
Embankment Fill	2.8	15	-	-	-	-
Embankment Fill	2.8	13	32	17	15	CL
Embankment Fill	3.4	13	32	15	17	CL
Embankment Fill	4.4	15	34	14	20	CL
Mercia Mudstone III/IV	6.6	19	-	-	-	-
Mercia Mudstone III/IV	8.0	17	-	-	-	-
Mercia Mudstone III/IV	9.0	16	-	-	-	-
Mercia Mudstone III/IV	9.5	8	-	-	-	-

3 No. Traixial Tests were undertaken within the Embankment Fill with the following results:

Stratum	Depth (mbgl)	Undrained Shear Strength (kN/m^2)
Embankment Fill	1.2	108.0
Embankment Fill	2.8	172.0
Embankment Fill	4.4	152.0

Lab Test Data – BRE Classification:

No chemical laboratory testing data is available for this location.

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Assumed Ground Model For Design:

Ground model is based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-000034, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01.

The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment fill	0.00 - 7.45	38.45-31.00	7.45	21	26	0	130	7.8	6.2	-	0.50	0.20	-	DS-2 AC-2
River Terrace Deposits	7.45-13.65	31.00-24.80	6.20	20	36	0	-	-	43.2	-	-	0.35	-	DS-3 AC-3
Mercia Mudstone III-IV	>13.65	<24.80	>4.80	21	30	2	220	8.7	7.0	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) c_u of Embankment Fill can be determined using SPT N values and the Stroud correlation; these results and those from hand shear vanes and triaxial tests are included as a plot of c_u versus elevation. Based on these values, it is considered that a cu of 130kN/m^2 is characteristic of the stratum.
(4) ϕ' of Embankment Fill can be determined using Table 2 in BS8002:2015 using a typical PI of 20% gives 26°.
(5) E' of Embankment Fill can be determined using Bowles relationship Eu = 300 (N + 6) = 300 (20 + 6) = 7.8MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 6.2MN/m^2.
(6) ϕ' of River Terrace Deposits can be determined using correlation with SPT (Peck 1974) N values (typical N value of 30) gives an angle of 36°.
(7) E' of River Terrace Deposits can be determined using Bowles correlation E' = 1200 (N + 6) which (using typical N value of 30) gives a value of 43.2MN/m^2.
(8) c_u of Mercia Mudstone – III/IV can be determined using SPT N values and the Stroud correlation; these results are included as a plot of c_u versus elevation. Based on these values, it is considered that a cu of 220kN/m^2 is characteristic of the stratum.
(9) Due to limited localised GI data, typical values for ϕ' of Mercia Mudstone – III/IV derived in the AMAR GIR are used.
(10) Eu for Mercia Mudstone – III/IV can be derived using N values (Bowles) where Eu = 300 (N+6); using a conservative N value of 23 gives Eu = 8.7MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 7.0MN/m^2.
(11) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data for SK42NE381 & SK42NE382, the classification used for the strata in the AMAR GIR was adopted.

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Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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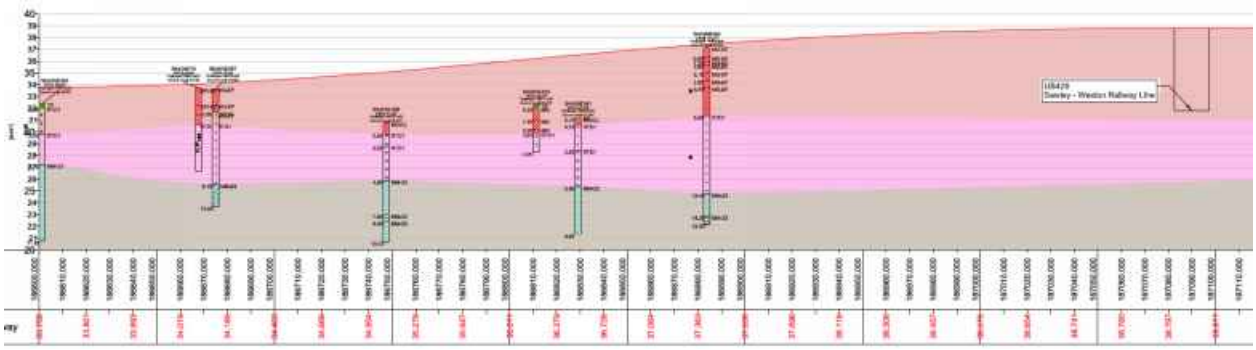


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
186760	186960	Full Height Embankment Widening (1:2)	4.00m	27°
186970	187070	Granular Wedge at Embankment Crest (1:2)	9.50m	45°

Proposed Structural Solution:

N/A

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FURTHER GROUND INVESTIGATION

'Just In Time' GI is not required at this location to confirm the ground conditions for embankment widening and granular wedge:

However the following GI has been proposed:

- BG-G301A at chainage 186847, northbound, dynamic sample with rotary follow to 18m bgl(Note: GI required for pile design verification at gantry 301 only)

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HISTORICAL EXPLORATORY HOLES

Rotary Core Log

Borehole No. SK42NE381
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447131.00 - 329149.00	Hole Type CP
Location:		Level: 31.26	Scale 1:50
Client: Highways England		Dates: 09/06/1992 - 11/06/1992	Logged By C.S.Owens

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.10	31.16		TOPSOIL TP Stiff CLAY and MARL (Driller's Description) (Made Ground) MG-CL
							0.70	30.56		Very dense becoming dense brown SAND AND subrounded fine to coarse GRAVEL, predominantly of quartzite. (River Terrace Deposits) RTD1
		1.20 - 1.65	B							
		1.90	W							
		2.10 - 2.55	B							
							2.80	28.46		Medium dense grey brown subrounded fine to coarse GRAVEL, predominantly of quartzite and sandstone. (River Terrace Deposits) RTD1
		3.00 - 3.45	B							
		4.00 - 4.45	B							Increasing coarse sand content
		5.00 - 5.45	B							Becoming very dense
							5.90	25.36		Stiff dark red brown mottled grey green CLAY with many fine gravel sized lithorelicts of weak mudstone. (Mercia Mudstone Group) MM-Z2
		6.00 - 6.45	U							
		6.50	J							
		6.60 - 7.05	S							
		7.50 - 7.90	U							
		7.90	J							
		8.00 - 8.45	S							Becoming very stiff
		9.00 - 9.24	U							Hard
		9.50 - 9.95	S							
							9.95	21.31		End of borehole at 9.95 m

Remarks

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Rotary Core Log

Borehole No. SK42NE382

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447132.00 - 329207.00	Hole Type CP
Location:		Level: 37.16	Scale 1:50
Client: Highways England		Dates: 09/06/1992 - 11/06/1992	Logged By M.Bryans

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										TARMACADAM AND CONCRETE (Drillers description) (Borehole predrilled to 0.80m using rotary coring techniques) MG-EF
		0.60	W							
		0.80 - 1.20	B				0.80	36.36		
		1.00	J							Stiff brown and dark slightly sandy CLAY with some angular to rounded fine to coarse gravel, including quartzite, coal, siltstone. (MADE GROUND) MG-EF
		1.19	J				1.20	35.96		
		1.20 - 1.65	U				1.50	35.66		
		1.79	J							Soft and firm red brown CLAY with many coarse sand sized lithorelicts of very weak mudstone and occasional angular gravel of quartzite. (MADE GROUND) MG-EF
		1.80 - 2.25	B							
		2.30 - 2.80	B				2.15	35.01		
		2.79	J				2.80	34.36		Stiff red brown intermixed dark brown slightly sandy CLAY with occasional angular to rounded fine to coarse gravel including siltstone, quartzite, flint and mudstone. (MADE GROUND) MG-EF
		2.80 - 3.25	U							
		3.39	J				3.40	33.76		Firm red brown silty CLAY. (MADE GROUND) MG-EF
		3.40 - 3.85	B							Stiff red brown CLAY with some angular fine to medium gravel of hard clay and mudstone. (MADE GROUND) MG-EF
	▼									
		4.00 - 4.40	B							Probably stiff, recovered firm, red brown CLAY with occasional angular fine to coarse gravel of grey green siltstone and fine grained sandstone. (MADE GROUND) MG-EF
		4.40 - 4.85	U							
		4.99	J							
		5.00 - 5.45	B							
		5.50 - 6.00	B							
							5.80	31.36		
		5.99	J							Very dense and dense red brown fine to coarse SAND AND subangular to rounded fine to coarse GRAVEL, including quartzite, siltstone and occasional cobbles. (River Terrace Deposits) RTD1
		6.01 - 6.45	B							
		6.50 - 7.00	B							*Clayey in parts driller records "boulder"*
		7.00 - 7.45	B							
		7.50 - 8.00	B							
		8.00 - 8.45	B							
		8.10	W							
		8.40	W							
		8.50 - 9.00	B							*Below 8.50m SPT's probably affected by loosening as borehole being advanced dry*
		9.00 - 9.45	B							
	▼	9.50 - 10.00	B							
		10.00 - 10.55	B							Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE382
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447132.00 - 329207.00	Hole Type CP
Location:		Level: 37.16	Scale 1:50
Client: Highways England		Dates: 09/06/1992 - 11/06/1992	Logged By M.Bryans

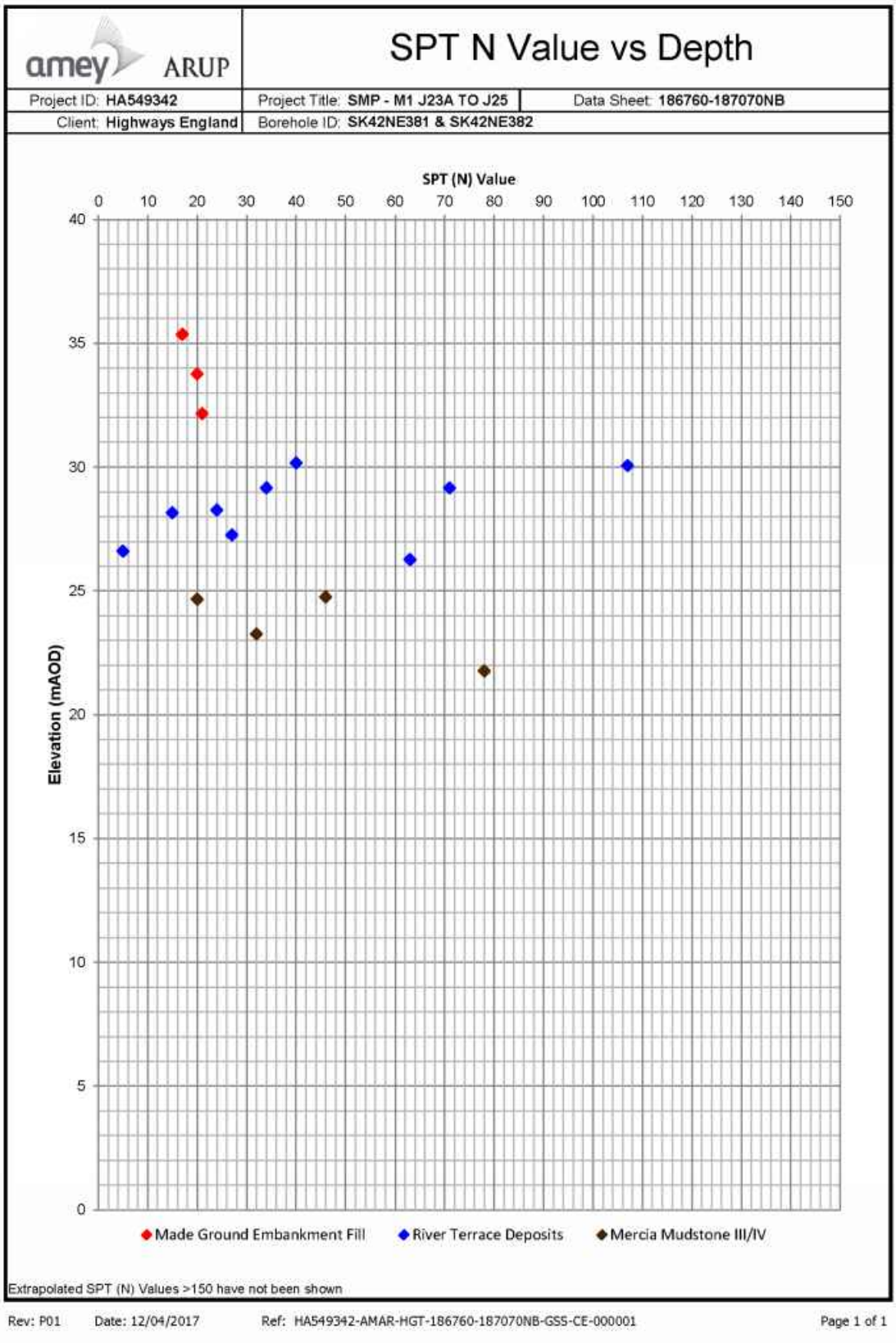
Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.55 - 11.00	B							Slightly clayey. (SPT probably affected by loosening as borehole progressed dry)
										Driller records "dense, large cobbles"
										Cobble
		12.00 - 12.40	B							
		12.39	J				12.40	24.76		
		12.40 - 12.85	B							Very stiff red brown slightly mottled light grey grenn, friable CLAY with many to 70% coarse sand sized to fine gravel lithorelicts of weak mudstone. (Mercia Mudstone Group) MM-Z3
										Cobble or boulder
		13.50 - 14.00	B							
		14.00 - 14.40	B							
							14.30	22.86		
		14.50 - 15.00	B							Moderately weak red brown MUDSTONE (recovered as angular gravel sized fragments) with some firm red brown clay matrix. (Driller records "occasional soft bands") MM-Z3
							15.00	22.16		End of borehole at 15.00 m

Remarks

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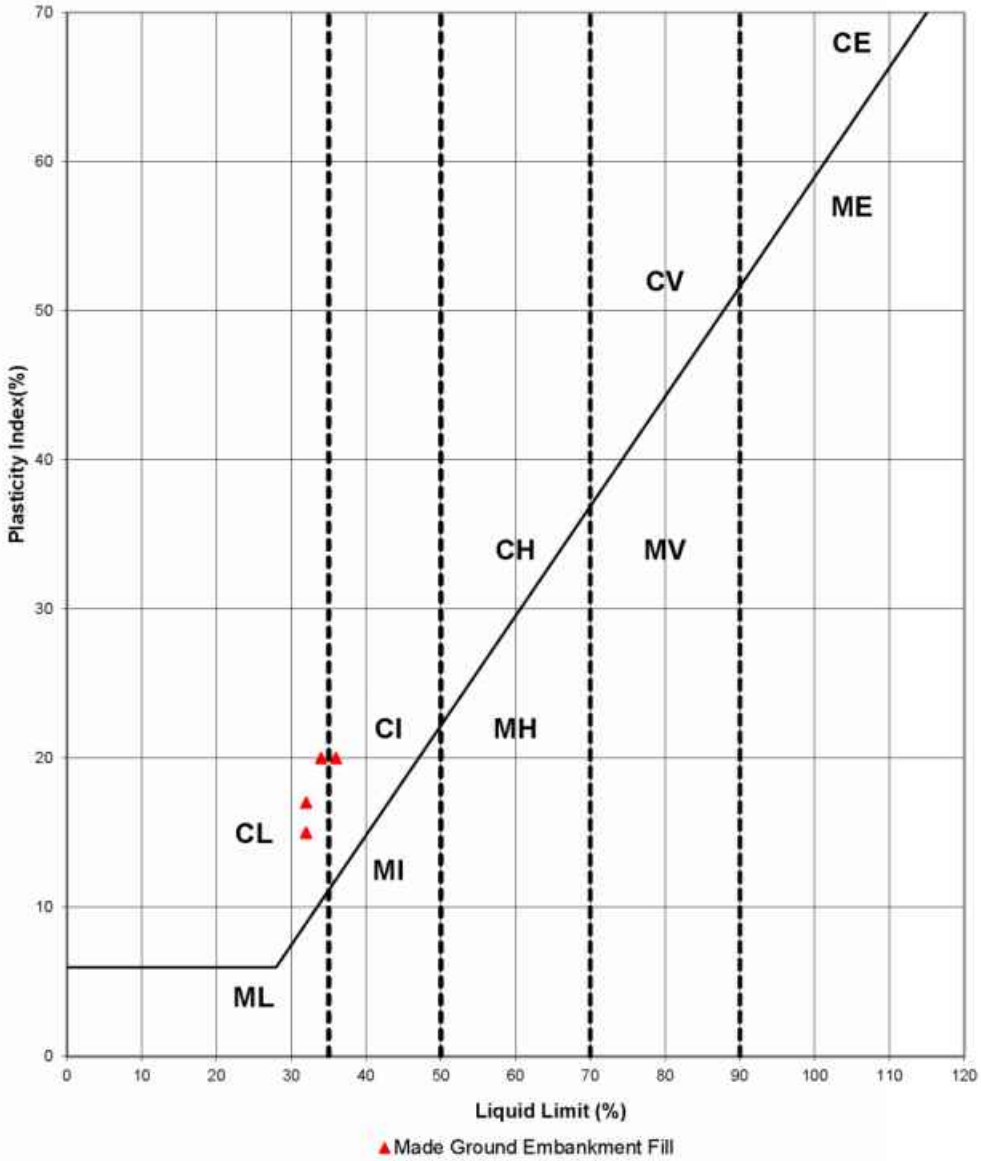
PLOTS



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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186760-187070NB**
Client: **Highways England**	Borehole ID: **SK42NE382**	



Key

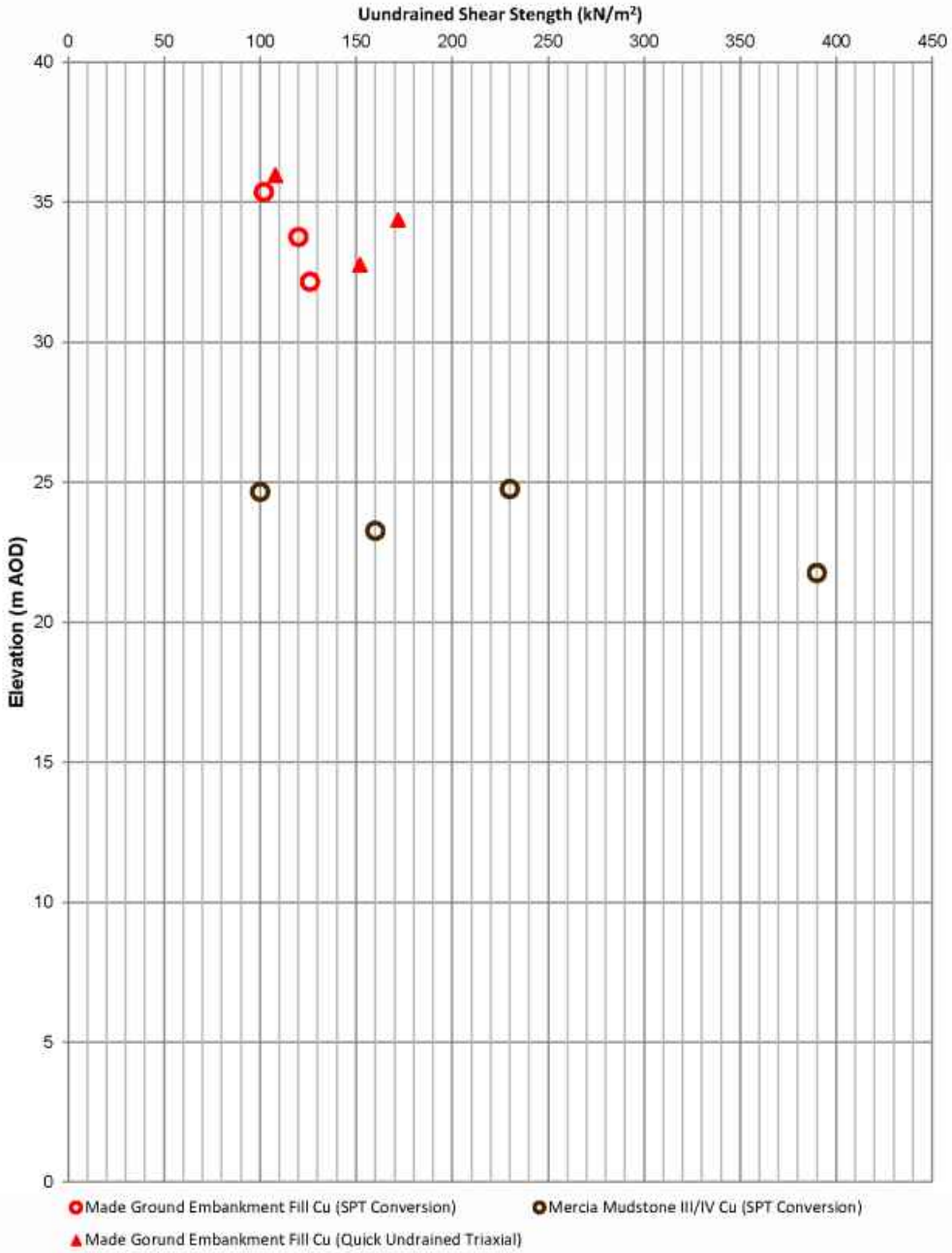
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 12/04/2017 Ref: HA549342-AMAR-HGT-186760-187070NB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **186760-187070NB**
Client: **Highways England**	Borehole ID: **SK42NE381 & SK42NE382**	



Rev: P01 Date: 12/04/2017 Ref: HA549342-AMAR-HGT-186760-187070NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-185400 – 1854510NB-GSS-000001		
Earthworks Widening Solution	Full Height Embankment Widening (1:2.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	185400-185510		
Carriageway	Northbound – Jct24 Merge (A453/A50/A6-M1 Onslip west)		
Marker Post	185/4A+00 – 185/5A+10		
National Grid Reference	E 447527, N 327781 – E 447513, N 3278891		
Existing Ground Level at Location	Carriageway	37.6-39.2mAOD	
	Toe of embankment	36.8-37.3mAOD	
Earthwork Type	NB: Embankment	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: 7_M1_20912	SB: N/A	HAGDMS designation
Earthwork Height	NB: 0.8-1.8m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 19-22°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Simon Arinze	17/03/2017	[redacted]
Checked	Roheel Masrat	02/05/2017	
Reviewed	Gary Summerfield	02/05/2017	
Approved	Tom Bulteel	09/05/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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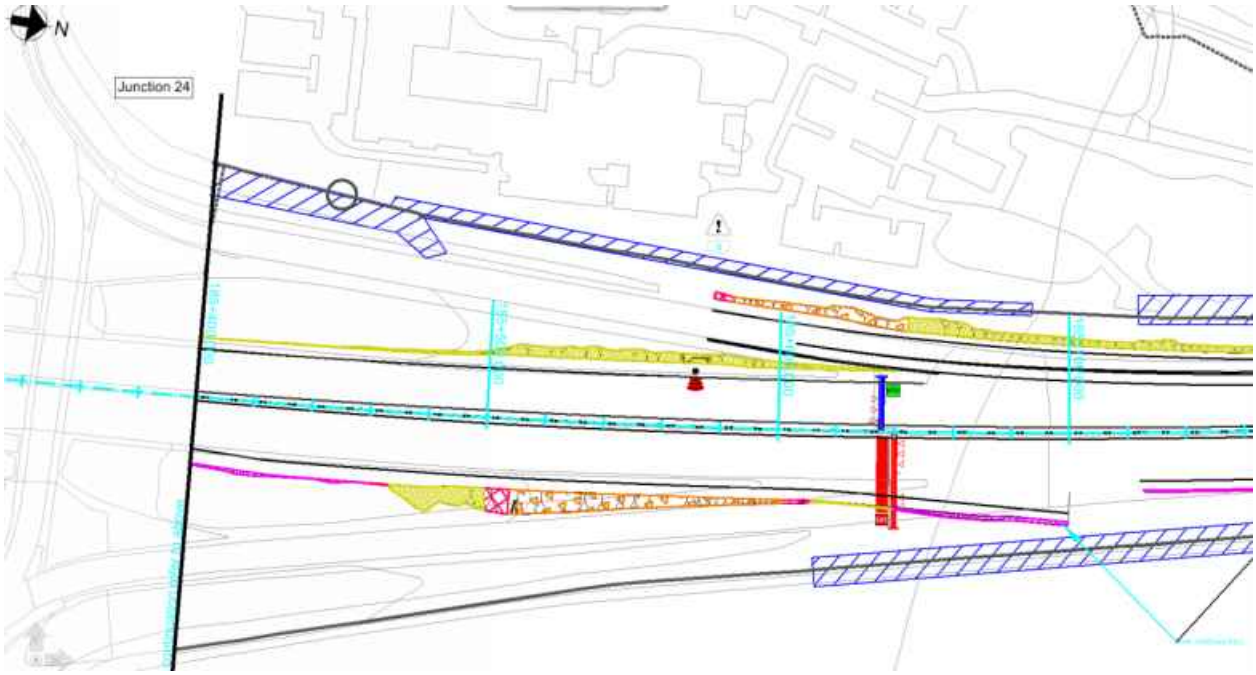


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch185400-185510, Full Height Embankment Widening (1:2.0);

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that location comprises an embankment of 0.8-1.8m height (increasing in height from south to north) and a proposed slope gradient of 27°.

The critical cross sections used is Ch185430.

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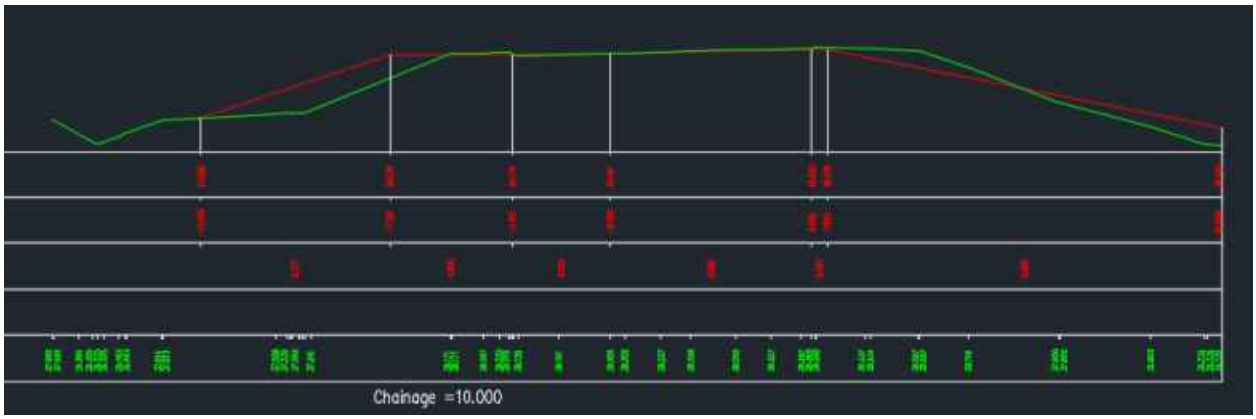


Figure 2 Topographic Critical Cross Section Chainage 185430 (Ch10)

Utilities:

A western power low voltage cable is located in the verge to the west of the slip road.

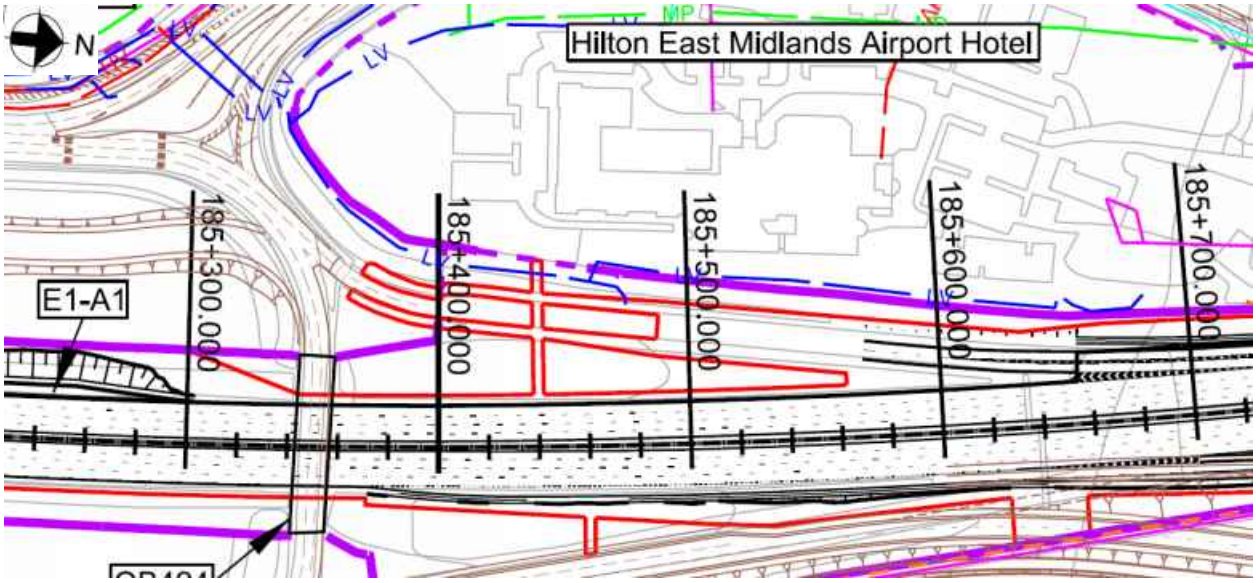


Figure 3 Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough, indicates that the site is underlain by:

Superficial Deposits: Holme Pierrepont Sand and Gravel Member (Sand and Gravel)

Solid Deposits: Branscombe Mudstone Formation (Mudstone – Mercia Mudstone Group)

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, with additional 3 no. relevant exploratory holes considered within close proximity; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000028, Rev P01.



Figure 4: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42NE11	NWHD1A	SK42NE12
Borehole Chainage	185359,	185516	185572
Borehole Location	Northbound	Northbound	Northbound
National Grid Reference	E 447510, N 327740	E 447493, N 327893	E 447490, N 327950
Ground Level at Exploratory Hole	37.20m AOD,	33.87m AOD	34.70m AOD
RAG Analysis	Amber	Amber	Amber
Date Drilled	09/08/1961	13/09/1999	09/08/1961
Termination Depth	12.19m bgl	3.10m bgl	9.14m bgl
Other Suitable Holes	None		

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (m bgl)	Depth to Base (m AOD)	SPT 'N' Value Range*	Hand Vane Strength Range (kN/m^2)
Embankment Fill	4.8	34.5	-	-
Glaciofluvial Deposits (Coarse Grained)	7.5	31.7	20-59 (40)	-
Mercia Mudstone – III/IV	>14.2	<25.0	-	-

(1) Ground level is assumed to be at the carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within historical exploratory holes SK42NE11 and SK42NE12.

Groundwater:

No ground water encountered within the exploratory boreholes.

Groundwater Design Level:

No local groundwater level is available and therefore a design groundwater level of 1.0m below toe of embankment has been assumed for the design.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

6 No. Atterberg Limit Test and 18No. Natural Moisture Content tests were undertaken within the Glaciofluvial Deposits and the Mercia Mudstone III/IV with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Glaciofluvial Deposits	0.3	14	-	-	-	-
Glaciofluvial Deposits	0.61	2	-	-	-	-
Glaciofluvial Deposits	0.76	15	-	-	-	-
Glaciofluvial Deposits	1.22	16	-	-	-	-
Glaciofluvial Deposits	1.37	-	22	13	9	CL
Glaciofluvial Deposits	1.52	6	-	-	-	-
Glaciofluvial Deposits	1.98	18	-	-	-	-
Glaciofluvial Deposits	2.29	-	23	15	8	CL
Mercia Mudstone III/IV	3.05	5	-	-	-	-
Mercia Mudstone III/IV	3.81	41	-	-	-	-
Mercia Mudstone III/IV	4.57	13	26	19	7	CL
Mercia Mudstone III/IV	5.18	15	-	-	-	-
Mercia Mudstone III/IV	5.41	16	-	-	-	-
Mercia Mudstone III/IV	6.10	32	34	24	10	ML
Mercia Mudstone III/IV	6.55	14	-	-	-	-
Mercia Mudstone III/IV	7.62	31	-	-	-	-
Mercia Mudstone III/IV	7.77	20	32	25	7	ML
Mercia Mudstone III/IV	8.84	8	-	-	-	-
Mercia Mudstone III/IV	9.14	20	-	-	-	-
Mercia Mudstone III/IV	10.67	14	28	17	11	CL

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5 No. Traixial Tests were undertaken within the Glaciofluvial Deposits and the Mercia mudstone III/IV with the following results:

Stratum	Depth to Top of Test (mbgl)	Undrained Shear Strength (kN/m^2)
Glaciofluvial Deposits	1.37	41
Glaciofluvial Deposits	2.29	38
Mercia Mudstone III/IV	6.10	66
Mercia Mudstone III/IV	6.10	150
Mercia Mudstone III/IV	7..62	420

Lab Test Data – BRE Classification:

No chemical laboratory testing data is available for this location.

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Assumed Ground Model For Design:

Ground model is based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-000034, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01.

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic boreholes it is assumed that an amount of embankment fill exists at road level above the Glaciofluvial Deposits.

The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0.00 – 5.20	39.20 -34.00	5.20	21	27	0	100	7.8	6.2	-	0.50	0.20	-	DS-2 AC-2
Glaciofluvial Deposits (Coarse Grained)	5.20 – 8.70	34.00-30.50	3.50	21	38	-	-	-	31.2	-	-	0.25	-	DS-3 AC-3
Mercia Mudstone III/IV	8.70->14.20	30.50-<25.00	>5.50	21	28	2	66	16.8	13.4	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Due to limited localised GI data for the Embankment Fill, typical values for cu, ϕ' and Young's Modulus derived in the AMAR GIR are used.
(4) ϕ' of Glaciofluvial Deposits can be determined using correlation with SPT (Peck 1974) N values (typical N value of 40) gives an angle of 38°.
(5) E' of Glaciofluvial Deposits can be determined using Bowles correlation E' = 1200 (N + 6) which (using typical N value of 20) gives a value of 31.2MN/m^2.
(6) Due to limited localised GI data, typical values for c_u of Mercia Mudstone – III/IV derived in the AMAR GIR are used.
(7) ϕ' of Mercia Mudstone III/IV can be determined using Table 2 in BS8002:2015 using typical PI of 11% gives 28°.
(8) Due to limited localised GI data, typical values for Eu & E' of Mercia Mudstone – III/IV derived from the AMAR GIR are used.

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(9) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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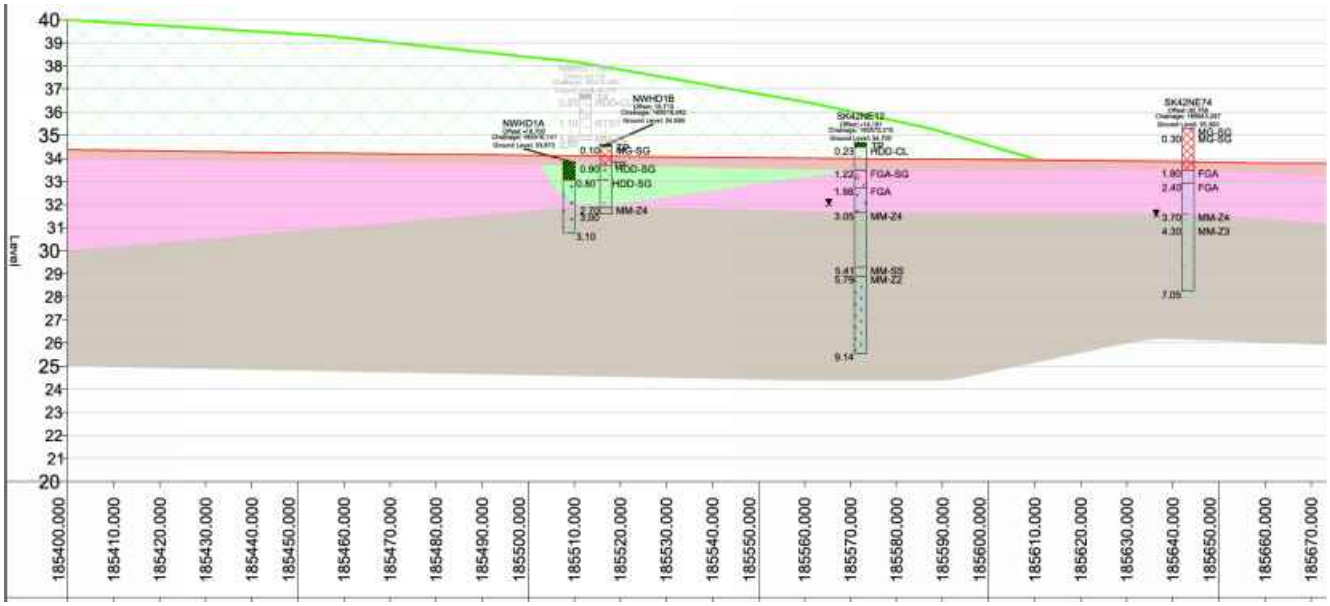


Figure 5: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (o)
185400	185510	Full Height Embankment Widening (1:2.0)	3.0	26.6º (1V;2H)

Proposed Structural Solution:

N/A

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FURTHER GROUND INVESTIGATION

‘Just In Time’ GI is not required at this location.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No.
SK42NE11
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447510.00 - 327740.00	Hole Type CP
Location:		Level: 37.20	Scale 1:50
Client: Highways England		Dates: 09/08/1961 - 11/08/1961	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	D				0.46	36.74		Topsoil TP
		0.61	D							Stiff brown clay & stones FGA-SG
		1.37 - 1.83 1.52	U D							
	▼	3.05	D				3.05	34.15		Soft clay, sand and gravel FGA-SG
		4.57	D							
		5.18	D				5.49	31.71		Firm to stiff red & grey silty clay MM-Z3
		6.10 6.10 - 6.55	D U							
		7.62 7.77 - 7.98	D U							
		9.14	D							

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No.
SK42NE11
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447510.00 - 327740.00	Hole Type CP
Location:		Level: 37.20	Scale 1:50
Client: Highways England		Dates: 09/08/1961 - 11/08/1961	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.67 - 10.92	U							
		12.19	D				12.19	25.01		End of borehole at 12.19 m
		12.19 - 12.20	U							

Remarks

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Borehole Log

Borehole No. **NWHD1A**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447493.18 - 327893.83	Hole Type WS
Location:		Level: 33.87	Scale 1:50
Client: Highways England		Dates: 13/09/1999 - 13/09/1999	Logged By NBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.00 - 0.80	D	Ublow=0				TOPSOIL with some fine to coarse subangular to subrounded gravel of limestone and quartz. TP
		0.00 - 0.80	D	Ublow=0				
		0.80 - 3.10	D	Ublow=0	0.80	33.07		Reddish brown clayey coarse SAND with some subrounded fine to coarse quartz gravel. HDD-SG
		0.80 - 3.10	D	Ublow=0				
					3.10	30.77		End of borehole at 3.10 m

Remarks
1. Hand excavated inspection pit to 0.70m (0.50m x 0.50m). 2. Hole complete at 3.10m. 3. Hole damp below 0.90m. 4. Hole backfilled withgrout. 5. Marker Post Ref 185/5 +50

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Rotary Core Log

Borehole No. **SK42NE12**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447490.00 - 327950.00	Hole Type CP
Location:		Level: 34.70	Scale 1:50
Client: Highways England		Dates: 09/08/1961 - 10/08/1961	Logged By

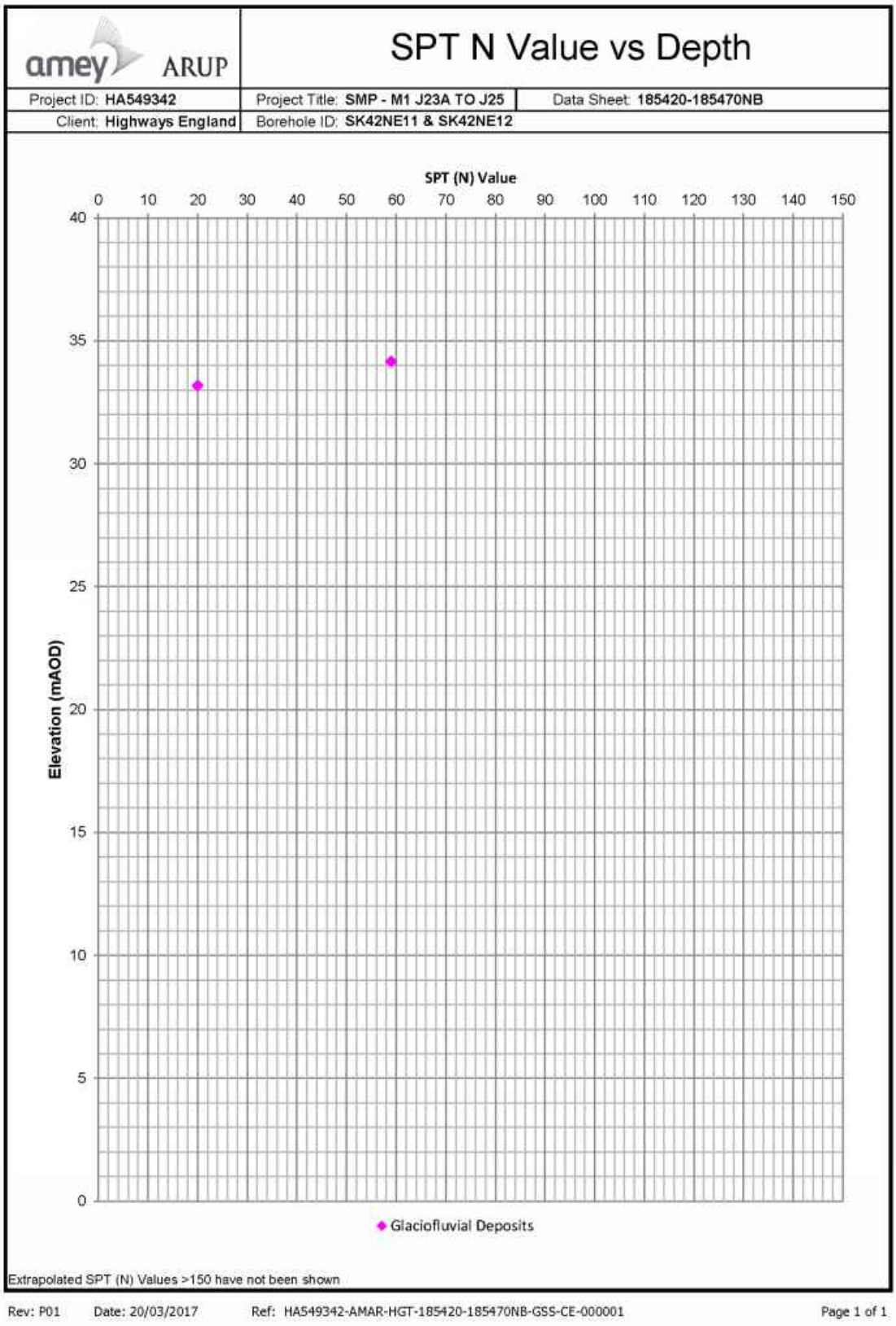
Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.23	34.47		Topsoil TP
										Brown clayey sand and stones HDD-CL
		0.76	D							
		1.22	D				1.22	33.48		Grey sand & stones FGA-SG
		1.98	D				1.98	32.72		Firm brown sandy clay and stones FGA-SG
		2.29 - 2.74	U							
		2.44	D							
	▼	2.44	W							
							3.05	31.65		Firm red & grey sandy clay MM-Z4
		3.81	D							
		4.57 - 5.03	U							
		5.41 - 5.79	D				5.41	29.29		Grey skerry MM-SS
							5.79	28.91		Stiff red silty clay and siltstone MM-Z2
		6.10 - 6.55	U							
		6.55	D							
		7.62 - 7.92	U							
		8.38	D							
		8.84 - 9.14	U							
							9.14	25.56		End of borehole at 9.14 m

Remarks

AGS

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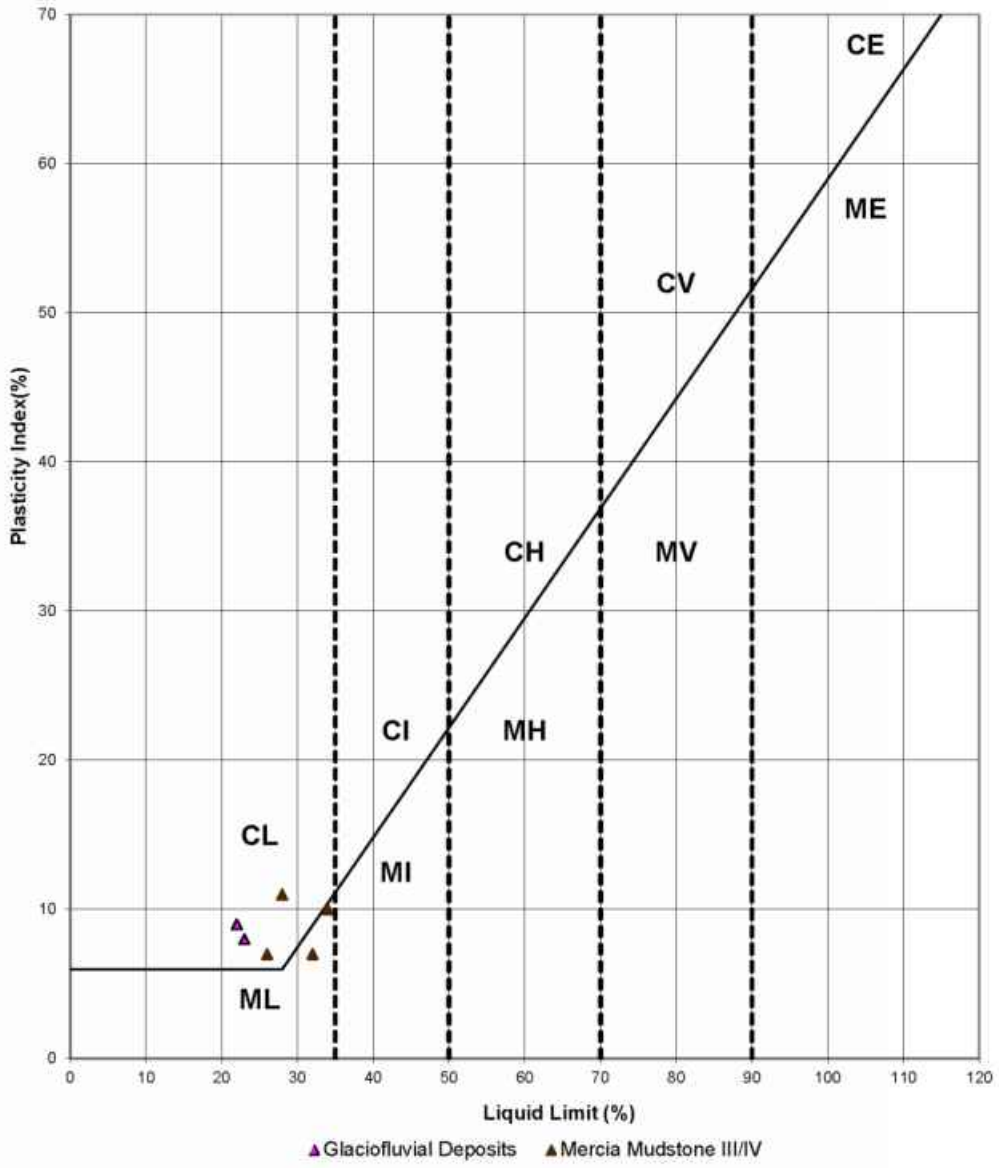
PLOTS



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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185420-185470NB**
Client: **Highways England**	Borehole ID: **SK42NE11 & SK42E12**	



Key

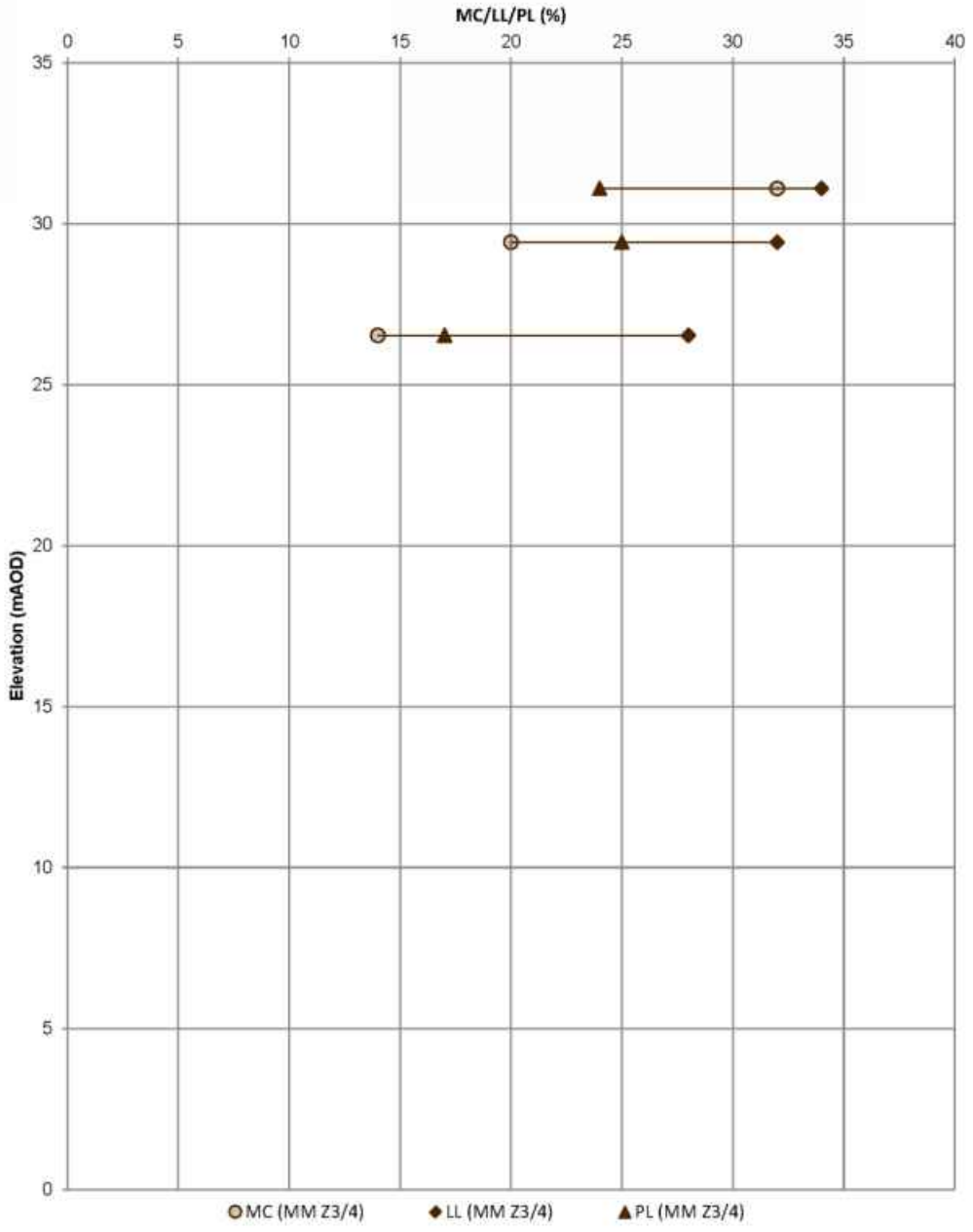
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 20/03/2017 Ref: HA549342-AMAR-HGT-185420-185470NB-GSS-CE-000001 Page 1 of 1

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185420-185470NB**
Client: **Highways England**	Borehole ID: **SK42NE11**	



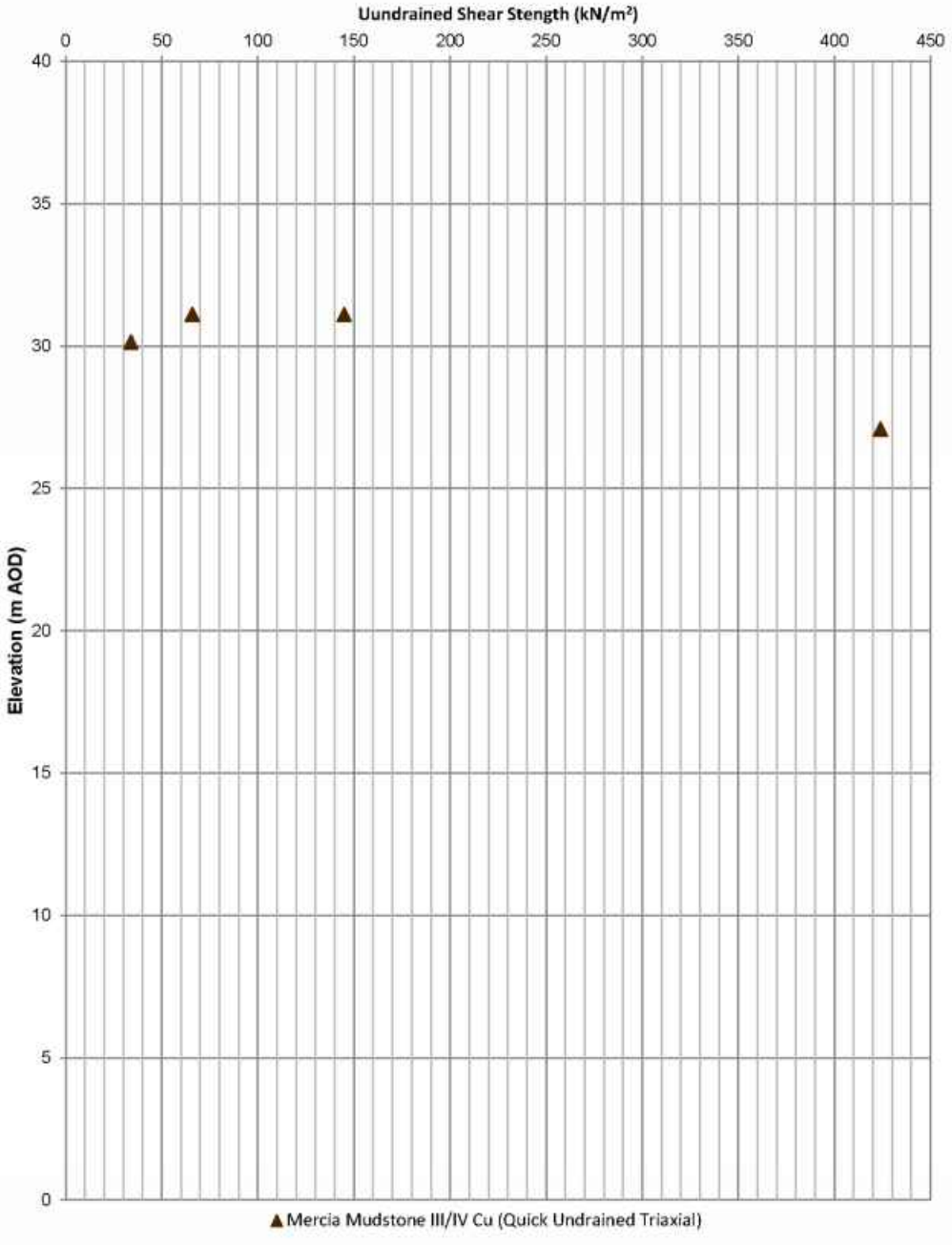
Rev: P01 Date: 20/03/2017 Ref: HA549342-AMAR-HGT-185420-185470NB-GSS-CE-000001 Page 1 of 1

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amey ARUP

Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185420-185470NB**
Client: **Highways England**	Borehole ID: **SK42NE11 & SK42NE12**	



Rev: P01 Date: 20/03/2017 Ref: HA549342-AMAR-HGT-185420-185470NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-185560 – 185640NB-GSS-000001		
Earthworks Widening Solution	Partial Height Regrade (1:3.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	185560-185640		
Carriageway	Northbound – Jct24 Merge (A453/A50/A6-M1 Onslip west)		
Marker Post	185/5A+50 – 185/6A+40		
National Grid Reference	E 447466, N 327943 – E 447465, N 328013		
Existing Ground Level at Location	Carriageway	33.5-35.0mAOD	
	Crest of cutting	34.5-35.8mAOD	
Earthwork Type	NB: Cutting	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: 7_M1_20911	SB: N/A	HAGDMS designation
Earthwork Height	NB: 0.7-1.3m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 18°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Simon Arinze	21/03/2017	[redacted]
Checked	Roheel Masrat	02/05/2017	
Reviewed	Gary Summerfield	03/05/2017	
Approved	Tom Bulteel	07/06/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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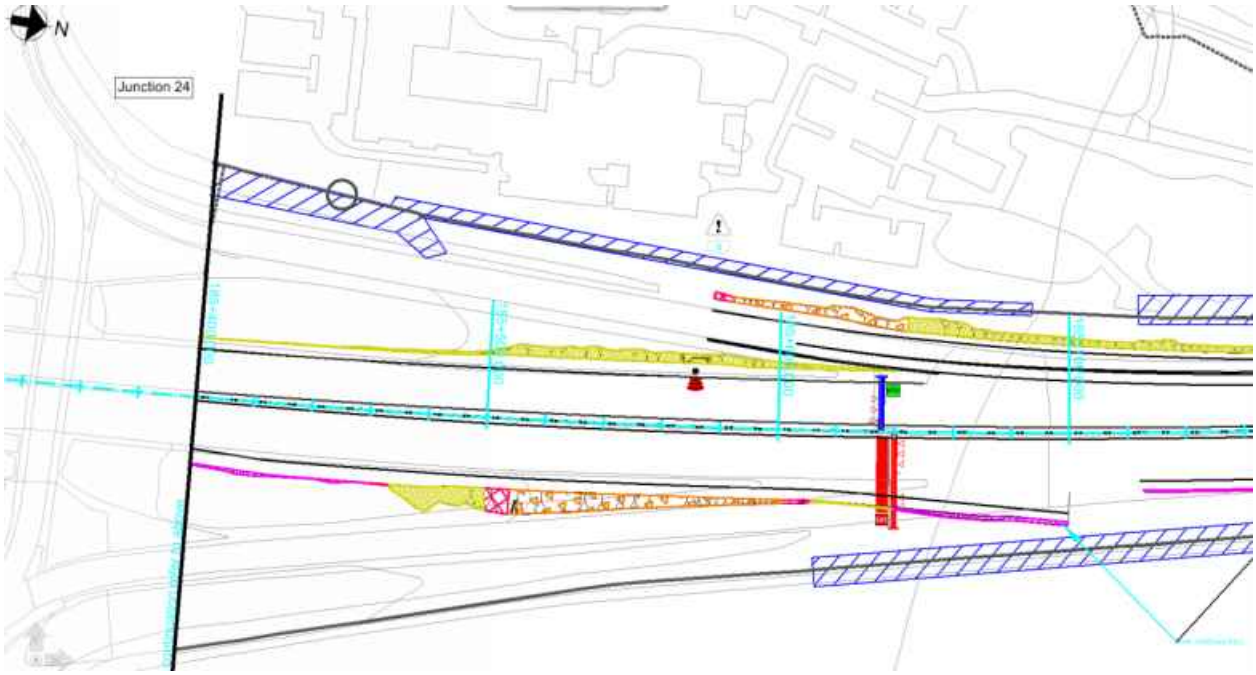


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch185550-185590, 1:3 Partial Height Regrade;
- Ch1856120-185640, 1:3 Partial Height Regrade;

Proposed Major Structures:

N/A

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that location comprises a cutting of 0.7-1.3m height (increasing in height from south to north) and a proposed slope gradient of 18°.

The critical cross sections used is Ch185620 (Ch190).



Figure 2 Topographic Critical Cross Section Chainage 185620 (Ch190)

Utilities:

A western power low voltage cable is located in the verge to the west of the slip road.

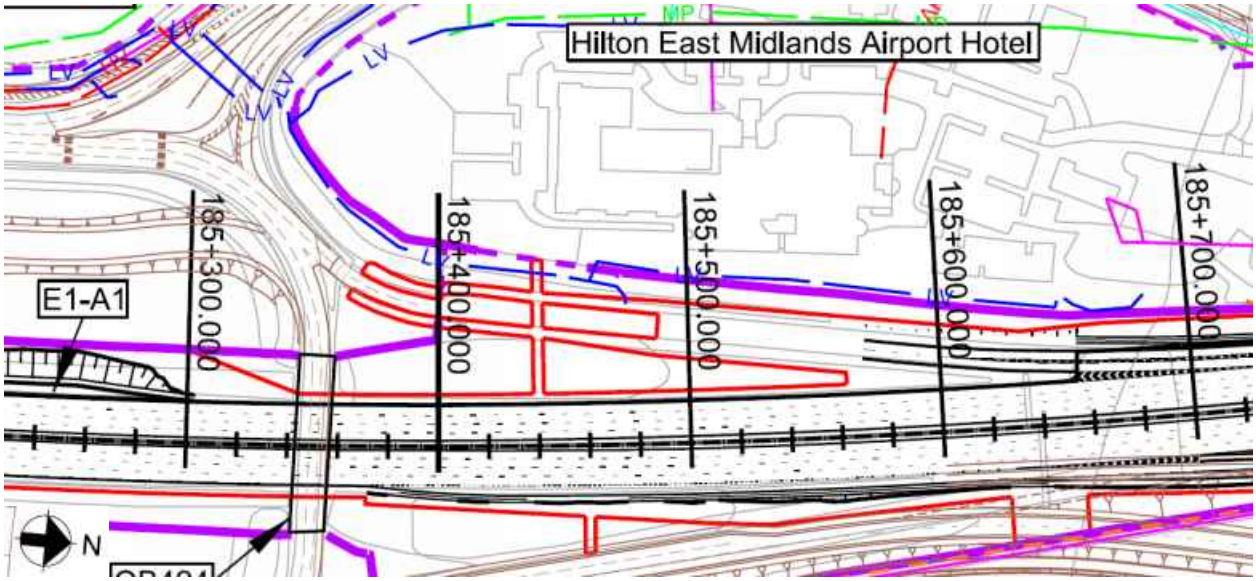


Figure 3 Utilities Location Plan

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough, indicates that the site is underlain by:

Superficial Deposits: Holme Pierrepont Sand and Gravel Member (Sand and Gravel)

Solid Deposits: Branscombe Mudstone Formation (Mudstone – Mercia Mudstone Group)

Ground Investigation:

There are no historical exploratory holes recorded within the design chainage, with additional 3 no. relevant exploratory holes considered within close proximity; as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000028, Rev P01.



Figure 4: Borehole Location Plan

Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42NE11	NWHD1A	SK42NE12
Borehole Chainage	185359	185516	185572
Borehole Location	Northbound	Northbound	Northbound
National Grid Reference	E 447510, N 327740	E 447493, N 327740	E 447490, N 327950
Ground Level at Exploratory Hole	37.20m AOD,	33.87m AOD	34.70m AOD
RAG Analysis	Amber	Amber	Amber
Date Drilled	09/08/1961	13/09/1999	09/08/1961
Termination Depth	3.10m bgl	12.19m bgl	9.14m bgl
Other Suitable Holes	None		

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (m bgl)	Depth to Base (m AOD)	SPT 'N' Value Range*	Hand Vane Strength Range (kN/m^2)
Embankment Fill	0.1	34.5	-	-
Glaciofluvial Deposits (Coarse Grained)	7.5	31.7	20-59 (20)	-
Mercia Mudstone – III/IV	>14.2	<25.0	-	-

(1) Ground level is assumed to be at the crest
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within historical exploratory holes SK42NE11 and SK42NE12.

Groundwater:

No ground water encountered within the exploratory boreholes.

Groundwater Design Level:

No local groundwater level is available and therefore a design groundwater level of 1.0m below ground level throughout the cutting has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

6 No. Atterberg Limit Test and 18No. Natural Moisture Content tests were undertaken within the Glaciofluvial Deposits and the Mercia Mudstone III/IV with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Glaciofluvial Deposits	0.30	14	-	-	-	-
Glaciofluvial Deposits	0.61	2	-	-	-	-
Glaciofluvial Deposits	0.76	15	-	-	-	-
Glaciofluvial Deposits	1.22	16	-	-	-	-
Glaciofluvial Deposits	1.37	-	22	13	9	CL
Glaciofluvial Deposits	1.52	6	-	-	-	-
Glaciofluvial Deposits	1.98	18	-	-	-	-
Glaciofluvial Deposits	2.29	-	23	15	8	CL
Mercia Mudstone III/IV	3.05	5	-	-	-	-
Mercia Mudstone III/IV	3.81	41	-	-	-	-
Mercia Mudstone III/IV	4.57	13	26	19	7	CL
Mercia Mudstone III/IV	5.18	15	-	-	-	-
Mercia Mudstone III/IV	5.41	16	-	-	-	-
Mercia Mudstone III/IV	6.10	32	34	24	10	ML
Mercia Mudstone III/IV	6.55	14	-	-	-	-
Mercia Mudstone III/IV	7.62	31	-	-	-	-
Mercia Mudstone III/IV	7.77	20	32	25	7	ML
Mercia Mudstone III/IV	8.84	8	-	-	-	-
Mercia Mudstone III/IV	9.14	20	-	-	-	-
Mercia Mudstone III/IV	10.67	14	28	17	11	CL

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5 No. Traixial Tests were undertaken within the Glaciofluvial Deposts and the Mercia mudstone III/IV with the following results:

Stratum	Depth to Top of Test (mbgl)	Undrained Shear Strength (kN/m^2)
Glaciofluvial Deposits	1.37	41
Glaciofluvial Deposits	2.29	38
Mercia Mudstone III/IV	6.10	66
Mercia Mudstone III/IV	6.10	150
Mercia Mudstone III/IV	7..62	420

Lab Test Data – BRE Classification:

No chemical laboratory testing data is available for this structure location.

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Assumed Ground Model For Design:

Ground model is based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-000034, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01.

Due to the current elevated ground level of the road surface at this location compared to the ground level that was recorded during the advancement of the historic boreholes it is assumed that an amount of embankment fill exists at road level above the Glaciofluvial Deposits.

The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0.00 – 1.10	35.10 -34.00	1.10	21	27	0	100	7.8	6.2	-	0.50	0.20	-	DS-2 AC-2
Glaciofluvial Deposits (Coarse Grained)	1.10 – 3.60	34.00-31.50	2.50	21	33	-	-	-	31.2	-	-	0.25	-	DS-3 AC-3
Mercia Mudstone III/IV	3.60->10.10	31.50- <25.00	>6.50	21	28	2	50	16.8	13.4	-	0.50	0.20	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Due to limited localised GI data for the Embankment Fill, typical values for cu, ϕ' and Young's Modulus derived in the AMAR GIR are used.
(4) ϕ' of Glaciofluvial Deposits can be determined using correlation with SPT (Peck 1974) N values (typical N value of 20) gives an angle of 33°.
(5) E' of Glaciofluvial Deposits can be determined using Bowles correlation E' = 1200 (N + 6) which (using typical N value of 20) gives a value of 31.2MN/m^2.
(6) Due to limited localised GI data, typical values for c_u of Mercia Mudstone – III/IV derived in the AMAR GIR are used.
(7) ϕ' of Mercia Mudstone III/IV can be determined using Table 2 in BS8002:2015 using typical PI of 11% gives 28°.

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(8) Due to limited localised GI data, typical values for Eu & E' of Mercia Mudstone – III/IV derived from the AMAR GIR are used.
(9) BRE Classification is determined using criteria set out in BRE Special Digest 1. In the absence of BRE test data, the classification used for the strata in the AMAR GIR was adopted.

Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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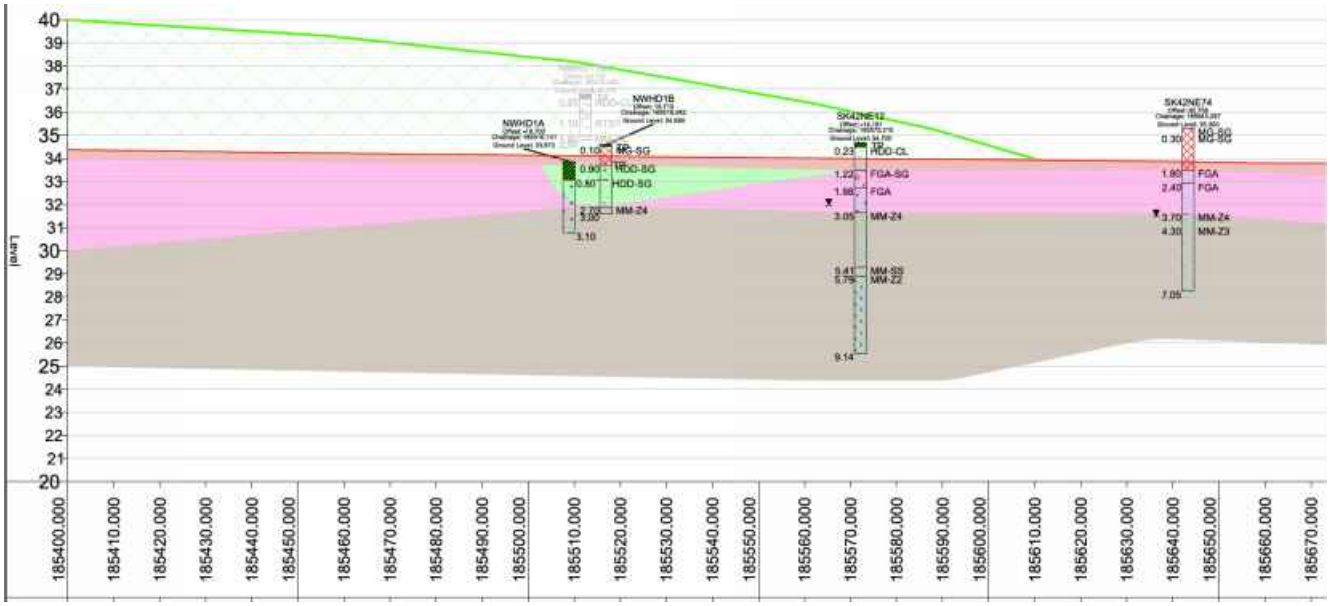


Figure 5: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
185550	185590	1:3 Partial Height Regrade
185610	185640	1:3 Partial Height Regrade

Proposed Structural Solution:

N/A

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FURTHER GROUND INVESTIGATION

No further ‘Just In Time’ GI is required at this location.

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HISTORICAL EXPLORATORY HOLES

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Rotary Core Log

Borehole No.
SK42NE11
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447510.00 - 327740.00	Hole Type CP
Location:		Level: 37.20	Scale 1:50
Client: Highways England		Dates: 09/08/1961 - 11/08/1961	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	D				0.46	36.74		Topsoil TP
		0.61	D							Stiff brown clay & stones FGA-SG
		1.37 - 1.83	U							
		1.52	D							
	▼	3.05	D				3.05	34.15		Soft clay, sand and gravel FGA-SG
		4.57	D							
		5.18	D							
							5.49	31.71		Firm to stiff red & grey silty clay MM-Z3
		6.10	D							
		6.10 - 6.55	U							
		7.62	D							
		7.77 - 7.98	U							
		9.14	D							

1 2 3 4 5 6 7 8 9 10

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE11**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447510.00 - 327740.00	Hole Type CP
Location:		Level: 37.20	Scale 1:50
Client: Highways England		Dates: 09/08/1961 - 11/08/1961	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.67 - 10.92	U							
		12.19	D				12.19	25.01		End of borehole at 12.19 m
		12.19 - 12.20	U							

Remarks

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Borehole Log

Borehole No. **NWHD1A** Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447493.18 - 327893.83	Hole Type WS
Location:		Level: 33.87	Scale 1:50
Client: Highways England		Dates: 13/09/1999 - 13/09/1999	Logged By NBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.00 - 0.80	D	Ublow=0				TOPSOIL with some fine to coarse subangular to subrounded gravel of limestone and quartz. TP
		0.00 - 0.80	D	Ublow=0				
		0.80 - 3.10	D	Ublow=0	0.80	33.07		Reddish brown clayey coarse SAND with some subrounded fine to coarse quartz gravel. HDD-SG
		0.80 - 3.10	D	Ublow=0				
					3.10	30.77		End of borehole at 3.10 m

Remarks
1. Hand excavated inspection pit to 0.70m (0.50m x 0.50m). 2. Hole complete at 3.10m. 3. Hole damp below 0.90m. 4. Hole backfilled withgrout. 5. Marker Post Ref 185/5 +50

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Rotary Core Log

Borehole No. **SK42NE12**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447490.00 - 327950.00	Hole Type CP
Location:		Level: 34.70	Scale 1:50
Client: Highways England		Dates: 09/08/1961 - 10/08/1961	Logged By

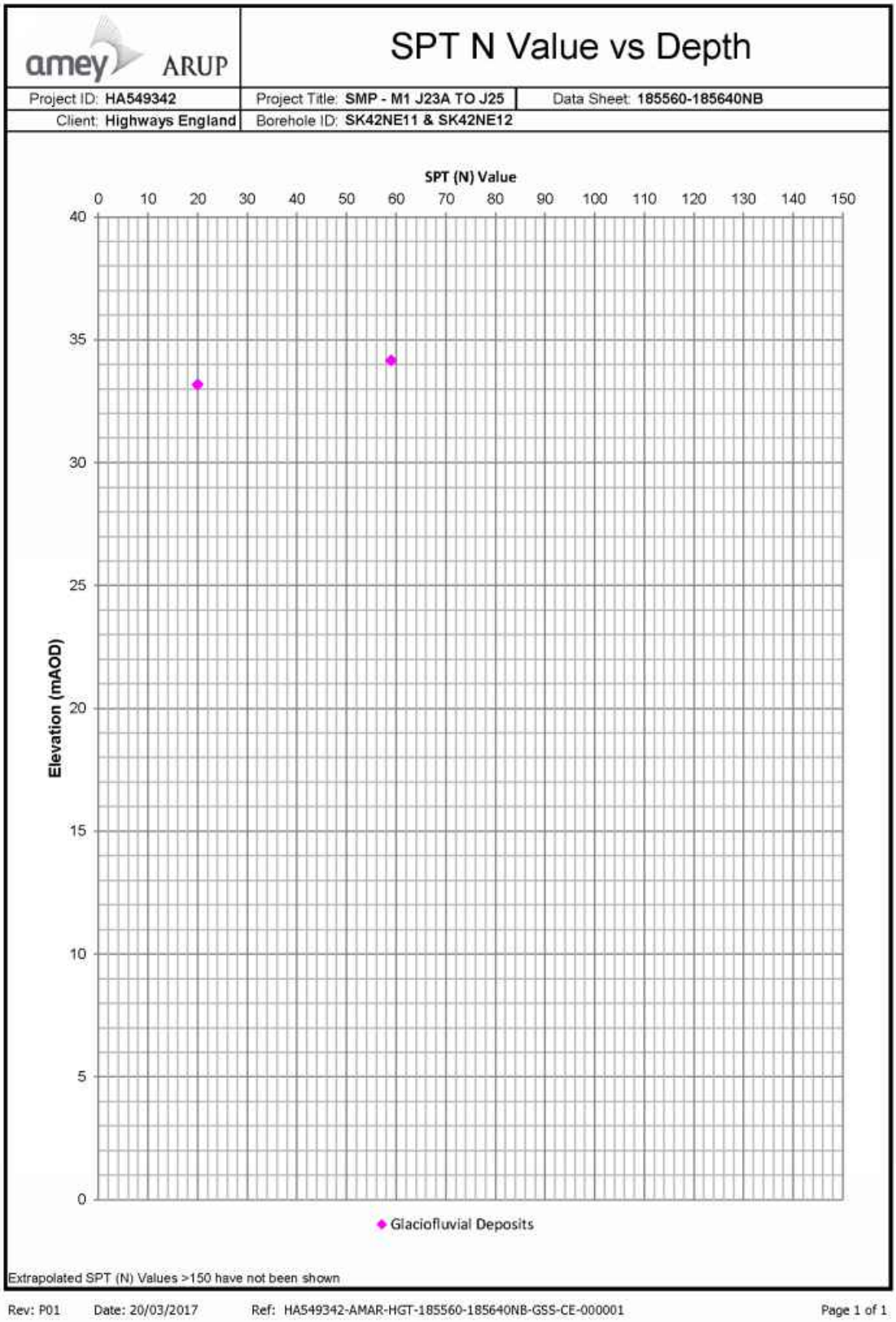
Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.23	34.47		Topsoil TP
										Brown clayey sand and stones HDD-CL
		0.76	D							
		1.22	D				1.22	33.48		Grey sand & stones FGA-SG
		1.98	D				1.98	32.72		Firm brown sandy clay and stones FGA-SG
		2.29 - 2.74	U							
		2.44	D							
	▼	2.44	W							
							3.05	31.65		Firm red & grey sandy clay MM-Z4
		3.81	D							
		4.57 - 5.03	U							
		5.41 - 5.79	D				5.41	29.29		Grey skerry MM-SS
							5.79	28.91		Stiff red silty clay and siltstone MM-Z2
		6.10 - 6.55	U							
		6.55	D							
		7.62 - 7.92	U							
		8.38	D							
		8.84 - 9.14	U							
							9.14	25.56		End of borehole at 9.14 m

Remarks

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PLOTS

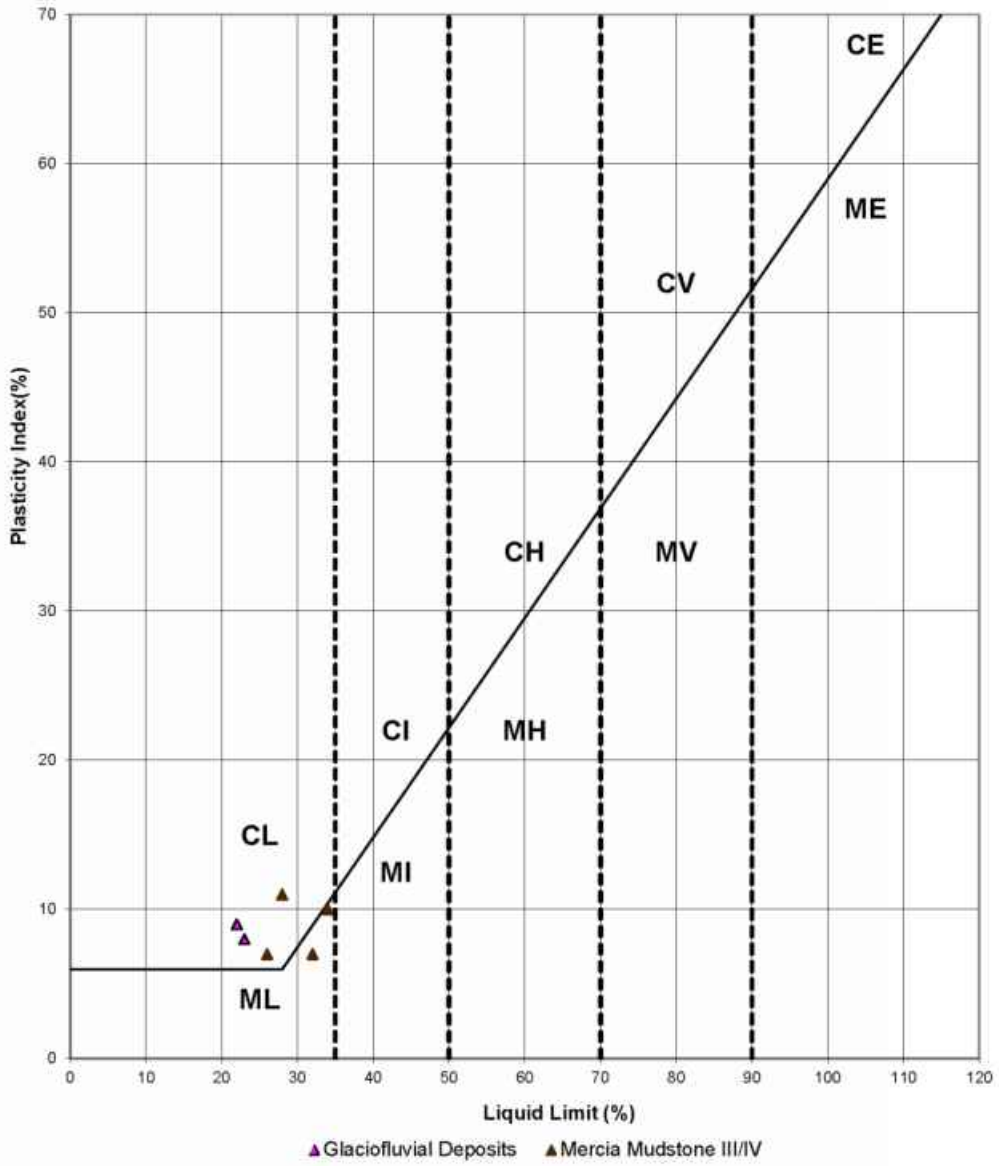


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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185560-185640NB**
Client: **Highways England**	Borehole ID: **SK42NE11 & SK42E12**	



Key

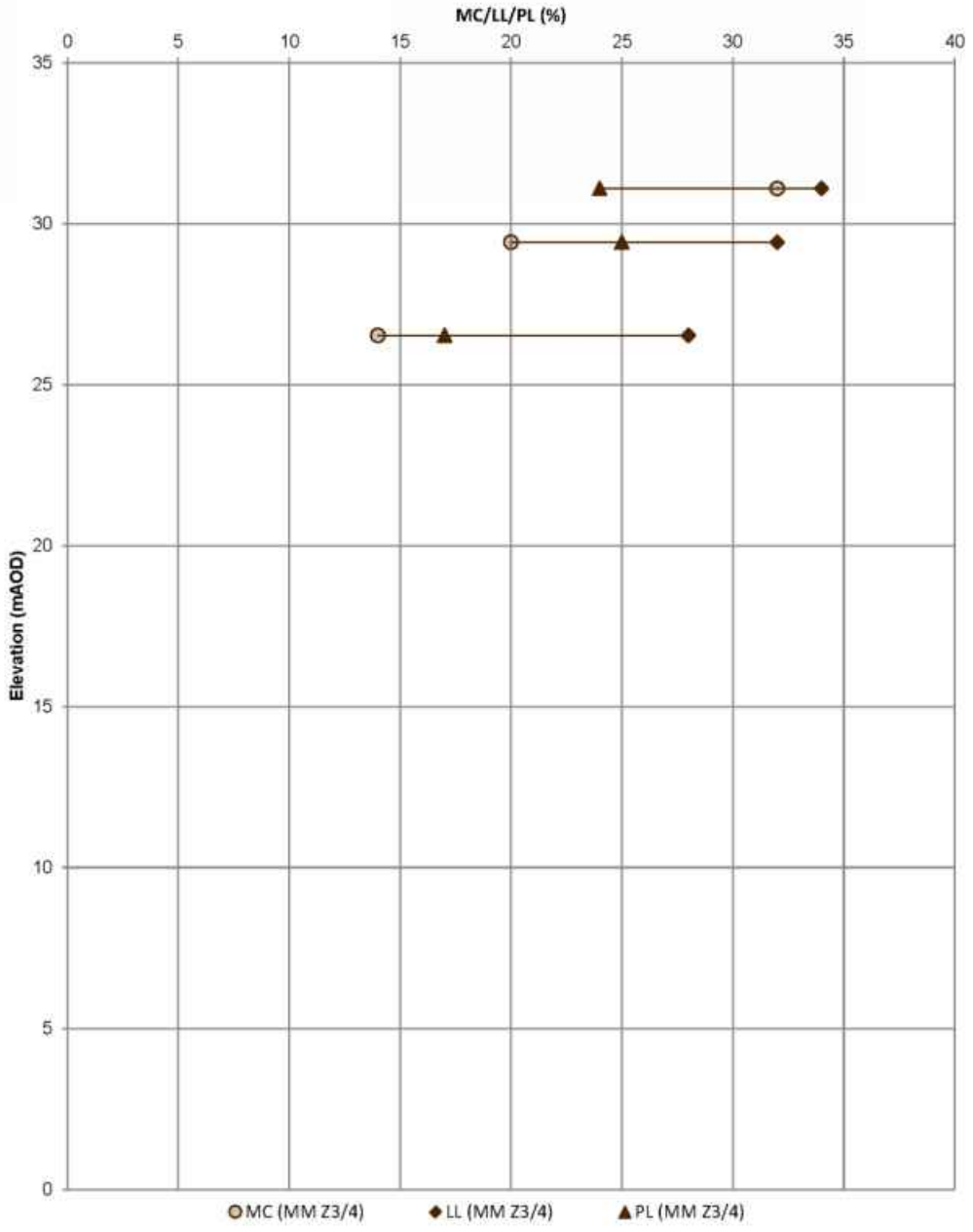
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 20/03/2017 Ref: HA549342-AMAR-HGT-185560-185640NB-GSS-CE-000001 Page 1 of 1

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Moisture Content/Atterberg Limits

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185560-185640NB**
Client: **Highways England**	Borehole ID: **SK42NE11**	



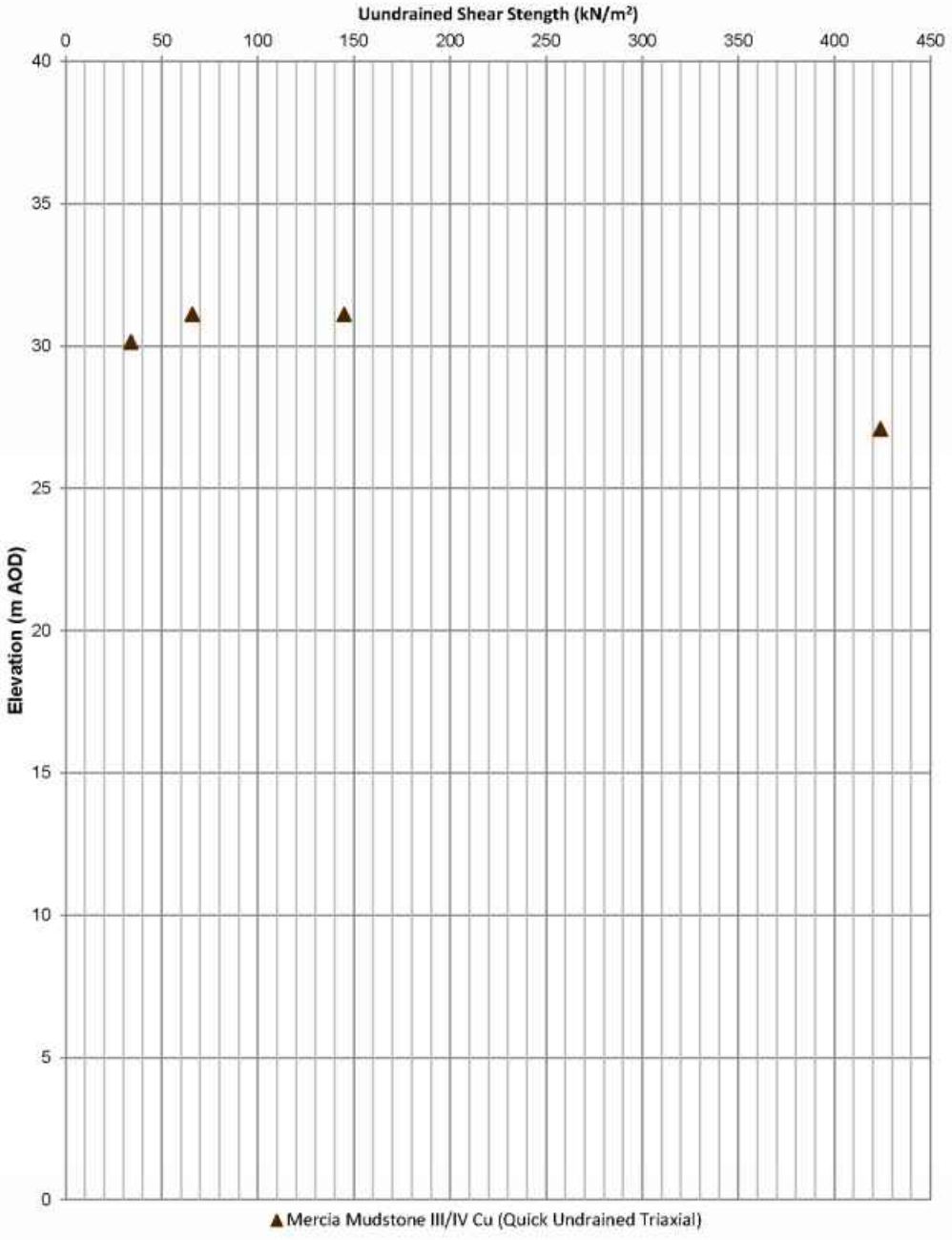
Rev: P01 Date: 20/03/2017 Ref: HA549342-AMAR-HGT-185560-185640NB-GSS-CE-000001 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **185560-185640NB**
Client: **Highways England**	Borehole ID: **SK42NE11 & SK42NE12**	



Rev: P01 Date: 20/03/2017 Ref: HA549342-AMAR-HGT-185560-185640NB-GSS-CE-000001 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-182120-182140NB-GSS-000001		
Earthworks Widening Solution	Granular Wedge at Embankment Crest (1:2.0)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	182120-182140		
Carriageway	Northbound Merge (Jct 23a)		
Marker Post	182/1A+20 – 182/1A+40		
National Grid Reference	E 446819, N 324596 – E 441825, N 324615		
Existing Ground Level at Location	Carriageway	66.1mAOD	
	Toe of embankment / Crest of cutting	60.7mAOD	
Earthwork Type	NB: Embankment	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: 7_M1_42110	SB: N/A	HAGDMS designation
Earthwork Height	NB: 5.4m	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: 22°	SB: N/A	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	07/06/2017	[redacted]
Checked	Scott Bishton	08/06/2017	
Reviewed	Gary Summerfield	08/06/2017	
Approved	Thomas Bulteel	08/06/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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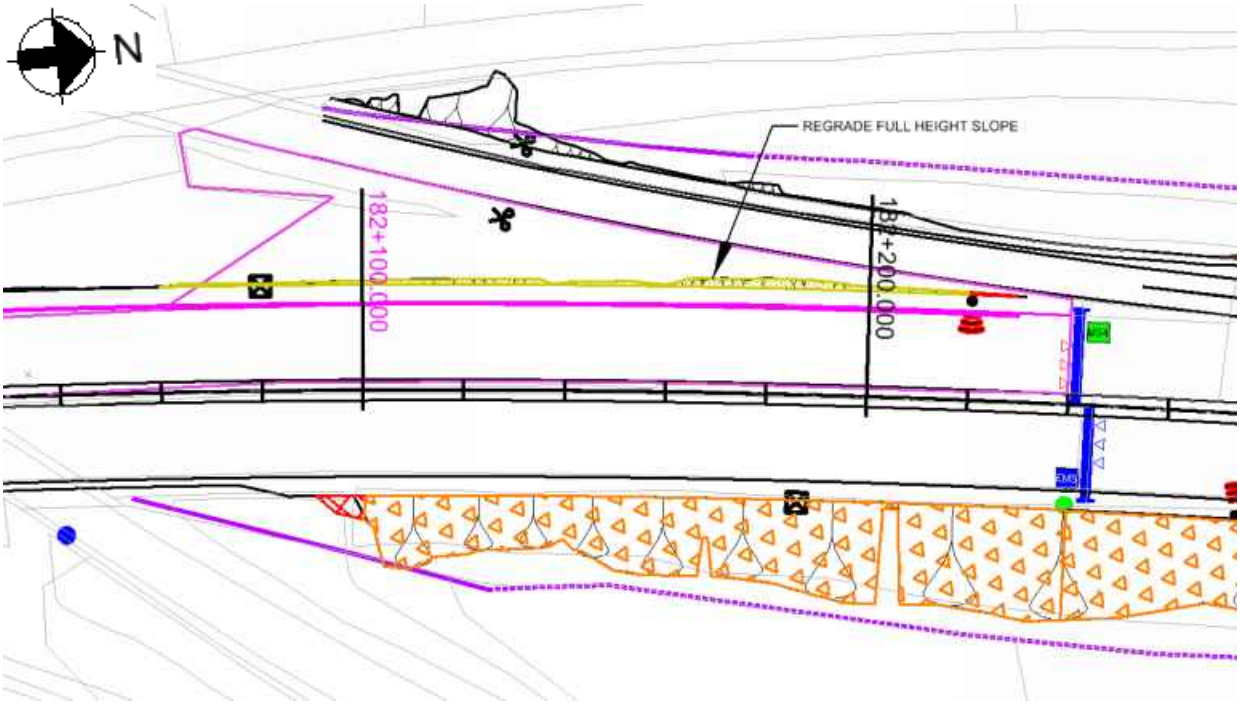


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch182120-182140, Granular Wedge at Embankment Crest (1:2.0)

Proposed Major Structures:

N/A.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that location comprises and embankment of 5.3m height and a slope gradient of 22°.

The critical cross section used is Ch182130.

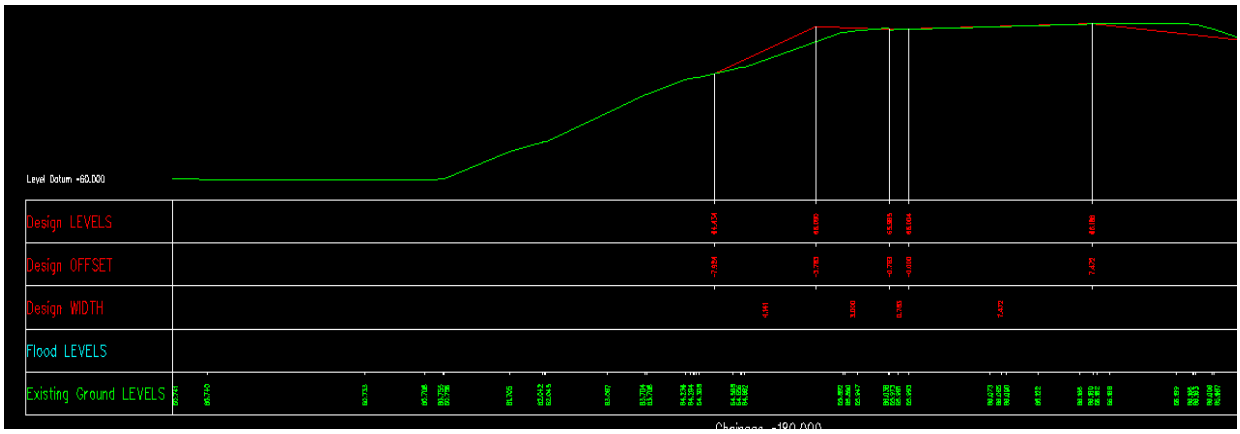


Figure 2 Topographic Critical Cross Section Chainage 182130 (Cross section 180)

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough, indicates that the site is underlain by:

Superficial Deposits: None Recorded

Solid Deposits: Gunthorpe Member - Mudstone (Mercia Mudstone Group)

Ground Investigation:

There are 4 No. historical exploratory holes recorded within the design chainage, with additional 3 no. relevant exploratory holes considered as shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000020, Rev P01.

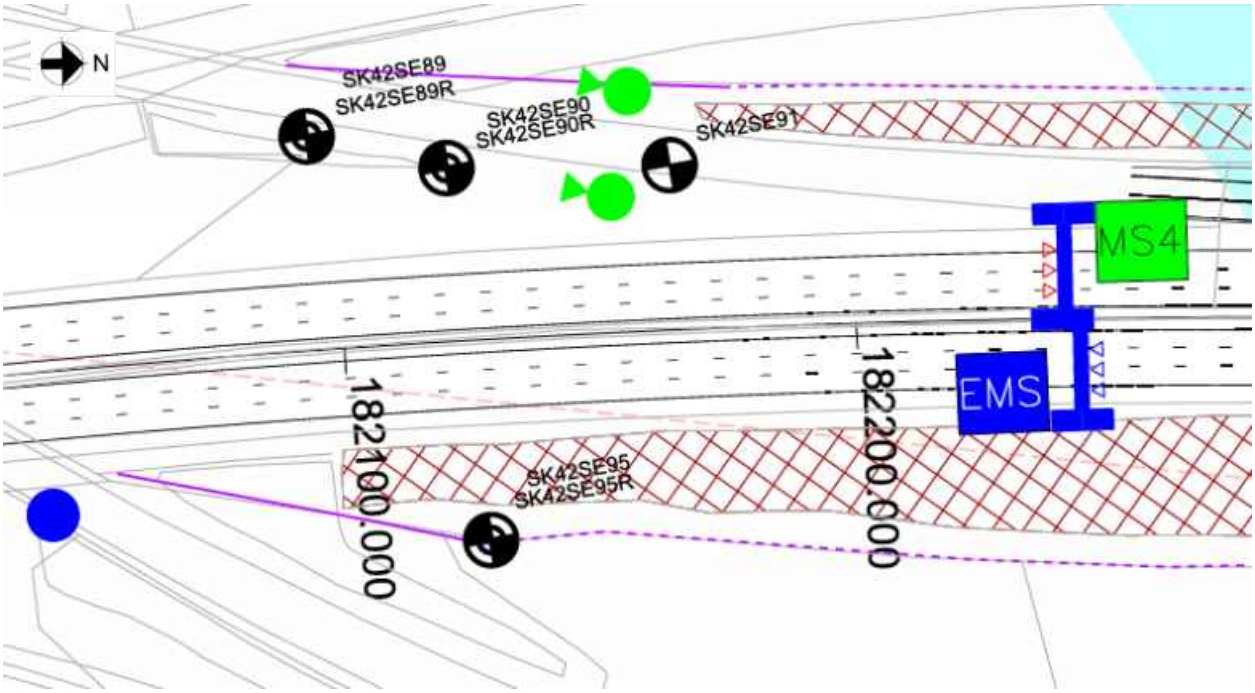


Figure 3: Borehole Location Plan

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Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42SE89/89 R	SK42SE90/90R	SK42SE91
Borehole Chainage	182040	182125	182167
Borehole Location	NB merge	NB merge	NB merge
National Grid Reference	E 446822, N 324571	E 446833, N 324597	E 446840, N 324640
Ground Level at Exploratory Hole	61.45mAOD (metres above Ordnance Datum)	61.84mAOD	63.59mAOD
RAG Analysis	Green	Green	Amber
Date Drilled	19/01/1988-22/01/1988	19/01/1998-25/01/1988	18/01/1988
Termination Depth	15.22mbgl (metres below ground level)	15.20mbgl	6.11mbgl
Other suitable holes	SK43SE95/95R		

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (m bgl)	Depth to Base (m AOD)	SPT 'N' Value Range*	Hand Vane Strength Range (kN/m^2)
Embankment Fill	5.4	60.7	-	-
Mercia Mudstone – III/IV	>5.4	<60.7	20-150 (25)	-

(1) Ground level is assumed to be at carriageway level
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within historical exploratory holes SK42NE381, SK42NE382 and SK42NE398.

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Groundwater:

Groundwater was recorded within exploratory hole SK43SE90 at 5.30mbgl (56.54m AOD) and rose to 3.60mbgl (58.24mAOD) within Mercia Mudstone – III/IV.

Groundwater Design Level:

A design groundwater level of 1.0m below toe of embankment has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

No geotechnical laboratory testing data is available for this location.

Lab Test Data – BRE Classification:

No chemical laboratory testing data is available for this location.

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Assumed Ground Model For Design:

Ground model is based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-000034, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01.

The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)		Poisson's Ratio		BRE Classification
								E_u	E'	v_u	v'	
Embankment Fill	0-5.4	60.1-60.7	1.70	21	27	0	100	7.8	6.2	0.50	0.20	DS-2 AC-2
Mercia Mudstone – III/IV	>5.4	<60.7	-	21	30	2	125	9.3	7.4	0.50	0.20	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.

(2) Due to limited localised GI data, typical values for bulk density, friction angle, cohesion and Poisson's ratio derived in the AMAR GIR are used.

(3) Due to limited localised GI data, the characteristic values for Embankment Fill from the AMAR GIR are adopted.

(4) c_u of Mercia Mudstone – III/IV can be derived using the Stroud correlation. A typical f1 value of 5.0; combined with a characteristic SPT N value of 25, this gives a cu of 125kN/m^2.

(5) Eu for Mercia Mudstone – III/IV can be derived using N values (Bowles) where Eu = 300 (N+6); using a characteristic N value of 25 gives Eu = 9.3MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 7.4MN/m^2.

(6) In the absence of BRE test data for, the classification used in the AMAR GIR was adopted.

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Imported Granular Fill (Class 6N) was used in the design of embankment widening; the granular material was assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E (MN/m^2)	Poisson's Ratio V
Granular Fill	20	36	20	0.25

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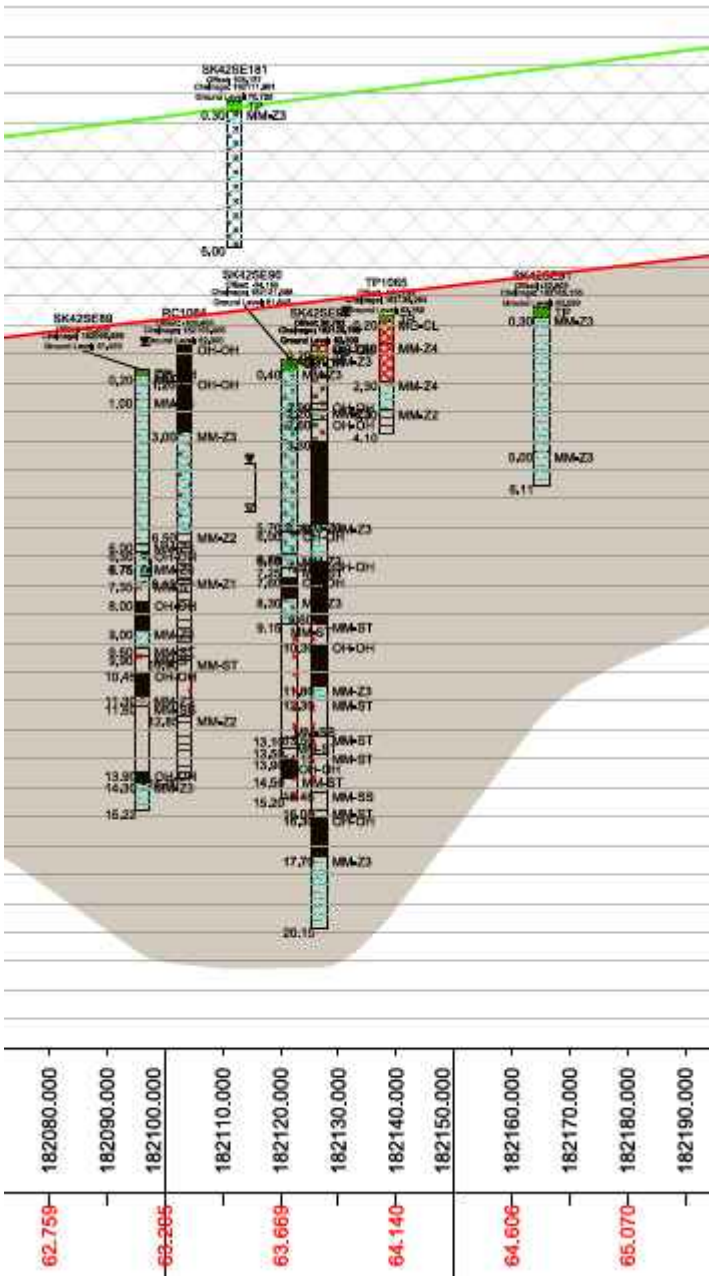


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution	Base Width (m)	Batter Angle (°)
182120	182140	Granular Wedge at Embankment Crest (1:2.0)	4.8	18 (1V:3H)

Proposed Structural Solution:

N/A.

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FURTHER GROUND INVESTIGATION

No ‘Just In Time’ GI is required at this location.

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HISTORICAL EXPLORATORY HOLES

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Borehole Log

Borehole No.
SK42SE89
HISTORIC
Sheet 1 of 1

Project Name:	SMP M1 J23a to J25	Project No. COCDFL1SMP01	Co-ords:	446822.00 - 324571.00	Hole Type CP
Location:	M1 J23a to J25		Level:	61.45mbgl	Scale 1:50
Client:	Highways England		Dates:	19/01/1988 - 20/01/1988	Logged By GAC

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.20	1D			0.20	61.25		Clayey topsoil TP
		0.50 - 0.65	2U	53blows					Stiff red brown sandy CLAY with occasional up to medium generally siltstone gravel (PROBABLE GLACIAL TILL) MM-Z4
		1.00	3D			1.00	60.45		
		1.00	SPT (S)	N=20 (3,5/4,5,5,6)	Water=-				Stiff red brown very silty CLAY with frequent lithorelics and occasional pockets and lenses of light green grey to light brown silt (KEUPER MARL 3/4a) below 2.50m with lenses/laminations of hard dark red brown clay by 3.50m becoming very stiff with black grained fissures MM-Z3
		1.00 - 1.45	4D						
		2.00	11W						
		2.00 - 2.45	5U	44blows					
		2.50	6D						
		2.50	SPT (S)	N=34 (5,7/8,7,9,10)	Water=-				
		2.50 - 2.95	7D						
		3.50 - 3.95	8U	150blows					
		4.00	9D						
		4.00	SPT (S)	N=26 (5,5/7,8,6,5)	Water=-				
		4.00 - 4.45	10D						
		5.00	SPT (S)	N=39 (6,6/7,8,10,14)	Water=-				
		5.00 - 5.45	12D						
		6.00	SPT (S)	76 (4,11/76 for 125mm)	Water=-	6.00	55.45		
		6.00 - 6.28	13D						Very stiff (hard) red brown to dark red brown very silty CLAY with bands of light grey fine sandy silt and siltstone (KM 3/4a) MM-Z3
		6.60	SPT (S)	0 (65 for 105mm/0 for 0mm)	Water=-	6.75	54.70		End of borehole at 6.75m
		6.60 - 6.70	14D						

Remarks

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Rotary Core Log

Borehole No. **SK42SE89R** HISTORIC Sheet 1 of 3

Project Name:	SMP M1 J23a to J25	Project No. COCDFL1SMP01	Co-ords: 446822.00 - 324571.00	Hole Type CP+RC
Location:	M1 J23a to J25		Level: 61.45mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client:	Highways England		Dates: 22/01/1988 - 24/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											Cable Tool Boring to 6.75m OH-OH
		6.30	SPT(S)				N=89 (7,14/17,19,24,29)	6.30	55.15		Assessed zone of core loss OH-OH
		6.30 - 8.00		74	21	13		6.75	54.70		Firm becoming stiff red brown locally very silty CLAY with occasional fine gravel sized lithorelics and rare pockets and lenses of light grey green silt and
								7.35	54.10		Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
22/01/1988 17:30	9.50		6.30	End of shift
23/01/1988 08:30	9.50	1.90	6.30	
23/01/1988 17:30	12.60	12.60	9.30	End of shift
24/01/1988 08:30	12.60	0.60	9.30	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush, using 6.75in rock bit from ground level to 6.30m

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Rotary Core Log

Borehole No. **SK42SE89R** HISTORIC Sheet 2 of 3

Project Name: SMP M1 J23a to J25	Project No. COCDFL1SMP01	Co-ords: 446822.00 - 324571.00	Hole Type CP+RC
Location: M1 J23a to J25		Level: 61.45mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 22/01/1988 - 24/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		8.00	SPT(S)				50 (27,39/50 for 55mm)	8.00	53.45		fine sand (KM 4a) MM-Z3
		8.00 - 9.00		0	0	0					Red brown moderately weathered SILTSTONE very weak with very closely spaced fractures with black speckled strain (HM2/3) MM-ST
											Assessed zone of core loss OH-OH
		9.00 - 9.50		100		0		9.00	52.45		Firm to stiff red brown very silty CLAY with frequent fine to medium occasionally coarse gravel sized lithorelics (weathered MUDSTONE) (KM 3/4a) MM-Z3
		9.60	SPT(S)	100		0	0 (50 for 45mm/0 for 0mm)	9.60	51.85		
		9.60 - 10.30		93	57	0		9.90	51.55		core pickled up on following run
											Light grey green slightly to moderately weathered fine sandy SILTSTONE strong (KM 2) MM-ST
		10.30 - 11.20		17	6	0		10.45	51.00		Red brown moderately weathered SILTSTONE weak with extremely to closely spaced fractures stained black (KM2) MM-ST
		11.20	SPT(S)				0 (64 for 85mm/0 for 0mm)	11.30	50.15		vertical joint stained black
		11.20 - 11.80		83	18	0		11.60	49.85		Assessed zone of core loss OH-OH
		11.80 - 12.60		100	81	46					Dense light grey green and red brown slightly fine sandy SILT with occasional fine gravel sized lithorelics (Weathered SILTSTONE) (KM 3) MM-Z3
		12.60 - 13.00		88	63	33					Light grey green slightly weathered locally very silty fine grained SANDSTONE strong to very strong with closely to very closely spaced sub-horizontal fractures Below 12.20m with occasional bands of very dense clayey silt with up to coarse gravel sized lithorelics (KEUPER SANDSTONE 2) MM-SS
		13.00 - 14.00		90	70	26		13.90	47.55		Assessed zone of core loss OH-OH
		14.00 - 15.00		70				14.30	47.15		Stiff red brown very silty CLAY with frequent medium to coarse gravel sized lithorelics (weathered MUDSTONE) (KEUPER MARL 3/4a)
		15.00	SPT(S)								Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
22/01/1988 17:30	9.50		6.30	End of shift
23/01/1988 08:30	9.50	1.90	6.30	
23/01/1988 17:30	12.60	12.60	9.30	End of shift
24/01/1988 08:30	12.60	0.60	9.30	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush, using 6.75in rock bit from ground level to 6.30m

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Rotary Core Log

Borehole No.
SK42SE89R
HISTORIC
Sheet 3 of 3

Project Name: SMP M1 J23a to J25	Project No. COCDFL1SMP01	Co-ords: 446822.00 - 324571.00	Hole Type CP+RC
Location: M1 J23a to J25		Level: 61.45mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 22/01/1988 - 24/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
							50 (18,24/50 for 65mm)	15.22	46.23		MM-Z3 End of borehole at 15.22 m

16 17 18 19 20 21 22

Shift Information

Date & Time	Depth	Water	Casing	Remarks
22/01/1988 17:30	9.50		6.30	End of shift
23/01/1988 08:30	9.50	1.90	6.30	
23/01/1988 17:30	12.60	12.60	9.30	End of shift
24/01/1988 08:30	12.60	0.60	9.30	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks
Open hole drilling, air flush, using 6.75in rock bit from ground level to 6.30m

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Borehole Log

Borehole No. **SK42SE90**
HISTORIC
Sheet 1 of 1

Project Name:	SMP M1 J23a to J25	Project No. COCDFL1SMP01	Co-ords:	446833.00 - 324597.00	Hole Type CP
Location:	M1 J23a to J25		Level:	61.84mbgl	Scale 1:50
Client:	Highways England		Dates:	19/01/1988 - 19/01/1988	Logged By GAC/AAC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Information	Depth (m)	Level (m)	Legend	Stratum Description
		0.25	1D						Clayey topsoil TP
		0.50 - 0.95	2U	54blows		0.40	61.44		Stiff becoming very stiff red brown very silty CLAY with occasional up to coarse gravel sized lithorelics and pockets of light green grey fine sandy silt (KEUPER MARL 3/4a) below 2.50m with occasional lense/ lamination of light green grey siltstone and light brown sandy siltstone below about 3.50m with occasional light green reduction spots and indistinct fissures with black staining MM-Z3
		1.00	3D						
		1.00	SPT (S)	N=21 (3,3/5,5,5,6)	Water=-				
		1.00 - 1.45	4D						
		2.00 - 2.45	5U	123blows					
		2.50	6D						
		2.50	SPT (S)	N=23 (5,5/4,6,6,7)	Water=-				
		2.50 - 2.95	7D						
	▼	3.50 - 3.95	8U	150blows					
		4.00	9D						
		4.00	SPT (S)	N=67 (7,10/15,15,17,20)	Water=-				
		4.00 - 4.45	10D						
		5.00	SPT (S)	N=66 (4,7/14,10,19,23)	Water=-				
	▽	5.00 - 5.45	11D						
		5.30	12W						
						5.70	56.14		Very stiff (hard) red brown fissured very silty CLAY with light grey silty fine sand lenses and partings (KEUPER MARL 3/4a) MM-Z3
		6.00	SPT (S)	50 (17,24/50 for 50mm)	Water=-				
		6.00 - 6.20	13D						
		6.60	SPT (S)	50 (19,21/50 for 27mm)	Water=-				
		6.60 - 6.78	14D			6.78	55.06		End of borehole at 6.78 m

Remarks

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Rotary Core Log

Borehole No. **SK42SE90R** HISTORIC Sheet 1 of 3

Project Name:	SMP M1 J23a to J25	Project No. COCDFL1SMP01	Co-ords:	446833.00 - 324597.00	Hole Type CP+RC
Location:	M1 J23a to J25		Level: 61.84mbgl	Orientation: ° Inclination: 90°	Scale 1:50
Client:	Highways England		Dates:	25/01/1988 - 27/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											Cable Tool Boring to 6.80m OH-OH
		6.00	SPT(S)				88 (7,9/88 for 220mm)	6.00	55.84		Assessed zone of core loss OH-OH
		6.00 - 7.10		23		0					
								6.85	54.99		Firm red brown silty CLAY with fine gravel sized lithorelics (KM 3/4a) MM-Z3
		7.10 - 7.60		70	40	0		7.25	54.59		assessed core loss
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
25/01/1988 17:30	7.60		6.00	End of shift
26/01/1988 08:30	7.60	0.45	6.00	
26/01/1988 17:30	13.20		7.50	End of shift
27/01/1988 10:00	13.20	0.65	7.50	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush, using 6.75in rock bit from ground level to 6.00m

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Rotary Core Log

Borehole No. **SK42SE90R** HISTORIC Sheet 2 of 3

Project Name: SMP M1 J23a to J25	Project No. COCDFL1SMP01	Co-ords: 446833.00 - 324597.00	Hole Type CP+RC
Location: M1 J23a to J25		Level: 61.84mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 25/01/1988 - 27/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
		7.60	SPT(S)				0 (22,50/0 for 0mm)	7.60	54.24		Red brown becoming light grey green locally thinly laminated slightly to moderately weathered SILTSTONE moderately weak to weak (KM 2) MM-ST
		7.60 - 8.60		30		0					*non intact*
								8.30	53.54		Assessed zone of core loss OH-OH
		8.60	SPT(S)				50 (18,32/50 for 60mm)				Firm to stiff red brown very silty CLAY with frequent fine to medium occasionally coarse gravel sized lithorelics (weathered MUDSTONE) Occasional pockets and lenses of light grey green silt and siltstone (KM 3/4a) MM-Z3
		8.60 - 9.80		92	17	0		9.15	52.69		Red brown moderately to highly weathered locally very clayey SILTSTONE moderately weak with very closely spaced sub-horizontal fractures with speckled black staining (KEUPER MARL 2/3) MM-ST
		9.80 - 10.60		100	50	0					*non intact* *vertical joint stained black* *2 intersecting vertical joints stained black* *non intact* *locally altered to lithorelics in a clayey silty matrix* *light grey green slightly fine sandy siltstone* *moderately strong to strong* *non intact with black speckled staining* *assessed zone of core loss*
		10.60 - 12.00		50	21	7					
		12.00	SPT(S)				0 (72 for 148mm/0 for 0mm)				
		12.00 - 13.20		75	46	30					
								13.10	48.74		Light greenish grey slightly weathered fine grained SANDSTONE strong (KSS 2) MM-SS
								13.50	48.34		
		13.20 - 14.20		70	55	40		13.90	47.94		Light greenish grey slightly to moderately weathered slightly fine sandy SILTSTONE weak (KEUPER MARL 2/3) MM-ST
		14.20 - 15.00		69	0	0		14.50	47.34		Assessed zone of core loss OH-OH
		15.00	SPT(S)								Red brown locally greenish grey
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
25/01/1988 17:30	7.60		6.00	End of shift
26/01/1988 08:30	7.60	0.45	6.00	
26/01/1988 17:30	13.20		7.50	End of shift
27/01/1988 10:00	13.20	0.65	7.50	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush, using 6.75in rock bit from ground level to 6.00m

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Rotary Core Log

Borehole No. SK42SE90R HISTORIC Sheet 3 of 3

Project Name: SMP M1 J23a to J25	Project No. COCDFL1SMP01	Co-ords: 446833.00 - 324597.00	Hole Type CP+RC
Location: M1 J23a to J25		Level: 61.84mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 25/01/1988 - 27/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
							50 (15,23/50 for 50mm)	15.20	46.64		moderately to highly weathered SILTSTONE very weak locally altered to a friable silt with frequent lithorelics (KEUPER MARL 3/4a) MM-ST End of borehole at 15.20 m

16 17 18 19 20 21 22

Shift Information

Date & Time	Depth	Water	Casing	Remarks
25/01/1988 17:30	7.60		6.00	End of shift
26/01/1988 08:30	7.60	0.45	6.00	
26/01/1988 17:30	13.20		7.50	End of shift
27/01/1988 10:00	13.20	0.65	7.50	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush, using 6.75in rock bit from ground level to 6.00m

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Borehole Log

Borehole No. **SK42SE91** HISTORIC Sheet 1 of 1

Project Name:	SMP M1 J23a to J25	Project No. COCDFL1SMP01	Co-ords:	446840.00 - 324640.00	Hole Type CP
Location:	M1 J23a to J25		Level:	63.59mbgl	Scale 1:50
Client:	Highways England		Dates:	18/01/1988 - 18/01/1988	Logged By JAS

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.30	1D			0.30	63.29		Clayey topsoil TP
		0.50 - 0.95	2U	50blows					Stiff becoming very stiff red brown locally very silty CLAY with occasional up to medium gravel sized lithorelics , pockets and lenses of light green grey silt and lenses/laminations of very weak mudstone. (KEUPER MARL 3/4a) MM-Z3
		1.00	3D						
		1.00	SPT (S)	N=14 (2,2/4,3,3,4)	Water=-				
		1.00 - 1.45	4D						slightly sandy with occasional siltstone gravel
		2.00 - 2.45	5U	121blows					
		2.50	6D						
		2.50	SPT (S)	N=30 (4,4/5,7,9,9)	Water=-				
		2.50 - 2.95	7D						
		3.50 - 3.95	8U	87blows					
		4.00	9D						
		4.00	SPT (S)	N=38 (6,7/7,9,11,11)	Water=-				
		4.00 - 4.45	10D						
		5.00 - 5.35	11U	150blows		5.00	58.59		Very stiff (hard) red brown extremely closely fissured very silty CLAY with pockets of green grey silt (KEUPER MARL 3/4a) MM-Z3
		5.40	12D						
		5.40	SPT (S)	50 (14,21/50 for 29mm)	Water=-				
		5.40 - 5.58	13D						
		6.00	SPT (S)	0 (77 for 108mm/0 for 0mm)	Water=-	6.11	57.48		End of borehole at 6.11 m
		6.00 - 6.11	14D						

Remarks

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Borehole Log

Borehole No.
SK42SE95
HISTORIC
Sheet 1 of 1

Project Name:	SMP M1 J23a to J25	Project No. COCDFL1SMP01	Co-ords:	446906.00 - 324593.00	Hole Type CP
Location:	M1 J23a to J25		Level:	62.30mbgl	Scale 1:50
Client:	Highways England		Dates:	26/01/1988 - 26/01/1988	Logged By AAC

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
						0.20	62.10		FILL (Foreman's description) MG-CL
						0.40	61.90		TOPSOIL (Foreman's description) TP
									Very dense (hard) red brown friable clayey SILT with fine becoming medium gravel sized lithorelics Below about 1.80m becoming very stiff (hard) red brown locally very silty CLAY locally with medium to coarse grave sized lithorelics and occasional inclusions of light grey green silt and siltstone (KEUPER MARL 3/4a) MM-Z3
		1.50 - 1.65	1U	75blows					
		1.70	2D						
		1.70	SPT (S)	N=41 (5,7/7,10,10,14)	Water=-				
		1.70 - 2.15	3D						
		2.60	SPT (S)	79 (13,19/79 for 150mm)	Water=-				
		2.60 - 2.90	4D						
		3.00	SPT (S)	81 (7,17/81 for 125mm)	Water=-				
		3.00 - 3.28	5D			3.30	59.00		End of borehole at 3.30 m

Remarks
Hand dug inspection pit from ground level to 1.50m

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Rotary Core Log

Borehole No. **SK42SE95R** HISTORIC Sheet 1 of 3

Project Name: SMP M1 J23a to J25	Project No. COCDFL1SMP01	Co-ords: 446906.00 - 324593.00	Hole Type CP+RC
Location: M1 J23a to J25		Level: 62.30mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 27/01/1988 - 29/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											Cable Tool Boring to 3.30m OH-OH
		2.00	SPT(S)				N=87 (5,12/15,17,25,30)	2.00	60.30		Assessed zone of core loss OH-OH
		2.00 - 3.50		20	5	0		2.20 2.60	60.10 59.70		Very stiff (hard) red brown silty CLAY with fine gravel sized lithorelics (weathered MUDSTONE (KM 3/4a) MM-Z3 *disturbed by SPT*
		3.50	SPT(S)				N=26 (3,3/4,5,8,9)				Assessed zone of core loss OH-OH
		3.50 - 4.50		0	0	0					
		4.50	SPT(S)				N=54 (0,4/5,10,10,29)				
		4.50 - 5.00		0	0	0					
		5.00 - 5.80		0	0	0					
		5.80	SPT(S)				0 (30,56/0 for 0mm)				
		5.80 - 7.50		76	38	11		6.20	56.10		Stiff becoming very stiff (hard) red brown silty CLAY with frequent fine gravel sized lithorelics (weathered MUDSTONE). Interbedded with red brown moderately weathered SILTSTONE weak to very weak locally with extremely closely spaced fractures with black speckled stain (KM 3/4a)
								7.50	54.80		Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
27/01/1988 18:00	5.00		5.00	End of shift
28/01/1988 08:00	5.00	1.20	5.00	
28/01/1988 18:00	13.50		6.80	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush to 5.00m, foam flush to 20.15m, using 6.75in rock bit from ground level to 2.00m

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Rotary Core Log

Borehole No. **SK42SE95R** HISTORIC Sheet 2 of 3

Project Name:	SMP M1 J23a to J25	Project No. COCDFL1SMP01	Co-ords: 446906.00 - 324593.00	Hole Type CP+RC
Location:	M1 J23a to J25		Level: 62.30mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client:	Highways England		Dates: 27/01/1988 - 29/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											MM-Z3 *light green grey fine sandy siltstone moderately strong* Assessed zone of core loss OH-OH
		7.50 - 10.30		25	16	0					
								9.60	52.70		Red brown moderately weathered locally very clayey SILTSTONE weak becoming moderately weak. Closely spaced sub-horizontal fractures with speckled black staining. (KEUPER MARL 2) MM-ST
		10.30 - 11.80		0	0	0		10.30	52.00		*50 joint with speckled black stain* *Light greenish grey fine sandy calcareous siltstone strong* Assessed zone of core loss OH-OH
								11.80	50.50		Very stiff (hard) red brown CLAY with frequent fine gravel sized lithorelics (weathered MUDSTONE) (KM2/3) MM-Z3
		11.80 - 13.50		100	38	29		12.30	50.00		Grey green becoming red brown moderately weathered locally fine sandy SILTSTONE moderately weak with extremely closely to closely spaced fractures stained black (KM 2/3) MM-ST
								13.50	48.80		Angular to sub-rounded medium to coarse gravel sized fragments of red brown SILTSTONE weak (possibly spoil) (KM 3/2?) MM-ST
		13.50 - 15.00		80	53	31		14.15	48.15		*Assessed zone of core loss* Light grey green slightly to moderately weathered slightly fine sandy SILTSTONE strong (KEUPER MARL 2) MM-ST
											Continued on next sheet

Shift Information

Date & Time	Depth	Water	Casing	Remarks
27/01/1988 18:00	5.00		5.00	End of shift
28/01/1988 08:00	5.00	1.20	5.00	
28/01/1988 18:00	13.50		6.80	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush to 5.00m, foam flush to 20.15m, using 6.75in rock bit from ground level to 2.00m

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Rotary Core Log

Borehole No. **SK42SE95R** HISTORIC Sheet 3 of 3

Project Name: SMP M1 J23a to J25	Project No. COCDFL1SMP01	Co-ords: 446906.00 - 324593.00	Hole Type CP+RC
Location: M1 J23a to J25		Level: 62.30mbgl Orientation: ° Inclination: 90°	Scale 1:50
Client: Highways England		Dates: 27/01/1988 - 29/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Results & Information	Depth (m)	Level (m)	Legend	Stratum Description
											very stiff red brown clay with occasional medium gravel sized lithorelics
											hard red brown clayey silt with occasional lithorelics
								15.45	46.85		Light green grey slightly to moderately weathered fine grained SANDSTONE moderately strong with closely spaced sub-horizontal fractures (KM 1/2) MM-SS
		15.00 - 17.00		65	52	43		16.05	46.25		
								16.30	46.00		Light greenish grey fine sandy SILTSTONE weak (KM 2) MM-ST
											Assessed zone of core loss OH-OH
								17.70	44.60		Stiff becoming very stiff (hard) red brown silty CLAY with fine to medium occasionally coarse gravel sized lithorelics (weathered MUDSTONE) Occasional pockets of light grey green silt (KEUPER MARL 3) Below 18.50m thinly interbedded with red brown locally light greenish grey moderately weathered SILTSTONE weak with very closely spaced fractures stained black. From 18.50m to 19.30m non intact MM-Z3
		17.00 - 20.00		77	37	20					
		20.00	SPT(S)				0 (31,53/0 for 0mm)	20.15	42.15		End of borehole at 20.15 m

16 17 18 19 20 21 22

Shift Information

Date & Time	Depth	Water	Casing	Remarks
27/01/1988 18:00	5.00		5.00	End of shift
28/01/1988 08:00	5.00	1.20	5.00	
28/01/1988 18:00	13.50		6.80	

Backfill

Top	Base	Description

Chiselling

Top	Base	Duration	Tool

Depth Related Remarks

Top	Base	Remarks

Water Strike

Struck	Rose to	Date	Time	Sealed	Casing	Remarks

Discontinuities

Top	Base	Strength	Seepage	Water Flow

Remarks

Open hole drilling, air flush to 5.00m, foam flush to 20.15m, using 6.75in rock bit from ground level to 2.00m

AGS

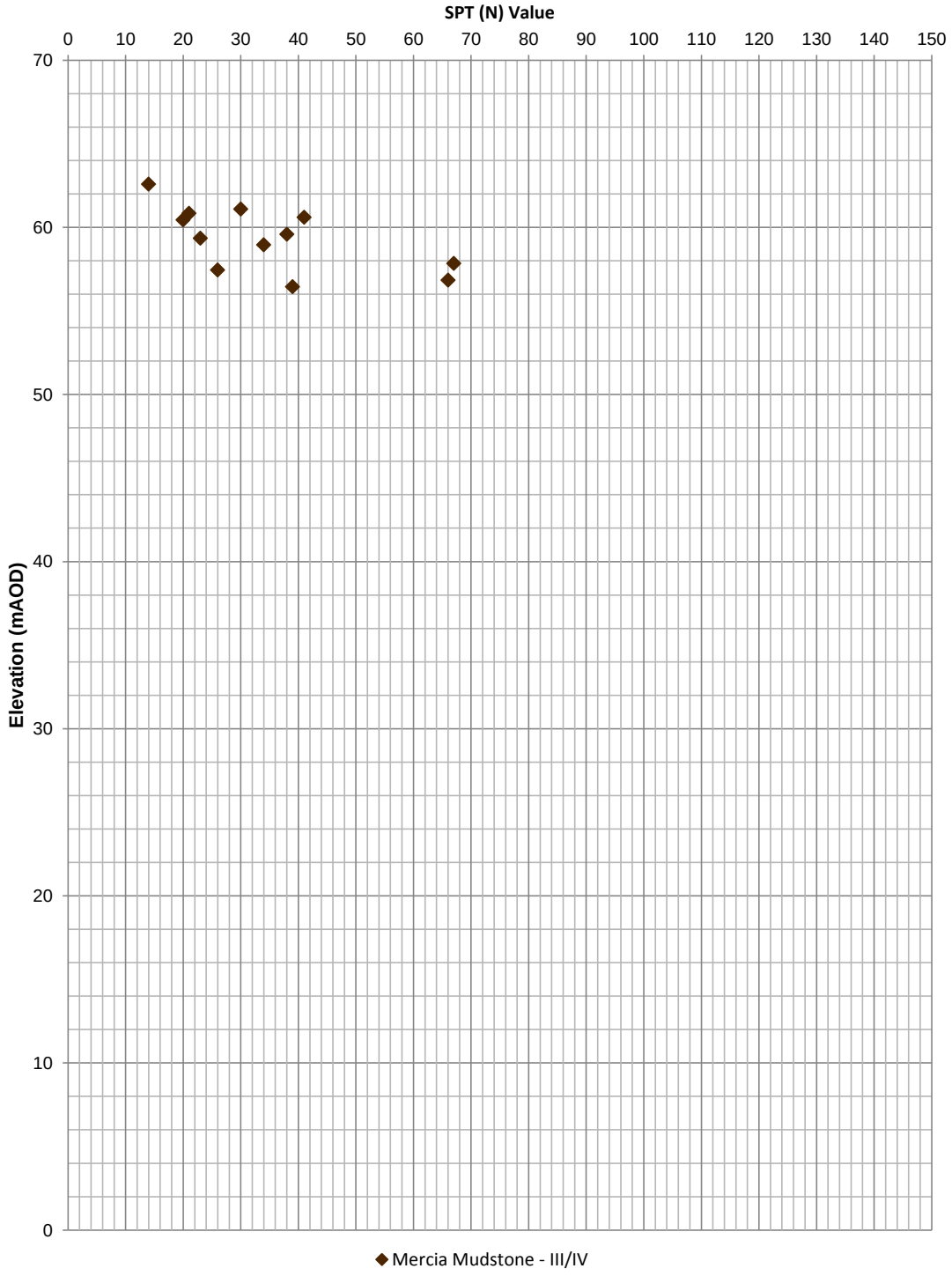
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PLOTS

amey ARUP

SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182120-182140NB J23a Merge**
Client: **Highways England**	Borehole ID: **SK42SE89/89R, SK42SE90/90R, SK42SE91, SK43SE95/95R**	

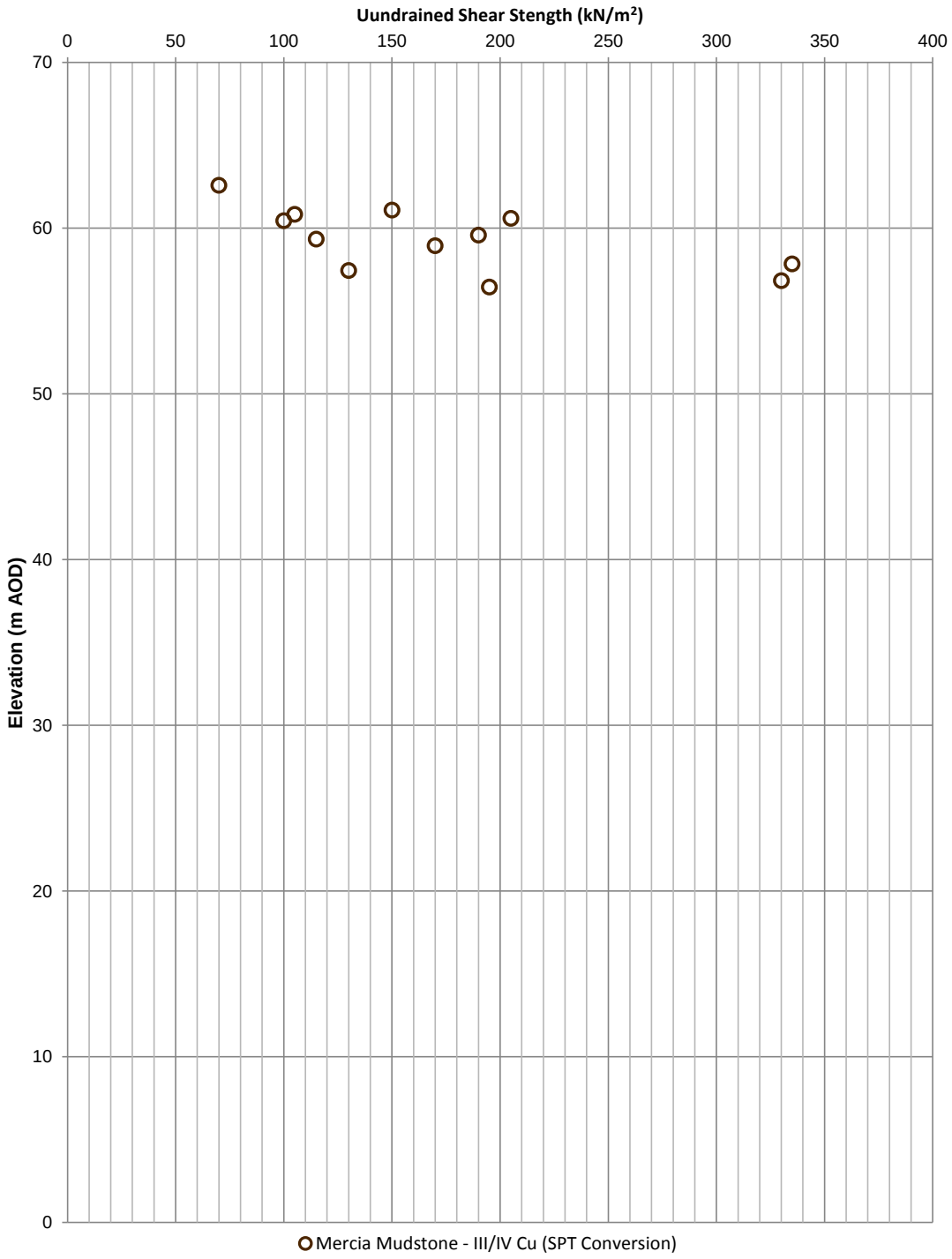


Extrapolated SPT (N) Values >150 have not been shown

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **Ch182120-182140NB J23a Merge**
Client: **Highways England**	Borehole ID: **SK42SE89, SK42SE90, SK42SE91, SK42SE95**	



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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-182720–182900SBD-GSS-000001		
Earthworks Widening Solution	Full Height Re-Grade (1:3)		
Structure Number	N/A		
Structure Type	N/A		
Design Chainage	182730-182900		
Carriageway	Southbound – Jct23a Diverge (M1-A42 east)		
Marker Post	182/7B+30 – 182/9B+00		
National Grid Reference	E 447030, N 325176 – E 447071, N 325341		
Existing Ground Level at Location	Carriageway	74.8-76.2mAOD	
	Crest of cutting	75.5-77.4mAOD	
Earthwork Type	NB: N/A	SB: Cutting	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Number	NB: N/A	SB: 7_M1_54220	HAGDMS designation
Earthwork Height	NB: N/A	SB: 1.2-2.3m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 6-9°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	01		

	Name	**Date**	**Signature**
Author	Simon Arinze/Scott Bishton	12/05/2017	[redacted]
Checked	Alice Bazen	06/06/2017	
Reviewed	Gary Summerfield	07/06/2017	
Approved	Tom Bulteel	07/06/2017	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each stratum has been taken from the AMAR GIR.

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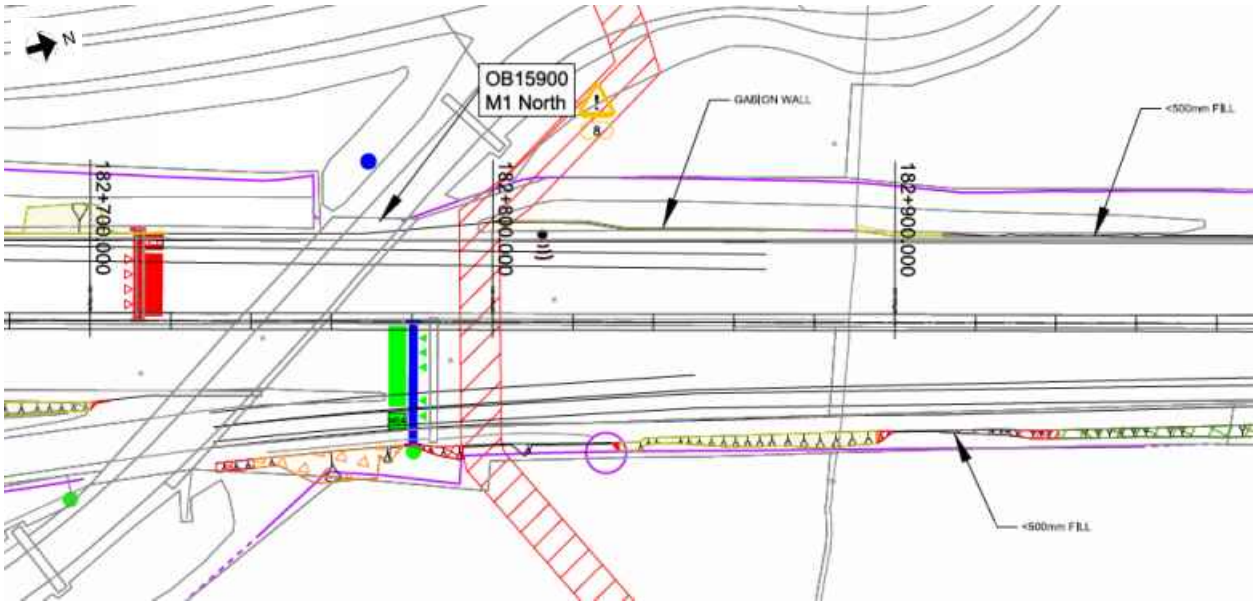


Figure 1: Location Plan

Proposed Earthworks Widening:

To accommodate earthworks widening for this location, the following solutions have been proposed:

- Ch182720-182760, Full Height Regrade 1:3;
- Ch182760-182770, Insufficient topographic data (TBC);
- Ch182780-182790, Full Height Regrade 1:3;
- Ch182790-182830, Insufficient topographic data (TBC);
- Ch182830-182900, Full Height Regrade 1:3.

Proposed Major Structures:

N/A.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that location comprises a cutting of 1.2-2.3m in height (increasing in height from south to north) and a proposed slope gradient of 18°.

The critical cross section used is Ch182750 (Ch410) was chosen based on greatest cut height.

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Figure 2 Topographic Critical Cross Section Ch182750 (Ch410)

Utilities:

There are no known existing utilities within the vicinity of the chainage extents.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough, indicates that the site is underlain by:

Superficial Deposits: None recorded.

Solid Deposits: Gunthorpe Member (Mudstone – Mercia Mudstone Group)

Ground Investigation:

There are 9 No. relevant historical exploratory holes recorded within the design chainage, with additional 22 No. considered relevant, of which are shown on Geological Long Section, Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000021, Rev P01.

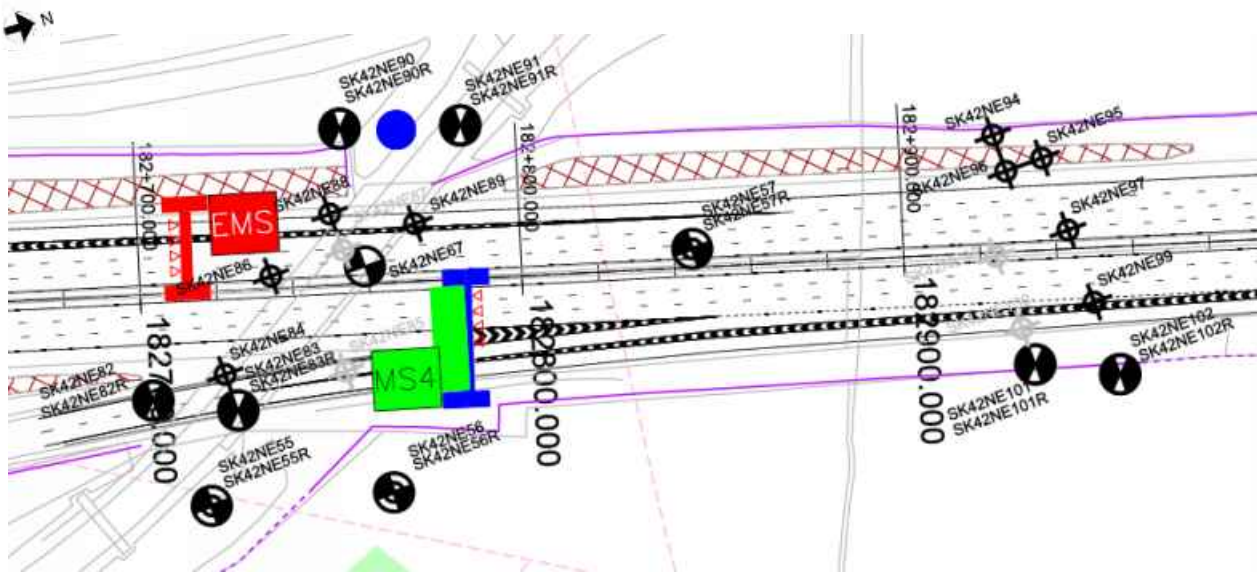


Figure 3: Borehole Location Plan

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Flood Risk:

The earthwork is not located in an area where flooding is a risk.

Historical Boreholes:

Relevant Borehole Number	SK42NE83/83R	SK42NE101/101R
Borehole Chainage	182725	182934
Borehole Location	Verge	Top of cutting
National Grid Reference	E 447030, N 325170	E 447080, N 325370
Ground Level at Exploratory Hole	75.72 metres Above Ordnance Datum (mAOD)	75.6mAOD
RAG Analysis	Green	Green
Date Drilled	21/09/1984	01/10/1984
Termination Depth	5.20 metres below ground level (mbgl)	6.50mbgl
Other suitable holes	SK42NE55-57, SK42NE67, SK42NE82-91, and SK42NE94-102	

Existing Ground Conditions:

The following ground conditions have been assumed based on historical Ground Investigation and driven LiDAR survey.

Stratum	Depth to Base (mbgl)	Depth to Base (mAOD)	SPT 'N' Value Range*	Hand Vane Strength Range (kN/m^2)
Mercia Mudstone – III/IV	Not Proven	Not Proven	10-150 (40)	-

(1) Ground level is assumed to be at the crest of the cutting
(2) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(3) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPTs) have been undertaken within historical exploratory holes SK42NE55-57, SK42NE67, SK42NE82-91, and SK42NE94-102.

No hand vane strength tests have been undertaken within the historical exploratory holes.

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Groundwater:

Exploratory Hole ID	Stratum	Groundwater Strike		Rise		
		mbgl	mAOD	Time	mbgl	mAOD
SK42NE102R	Mercia Mudstone – Siltstone	10.5	65.5	-	-	-
SK42NE55	Mercia Mudstone – III/IV	3.9	73.1	20 minutes	3.8	73.2
SK42NE56	Mercia Mudstone – III/IV	5.3	70.5	20 minutes	3.3	72.5
SK42NE83R	Mercia Mudstone – I/II	5.0	71.3	-	-	-
SK42NE86	Mercia Mudstone – III/IV	5.5	69.8	-	-	-
SK42NE88	Mercia Mudstone – Siltstone	10.1	65.0	-	-	-
SK42NE89	Mercia Mudstone – Siltstone	11.9	63.4	-	-	-
SK42NE95	Mercia Mudstone – Siltstone	11.8	64.8	-	-	-

The following groundwater data was recorded in the historical exploratory holes:

Groundwater Design Level:

A design groundwater level of 1.0m below ground level throughout cutting has been assumed.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

23 No. Atterberg Limit Test and 52 No. Natural Moisture Content tests were undertaken within the Mercia Mudstone – III/IV with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Mercia Mudstone – III/IV	0.5-7.5	11-28	28-49	16-23	10-26	CL-CI

8 No. Atterberg Limit Test and 23 No. Natural Moisture Content tests were undertaken within the Mercia Mudstone – I/II with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Mercia Mudstone – I/II	0.3-7.0	7-22	31-39	16-23	13-17	CL-CI

6 No. Atterberg Limit Test and 12 No. Natural Moisture Content tests were undertaken within the Mercia Mudstone – Siltstone with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class
Mercia Mudstone – Siltstone	0.5-7.5	8-23	24-39	16-20	6-19	CL-CI

19 No. Triaxial Tests were undertaken in the Mercia Mudstone – III/IV with the following results:

Stratum	Depth to Top of Test (mbgl)	Undrained Shear Strength (kN/m^2)
Mercia Mudstone – III/IV	0.5-5.0	45-400

8 No. Triaxial Tests were undertaken in the Mercia Mudstone – I/II with the following results:

Stratum	Depth to Top of Test (mbgl)	Undrained Shear Strength (kN/m^2)
Mercia Mudstone – I/II	0.5-5.0	110-450

Lab Test Data – BRE Classification:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Mercia Mudstone – III/IV	pH	2:1 Solid/Water Extract	10	7.7-8.2	-
Mercia Mudstone – III/IV	Sulphate	2:1 Solid/Water Extract	9	0.05-0.08	g/l SO4
Mercia Mudstone – I/II	pH	2:1 Solid/Water Extract	2	7.7-8.1	-
Mercia Mudstone – I/II	Sulphate	2:1 Solid/Water Extract	2	0.01-0.06	g/l SO4
Mercia Mudstone - Siltstone	pH	2:1 Solid/Water Extract	1	8.1	-

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Mercia Mudstone - Siltstone	Sulphate	2:1 Solid/Water Extract	2	0.01-0.05	g/l SO4

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Assumed Ground Model For Design:

Ground model is based on Geological Long Sections HA549342-AMAR-HGT-SWI-DR-000021, Rev P01 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002, Rev P01. The below table outline the assumed anticipated ground model to be confirmed with 'Just In Time' Validation Ground Investigation:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)		Poisson's Ratio		BRE Classification
								E_u	E'	v_u	v'	
Mercia Mudstone III/IV	0.00 - >22.63	77.40 - >54.77	>22.63	21	27	2	200	13.8	11.0	0.50	0.20	DS-1 AC-1

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) c_u of Mercia Mudstone – III/IV can be derived using the Stroud correlation. An f1 value of 5.0; combined with a characteristic SPT N value of 40, this gives a cu of 200kN/m^2.
(4) ϕ' of Mercia Mudstone – III/IV can be determined using Table 2 in BS8002:2015 using typical PI of 15% gives 27°.
(5) Eu for Mercia Mudstone – III/IV can be derived using N values (Bowles) where Eu = 300 (N+6); using a characteristic SPT N value of 40 gives Eu = 13.8MN/m^2. Using Wroth (1972) E' can then be calculated using E' = 2/3 (1 + v) Eu = 11.0MN/m^2.
(6) BRE Classification is determined using criteria set out in BRE Special Digest 1.

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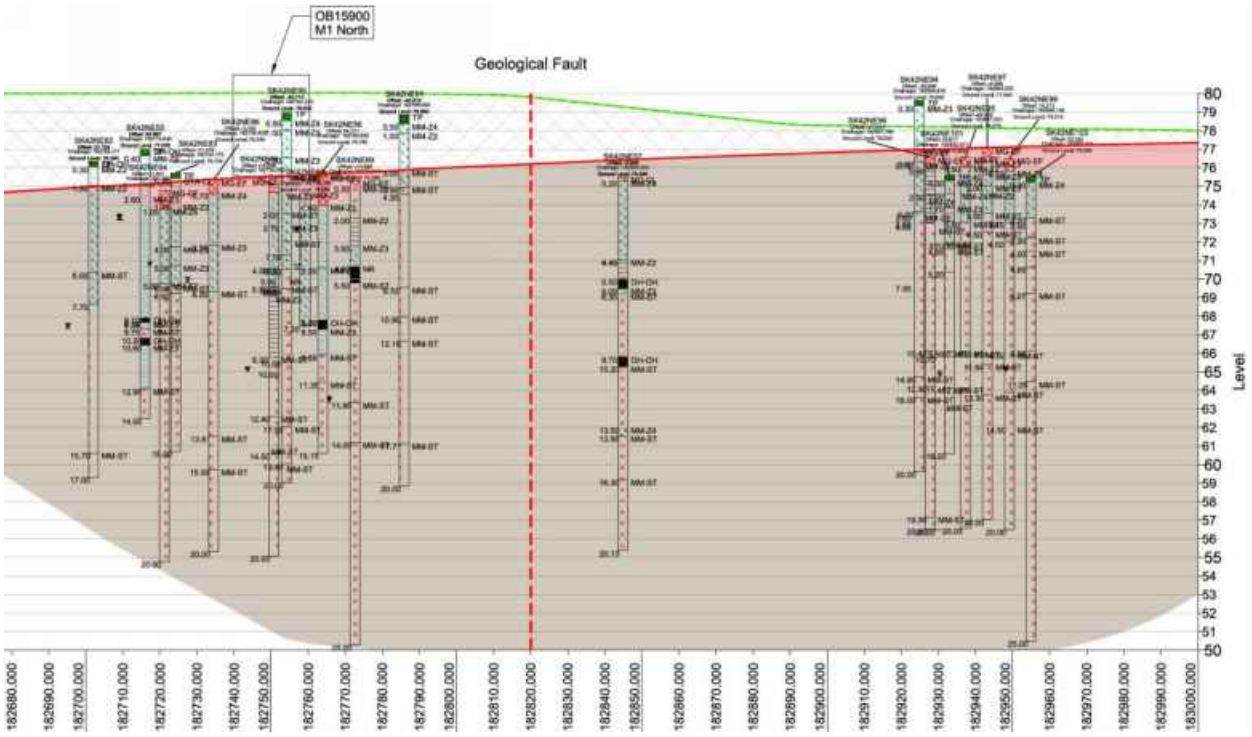


Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Following design, the below widening solutions are proposed:

Start Chainage	End Chainage	Widening Solution
182720	182760	Full Height Re-grade (1:3)
182780	182790	Full Height Re-grade (1:3)
182830	182900	Full Height Re-grade (1:3)

Proposed Structural Solution:

N/A.

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FURTHER GROUND INVESTIGATION

No further ground investigation is required at this location.

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HISTORICAL EXPLORATORY HOLES

amey

Rotary Core Log

Borehole No. **SK42NE99** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447080.00 - 325390.00	Hole Type CP+RC
Location:		Level: 76.51	Scale 1:50
Client: Highways England		Dates: 17/09/1984 - 18/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPING. (MADE GROUND - MOTORWAY VERGE) MG-EF
		0.70	J				0.70	75.81		
		1.00	J							Firm red brown mottled grey green fissured very silty CLAY with many mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE II/III) Becoming stiff and very stiff with depth. Occasional thin bands of highly weathered fissured grey green weak to very weak siltstone at 1.00m and 2.00m. MM-Z4
		1.50 - 1.95	U							
		2.00	J							
		2.45	J							
		2.70	J							
		3.00 - 3.45	U							
		3.45	J				3.45	73.06		Highly weathered fissured red brown mottled grey green very weak SILTSTONE with residual silty clay. (KEUPER MARL : ZONE III) Moderately weak at 4.00m. MM-ST
		3.75	J							
		4.00	J							
		4.50	J				4.50	72.01		Slightly weathered fissured red brown very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST
		4.50 - 5.50		98		60				highly weathered zone slightly weathered grey green moderately weak band
		5.50 - 7.00		98		34				slightly weathered grey green moderately weak band
		7.00 - 8.50		94		60				subvertical discontinuity slightly weathered grey green moderately weak band
		8.50 - 11.35		99		27				slightly weathered grey green moderately weak band subvertical discontinuity

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE99 Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447080.00 - 325390.00	Hole Type CP+RC
Location:		Level: 76.51	Scale 1:50
Client: Highways England		Dates: 17/09/1984 - 18/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 10.50 - 10.74	B C				10.50	66.01		Slightly weathered grey green moderately strong calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST
		11.35 - 13.10		100		69				highly weathered very weak zone highly weathered very weak zone highly weathered very weak zone
							12.60	63.91		Moderately weathered fissured red brown occasionally mottled grey green very weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST
		13.10 - 14.50		97		49				
							14.50	62.01		Slightly weathered fissured red brown occasionally mottled grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced smooth subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST
		14.50 - 17.50		100		62				45 deg discontinuity
										slightly weathered grey green moderately strong band
		17.50 - 20.00		99		66				slightly weathered grey green moderately strong band
							20.00	56.51		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE98**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447060.00 - 325370.00	Hole Type CP+RC
Location:		Level: 76.94	Scale 1:50
Client: Highways England		Dates: 27/09/1984 - 28/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPINGS. (MADE GROUND - MOTORWAY CENTRAL RESERVE) MG-EF
		0.70	J				0.70	76.24		Stiff becoming very stiff red brown fissured silty CLAY with occasional mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE III/IV) Occasional bands of highly weathered very weak mudstone/siltstone below 2.00m. MM-Z3
		1.00	J							
		1.50 - 1.95	U							
		2.00	J							
		2.45	J							
		2.50	B							
		2.80	J							
		3.00 - 3.45	U							
		3.50	J				3.50	73.44		Very stiff red brown mottled grey green fissured silty to very silty CLAY with some bands of highly weathered very weak mudstone/siltstone. (KEUPER MARL : ZONE III) MM-Z3
		3.72	J				3.85	73.09		
		4.00	J				4.00	72.94		Highly to moderately weathered intact red brown and grey green very weak calcareous SILTSTONE with residual silty clay. (KEUPER MARL : ZONE II) MM-ST
		4.00 - 5.50		44		0				Slightly weathered fissured to very fissured red brown very weak to weak calcareous SILTSTONE. Very to extremely closely spaced rough subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST
										moderately strong band. Subvertical discontinuity highly weathered zone
		5.50 - 7.30		52		6				
							7.30	69.64		End of borehole at 7.30 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE97**

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447060.00 - 325390.00	Hole Type CP+RC
Location:		Level: 77.04	Scale 1:50
Client: Highways England		Dates: 27/09/1984 - 28/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPINGS. (MADE GROUND - Motorway central reserve) MG-EF
		0.70	J				0.70	76.34		Firm red brown mottled grey green fissured silty CLAY with many mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE III) MM-Z3
		1.00	J							
		1.40	J				1.40	75.64		Firm red brown fissured silty CLAY with occasional mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE IVa) MM-Z3
		1.50 - 1.95	U							
		2.00	J				2.00	75.04		Stiff red brown mottled grey green fissured silty to very silty CLAY with many mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE II/III) Occasional thin bands of highly weathered very weak calcareous siltstone at 2.00m. Very stiff towards base. MM-Z3
		2.45	J							
		2.50	B							
		2.80	J							
		3.00 - 3.45	U							
		3.50	J				3.50	73.54		Highly weathered fissured red brown very weak calcareous SILTSTONE with residual silty clay. (KEUPER MARL : ZONE III) MM-ST
		3.80	J							
		4.50	J				4.50	72.54		Moderately to slightly weathered fissured red brown very weak calcareous SILTSTONE with occasional thin mudstone bands. Very to extremely closely spaced rough subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		4.59 - 4.50								
		5.54	B	98		53				45 deg discontinuity
		5.54 - 5.90	C							
										highly weathered zone degraded to stiff silty clay with many lithorelicts
										slightly weathered grey green moderately weak band
										highly weathered zone degraded to stiff silty clay with many lithorelicts
		6.50 - 7.90		100		18				
		8.59 - 8.70	C							
		8.70	C							
		7.90 - 9.95		97		46				
										subvertical discontinuity
										slightly weathered grey green moderately weak band
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE97** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447060.00 - 325390.00	Hole Type CP+RC
Location:		Level: 77.04	Scale 1:50
Client: Highways England		Dates: 27/09/1984 - 28/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.30 - 10.40	C							slightly weathered grey green moderately weak band
		10.40 - 10.50	C							
		9.95 - 12.60		95		58				
		11.40 - 11.50	C							
		11.50 - 11.64	C							
		11.64 - 11.76	C				11.64	65.40		Slightly weathered grey green moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		11.76 - 11.88	C							moderately weathered zone
										subvertical discontinuity
										moderately weathered zone
		12.60 - 13.30		95		54				
		13.08 - 13.19	C							
		13.19 - 13.30	C							
		13.75	B				13.30	63.74		Moderately to slightly weathered fissured red brown occasionally grey green very weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		13.75 - 14.12	C							slightly weathered grey green moderately weak band
		13.30 - 15.00		97		38				completely weathered zone degraded to stiff silty clay with many lithorelicts
										completely weathered zone degraded to stiff silty clay with many lithorelicts
		15.00 - 15.70		100		25				slightly weathered grey green moderately weak band
		16.27 - 16.38	C							
		16.38 - 16.50	C							
		15.70 - 18.10		97		58				
		18.10 - 18.20	C							slightly weathered grey green moderately weak band
		18.20 - 18.30	C							
										completely weathered zone degraded to stiff silty clay with many lithorelicts
		18.10 - 20.00		96		81				
		19.10 - 19.21	C							
		19.21 - 19.33	C							
							20.00	57.04		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE96**

Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447040.00 - 325380.00	Hole Type CP+RC
Location:		Level: 76.54	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 11/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPINGS (MADE GROUND - MOTORWAY VERGE) MG-EF
		0.60	J				0.60	75.94		Highly weathered very weak fissured calcareous MUDSTONE tending to stiff and very stiff silty clay. (KEUPER MARL : ZONE III) MM-Z3
		1.00	J							
		1.00	B							
		1.00 - 1.50	B							
		1.50 - 1.95	U							
		2.00	J				2.00	74.54		Very stiff red brown silty CLAY with bands of highly weathered very weak calcareous MUDSTONE. (KEUPER MARL : ZONE III) Becoming very silty clay with zones of clayey silt. Band of moderately weak to weak red brown calcareous mudstone at 3.20m. MM-Z4
		2.45	J							
		2.70	B							
		2.80	J							
		3.00 - 3.20	U							
		3.20	J							
		3.50	J				3.50	73.04		Slightly weathered fissured red brown very weak to weak SILTSTONE. Very to extremely closely spaced, subhorizontal rough and smooth discontinuities. (KEUPER MARL : ZONE II) MM-ST
		3.97 - 4.07	C							
		4.07 - 4.18	C							
		3.50 - 5.00		100		36				
										highly weathered zone degraded to stiff silty clay with many lithorelicts
										slightly weathered red brown and grey green moderately weak band
										slightly weathered red brown and grey green moderately weak band
										slightly weathered red brown and grey green moderately weak band
		5.00 - 6.90		91		41				
		6.50 - 6.62	C							
		6.90 - 8.50		97		41				
										subvertical discontinuities
										slightly weathered red brown and grey green moderately weak band
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE96**

Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447040.00 - 325380.00	Hole Type CP+RC
Location:		Level: 76.54	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 11/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 10.50 - 10.91 8.50 - 11.50	B C	96		62	10.40	66.14		Slightly weathered grey green occasionally red brown moderately weak to moderately strong SILTSTONE. Very to extremely closely spaced, subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST *occasional voids approx. 20mm diameter containing completely weathered siltstone* *moderately weathered zone* *45 deg discontinuity* *moderately weathered zone* *45 deg discontinuity*
		11.50 - 14.10		98		51	12.32	64.22		Slightly weathered fissured red brown occasionally grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II/III) MM-ST *grey green moderately weak band* *grey green moderately weak band* *highly weathered zone degraded to stiff silty clay with many lithorelicts* *highly weathered zone degraded to stiff silty clay with many lithorelicts*
		14.10 - 17.10		98		75				*highly weathered zone degraded to stiff silty clay with many lithorelicts*
		17.10 - 20.00		97		65				*grey green moderately weak band* *grey green moderately weak band*
							19.36	57.18		Highly weathered fissured red brown and grey green very weak calcareous SILTSTONE. (KEUPER MARL : ZONE III) MM-ST
							20.00	56.54		Continued on next sheet

Remarks

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Rotary Core Log

Borehole No.
SK42NE96
Sheet 3 of 3

Project Name:	SMP - M1 J23A TO J25	Project No.	COCDFL1SMP01	Co-ords:	447040.00 - 325380.00
Location:				Level:	76.54
Client:	Highways England			Dates:	10/09/1984 - 11/09/1984

Hole Type: CP+RC
Scale: 1:50
Logged By:

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										slightly weathered grey green moderately strong siltstone 45 deg discontinuity End of borehole at 20.00 m

21 22 23 24 25 26 27 28 29 30

Remarks

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Rotary Core Log

Borehole No. **SK42NE95** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447040.00 - 325390.00	Hole Type CP+RC
Location:		Level: 76.57	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 11/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE BALLAST. (MADE GROUND - MOTORWAY VERGE) MG-EF
		0.50	J				0.50	76.07		Firm red brown friable very silty CLAY with thin bands of highly weathered very weak calcareous mudstone. (KEUPER MARL : ZONE III) MM-Z2
		1.00	J							
		1.50	B							
		1.50 - 1.95	U							
		2.00	J				2.00	74.57		Stiff red brown slightly mottled grey green fissured silty CLAY with many mudstone lithorelicts. Occasional pockets of sand and bands of highly weathered weak and moderately weak calcareous mudstone/siltstone. (KEUPER MARL : ZONE II/III) MM-Z2
		2.45	J							
		2.70	B							
		2.80	J							
		2.90	J							
		3.30	J							
		3.50 - 5.00		98		12	3.50	73.07		Slightly weathered fissured red brown occasionally mottled grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced, rough subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST subvertical discontinuities highly weathered zone degraded to stiff silty clay with many lithorelicts slightly weathered grey green moderately weak band
		5.00 - 6.80		84		5				slightly weathered grey green moderately weak band subvertical discontinuities
		7.60 - 7.72	C							
		7.72 - 7.82	C							
		6.80 - 9.50		100		51				subvertical discontinuities slightly weathered grey green moderately weak band subvertical discontinuities slightly weathered grey green moderately weak band
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE95**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447040.00 - 325390.00	Hole Type CP+RC
Location:		Level: 76.57	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 11/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.08 - 10.19	C							
		10.19 - 10.30	C							
		10.50 - 10.52	C				10.48	66.09		
		10.52 - 10.64	C							Slightly weathered fissured grey green moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
	▼	9.50 - 11.80		94		41				45 deg discontinuity very weak siltstone
		12.05 - 12.17	C							
		12.17 - 12.29	C							
							12.43	64.14		Slightly weathered fissured red brown occasionally grey green very weak calcareous SILTSTONE. Very to extremely closely spaced, subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST
		11.80 - 13.80		100		47				grey green moderately weak siltstone
		13.80 - 15.00		94		32				grey green moderately weak siltstone
		15.38 - 15.50	C							
		16.14 - 16.25	C							
		16.25 - 16.37	C							
		15.00 - 17.90		96		68				subvertical discontinuities
		17.27 - 17.37	C							
		17.37 - 17.47	C							grey green moderately weak siltstone
		17.90 - 20.00		97		68				highly weathered zones
		19.50 - 19.62	C							
		19.62 - 19.72	C							grey green moderately weak siltstone
							20.00	56.57		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE94**

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325380.00	Hole Type CP+RC
Location:		Level: 79.62	Scale 1:50
Client: Highways England		Dates: 01/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	J				0.30	79.32		TOPSOIL TP
		0.50 - 0.95	U							Very stiff red brown silty CLAY with some mudstone/siltstone lithorelicts, becoming mottled grey/green below 1.00m. (KEUPER MARL : ZONE III) Thin band of highly weathered fissured weak calcareous siltstone with residual silty clay at 1.80m. Clay becoming stiff at 2.50m with occasional thin bands of highly weathered fissured red brown very weak calcareous siltstone with residual silty clay. MM-Z3
		1.00	J							
		1.45	J							
		1.80	J							
		2.00 - 2.45	U							
		2.50	J							
		2.95	J							
		3.30	J				3.30	76.32		Very stiff red brown fissured silty CLAY with some siltstone lithorelicts. Some thin bands of highly weathered fissured red brown and grey green weak calcareous siltstone with residual silty clay between 4.00 and 5.50m. (KEUPER MARL : ZONE III/IVa) MM-Z3
		4.00	J							
		4.45	J							
		4.80	J							
		5.50	J							
		5.75	J							
		6.00	J				6.00	73.62		Slightly weathered laminated and thinly bedded red brown fine grained very weak to weak SILTSTONE. With bands (up to 150mm) of highly weathered very weak clayey siltstone between 6.00 - 9.50m. (KEUPER MARL : ZONE II) MM-ST
		6.00 - 7.00		83		10				siltstone very fractured. Generally intact below 11.20m
		7.00 - 8.00		84		0				
		8.00 - 9.00		85		15				
		9.00 - 10.50		100		0				

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE94**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325380.00	Hole Type CP+RC
Location:		Level: 79.62	Scale 1:50
Client: Highways England		Dates: 01/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.50 - 12.00		93		19				
		12.00 - 13.50		100		37				
		13.50 - 15.00		100		41				
							14.90	64.72		Slightly weathered to fresh very thinly and thinly bedded green grey occasionally red brown fine grained weak to moderately weak SILTSTONE. (KEUPER MARL : ZONE I) MM-ST
		15.00 - 16.65		100		69				
							16.00	63.62		Slightly weathered very thinly and thinly bedded red brown occasionally green grey fine grained very weak to weak SILTSTONE. (KEUPER MARL : ZONE I/II) MM-ST
		16.65 - 17.00		94		43				highly weathered zone of very weak clayey siltstone
		17.00 - 18.50		85		62				highly weathered zone of very weak clayey siltstone
		18.50 - 20.00		99		90				
							20.00	59.62		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. SK42NE91R
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446980.00 - 325250.00	Hole Type RC
Location:		Level: 78.85	Scale 1:50
Client: Highways England		Dates: 04/10/1984 - 04/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Rotary Open Holed through previously drilled Shell and Auger hole to 3.00 OH-OH
		3.00 - 3.70		71		22	3.00	75.85		Highly weathered fissured red brown very weak SILTSTONE. (KEUPER MARL : ZONE III) MM-ST
		3.70 - 4.70		94		20	3.90	74.95		Slightly weathered fissured red brown occasionally grey green very weak SILTSTONE. Very to extremely closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST highly weathered zone slightly weathered grey green moderately weak band
		4.70 - 6.20		99		53				highly weathered zone slightly weathered grey green moderately weak band
		6.20 - 7.90		100		49				slightly weathered grey green moderately weak band slightly weathered grey green moderately weak band
		7.90 - 9.40		97		48				slightly weathered grey green moderately weak band
		9.40 - 10.50		98		0	9.32	69.53		Slightly weathered very fissured red brown and grey green weak to moderately weak calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE91R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446980.00 - 325250.00	Hole Type RC
Location:		Level: 78.85	Scale 1:50
Client: Highways England		Dates: 04/10/1984 - 04/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										subvertical discontinuity
		10.50 - 11.75		100		43	10.90	67.95		Highly weathered fissured red brown mottled grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE III) MM-ST
		11.75 - 13.45		94		33	12.18	66.67		slightly weathered grey green moderately weak band Slightly weathered fissured to very fissured red brown very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST
		13.45 - 15.00		85		21				subvertical discontinuity 45 deg discontinuity
		15.00 - 16.85		92		29				slightly weathered grey green moderately weak band
		16.85 - 17.85		65		48				45 deg discontinuity
		17.85 - 18.85		100		32	17.71	61.14		Slightly weathered fissured grey green moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		18.85 - 20.00		81		59				subvertical discontinuity subvertical discontinuity
							20.00	58.85		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE91**

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446980.00 - 325250.00	Hole Type CP
Location:		Level: 78.85	Scale 1:50
Client: Highways England		Dates: 16/08/1984 - 16/08/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										TOPSOIL TP
		0.50	J				0.50	78.35		
		0.50 - 0.95	U							Very stiff red brown mottled light brown fissured silty CLAY with mudstone lithorelicts and rootlets. (KEUPER MARL : ZONE III) MM-Z4
		1.00	J				1.00	77.85		Very stiff red brown slightly mottled grey green fissured silty CLAY with mudstone lithorelicts becoming firm to stiff sand friable in zones. Bands of weak to very weak grey green siltstone at 1.00m and 2.40m. Tending to very weak and weak mudstone in zone below 3.50m. (KEUPER MARL : II/III) MM-Z2
		1.45	J							
		1.70	J							
		2.00 - 2.45	U							
		2.50	J							
		2.95	J							
		4.00	J							
		4.00	B							
		4.30	J				4.30	74.55		End of borehole at 4.30 m
		5.23	B							
		5.23 - 5.66	C							
		8.20 - 8.30	C							
		8.30 - 8.44	C							
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE91**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446980.00 - 325250.00	Hole Type CP
Location:		Level: 78.85	Scale 1:50
Client: Highways England		Dates: 16/08/1984 - 16/08/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		12.64 - 12.78	C							
		12.96 - 13.09	C							
		14.86 - 14.97	C							
		14.97 - 15.10	C							
		15.42 - 15.52	C							
		15.52 - 15.62	C							
		17.74 - 17.85	C							
		17.85 - 17.96	C							

11 12 13 14 15 16 17 18 19 20

Remarks

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Rotary Core Log

Borehole No. SK42NE90R
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446970.00 - 325220.00	Hole Type RC
Location:		Level: 79.03	Scale 1:50
Client: Highways England		Dates: 09/10/1984 - 11/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		7.00 - 8.00		80		0				Moderately to highly weathered friable weak to very weak red brown mottled grey green calcareous SILTSTONE. Extremely closely spaced subhorizontal discontinuities containing some clay. (KEUPER MARL : ZONE II/III) MM-ST
										highly weathered zone degraded to stiff silty clay with many lithorelicts
		8.00 - 9.50		93		7				
		9.50 - 9.90		88		0	9.55	69.48		Moderately to slightly weathered weak to moderately weak red brown mottled grey green
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE90R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446970.00 - 325220.00	Hole Type RC
Location:		Level: 79.03	Scale 1:50
Client: Highways England		Dates: 09/10/1984 - 11/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.90 - 11.15		96		16				calcareous SILTSTONE. Very to extremely closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST *highly weathered zone degraded to stiff silty clay with many lithorelicts*
		11.15 - 12.15		90		15				*highly weathered zone degraded to stiff silty clay with many lithorelicts*
		12.15 - 13.80		56		7				
		13.80 - 14.80		85		33				
		14.80 - 17.00		81		22				*subvertical discontinuities* *very weak highly weathered zone* *subvertical discontinuities* *very weak highly weathered zone*
		17.00 - 18.75		100		42	17.00	62.03		Slightly weathered moderately weak to moderately strong grey green SILTSTONE. Very closely and closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST
							19.00	60.03		Moderately to highly weathered very weak friable red brown SILTSTONE. Very closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
							20.00	59.03		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE90** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446970.00 - 325220.00	Hole Type CP
Location:		Level: 79.03	Scale 1:50
Client: Highways England		Dates: 14/08/1984 - 15/08/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										TOPSOIL. TP
		0.50	J				0.50	78.53		
		0.50 - 0.95	U							Firm to stiff red brown fissured silty CLAY with many subangular grey green fine to medium sized fragments of very weak siltstone. (KEUPER MARL : ZONE IV) MM-Z4
		1.00	J				1.00	78.03		
		1.45	J							Firm red brown mottled grey green silty CLAY and very silty CLAY with lithorelicts of siltstone becoming very stiff tending to very weak siltstone 1.00-1.30m. Friable with no lithorelicts below 1.80m. (KEUPER MARL : ZONE III/IVa) MM-Z3
		1.50	B							
		1.80	J							
		2.00 - 2.45	U							
		2.50	J				2.50	76.53		
		2.95	J							Stiff and very stiff red brown occasionally mottled grey green silty CLAY with lithorelicts of mudstone. (KEUPER MARL : ZONE III) Occasional thin bands of very weak mudstone and firm friable silty clay. Band of very weak mudstone at 4.20m. Band of very weak grey green siltstone noted at 4.80m. MM-Z3
		3.00	B							
		3.30	J							
		3.50 - 3.95	U							
		4.00	J							
		4.20	J							
		4.95	J							
		5.00	B							
		5.00	J							
		5.00 - 5.45	U							
		5.50	J				5.50	73.53		
		5.95	J							Very stiff red brown fissured silty CLAY and bands of grey green fissured clayey silt with many siltstone lithorelicts. Band of stiff friable silty clay at 6.30m. (KEUPER MARL : ZONE III) MM-Z3
		6.00	B							
		6.30	J							
		6.50 - 6.95	U							
		7.00	J							
		7.45	J							
		7.50	B							
		7.70	J				7.70	71.33		
		8.20	J							Firm red brown slightly mottled grey green friable silty CLAY with mudstone lithorelicts becoming stiff to very stiff below 8.30m. Band of very weak fissured mudstone at 8.20m and weak to moderately weak siltstone at 8.40m. (KEUPER MARL : ZONE III) MM-Z3
							8.50	70.53		End of borehole at 8.50 m
		10.00 - 10.10	C							Continued on next sheet.

Remarks

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Rotary Core Log

Borehole No. **SK42NE90**
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446970.00 - 325220.00	Hole Type CP
Location:		Level: 79.03	Scale 1:50
Client: Highways England		Dates: 14/08/1984 - 15/08/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.10 - 10.20	C							
		12.05 - 12.15	C							
		12.30 - 12.40	C							
		16.30 - 16.42	C							
		16.42 - 16.54	C							

11 12 13 14 15 16 17 18 19 20

Remarks

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Rotary Core Log

Borehole No. **SK42NE89**

Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 325230.00	Hole Type CP+RC
Location:		Level: 75.29	Scale 1:50
Client: Highways England		Dates: 11/09/1984 - 14/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.30	74.99		LIMESTONE BALLAST. (Motorway verge) MG-EF
		0.50 - 1.00	B							Slightly weathered moderately weak red brown grey green calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		1.30	J							
		1.50 - 1.95	U							
		2.00	J				2.00	73.29		Highly weathered very weak red brown micaceous MUDSTONE. (KEUPER MARL : ZONE III) MM-Z2
		2.00 - 2.50	C							
		2.45	J							
		2.80	J							
		3.00	B							
		3.00 - 3.45	U							
		3.50	J				3.50	71.79		Very stiff red brown and grey green very silty CLAY with bands of highly weathered weak mudstone/siltstone. (KEUPER MARL : ZONE III) MM-Z3
		3.95	J							
		4.30	J							
		4.60	J				4.60	70.69		LIMESTONE FRAGMENTS (fallen limestone fragments after Shell and Auger drilling). NR
							5.50	69.79		Slightly weathered fissured red brown very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST
		5.50 - 7.00		97		18				45 deg discontinuity Subvertical discontinuities Highly weathered zone
		7.00 - 8.00		100		11				Slightly weathered grey green moderately strong band
		8.00 - 9.60		95		61				Highly weathered zone
		10.00 - 10.10	C							

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE89** Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 325230.00	Hole Type CP+RC
Location:		Level: 75.29	Scale 1:50
Client: Highways England		Dates: 11/09/1984 - 14/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.10 - 10.20	C							Highly weathered zone Highly weathered zone
		9.60 - 11.40		97		33				Subvertical discontinuities
	▼	11.40 - 11.90		100		0				Highly weathered zone
		12.05 - 12.15	C				11.95	63.34		Slightly weathered fissured grey green occasionally red brown moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II/III) MM-ST
		12.30 - 12.40	C							45 deg discontinuity
		11.90 - 13.30		100		50				Highly weathered zone degraded to stiff silty clay with many lithorelicts
										Highly weathered zone degraded to stiff silty clay with many lithorelicts
										45 deg discontinuity
		13.30 - 15.10		100		42	14.09	61.20		45 deg discontinuity Moderately to slightly weathered fissured red brown occasionally grey green very weak calcareous SILTSTONE. Becoming slightly weathered below 19.10m. Very to extremely closely spaced rough subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
										45 deg discontinuity
		15.10 - 16.10		93		32				Slightly weathered grey green moderately weak band Slightly weathered grey green moderately weak band
										Completely weathered zone degraded to stiff silty clay with many lithorelicts
										Slightly weathered grey green moderately weak band
		16.30 - 16.42	C							
		16.42 - 16.54	C							
		16.10 - 19.10		95		53				Completely weathered zone degraded to stiff silty clay with many lithorelicts Completely weathered zone degraded to stiff silty clay with many lithorelicts Slightly weathered grey green moderately weak band
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE89**
Sheet 3 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 325230.00	Hole Type CP+RC
Location:		Level: 75.29	Scale 1:50
Client: Highways England		Dates: 11/09/1984 - 14/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		19.10 - 22.00		99		59				Slightly weathered grey green moderately weak band
		22.00 - 23.40		97		27				Slightly weathered grey green moderately weak band Completely weathered zone degraded to stiff silty clay with many lithorelicts Slightly weathered grey green moderately weak band Subvertical discontinuity Slightly weathered grey green moderately weak band
		23.40 - 25.00		96		67				Slightly weathered grey green moderately weak band Completely weathered zone degraded to stiff silty clay with many lithorelicts
							25.00	50.29		End of borehole at 25.00 m

21 22 23 24 25 26 27 28 29 30

Remarks

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Rotary Core Log

Borehole No. **SK42NE88** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446990.00 - 325210.00	Hole Type CP+RC
Location:		Level: 75.09	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 19/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.40	74.69		Limestone Ballast. (MADE GROUND, MOTORWAY VERGE) MG-EF
		0.50	J							Very stiff red brown silty CLAY with occasional mudstone lithorelicts and thin bands of highly weathered very weak calcareous mudstone, siltstone. (KEUPER MARL : ZONE III) Band of moderately weak to weak calcareous mudstone at 2.00m. MM-Z3
		1.00	J							
		1.50 - 1.95	U							
		2.00	J							
		2.30	J							
		2.80	J							
		3.00	B							
		3.10	D							
		3.10	J							
		3.60	J							
		3.80	J							
		4.45	J				4.50	70.59		Very stiff red brown mottled grey green silty/very silty CLAY with occasional bands of highly weathered very weak calcareous mudstone. (KEUPER MARL : ZONE III) MM-Z3
		4.80	J							
		5.45	J				5.50	69.59		Highly to moderately weathered fissured very weak red brown occasionally grey green calcareous MUDSTONE, blue grey staining on fissure surfaces with very and extremely closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-Z2
		5.73	B							
		5.73 - 5.98	C							
		5.50 - 7.10		98		34				
										Highly weathered zone degraded to stiff silty clay with many lithorelicts
										Highly weathered zone degraded to stiff silty clay with many lithorelicts
		7.10 - 8.20		99		0				*Subvertical discontinuity*
										Highly weathered zone degraded to stiff silty clay with many lithorelicts
		8.20 - 10.10		95		41				
							9.30	65.79		Moderately weathered slightly fissured very weak red brown mottled grey green calcareous SILTSTONE. Very to extremely closely spaced subhorizontal discontinuities. Becoming highly
		9.70 - 9.80	C							
		9.80 - 9.90	C							

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE88** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 446990.00 - 325210.00	Hole Type CP+RC
Location:		Level: 75.09	Scale 1:50
Client: Highways England		Dates: 10/09/1984 - 19/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
	▼									weathered and fissured below 11.76. (KEUPER MARL : ZONE II/III) MM-ST
										Subvertical discontinuity
										Moderately weak band
										Moderately weak band
		10.10 - 13.10		100		59				
		12.65 - 12.77	C				12.49	62.60		
		12.77 - 12.90	C							Moderately weathered weak to moderately weak grey green calcareous SILTSTONE. Very to extremely closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		13.73 - 13.84	C							
		13.91 - 14.04	C							Highly weathered zone degraded to very silty clay
		13.10 - 15.10		97		28				Highly weathered zone degraded to very silty clay
										Highly weathered zone degraded to very silty clay
							14.50	60.59		Highly weathered zone degraded to very silty clay
										Highly weathered very weak fissured red brown and grey green SILTSTONE. (KEUPER MARL : ZONE II/III) MM-ST
										Highly weathered zone degraded to stiff very silty clay with many lithorelicts
		15.10 - 16.10		100		83				
		16.10 - 18.10		100		55				
		17.30 - 17.42	C							
		18.10 - 18.20	C							Moderately weak siltstone moderately weathered bands
		18.20 - 18.32	C							Highly weathered zone degraded to stiff very silty clay with many lithorelicts
		18.10 - 20.00		94		35				Highly weathered zone degraded to stiff very silty clay with many lithorelicts
										Highly weathered zone degraded to stiff very silty clay with many lithorelicts
							20.00	55.09		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 325210.00	Borehole No. SK42NE87 Sheet 1 of 1
Location:		Level: 75.59	Hole Type CP+RC
Client: Highways England		Dates: 25/09/1984 - 27/09/1984	Scale 1:50
			Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPINGS. (Motorway central reserve) MG-EF
		0.70	J				0.70	74.89		Firm red brown mottled grey green, fissured silty to very silty CLAY with many mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE III) Occasional thin bands of highly weathered fissured red brown weak micaceous mudstone/ siltstone at 1.00. MM-Z3
		1.00	J							
		1.50 - 1.95	U							
		2.00	J				2.00	73.59		Highly weathered fissured red brown very weak calcareous SILTSTONE with residual silty clay. (KEUPER MARL : ZONE III) MM-ST
		2.45	J							
		2.50	B							
		2.70	J				2.70	72.89		Stiff red brown fissured silty CLAY with some mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE III) Occasional bands of highly weathered fissured weak calcareous siltstone at 3.50. Becoming very stiff below 4.20m MM-Z3
		3.00 - 3.45	U							
		3.50	J							
		3.95	J							
		4.20	J							
		4.50 - 4.95	U							
		5.00	J				5.00	70.59		Very stiff red brown mottled grey green fissured silty CLAY with many siltstone lithorelicts and some thin bands of highly weathered very weak calcareous siltstone. (KEUPER MARL : ZONE III) Weak siltstone bands at 5.80. Clay becoming very stiff below 5.90m. MM-Z3
		5.45	J							
		5.90	J							
		5.90	B							
		6.20	J				6.20	69.39		Highly weathered zone. Slightly weathered grey green moderately strong band.
		6.20 - 7.00		68		0				Slightly weathered very closely fissured red brown very weak to weak calcareous SILTSTONE. Very to extremely closely spaced rough subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST. Highly weathered zone.
		7.00 - 8.00		89		0				
		8.00 - 9.00		97		15				Highly weathered zone. Slightly weathered grey green moderately strong band. Slightly weathered grey green moderately strong band.
		9.32 - 9.44	C							Subvertical discontinuity. 45 deg discontinuity.
		9.00 - 10.00		100		14				Highly weathered zone.
							10.00	65.59		End of borehole at 10.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE86** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 325190.00	Hole Type CP+RC
Location:		Level: 75.33	Scale 1:50
Client: Highways England		Dates: 26/09/1984 - 29/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPINGS (Motorway central reserve) MG-EF
		0.70	J				0.70	74.63		Firm red brown fissured silty CLAY with many siltstone lithorelicts. (KEUPER MARL : ZONE III) Becoming stiff and very stiff with depth. Occasional thin bands of highly weathered very weak siltstone at 2.00. MM-Z4
		1.00	J							
		1.50 - 1.95	U							
		2.00	J							
		2.45	J							
		2.50	B							
		2.80	J							
		3.00 - 3.45	U							
		3.50	J				3.50	71.83		Stiff red brown fissured silty CLAY with many mudstone/siltstone lithorelicts and occasional thin bands of highly weathered very weak to weak mudstone/siltstone. (KEUPER MARL : ZONE III) Mottled grey green at 5.00. MM-Z3
		3.95	J							
		4.00	B							
		4.20	J							
		4.50 - 4.95	U							
		5.00	J							
	▼	5.45	J							
		5.60	J							
		6.00	J				6.00	69.33		Slightly weathered fissured red brown very weak to weak calcareous SILTSTONE occasionally with thin interstratified mudstone. Very to extremely closely spaced rough subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		6.00 - 8.40		97		26				Slightly weathered grey green moderately weak band Slightly weathered grey green moderately weak band Subvertical discontinuity Slightly weathered grey green moderately weak band
		8.40 - 8.80		100		0				Slightly weathered grey green moderately weak band Slightly weathered grey green moderately weak band
		8.80 - 9.50		94		0				Highly weathered zone degraded to stiff silty clay with many lithorelicts Subvertical discontinuity
										Continued on next sheet

Remarks

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Rotary Core Log

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447000.00 - 325190.00	Borehole No. SK42NE86 Sheet 2 of 2
Location:		Level: 75.33	Hole Type CP+RC
Client: Highways England		Dates: 26/09/1984 - 29/09/1984	Scale 1:50
			Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.50 - 12.25		96		23				Subvertical discontinuity
										Slightly weathered grey green moderately weak band
										45 deg discontinuity
										45 deg discontinuity
										45 deg discontinuity
										Subvertical discontinuity
		12.25 - 14.50		98		54				Subvertical discontinuity
							13.81	61.52		Slightly weathered grey green occasionally red brown moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
										45 deg discontinuity
		14.50 - 16.90		92		57	15.59	59.74		Slightly weathered fissured red brown occasionally grey green very weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		16.90 - 17.70		100		26				Subvertical discontinuity
										Highly weathered zone degraded to stiff silty clay with many lithorelicts
		17.70 - 20.00		94		43				Highly weathered zone degraded to stiff silty clay with many lithorelicts
							20.00	55.33		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE85**
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325200.00	Hole Type CP+RC
Location:		Level: 75.00	Scale 1:50
Client: Highways England		Dates: 18/09/1984 - 19/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPINGS, Motorway Verge. MG-EF
		0.70	J							
		1.20	J				1.20	73.80		Very stiff red brown fissured silty CLAY with many mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE III) MM-Z3
		1.50 - 1.95	U							
		2.00	J							
		2.00 - 2.50	AMAL							
		2.45	J							
		2.50	B							
		2.70	J							
		3.00 - 3.45	U							
		3.50	J				3.50	71.50		Stiff red brown and grey green fissured silty CLAY with many mudstone/siltstone lithorelicts and some thin bands of highly weathered fissured very weak to weak mudstone/siltstone. (KEUPER MARL : ZONE III) MM-Z3
		3.95	J							
		4.00 - 4.50	SPTLS							
		4.00 - 4.50	B							
		4.60	J							
		5.00	J				5.00	70.00		LIMESTONE CHIPPINGS (fallen limestone fragments after Shell and Auger drilling). NR
							5.50	69.50		
		5.50 - 6.00		100		28				Highly weathered fissured very weak red brown calcareous MUDSTONE, closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-Z3
		6.00 - 7.30		95		26				*Moderately weathered band weak mudstone* *Moderately weak siltstone* *Moderately weathered band weak mudstone* *Moderately weathered band weak mudstone*
		7.30 - 8.10		98		19				*Moderately weathered band weak mudstone* *45 deg discontinuity*
		8.10 - 10.00		100		48				*Moderately weathered band weak mudstone* *Highly weathered zone degraded to stiff silty clay with many lithorelicts*
							10.00	65.00		End of borehole at 10.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE84** Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447020.00 - 325170.00	Hole Type CP+RC
Location:		Level: 74.77	Scale 1:50
Client: Highways England		Dates: 18/09/1984 - 19/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPINGS, Motorway verge MG-EF
		1.00	J				1.00	73.77		Stiff to very stiff red brown mottled grey green fissured silty to very silty CLAY with some mudstone/siltstone lithorelicts. (KEUPER MARL : ZONE III) Occasional thin bands of moderately weathered fissured weak calcareous siltstone below 2.00m and many mudstone/siltstone lithorelicts. Becoming mottled grey green below 2.70m. MM-Z4
		1.20	J							
		1.50 - 1.95	U							
		2.00	J							
		2.45	J							
		2.50	B							
		2.70	J							
		3.50	B							
		3.65	J							
		4.30	J							
		4.50	J							
		5.00	J				5.00	69.77		Slightly weathered fissured red brown occasionally grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal smooth discontinuities. (KEUPER MARL : ZONE II) MM-ST
		5.50	B							
		5.50 - 5.83	C							
		5.50 - 5.85	C							
		5.00 - 7.00		97		45				Slightly weathered grey green moderately weak bands
		6.10 - 6.20	C							
		6.20 - 6.34	C							Slightly weathered grey green moderately weak bands
										Slightly weathered grey green moderately weak bands
		7.00 - 7.15	C							Highly weathered zone degraded to stiff silty clay with many lithorelicts
		7.15 - 7.25	C							
		7.00 - 8.50		100		40				Subvertical discontinuities
										Highly weathered zone degraded to stiff silty clay with many lithorelicts
										Slightly weathered grey green moderately weak bands
		8.50 - 9.50		97		0				Slightly weathered grey green moderately weak bands
										Slightly weathered grey green moderately weak bands
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE84** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447020.00 - 325170.00	Hole Type CP+RC
Location:		Level: 74.77	Scale 1:50
Client: Highways England		Dates: 18/09/1984 - 19/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.58 - 10.86 10.86 - 11.00	C C	96		56				
		11.50 - 14.30 13.00 13.00 - 13.30 13.35 - 13.45 13.45 - 13.55 13.55 - 13.66 13.66 - 13.76	B C C C C C	95		56				Slightly weathered grey green moderately weak bands Subvertical discontinuities
		14.30 - 14.75		97		0				Slightly weathered grey green moderately weak bands 45 deg discontinuity
		14.75 - 15.80 15.66 - 15.80	C C	100		47				Slightly weathered grey green moderately weak bands Subvertical discontinuities Slightly weathered grey green moderately weak bands
		15.80 - 17.40		92		41				Highly weathered zone degraded to stiff silty clay with many lithorelicts Highly weathered zone degraded to stiff silty clay with many lithorelicts Slightly weathered grey green moderately weak bands
		17.74 - 17.86 17.86	C C							
		17.40 - 20.00		94		51				Slightly weathered grey green moderately weak bands
							20.00	54.77		End of borehole at 20.00 m

Remarks

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Rotary Core Log

Borehole No. SK42NE83R
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325170.00	Hole Type RC
Location:		Level: 75.72	Scale 1:50
Client: Highways England		Dates: 01/10/1984 - 01/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Rotary Open Holed alongside Shell and Auger Hole previously drilled to 5.00m. OH-OH
	▼	5.00 - 6.00		81		20	5.00	70.72		Highly weathered red brown siltstone degraded to stiff silty CLAY with many siltstone lithorelicts. (KEUPER MARL : ZONE III) MM-Z3
		6.00 - 6.70		98		0	6.08	69.64		Slightly weathered fissured red brown occasionally grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		6.70 - 8.30		96		26				Slightly weathered grey green moderately weak bands. Slightly weathered grey green moderately weak bands. Highly weathered degraded to stiff silty clay with many lithorelicts
		8.30 - 9.60		100		28				Slightly weathered grey green moderately weak bands. Slightly weathered grey green moderately weak bands.
										Continued on next sheet.

Remarks

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Rotary Core Log

Borehole No. SK42NE83R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325170.00	Hole Type RC
Location:		Level: 75.72	Scale 1:50
Client: Highways England		Dates: 01/10/1984 - 01/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.60 - 11.00		94		27				
		11.00 - 12.60		100		53				Subvertical discontinuities
		12.60 - 15.00		95		62				Slightly weathered grey green moderately weak bands
							15.00	60.72		Slightly weathered grey green moderately weak bands End of borehole at 15.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE83**

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325170.00	Hole Type CP
Location:		Level: 75.72	Scale 1:50
Client: Highways England		Dates: 20/09/1984 - 21/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										TOPSOIL TP
		0.30	J				0.30	75.42		Very stiff yellowish brown fissured sandy CLAY with occasional subangular medium gravel (sandstone and flint). (GLACIAL TILL) GTA-CL
		0.50 - 0.95	U							
		1.00	J							
		1.45	J							
		1.70	J				1.70	74.02		Very stiff red brown fissured silty to very silty CLAY with many siltstone/mudstone lithorelicts. (KEUPER MARL : ZONE III) MM-Z2
		2.00 - 2.45	U							
		2.50	J							
		2.95	J							
		3.00	B							
		3.20	J							
		3.50 - 3.95	U							
		4.00	J				4.00	71.72		Very stiff red brown and grey green fissured silty CLAY with many siltstone lithorelicts and occasional bands of highly weathered fissured very weak calcareous siltstone with residual silty clay. (KEUPER MARL : ZONE III) MM-Z3
		4.45	J							
		4.50	B							
		4.70	J							
		5.00 - 5.40	U							
		5.40	J							
		5.50 - 5.85	J							
		6.10	J							
		6.50	J				6.50	69.22		End of borehole at 6.50 m
		9.50 - 9.60	C							

Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. **SK42NE83** Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447030.00 - 325170.00	Hole Type CP
Location:		Level: 75.72	Scale 1:50
Client: Highways England		Dates: 20/09/1984 - 21/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		10.22 - 10.34	C							
		10.34 - 10.45	C							
		11.09 - 11.20	C							
		12.20 - 12.32	C							
		12.32 - 12.46	C							
		13.24 - 13.36	C							
		13.36 - 13.46	C							
		14.48 - 14.58	C							
		14.58 - 14.69	C							
		14.69 - 14.81	C							

Remarks

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Rotary Core Log

Borehole No. SK42NE82R

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447020.00 - 325150.00	Hole Type RC
Location:		Level: 76.34	Scale 1:50
Client: Highways England		Dates: 02/10/1984 - 02/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Rotary open holed through overburden alongside Shell and Auger Hole previously drilled to 6.00m. OH-OH
		6.00 - 7.00		79		0	6.00	70.34		Moderately to slightly weathered very fissured red brown occasionally grey green very weak to weak calcareous SILTSTONE. Very to extremely closely spaced rough subhorizontal discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
		7.00 - 8.20		93		29				*Highly weathered degraded to stiff silty clay with many lithorelicts*
		8.20 - 9.00		100		0				*Slightly weathered grey green moderately weak bands*
	▼	9.00 - 10.60		98		17				*Slightly weathered grey green moderately weak bands*
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE82R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447020.00 - 325150.00	Hole Type RC
Location:		Level: 76.34	Scale 1:50
Client: Highways England		Dates: 02/10/1984 - 02/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Highly weathered degraded to stiff silty clay with many lithorelicts
		10.60 - 11.80		95		9				*Slightly weathered grey green moderately weak bands*
										Highly weathered degraded to stiff silty clay with many lithorelicts
		11.80 - 13.50		99		0				*Slightly weathered grey green moderately weak bands*
										Highly weathered degraded to stiff silty clay with many lithorelicts
		13.50 - 15.50		93		51				*Slightly weathered grey green moderately weak bands*
		15.50 - 17.00		98		24	15.70	60.64		Slightly weathered fissured grey green moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
							17.00	59.34		End of borehole at 17.00 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE82**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447020.00 - 325150.00	Hole Type CP
Location:		Level: 76.34	Scale 1:50
Client: Highways England		Dates: 21/09/1984 - 02/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	J				0.30	76.04		TOPSOIL TP
		0.50 - 0.95	U							Very stiff yellowish brown fissured sandy CLAY with occasional subangular fine to medium gravel. MM-Z2
		1.00	J							
		1.45	J				1.30	75.04		Firm to stiff red brown mottled grey green fissured silty and very silty CLAY with many siltstone lithorelicts and occasional thin bands of moderately weathered grey green very weak siltstone. (KEUPER MARL : ZONE II/III) Becoming very stiff and stiff below 2.00m. Band of siltstone become weak below 6.50m. MM-Z2
		1.70	J							
		2.00 - 2.45	U							
		2.50	J							
		2.95	J							
		3.00	B							
		3.20	J							
		3.50 - 3.95	U							
		4.00	J							
		4.45	J							
		4.50	B							
		4.70	J							
		5.00 - 5.40	U							
		5.50	J							
		5.95	J							
		6.30	J							
		6.95	J							
		7.10	J							
		7.70	J				7.70	68.64		End of borehole at 7.70 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE67**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447006.00 - 325214.00	Hole Type CP
Location:		Level: 74.65	Scale 1:50
Client: Highways England		Dates: 27/01/1988 - 28/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.00 - 1.00	B							Very stiff (hard) red brown locally friable very silty CLAY with frequent fine to medium gravel sized mudstone lithorelics. Locally with closely spaced subhorizontal fissures. (KEUPER MARL) Below 1.25m with occasional pockets and lenses of light greenish grey silt. Below 6.70m with medium to coarse gravel sized mudstone lithorelics. MM-Z3
		1.00 - 1.20	U							
		1.25	D							
		1.25 - 1.55	D							
		2.25 - 2.70	D							*dense friable red brown silt with frequent fine to medium gravel sized lithorelics.*
		3.25 - 3.70	D							
		4.25 - 4.55	D							
		5.20 - 5.43	D							*light red brown locally greenish probably moderately weathered silty fine grained sandstone weak*
		5.60	W							
		6.25 - 6.70	D							
		7.00	D							
							7.20	67.45		End of borehole at 7.20 m

Remarks
Hand dug inspection pit from ground level to 1.00m

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Rotary Core Log

Borehole No. SK42NE57R
Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447031.00 - 325296.00	Hole Type CP+RC
Location:		Level: 75.49	Scale 1:50
Client: Highways England		Dates: 01/02/1988 - 03/02/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Cable Tool Boring to 4.45m OH-OH
		4.00 - 5.50		87	50	11	4.45	71.04		Red brown moderately locally highly weathered locally very silty MUDSTONE weak with occasional bands of light grey green fine sandy siltstone up to 80mm thick. Very closely spaced often tight sub-vertical joints with black stain (KM 2/3) MM-Z2
							5.50	69.99		Assessed zone of core loss OH-OH
		5.50 - 6.70		58	33	13	6.00	69.49		Very stiff red brown very silty CLAY with frequent fine to medium gravel sized lithorelics (weathered MUDSTONE) (KM 3/4a) MM-Z3
							6.30	69.19		Red brown moderately weathered locally very clayey SILTSTONE moderately weak: extremely closely fractured with black staining (KEUPER MARL 2) From 7.00m to 7.40m with occasional bands of light grey green slightly fine sandy siltstone strong. From 8.75m to 9.40m moderately to highly weathered weak to very weak locally altered to a hard clayey silt with up to coarse gravel sized lithorelics MM-ST
		6.70 - 9.70		93	20	13				non intact assessed zone of core loss non intact non intact non intact non intact
							9.70	65.79		Assessed zone of core loss
										Continued on next sheet

Remarks
Open hole drilling, air flush, using 6.75in rock bit from ground level to 4.00m

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Rotary Core Log

Borehole No. SK42NE57R
Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447031.00 - 325296.00	Hole Type CP+RC
Location:		Level: 75.49	Scale 1:50
Client: Highways England		Dates: 01/02/1988 - 03/02/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										OH-OH
		9.70 - 12.60		83	43	21	10.20	65.29		Red brown slightly to moderately weathered SILTSTONE moderately strong becoming strong with very closely spaced sub-horizontal fractures. From 11.05m to 11.60m thinly interbedded with hard red brown clayey silt. Below 11.60m becoming light green slightly fine to sandy with closely to moderately widely spaced sub-horizontal fractures (bedding?) (KEUPER MARL 2) MM-ST *light greenish grey fine sandy siltstone strong* *non intact due to 2 intersecting sub-vertical joints with black staining* *non intact due to 2 intersecting sub-vertical joints with black staining* *occasional bands and lenses of red brown mudstone and very stiff hard red brown clay*
		12.60 - 15.55		88	73	37	13.50 13.95	61.99 61.54		Very stiff (hard) red brown very clayey SILT (weathered SILTSTONE) (KM3/4a) MM-Z4 Light grey green and red brown mottled moderately becoming highly weathered fine sandy SILTSTONE moderately weak to moderately strong (KEUPER MARL 3/4a) Below 14.50m becoming completely weathered altered to a dense silt with fine to coarse gravel sized lithorelics MM-ST *non intact* *assessed zone of core loss*
		15.55 - 18.00		80	20	16	16.30	59.19		Red brown slightly to moderately weathered locally very clayey SILTSTONE weak becoming moderately weak with extremely closely spaced often tight sub-horizontal fractures with black staining Below 18.20m becoming weak with occasional bands of very stiff (hard) red brown silty CLAY (KM 2) MM-ST *non intact* *assessed zone of core loss*
		18.00 - 20.00		90	75	48				*light grey green slightly fine sandy siltstone moderately weak* *non intact* Continued on next sheet

Remarks
Open hole drilling, air flush, using 6.75in rock bit from ground level to 4.00m

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Rotary Core Log

Borehole No. SK42NE57R
Sheet 3 of 3

Project Name:	SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords:	447031.00 - 325296.00	Hole Type CP+RC
Location:			Level:	75.49	Scale 1:50
Client:	Highways England		Dates:	01/02/1988 - 03/02/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							20.13	55.36		End of borehole at 20.13 m

Remarks
Open hole drilling, air flush, using 6.75in rock bit from ground level to 4.00m

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Rotary Core Log

Borehole No. **SK42NE57**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447031.00 - 325296.00	Hole Type CP
Location:		Level: 75.49	Scale 1:50
Client: Highways England		Dates: 28/01/1988 - 29/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.20	75.29		FILL (Foreman's description) MG-CL
		1.00 - 1.45	U							Very stiff (hard) red brown very silty CLAY locally with occasional fine gravel sized lithorelics (KEUPER MARL 3/4a) Below 3.80m with occasional medium gravel sized lithorelics and occasional bands and lenses of light greenish grey locally slightly fine sandy silt and siltstone MM-Z4
		1.60	D							
		1.60 - 2.01	D							
		2.30 - 2.75	D							
		3.60 - 3.80	D							*thinly laminated clay with frequent fine gravel sized lithorelics and occasional fine to medium sub-rounded fine to medium gravel*
		3.80	D							
		3.80 - 4.02	D							
		4.30 - 4.45	D							
							4.45	71.04		End of borehole at 4.45 m

Remarks

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Rotary Core Log

Borehole No. SK42NE56R
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447064.00 - 325201.00	Hole Type CP+RC
Location:		Level: 75.78	Scale 1:50
Client: Highways England		Dates: 21/01/1988 - 22/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Cable Tool Boring to 8.00m OH-OH
							8.00	67.78		Assessed zone of core loss OH-OH
		8.00 - 9.00		50	20	10	8.50	67.28		Stiff becoming very stiff red brown silty CLAY with fine to medium gravel sized lithorelics thinly interbedded with red brown locally light grey green moderately weathered SILTSTONE moderately weak (KEUPER MARL 2/3) MM-Z3
		9.00 - 10.50		100	5	0				*disturbed* *sub-vertical joint stained black* *disturbed by SPT* *closely spaced joints stained black*
							9.88	65.90		Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE56R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447064.00 - 325201.00	Hole Type CP+RC
Location:		Level: 75.78	Scale 1:50
Client: Highways England		Dates: 21/01/1988 - 22/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							11.35	64.43		Red brown locally light grey green moderately weathered SILTSTONE weak to moderately weak. Very to extremely closely spaced fractures with speckled black staining (KEUPER MARL 2) MM-ST very stiff (hard) red brown very silty CLAY assessed zone of core loss assessed zone of core loss
		10.50 - 13.20		81	22	20				Red brown moderately weathered SILTSTONE strong becoming moderately strong with occasional bands of dense clayey silt with frequent fine to medium gravel sized lithorelics (KEUPER MARL 2) Below 11.80m with extremely closely spaced often tight generally sub-vertical joints with speckled black staining. From 13.50m to 13.90m greenish grey slightly to moderately weathered . Below 14.90m becoming light greenish grey slightly weathered moderately strong to strong MM-ST 70 joint stained black non intact very stiff (hard) red brown CLAY non intact assessed zone of core loss
		13.20 - 15.00		83	25	11				non intact non intact due to 2 intersecting sub-vertical joints stained black non intact
							15.15	60.63		End of borehole at 15.15 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE56**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447064.00 - 325201.00	Hole Type CP
Location:		Level: 75.78	Scale 1:50
Client: Highways England		Dates: 20/01/1988 - 21/01/1988	Logged By GAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.20	D				0.20	75.58		Clayey topsoil TP
		0.50 - 0.95	U							Firm yellow brown, red brown and brown sandy CLAY with occasional assorted generally subrounded gravel and black organic pockets (PROBABLE FILL) MG-EF
		1.00	D							
		1.00 - 1.45	D							
		1.80	D				1.80	73.98		Stiff becoming very stiff red brown CLAY with frequent up to coarse gravel sized lithorelics (KEUPER MARL 3/4a) below 2.40m with occasional pockets of light red brown silt becoming very silty by 3.40m below 3.90m with bands of hard very silty clay MM-Z3
		1.90 - 2.35	U							
		2.40	D							
		2.40 - 2.85	D							
	▼	3.40 - 3.85	U							
		3.90	D							
		3.90 - 4.35	D							
		4.90 - 5.20	U							
	▽	5.25	D				5.20	70.58		Very stiff (hard) red brown to dark red brown extremely to closely fissured very silty CLAY with pockets and lenses of light grey to light red brown silt locally cemented and occasional lens of green grey fine sandy siltstone , black speckled staining on vertical fissures (KEUPER MARL 3/4a) MM-Z3
		5.25 - 5.70	D							
		5.30	W							
		6.25 - 6.44	D							
		7.25 - 7.51	D							
		7.80 - 7.91	D							
							8.00	67.78		End of borehole at 8.00 m

Remarks

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Rotary Core Log

Borehole No. SK42NE55R
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447051.00 - 325155.00	Hole Type CP+RC
Location:		Level: 77.03	Scale 1:50
Client: Highways England		Dates: 23/01/1988 - 24/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Cable Tool Boring to 9.325m OH-OH
							9.10	67.93		Assessed zone of core loss OH-OH
		9.10 - 10.20		77	0	0	9.35	67.68		Stiff becoming hard red brown CLAY (KEUPER MARL 3/4a) MM-Z3
							9.75	67.28		70 joint
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE55R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447051.00 - 325155.00	Hole Type CP+RC
Location:		Level: 77.03	Scale 1:50
Client: Highways England		Dates: 23/01/1988 - 24/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							10.20	66.83		Red brown slightly to moderately weathered siltstone weak (KM 2) MM-ST
							10.60	66.43		Assessed zone of core loss OH-OH
		10.20 - 12.00		78	36	19				Stiff locally very stiff (hard) red brown CLAY very thinly interbedded with moderately weathered SILTSTONE weak. Occasional pockets and lenses of light greenish grey silt and siltstone. Closely locally very closely fractured (KM 3) MM-Z3
										60 joint stained black
										non intact
										non intact
										Assessed zone of core loss
										non intact
										non intact due to sub-vertical joint with speckled black staining
							12.95	64.08		
		12.00 - 14.50		88	32	18				Red brown slightly to moderately weathered locally clayey SILTSTONE weak to moderately weak with closely spaced thigh joints frequently with black speckled staining (KEUPER MARL 2) MM-ST
										non intact
										non intact
							14.55	62.48		End of borehole at 14.55 m

Remarks

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Rotary Core Log

Borehole No. **SK42NE55** Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447051.00 - 325155.00	Hole Type CP
Location:		Level: 77.03	Scale 1:50
Client: Highways England		Dates: 20/01/1988 - 21/01/1988	Logged By AAC

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
							0.40	76.63		TOPSOIL TP
		0.60 - 1.05	U							Firm to stiff red brown locally silty CLAY with up to coarse gravel sized mudstone lithorelics Occasional pockets and lenses of light green grey silt and siltstone (KEUPER MARL 3/4) MM-Z3
		1.20	D							
		1.20 - 1.65	D							
		2.00 - 2.45	U							
		2.60	D				2.60	74.43		
		2.60 - 3.05	D							Very stiff (hard) red brown very silty CLAY with frequent medium to coarse occasionally fine gravel sized mudstone lithorelics Locally with up to medium gravel sized inclusions of light grey green silt and siltstone (KEUPER MARL 3) Below 6.90m with bands of dense red brown silt and frequent siltstone lithorelics: black speckled staining on occasional vertical fissures MM-Z3
		3.50 - 3.90	U							
	▼	3.90	D							
		3.95 - 4.40	D							
		5.00 - 5.40	U							
		5.40	D							
		5.40 - 5.68	D							
		6.50 - 6.71	D							
		6.90 - 7.35	D							
		7.70 - 7.99	D							
		8.50 - 8.76	D							
		9.10 - 9.32	D							
							9.32	67.71		End of borehole at 9.32 m

Remarks

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Rotary Core Log

Borehole No. SK42NE102R
Sheet 1 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447100.00 - 325390.00	Hole Type RC
Location:		Level: 75.50	Scale 1:50
Client: Highways England		Dates: 03/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Rotary Open Holed through overburden alongside Shell and Auger Hole previously drilled to 4.00 OH-OH
		4.00 - 5.50		100		44	4.00	71.50		Highly weathered very fissured red brown very weak calcareous SILTSTONE. Very to extremely closely spaced, rough discontinuities. (KEUPER MARL : ZONE III) MM-ST slightly weathered moderately weak band
		5.50 - 8.50		99		33	6.27	69.23		Slightly weathered fissured red brown very weak to weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal rough discontinuities. (KEUPER MARL : ZONE II) MM-ST subvertical discontinuities slightly weathered grey green moderately weak band subvertical discontinuities 45 deg discontinuities
		8.50 - 10.50		97		39	9.36	66.14		subvertical discontinuities 45 deg discontinuities 45 deg discontinuities Slightly weathered grey green moderately weak to moderately strong calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE102R
Sheet 2 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447100.00 - 325390.00	Hole Type RC
Location:		Level: 75.50	Scale 1:50
Client: Highways England		Dates: 03/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
	▼						11.05	64.45		very weak band
		10.50 - 12.50		95		50				Moderately to slightly weathered fissured red brown occasionally grey green very weak calcareous SILTSTONE. Very to extremely closely spaced subhorizontal smooth discontinuities. (KEUPER MARL : ZONE II/III) MM-ST
										slightly weathered grey green moderately strong band
										slightly weathered grey green moderately strong band
										highly weathered zone degraded to stiff silty clay with many lithorelicts
		12.50 - 15.20		100		74				highly weathered zone degraded to stiff silty clay with many lithorelicts
										highly weathered zone degraded to stiff silty clay with many lithorelicts
		15.20 - 17.00		94		41				slightly weathered grey green moderately strong band
										slightly weathered grey green moderately strong band
		17.00 - 18.30		100		66				slightly weathered grey green moderately strong band
										highly weathered zone degraded to stiff silty clay with many lithorelicts
		18.30 - 19.80		96		23				slightly weathered grey green moderately strong band
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE102R
Sheet 3 of 3

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447100.00 - 325390.00	Hole Type RC
Location:		Level: 75.50	Scale 1:50
Client: Highways England		Dates: 03/10/1984 - 03/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		19.80 - 22.00		98		30				highly weathered zone degraded to stiff silty clay with many lithorelicts
		22.00 - 24.50		97		30				highly weathered zone degraded to stiff silty clay with many lithorelicts
		24.50 - 25.00		88		0				
							25.00	50.50		End of borehole at 25.00 m

21 22 23 24 25 26 27 28 29 30

Remarks

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Rotary Core Log

Borehole No. SK42NE102

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447100.00 - 325390.00	Hole Type CP
Location:		Level: 75.50	Scale 1:50
Client: Highways England		Dates: 28/09/1984 - 28/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	J				0.30	75.20		Turf onto TOPSOIL. TP
		0.50 - 0.95	U							Very stiff and stiff red brown fissured silty to very stiff CLAY with many siltstone lithorelicts. (KEUPER MARL : ZONE III) Some thin bands of highly weathered weak to moderately weak siltstone below 0.30m. Becoming mottled grey green below 1.70m. MM-Z4
		1.00	J							
		1.00 - 1.50	B							
		1.45	J							
		1.70	J							
		2.20	J				2.20	73.30		Moderately weathered fissured grey green weak to moderately weak calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
							2.50	73.00		
		2.95	J							Very stiff red brown fissured silty CLAY with many mudstone/siltstone lithorelicts and occasional thin bands of highly weathered very weak mudstone/siltstone. (KEUPER MARL : ZONE II/III) MM-ST
		3.20	J				3.20	72.30		
		3.50 - 4.00	B				3.30	72.20		
		3.95	J							Moderately weathered fissured grey green weak to moderately weak calcareous SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		4.00	B							
		4.30	J							Very stiff red brown mottled grey green silty to very silty CLAY with some thin bands of highly weathered weak calcareous siltstone. (KEUPER MARL : ZONE III) MM-ST
		4.85	J				4.85	70.65		
										End of borehole at 4.85 m
		6.27 - 6.56	C							
		6.27 - 6.56	C							
		7.71 - 7.81	C							
		7.71 - 7.81	C							
		7.81 - 7.91	C							
		7.81 - 7.91	C							
		8.50 - 8.60	C							
		8.50 - 8.60	C							
		8.60 - 8.71	C							
		8.60 - 8.71	C							

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Rotary Core Log

Borehole No. SK42NE101R

Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447090.00 - 325370.00	Hole Type RC
Location:		Level: 75.60	Scale 1:50
Client: Highways England		Dates: 04/10/1984 - 04/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										Open hole adjacent to previously drilled percussion hole OH-OH
		4.00 - 4.70		100		20	4.00	71.60		Slightly occasionally moderately weathered laminated to thinly bedded red brown occasionally green grey fine grained very weak occasionally weak SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		4.70 - 7.00		98		34				
		7.00 - 8.20		100		9				
		8.20 - 9.80		98		26				
							9.50	66.10		Slightly weathered thinly bedded green grey occasionally red brown fine grained weak and moderately weak SILTSTONE. (KEUPER MARL
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE101R
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447090.00 - 325370.00	Hole Type RC
Location:		Level: 75.60	Scale 1:50
Client: Highways England		Dates: 04/10/1984 - 04/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										: ZONE I) MM-ST
		9.80 - 12.50		98		50	11.45	64.15		Slightly to moderately weathered laminated to very thinly bedded red brown occasionally green grey fine grained very weak clayey SILTSTONE. (KEUPER MARL : ZONE II) MM-ST
		12.50 - 13.80		97		50				
		13.80 - 15.00		67		19				
							15.00	60.60		End of borehole at 15.00 m

11 12 13 14 15 16 17 18 19 20

Remarks

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Rotary Core Log

Borehole No. **SK42NE101**

Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447090.00 - 325370.00	Hole Type CP
Location:		Level: 75.60	Scale 1:50
Client: Highways England		Dates: 01/10/1984 - 01/10/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		0.30	J				0.30	75.30		Turf onto TOPSOIL TP
		0.50 - 0.95	U							Very stiff red brown mottled grey green fissured silty CLAY with many mudstone/siltstone lithorelicts and occasional thin bands of highly weathered very weak to weak siltstone. (KEUPER MARL : ZONE III) MM-Z4
		1.00	J				1.00	74.60		
		1.00 - 1.50	B							Stiff red brown and grey green fissured silty to very silty CLAY with some siltstone lithorelicts and occasional thin bands of highly weathered very weak siltstone. (KEUPER MARL : ZONE III) MM-Z4
		1.45	J							
		1.70	J				1.70	73.90		
		2.00 - 2.45	U							Highly weathered fissured red brown very weak MUDSTONE/SILTSTONE with residual silty clay. (KEUPER MARL : ZONE III) MM-Z3
		2.50	J				2.50	73.10		
		2.95	J							Very stiff red brown fissured silty CLAY with many siltstone lithorelicts. (KEUPER MARL : ZONE II/III) Some thin bands of highly weathered fissured grey green very weak siltstone. MM-Z2
		3.20	J							
		3.70	J				3.70	71.90		
		4.45	J							Moderately weathered fissured red brown and grey green weak calcareous SILTSTONE. (KEUPER MARL : ZONE II) Becoming just red brown below 4.90m. MM-ST
		4.50	B							
		4.60	J							
		5.20	J				5.20	70.40		End of borehole at 5.20 m

Remarks

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Rotary Core Log

Borehole No. SK42NE100
Sheet 1 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447080.00 - 325370.00	Hole Type CP+RC
Location:		Level: 76.50	Scale 1:50
Client: Highways England		Dates: 17/09/1984 - 18/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
										LIMESTONE CHIPPINGS. (MADE GROUND - MOTORWAY VERGE) MG-EF
		0.70	J				0.70	75.80		Firm red brown occasionally mottled grey green fissured silty CLAY with occasional mudstone/ siltstone lithorelicts. (KEUPER MARL : ZONE III/ IV) Occasional thin bands of highly weathered very weak siltstone mudstone at 2.00m. MM-Z3
		1.10	J							
		1.50 - 1.95	U							
		2.00	J							
		2.45	J							
		2.70	J							
		3.00 - 3.40	U							
		3.40	J				3.40	73.10		Highly weathered fissured red brown very weak to weak SILTSTONE with residual silty clay. (KEUPER MARL : ZONE III) MM-ST
		3.40 - 4.00	B							
		3.75	J							
		4.00	B							
		4.50	J				4.50	72.00		Moderately weathered dark red brown mottled light grey green very weak and weak friable SILTSTONE, thinly bedded with very closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE II) MM-ST
		4.50 - 5.90		100		39				
										completely weathered zone
		5.90 - 7.00		91		0				
										becoming weak
		7.40 - 7.50	C							
		7.50	B							
		7.50 - 7.80	C							
		7.00 - 9.20		100		32				
										moderately weak light grey green SILTSTONE/fine grained sandstone band
										closely spaced discontinuities
		9.60 - 9.72	C							
		9.72 - 9.84	C							
										Continued on next sheet

Remarks

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Rotary Core Log

Borehole No. SK42NE100
Sheet 2 of 2

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447080.00 - 325370.00	Hole Type CP+RC
Location:		Level: 76.50	Scale 1:50
Client: Highways England		Dates: 17/09/1984 - 18/09/1984	Logged By

Well	Water Strikes	Depth (m)	Type / Fl	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m)	Legend	Stratum Description
		9.20 - 11.70 10.96 - 11.07 11.07 - 11.19	 C C	98		76	10.70	65.80		Slightly to moderately weathered moderately weak light grey green mottled dark red brown SILTSTONE with much low amplitude ripple bedding and very closely spaced subhorizontal discontinuities. (KEUPER MARL : ZONE I) MM-ST
		11.70 - 14.35		55		40	13.30	63.20		Slightly to moderately weathered dark red brown mottled light grey green very weak and weak calcareous micaceous SILTSTONE with very closely spaced subhorizontal discontinuities containing some silty clay. (KEUPER MARL : ZONE II) MM-ST
		14.79 - 14.89 14.89 - 15.00	C C							
		14.35 - 17.00 15.86 - 15.97 15.97 - 16.08	 C C	93		36				sticknade surface
		18.60 - 18.80 18.60 - 18.70	C C	100		68				
							20.00	56.50		End of borehole at 20.00 m

Remarks

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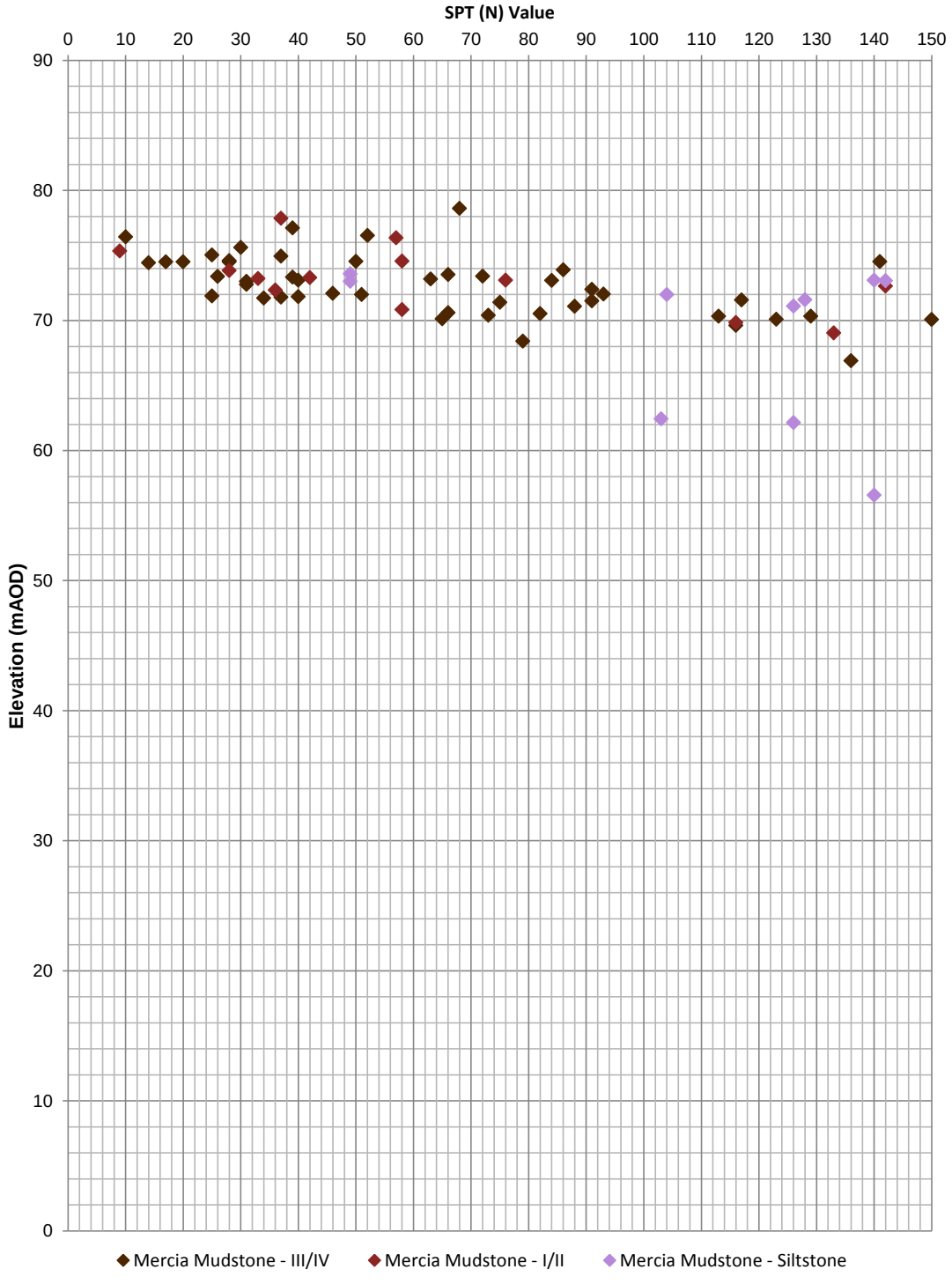
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PLOTS

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SPT N Value vs Depth

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182730-182900SBD**
Client: **Highways England**	Borehole ID: **SK42NE55-57, SK42NE67, SK42NE82-91, SK42NE94-102**	



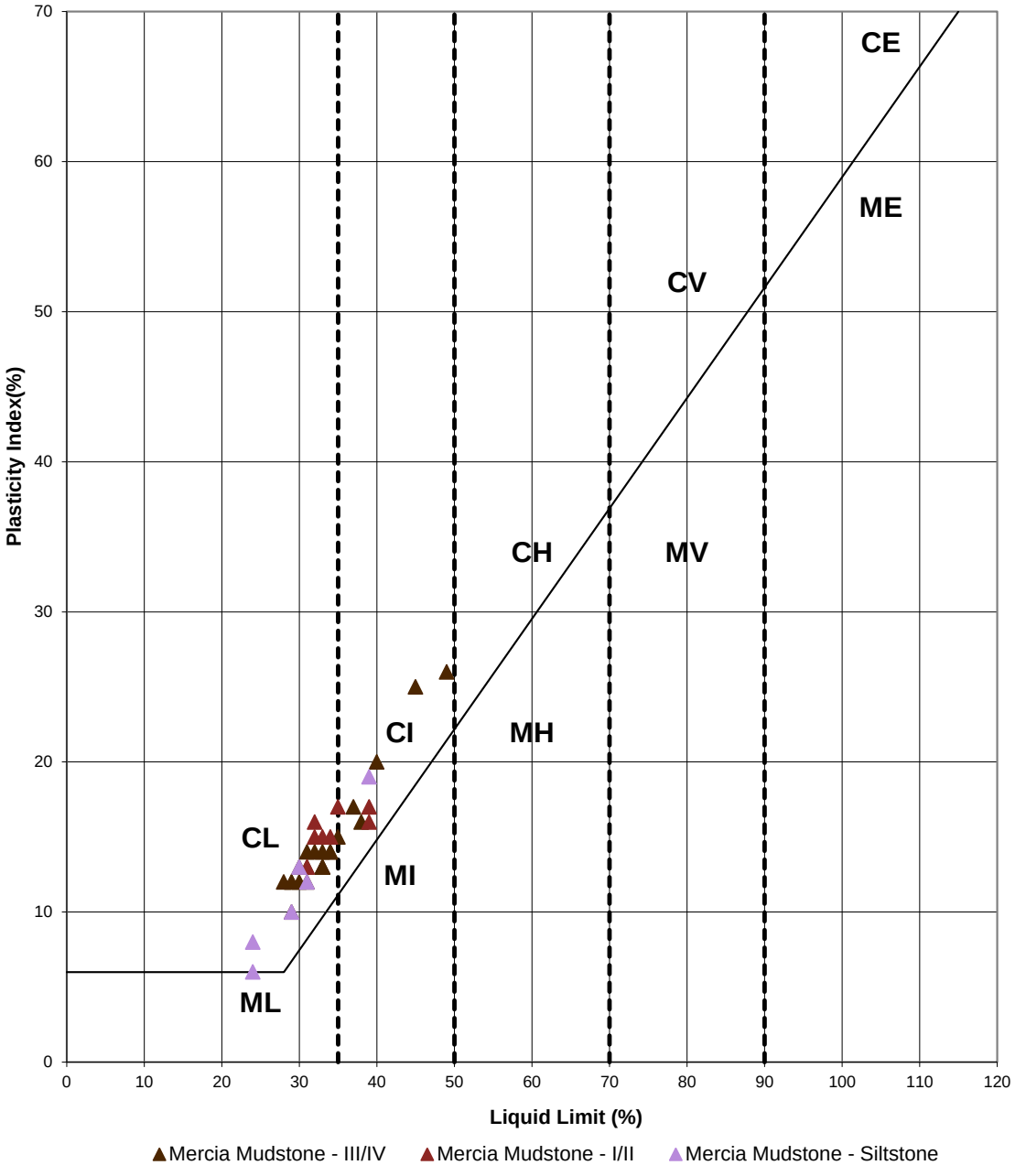
Extrapolated SPT (N) Values >150 have not been shown

Rev: P01 Date: 10/05/2017 Ref: HA549342-AMAR-HGT-182730-182900SBD-GSS-CE-00000 Page 1 of 1

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A Line Plot

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182730-182900SBD**
Client: **Highways England**	Borehole ID: **SK42NE82-91, SK42NE94-102**	



Key

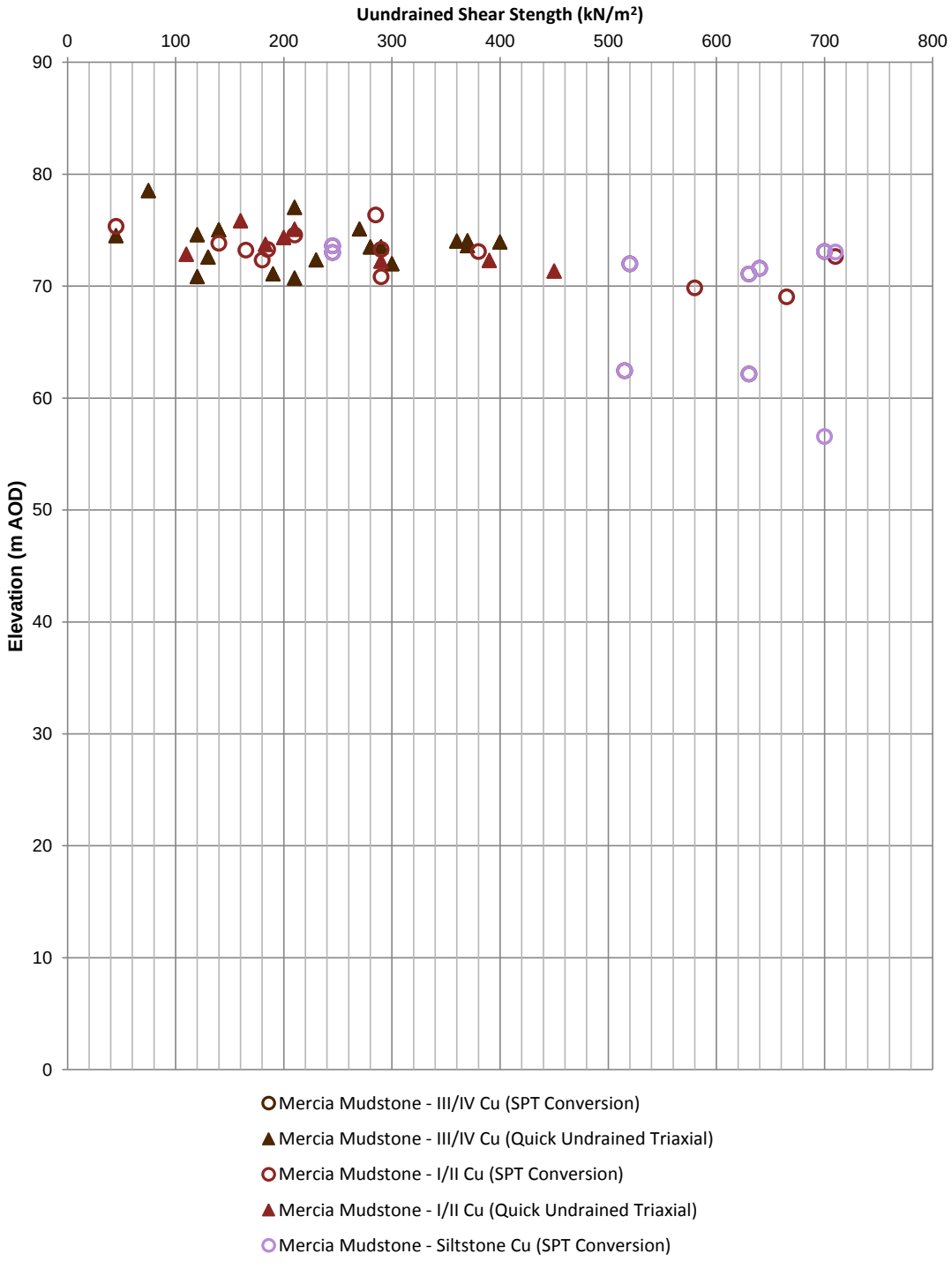
CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

Rev: P01 Date: 10/05/2017 Ref: HA549342-AMAR-HGT-182730-182900SBD-GSS-CE-00000 Page 1 of 1

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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **182730-182900SBD**
Client: **Highways England**	Borehole ID: **SK42NE55-57, SK42NE67, SK42NE82-91, and SK42NE94-102**	



Rev: P01 Date: 10/05/2017 Ref: HA549342-AMAR-HGT-182730-182900SBD-GSS-CE-00000 Page 1 of 1

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Geotechnical Summary Sheet

Job Name	Highways England Smart Motorways Programme: SMP M1 J23a – J25		
HA Pin	549342		
Document Reference	HA549342-AMAR-HGT-184860-185000SB Slip Road-GSS-000001		
Earthworks Widening Solution	King Sheet Pile Retaining Wall		
Design Chainage	184860-185000		
Carriageway	Southbound		
Marker Post	MP184/8B+60 – MP185/0B+00		
National Grid Reference	E 447567, N 327257 – E 447588, N 327388		
Existing Ground Level at Location	Carriageway	44.16mAOD	
	Toe of embankment	39.55mAOD	
Earthwork Type	NB: N/A	SB: Embankment	HAGDMS designation
Earthwork Number	NB: N/A	SB: 7_M1_54219	HAGDMS designation
Earthwork Height	NB: N/A	SB: 4.6m	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Earthwork Angle	NB: N/A	SB: 20°	From Lidar Survey TMM_M1_Jct_24-25_Rev0_20150130
Revision	00		

	Name	**Date**	**Signature**
Author	Roheel Masrat	26/01/2017	[redacted]
Checked	Alice Bazen	08/02/2017	
Reviewed	Gary Summerfield	04/05/2017	
Approved	Tom Bulteel	06/06/2016	

Laboratory and In-Situ testing specifically relate to the relevant borehole(s) associated with this location. Where no local data exists, generalised information for each strata has been taken from the AMAR GIR.

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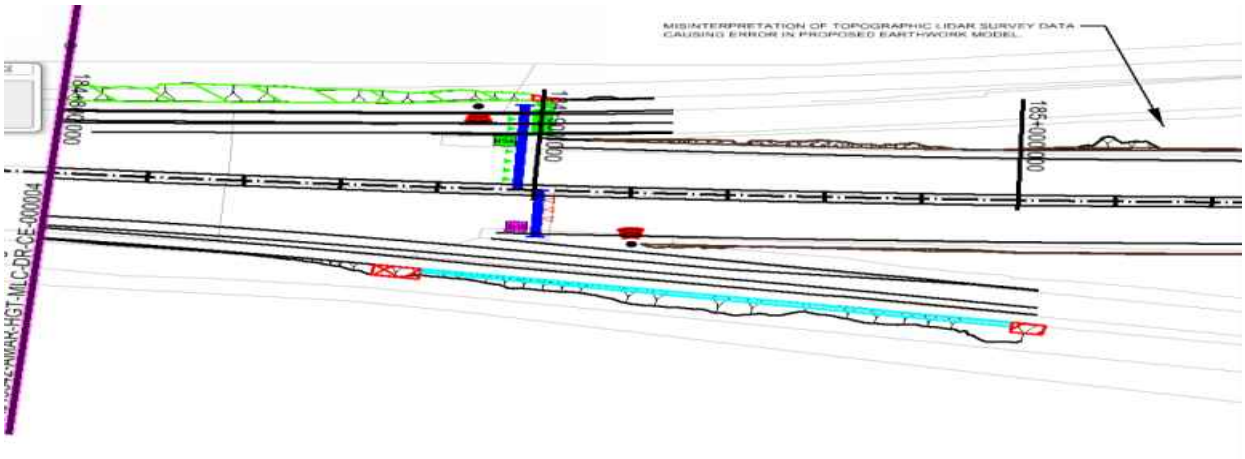


Figure 1: Location Plan

Proposed Widening:

A steel king sheet pile retaining wall has been proposed at J24 On Slip due to verge widening.

Topography:

Topographic information, in the form of a Lidar survey (TMM_M1_Jct24-25_Rev0_20150130), has been supplied to AMAR indicating that the earthwork at the location is classified as an embankment of 1.4-4.6m height and a typical slope angle of 20°.

The maximum embankment height is at ch.184860, however the maximum retained height is at ch. 184950 as a result greater verge widening proposed at this location. As a result, two critical cross sections were used to complete the analysis as shown below:

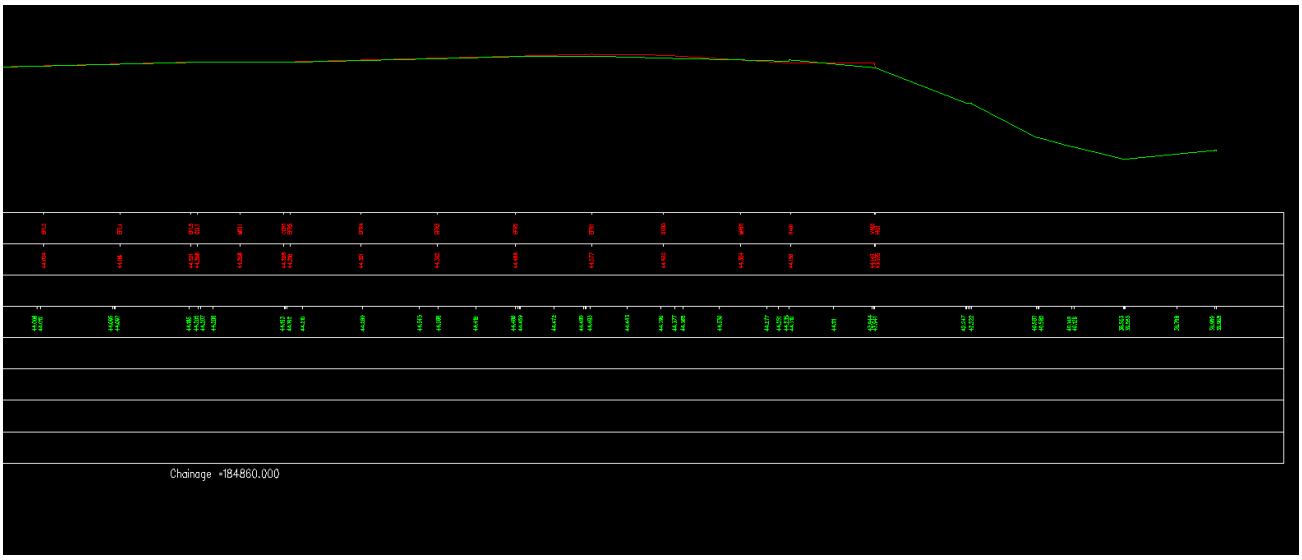


Figure 2: Topographic Critical Cross Section Ch184860

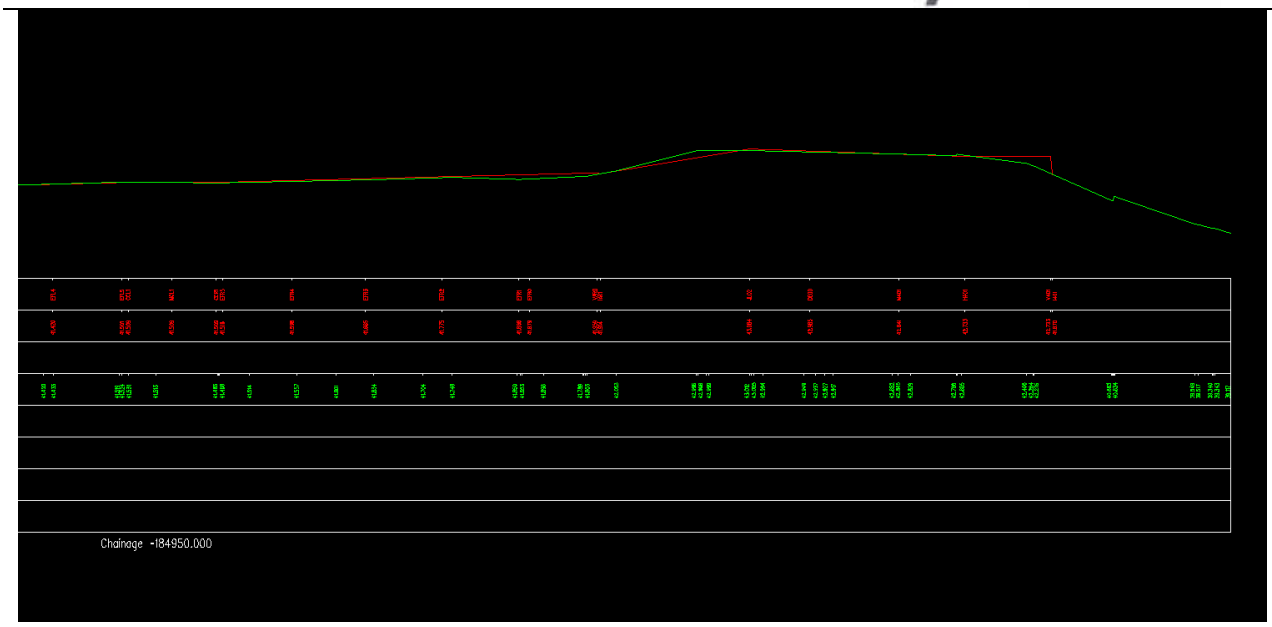


Figure 3: Topographic Critical Cross Section Ch184950

Utilities:

No known utilities present between 184860 and 185000 on the slip road.

Geology:

The British Geological Society (BGS) online Geology of Britain map viewer in conjunction with BGS 1:50 000 Map Sheet 141, Loughborough; indicates that the site is underlain by:

Superficial Deposits: Egginton Common Sand And Gravel Member - Sand And Gravel

Solid Deposits: Edwalton Member (Mercia Mudstone Group)

Ground Investigation:

1 No. historical exploratory hole is located between 184860 and 185000.

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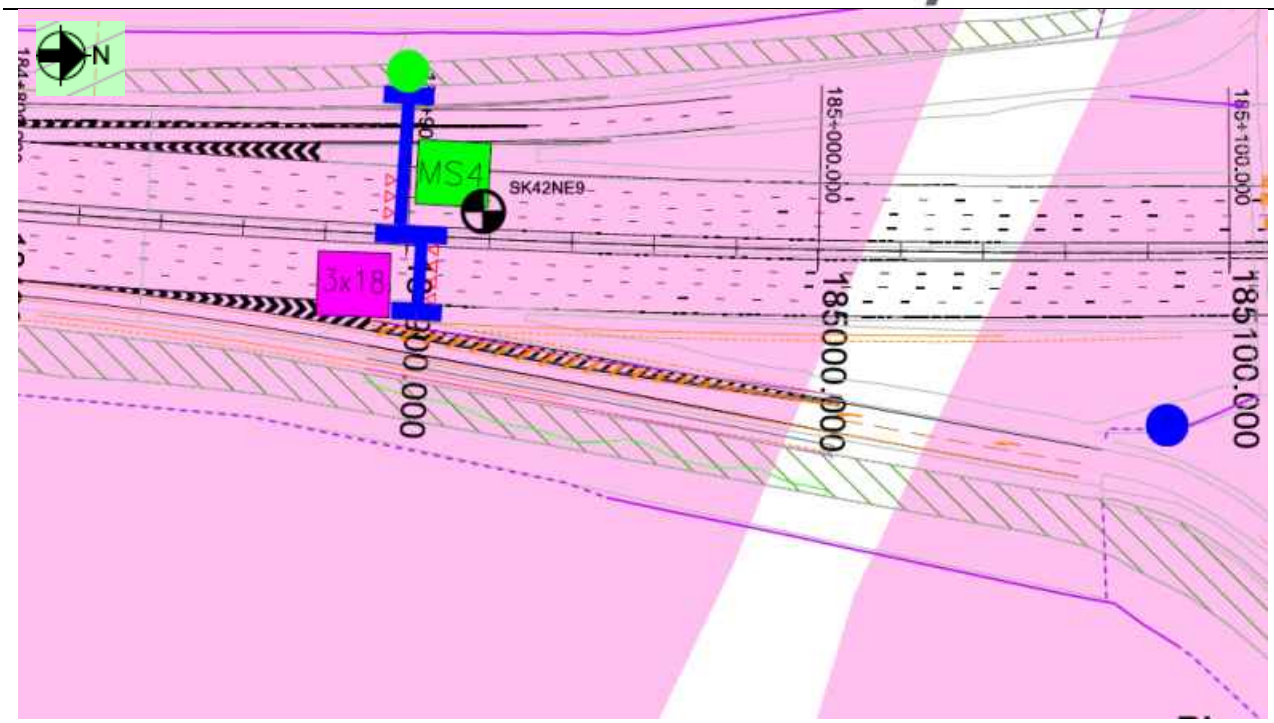


Figure 3: Borehole Location Plan

Flood Risk:

This location is not within a flood risk zone.

Historical Boreholes:

Relevant Borehole Number	SK42NE9
Borehole Chainage	184918
Borehole Location	Northbound
National Grid Reference	E 447530, N 327300
Ground Level at Exploratory Hole	40.10AOD
Date Drilled	16/08/1961 – 17/08/1961
Termination Depth	6.10 metres below ground level (mbgl)
Other suitable holes	None

Existing Ground itions:

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The following ground conditions are assumed based on previous GI data.

Stratum	Depth to Base (mbgl[+])	Depth to Base (mAOD)	SPT 'N' Value Range*
Embankment Fill	6.5	2	-
Mercia Mudstone III/IV <10mbgl	10.00	26.1	-
Mercia Mudstone III/IV >10mbgl	-	-	-

(1) Ground level is assumed to be at carriageway level.
(2) Embankment height will vary per location analysed, therefore the above elevation/depth of embankment fill may vary.
(3) SPT capped at 150. Characteristic 'N' Values are given in brackets.
(4) Given the uncertainties on ground conditions, only Mercia Mudstone –III/IV has been used in the ground model.

In Situ Testing:

Standard Penetration Tests (SPTs) have not been undertaken within the historical exploratory hole..

Groundwater:

Groundwater was encountered within SK42NE9 at 1.07mbgl.

Groundwater Design Level:

A groundwater level of 1.0m below toe of embankment has been assumed for WALLAP analysis for king sheet piles. When checking the global stability check of the earthwork and king sheet pile (analysed using SLOPE W) an Ru value of 0.2 for has been used for all strata.

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GEOTECHNICAL PARAMETERS

Lab Test Data - Geotechnical Testing:

2 No. Atterberg Limit Tests, 3 No. Moisture Content Tests and 2 No. Undrained Triaxial Tests were undertaken within the Mercia Mudstone layer in the historical exploratory hole with the following results:

Stratum	Depth to Top of Test (mbgl)	Natural Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Plasticity Class	C_u (kN/m^2)
Mercia Mudstone	3.05	18	-	-	-	-	-
Mercia Mudstone	3.35	-	36	21	15	CI	110
Mercia Mudstone	4.27	-	39	21	15	CI	93
Mercia Mudstone	4.57	21	-	-	-	-	-
Mercia Mudstone	5.18	26	-	-	-	-	-

Lab Test Data – BRE Classification:

The following chemical testing data was available from the historical exploratory holes:

Stratum	Determinand	Solid/Water	No. of Tests	Result (range)	Unit
Embankment Fill	pH	Solid	1	8.4	-
Embankment Fill	pH	Water	1	8.6	-
Embankment Fill	Sulphate (Total) as SO_4	Solid	1	0.06	%SO4
Embankment Fill	Sulphate (Total) as SO_4	Water	1	0.03	g/l

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Assumed Ground Model For Design:

Ground model based on geological long sections HA549342-AMAR-HGT-SWI-DR-CE-000031 and Section 5 of the GIR HA549342-AMAR-HGT-SWI-RP-CE-000002. The below table outlines the assumed anticipated ground model:

Stratum	Depth (m bgl)	Depth (m AOD)	Thickness (m)	Bulk Density γb (kN/m3)	Friction Angle ϕ' (°)	Cohesion c' (kN/m^2)	Undrained Shear Strength c_u (kN/m^2)	Young's Modulus (MN/m^2)			Poisson's Ratio			BRE Classification
								E_u	E'	E	V_u	v'	v	
Embankment Fill	0.00 – 6.50	44.16 – 37.66	6.50	21	27	0	100	7.8	6.2	-	0.5	0.20	-	DS-2 AC-2
Mercia Mudstone – III/IV (<10mbgl)	6.5 – 10.16	37.66 – 34.00	3.66	21	30	2	100	10.8	8.60	-	0.5	0.2	-	DS-2 AC-2
Mercia Mudstone – III/IV (>10mbgl)	>10.16	<34.00	-	21	30	2	150	16.8	13.4	-	0.5	0.2	-	DS-2 AC-2

(1) This table is to be read in conjunction with the AMAR GIR (2016) and AMAR GDR (2016) and should not be used in isolation. The above parameters are an interpretation of the findings from local historical GI data (where data was available) for the proposed location only.
(2) Due to limited localised GI data, typical values for bulk density, cohesion and Poisson's ratio derived in the AMAR GIR are used.
(3) Due to limited localised data, the geotechnical parameters have been based on average conservative values derived in the AMAR GIR.

Granular material to be allow widening of the verge has been assumed to have the following properties:

Stratum	Bulk Density γb (kN/m^3)	Friction Angle ϕ' (°)	Young's Modulus E' (MN/m^2)	Poisson's Ratio v'
Granular Fill	20	36	20	0.25

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Figure 4: Geological Long Section

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GEOTECHNICAL DESIGN CONCLUSIONS

Proposed Earthwork Widening Solution:

Earthwork regrade was considered at this location, however due to additional land take, this solution was not viable. A retaining wall is recommended as the earthwork widening solution:

Start Chainage	End Chainage	King Section Type	Retained Height (m)	Embedded Depth (m)	Total Pile Length (m)	Maximum Structural Degree of Utilisation (%)	Global Earthwork Stability Maximum Degree of Utilisation (%)	Maximum Deflection (mm)	Maximum Bending Moment (kN.m/m)
184860	184500	AZ-12 S 390 GP	1.0	3.0	4	80	68	11	13

Intermediate king sheet piles to be a pair of AZ-12 770 grade S270 GP steel with a minimum embedment depth of 1.0m below ground level.

Corrosion of the king and intermediate sheet pile has been considered and the specified section and steel grade is deemed adequate having sufficient thickness for a 120 year design life.

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FURTHER GROUND INVESTIGATION

Additional GI for this location will be undertaken to confirm ground conditions. The following is scheduled:

- T-CCD-12 – 184931 on SB on Slip up to a maximum depth of 5mbgl.

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HISTORICAL EXPLORATORY HOLES

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Borehole Log

Borehole No.
SK42NE9
HISTORIC
Sheet 1 of 1

Project Name: SMP - M1 J23A TO J25	Project No. COCDFL1SMP01	Co-ords: 447530.00 - 327300.00	Hole Type CP
Location:		Level: 40.10mbgl	Scale 1:50
Client: Highways England		Dates: 16/08/1961 - 17/08/1961	Logged By

Well	Water Strikes	Samples and In Situ Testing				Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results	Information				
		0.30	587D			0.30	39.80		Topsoil TP
		0.61	588D						Silty soil & stones ALV
	▼	1.07	SPT (S)	0 (0 for 0mm/0 for 0mm)	Water=-	0.91	39.19		Brown clayey sand and stones RTD1
		1.52	589D						
						2.44	37.66		Stiff red & grey silty clay & siltstone MM-Z4
		3.05	591D						
		3.35 - 3.45	592U	200blows					
		4.27 - 4.57	593U	220blows					
		4.57	594D						
		5.18 - 5.41	595U	200blows					
		6.10	596D			6.10	34.00		End of borehole at 6.10 m

1 2 3 4 5 6 7 8 9 10

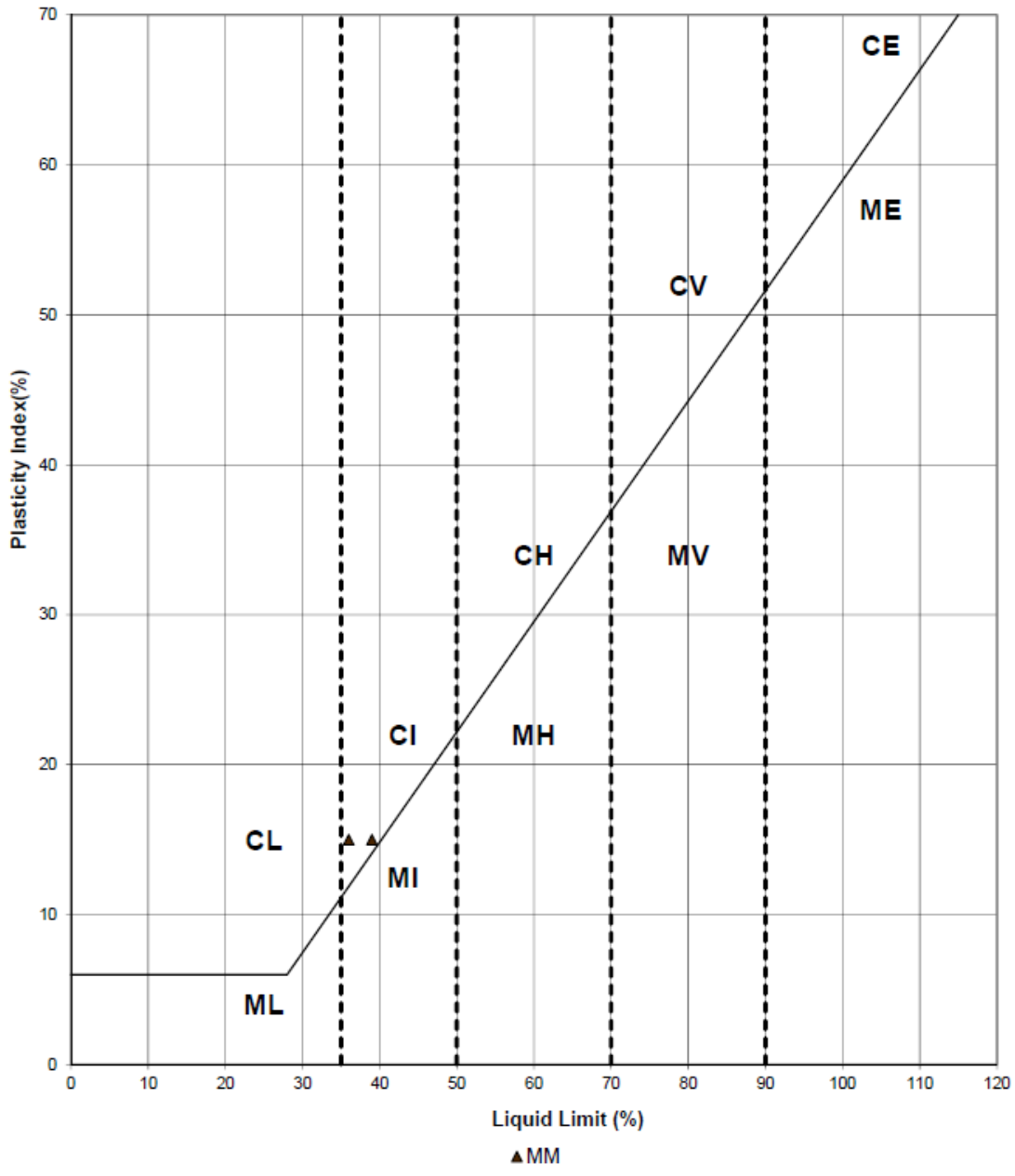
Remarks

AGS

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PLOTS

amey ARUP	A Line Plot	
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184860-185000 SB Slip Road**
Client: **Highways England**	Borehole ID: **SK42NE9**	



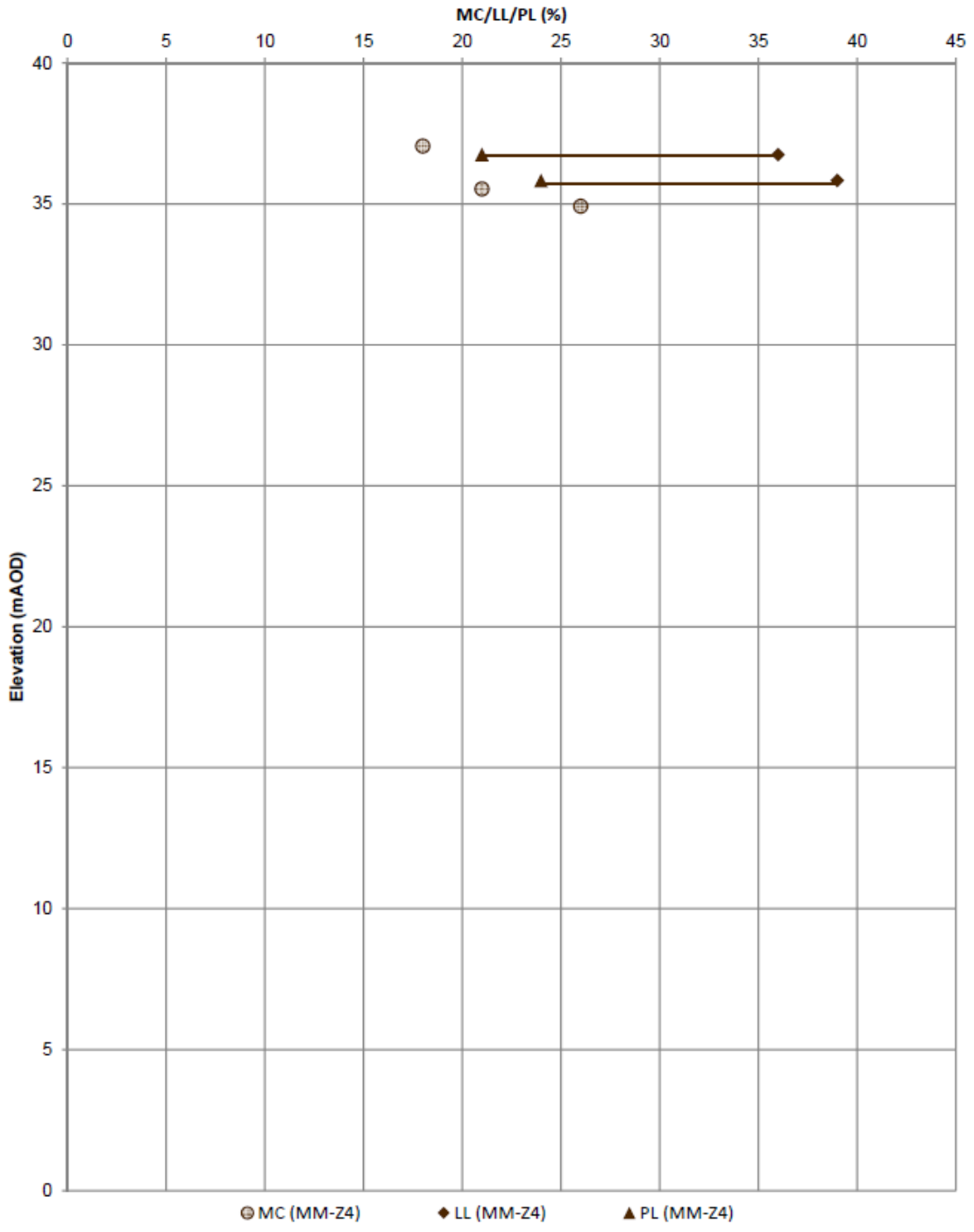
Key

CL - Clay_Low Plasticity	ML - Silt_Low Plasticity
CI - Clay_Intermediate Plasticity	MI - Silt_Intermediate Plasticity
CH - Clay_High Plasticity	MH - Silt_High Plasticity
CV - Clay_Very High Plasticity	MV - Silt_Very High Plasticity
CE - Clay_ Extremely High Plasticity	ME - Silt_Extremely High Plasticity

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Moisture Content/Atterberg Limits

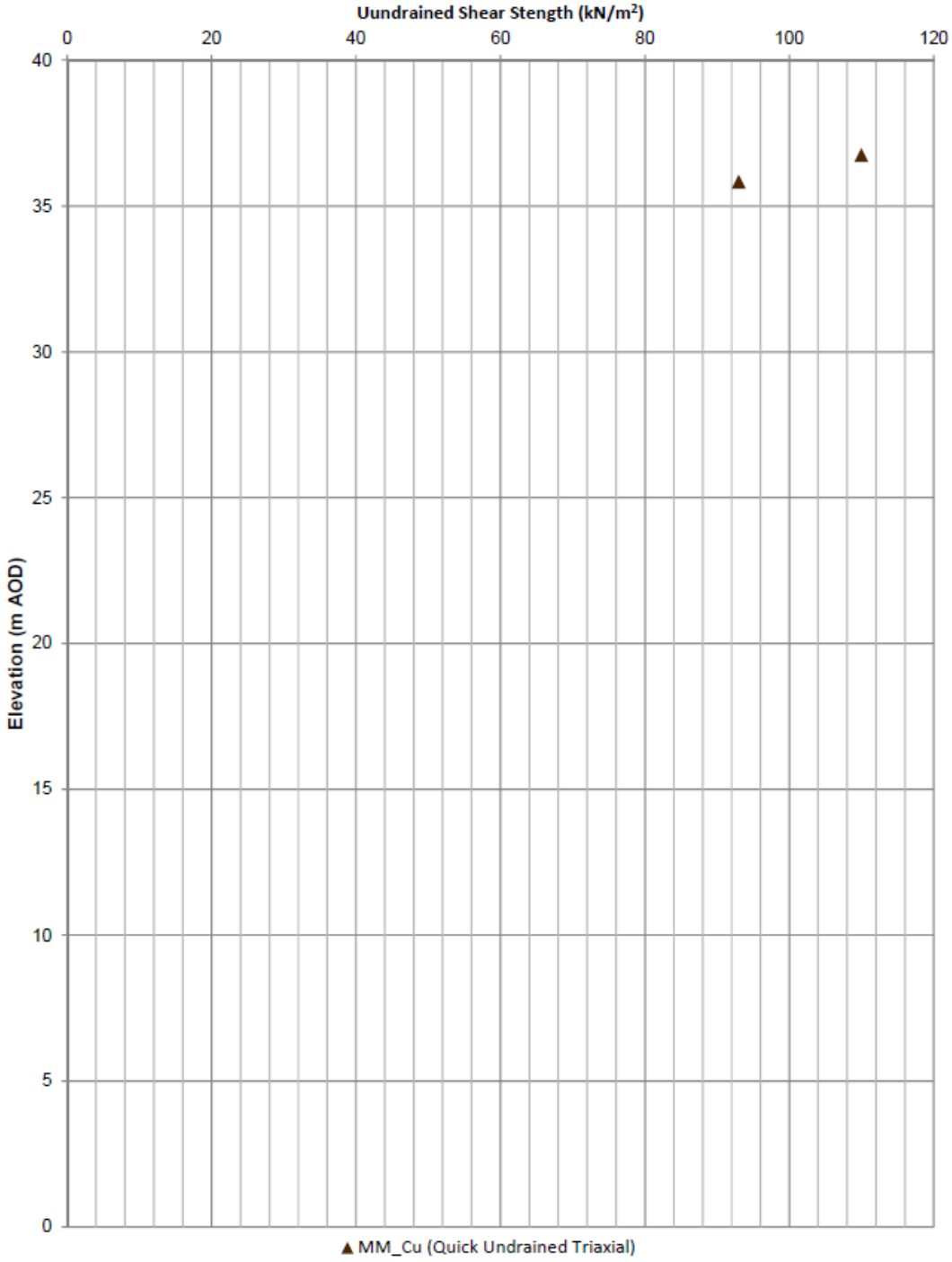
Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184860-185000 SB On Slip**
Client: **Highways England**	Borehole ID: **SK42NE9**	



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Undrained Shear Strength vs Elevation

Project ID: **HA549342**	Project Title: **SMP - M1 J23A TO J25**	Data Sheet: **184860-185000 SB Slip Road**
Client: **Highways England**	Borehole ID: **SK42NE9**	



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Appendix B. ‘Just in Time’ Validation Ground Investigation Specification

highways england

amey ARUP

06 Product Development & Production

Preconstruction and Construction services

Smart Motorways Programme

M1 Junction 23a to 25

Addendum to Specification Appendix 1/5 – Validation Ground Investigation Specification

HA549342-AMAR-HGT-SWI-SP-CE-000005

June 2017

Notice

This document and its contents have been prepared and are intended solely for Highways England's information and use in relation to the Smart Motorways Programme.

Document history

Amey Arup assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

Revision history

Job number: 244508/COCDFL1SMP01			**Document ref: HA549342-AMAR-HGT-SWI-SP-CE-000005**			
Revision	Purpose description	Originated	Checked	Reviewed	Approved	Date
P01	DF4 For Pricing	RM	SA	SG	TB	01/07/2016
P02	DF5	SA	AB	GS	TB	23/12/2016
P03	Post DF5	SA	AB	GS	TB	07/02/2017
P04	Revise GI scope	SB	AB	GS	TB	05/04/2017
P05	Construction issue	SB	AB	GS	TB	18/04/2017
P06	Revised Construction Issue	SA	SB	GS	TB	04/05/2017
P07	Revised Construction Issue	SA	SB	AB	LP	Internal issue only
P08	Revised Construction Issue	SA	SB	AB	LP	06/06/2017

Document control

Client	Highways England
Project	SMP M1 Junction 23a to 25 PIN No 549342
Document title	Addendum to Specification Appendix 1/5 – Validation Ground Investigation Specification
Job no.	244508/COCDFL1SMP01
Document reference	Report Ref. HA549342-AMAR-HGT-SWI-SP-CE-000005

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Preamble

The Specification referred to in this document shall be the “UK Specification for Ground Investigation” (Second Edition, 2012), published by ICE (Institute of Civil Engineers) Publishing, modified and extended by any Amended, Additional or Cancelled Clause or Table listed in Schedules 4 and 5.

An Amended Clause as indicated by the suffix "M" is a modification originating from the Overseeing Organisation. An Amended Clause suffixed "MR" is a Regional or scheme specific modification.

Any Additional Clause supplementing the Specification with a suffix "A" originates from the Overseeing Organisation. A Clause with suffix "AR" is a Regional or scheme specific addition.

A Cancelled Clause is indicated by the suffix "C" or "CR" and is a Clause entirely deleted from the Specification either by the Overseeing Department or a scheme specific cancellation respectively.

Insofar as any of the numbered Appendices, Additional or Amended Clauses may conflict or be inconsistent with any provision of the specification for Ground Investigation, then the numbered Appendices, Additional or Amended Clauses shall always prevail.

Any references in the Contract to a Clause number or Appendix shall be deemed to refer to any amended version of that Clause or Appendix as listed in Schedules 4 and 5.

Reference to Clauses shall apply equally to Tables. Where a Clause is amended, any Tables referred to in the original Clause shall apply unless the Table is also amended. When a Table is amended any reference in a Clause to the original table shall apply to the amended Table.

Any Clauses or Appendices in the Specification which relates to work or materials not required for the Investigation shall be deemed not to apply.

Any Appendices or Schedules referred to in the Specification which are not used shall be deemed not to apply.

1. Schedule 1 - Information

1.1. Name of Contract

Smart Motorways Programme (SMP) M1 Junction 23a to Junction 25.

1.2. Investigation Supervisor

Amey Arup (AMAR) will fulfil the role of Principal Designer and will be the Ground Investigation Supervisor.

The Principal Contractor shall be responsible for procurement and planning of the Ground Investigation (GI) in accordance with this Specification. The Principal Contractor shall define the Conditions of Contract, however it shall be assumed to be the NEC3 Engineering and Construction Contract (2005), Option B and Option W1 unless otherwise confirmed.

1.3. Description of Site

The Site stretches from M1 Junction 23a (The South West, Tamworth and Birmingham A42 (M42)) to Junction 25 (Nottingham South, Derby A52), Northbound and Southbound.

1.4. Main Works Proposed and Purpose of This Contract

This document details the specification for Validation ("Just in Time") GI for the above Contract. This Specification has been provided by AMAR (the Principal Designer/GI Supervisor) to the Principal Contractor for the purposes of pricing.

The proposed SMP scheme for M1 Junctions 23a to 25 includes the following elements:

- Smart Motorway infrastructure to enable hard shoulder running;
- Emergency Refuge Areas (ERAs);
- Lane specific signals and gateway gantries;
- Rigid concrete barrier in central reserve;
- Lighting;
- Pavement and drainage renewals;
- Environmental barrier; and
- Tie-in to development of the proposed strategic rail freight terminal between Junctions 24 and 24a.

This GI Specification describes the Validation ("Just in Time") GI required at proposed gantry and ERA locations to validate the ground conditions utilised in design, where necessary.

It is anticipated that the works will comprise the following:

- Setting out of exploratory hole locations;
- Excavation of hand dug service inspection pits for service location prior to commencement of all exploratory holes;
- 50 No. dynamic sampling boreholes with rotary follow on using a multi-purpose rig to specified depths;
- 4 No. dynamic sampling boreholes with rotary follow on using a slope climbing rig to specified depths;
- 6 No. Cone Penetration Testing (CPT) holes to specified depths;
- 6 No. Thermal Resistivity/Conductivity test at specified depths;
- In-situ Standard Penetration Tests and hand shear vane tests where suitable;
- Recovery of Class 1 to Class 5 soil samples and samples for chemical analysis from exploratory holes;
- Recovery of core samples where rotary drilling undertaken;
- Backfilling of exploratory holes upon completion;

- Controlled storage of soil and groundwater samples recovered during fieldworks prior to transportation to laboratory facilities;
- Laboratory testing of soil samples and water samples;
- Surveying of levels and co-ordinates of all exploratory holes; and
- Production of a Factual Report in accordance with BS EN 1997-1:2004+A1:2013 and BS EN 1997-2:2007.

1.5. Scope and Objectives of the Contract

The purpose of this Validation GI is:

- To verify the ground conditions assumed in geotechnical design, including the ground model and soil parameters.
- To identify contamination and ground chemistry of the underlying soils with particular attention to geotechnical engineering constraints and waste disposal.

The GI shall be programmed to be undertaken at each location in sufficient time to allow for undertaking the investigation works, production of exploratory hole logs, completion of necessary geo-environmental testing and validation of design (if necessary) prior to construction works. An indicative programme is provided in Schedule 1.8.

1.6. Geology and Ground Conditions

Large extents of the Site are situated on significant height embankments; the geology noted below is from the base of embankments. For the majority, Embankment Fill comprises re-worked Mercia Mudstone.

The British Geological Survey (BGS) records that the Site lies within an area where predominately coarse grained Glaciofluvial Deposits are likely to be encountered at ground level, especially between Junctions 24 and 25. Fine grained deposits in the form of Head and Alluvium are also present in close proximity to some surface water features Site. BGS records show the Superficial Deposits to be underlain by mudstones, siltstones and sandstones of the Mercia Mudstone Group of varying formations.

1.7. Schedule of Drawings

The location of the Site and a proposed exploratory plan are included as Appendix A. Utilities drawings are included in Appendix B.

1.8. General Requirements

Times for completion are set out below:

Description of Work	Time For Completion from Start Date
Section 1 (Site works: exploratory holes, their associated in-situ testing and submission of drillers records, topographic survey)	**TBC**
Section 2 Preliminary exploratory hole logs and in-situ testing data (logs should include both Engineer's logs and driller's logs)	**MUST** be issued to the Designer up to 48hours after completion of exploratory hole.

Description of Work	Time For Completion from Start Date
Section 3 Preliminary laboratory test data	**MUST** be issued to the Designer up to 2 Weeks after completion of exploratory hole
Section 4 Submission of final exploratory hole data and lab data as a Factual Report complete with AGS format data	**MUST** be issued to the Designer up to 4 Weeks after completion of GI.

The method of measurement for the works is the Method of Measurement for GI for Highway Works, (MCHW5.3, August 1997), published by the Stationery Office Ltd.

Notwithstanding depths of exploratory holes shown in Schedule 2, no exploratory hole shall be commenced, terminated or backfilled without the agreement of the AMAR Supervising Engineer.

All personnel working on the Highway infrastructure shall have an up to date Personal Highway Safety (PHS) and/or Construction Skills Certification Scheme (CSCS) competence and have undertaken the Principal Contractor site induction.

Lubricants used on equipment are to be vegetable based. Equipment shall be degreased as necessary before use on Site and between holes.

Geotechnical testing to be carried out by UKAS accredited laboratories. Environmental testing to be carried out by a laboratory possessing UKAS approval for all analytical methods specified in the Contract. Documentation must be supplied with the Tender.

Works are to be undertaken within Traffic Management (TM) provided by the Principal Contractor.

1.8.1. Quality Management System

Works shall be carried out in accordance with the requirements of BS EN 1997 Eurocode 7: Geotechnical Design parts 1:2004+A1:2013 and 2:2007, as well as EN ISO 22475 Geotechnical investigation and testing Part 1:2006 and the other supporting standards.

The Contractor shall submit to the Engineer for approval all detailed method statements including statements that the appropriate sample classes can be achieved..

1.8.2. Professional Attendance

Copies of the British Drillers Association (BDA) and CAT and GENE Certificates of Competence for each driller on Site shall be provided to the AMAR Engineer prior to commencement of Siteworks. All other Site operatives shall be able to demonstrate having achieved the required level of competence for operating plant and equipment. In addition, evidence of current appropriate health and safety training shall be provided with the tender.

The GI Contractor will provide full-time engineering supervision of the Site works. The Engineer or Engineering Geologist specified by Clause 3.12.1 shall possess at least 3 years post graduate experience supervising GI works. They will have a degree in Civil Engineering, Engineering Geology or Geology, and have adequate knowledge and experience of the technical direction and output required for the Site Operations. This Engineer or Engineering Geologist may be the person appointed to the Site by the Contractors agent or representative under the Conditions of Contract, or he may supplement that person should that person not have the preceding technical experience.

The description of soils and logging of continuous samples shall be carried out by an Engineer or Engineering Geologist with at least 3 years post graduate experience in the examination and logging of soils in accordance with BS EN 1997-2:2007, BS 5930:2015 and BS EN ISO 14688-1:2002+A1:2013. That person shall have an appropriate degree.

The Contractor should supply CV's of proposed technical staff for the works.

There is no requirement in the Contract for interpretative or advisory services.

1.8.3. Provision of Ground Practitioners and Other Personnel

The Contractor is to prepare a full factual Ground Investigation Report (GIR) in accordance with the requirements of Eurocode 7 following the GI works. Exploratory hole logs are to be provided throughout the GI programme as stipulated in Schedule 1.8. The Contractor's expected staff times for report compilation, preparation and checking are to be charged for based on Annex A. The Contractor is required to complete the Bill of Quantities in Appendix A.

No other personnel (Clauses 3.6.2 of the Specification) are to be provided by the Contractor.

1.8.4. Hazardous Ground, Land affected by Contamination and Notifiable and Invasive Weeds

There are no known notifiable or invasive weeds at this time.

1.8.5. Additional Information on Services Not Shown on Contract Drawings

Existing service plans are included in Appendix B.

The Contractor shall review all services information provided, (including overhead and buried utilities) prior to the start of the works to identify exploratory hole locations that are remote from services.

A services inspection pit shall be excavated by the Contractor for all exploratory holes.

1.8.6. Known/Suspected Mine Workings/Mineral Extractions

None.

1.8.7. Protected Species

An Ecologist is to be on Site to monitor any vegetation clearance required.

1.8.8. Archaeological Remains

N/A.

1.8.9. Security of Site

Works will be undertaken under TM, provided by the Principal Contractor. When not in the use all drilling equipment must be stored in the designated Site areas or left securely fenced off using Herras Fencing. No machinery or equipment is to be left on the Site after completion of a shift when TM is not in use.

All holes, excavations, machines and equipment shall be supervised at all times by suitably experienced and qualified personnel and the Site kept tidy. All plant shall be operated by suitably experienced and certified/qualified personnel.

The Contractor is responsible for the security of all plant, personnel and compounds. The Contractor must secure the working areas during the entirety of the works, both during the day and at the end of each working day. The Site must be restored and secured like-for-like on completion of the contract.

The storage of exploratory hole equipment, containers etc. is to be arranged by the Contractor.

1.8.10. Traffic Management Measures

Works are planned adjacent to a live Motorway; therefore TM system is required. The TM will be provided by the Principal Contractor. The Contractor shall be inducted into the Principal Contractors safe systems of work and will be assumed to have allowed for induction time in their Tender.

All Contractors' personnel are required to wear EN ISO 20471:2013 Class 3 compliant PPE in accordance with; both the Principal Contractors Site rules and specification set out by Highways England; at all times while engaged on works, or visiting Site.

The Contractor will furnish the Principal Contractor with a method statement and risk assessment at least 2 weeks prior to the commencement of works. The Contractor must hold a copy of these documents on Site at all times. The method statement and risk assessment will be signed by the Contractors' personnel to confirm familiarity.

1.8.11. Restricted Working Hours

To be confirmed by the Principal Contractor. However night-time working is expected.

1.8.12. Trainee Site Operatives

The Contractor shall ensure that any trainee operatives on site are supervised by an appropriately qualified and experienced operative.

1.8.13. Contamination Avoidance and/or Aquifer Protection Measures Required

GI on potentially contaminated land requires special measures and provisions with respect to health and safety, drilling techniques and environmental protection.

The Contractor shall provide appropriate PPE. Method statements shall be submitted to AMAR for approval 10 working days prior to commencement of works. Method statements are to include COSHH assessments of materials that may be used by the Contractor. Excess arisings may require waste disposal to a licensed facility and a duty of care must be adopted by the Contractor.

1.8.14. Maximum Period of Boring, Pitting or Trenching Through Hard Material, Hard Stratum or Obstruction

Dynamic sampling boreholes are scheduled for rotary follow on (where required). Upon encountering bedrock the AMAR Engineer should be immediately contacted.

1.8.15. Reinstatement Requirements

The Contractor shall backfill all exploratory holes using a 1:1 cement/bentonite grout mix. Reinstate surface using cold laid tarmac to previous condition with smooth finish in accordance with the New Roads and Streetworks Act and the Specification for the Reinstatement of Openings in Highways.

The Site shall be left clean and tidy on completion of the works. On completion of each exploratory hole, the reinstated surface shall be to the approval of the AMAR Supervising Engineer.

1.8.16. Hygiene Facilities Required

The Contractor is to provide a HSE compliant welfare van for works.

1.8.17. Unavoidable Damage to be Reinstated by Contractor

N/A.

1.8.18. Accuracy of Exploratory Holes Locations

The location of each exploratory hole shall be as shown on the Exploratory Hole Location Plan and as per Schedule 2. Before any excavation of an exploratory hole commences, the AMAR Engineer shall agree the position of the hole.

The Contractor shall be responsible for setting out the exploratory holes to an accuracy of 0.5m in plan. The locations and ground levels at each exploratory hole location shall be recorded in relation to the Ordnance Survey National Grid and Ordnance Datum. Ground levels at exploratory holes shall be recorded to 50mm accuracy.

1.8.19. Photography Requirements

Sufficient photographs to show the condition of the Site prior to the start of works and an analogous set of photographs on completion.

Photographs shall be taken digitally with a camera of sufficient resolution and provided on a CD-ROM, fully annotated and labelled.

Photographs shall be taken of all dynamic sample liners recovered and all core samples prior to sub-sampling. Photographs shall include a photo board containing as a minimum: the exploratory hole ID, date of completion, job name and number, depth reached and a colour chart.

1.9. Particular Borehole Requirement

50 No. exploratory holes have been scheduled for this investigation, utilising a dynamic sampling/rotary multi-purpose rig; an additional 4 No. exploratory holes are situated on slopes, as such a suitable drilling rig/method should be employed. It is envisaged that 6 No. additional exploratory holes will be undertaken using CPT.

Where specified, the drilling rig shall be capable of Sampling Category A and Sampling Category B in accordance with EN 1997-2:2007 and EN ISO 22475-1:2006, to recover Class 1 to Class 3 quality samples.

The minimum diameter of borings or internal diameter of casing shall be suitable to enable the full scheduled depth of each hole to be achieved. Where borings are of such depth that the advancement of a casing becomes impracticable or where hard strata and obstructions are likely to be met, the Contractor shall bore or provide casings of sufficient diameter to complete the work.

Exploratory hole diameter shall be sufficient to facilitate full core recovery from rotary boreholes.

The Contractor shall be responsible for selecting the appropriate diameter casing at the start of boring/drilling to account for any necessary reduction in casing size to achieve the minimum diameter required at the base of the exploratory hole.

1.9.1. Permitted Methods and Restrictions

The Contractor will be responsible for choosing an appropriate casing to ensure that the exploratory hole can be progressed via rotary coring methods following completion of dynamic sampling where specified.

In reference to encountering obstructions or hard stratum, not including bedrock, the Contractor shall employ chiselling techniques for a period of up to 1 hour. Should this not penetrate the stratum or obstruction the

Contractor shall inform the AMAR Engineer who will instruct subsequent action, which may include further chiselling or switching to rotary cored follow-on techniques.

4 No. Boreholes are scheduled to be advanced using a suitable slope climbing rig in areas of cutting.

1.9.2. Backfilling

Exploratory holes shall be backfilled with a 1:1 bentonite/cement grout fill.

1.9.3. Dynamic Sampling

In the interest of cost saving and reducing the amount of equipment mobilised to Site a multi-purpose dynamic sample/rotary coring rig may be employed.

Windowless liner techniques must be employed.

One photograph of the undisturbed complete sets of window samples for each exploratory hole are required prior to splitting for logging and sub-sampling. This should have a borehole identifier board and scale present.

Concrete coring will be required to allow removal of a 250mm minimum diameter plug of pavement material, if necessary, to allow advancement of the services inspection pit and the borehole.

1.10. Rotary Drilling

1.10.1. Augering Requirements and Restrictions

N/A.

1.10.2. Particular Rotary Drilling Techniques

The Contractor shall carry out rotary core drilling following on from the 50 No. dynamic sampled boreholes on the instruction of AMAR and as defined in Schedule 2. The Contractor may choose to re-drill that depth of a borehole previously achieved by dynamic sampling using open hole rotary techniques before switching to rotary core drilling if a time, cost or safety benefit can be demonstrated to AMAR in doing so. The Contractor shall notify the AMAR Engineer immediately of any obstruction encountered. 4 No. rotary cored boreholes will need to be advanced using a suitable slope climbing rig.

The method of rotary core drilling selected by the Contractor shall ensure that a minimum core recovery of 90% can be achieved. In the case where less than 90% core recovery arises, the Contractor shall take immediate and appropriate action to re-establish 90% core recovery. If the prevailing conditions are such that 90% core recovery cannot be achieved, the Contractor shall notify the Engineer immediately.

All cores shall be stored in secure boxes for storage and transport. A continuous engineering log and photographic record shall be provided of all core samples. The photographs will be in accordance with the specifications stated in Section 1.8.19. All cores shall be transported to the Contractors premises and stored in a protected, secure, dry storage space for a minimum period of 3 months and a maximum of 6 months, after completion of the final Factual Report.

The cores shall be stored in such a way that all cores shall be easily accessible for viewing. No boxed core shall exceed 1.5m in length.

Provision for large diameter rotary coring of hardstanding/road surfaces should be allowed for to enable the initial excavation of inspection pits at locations specified.

It is anticipated that traffic management will be removed from site at the end of each shift, as such all recovered geotechnical/geochemical samples should be removed from site at eh end of each shift and transported to the GI contractors depot/laboratory ready for scheduling.

1.10.3. Drilling Fluid Type and Collection

Air mist / recirculated water flush.

Water shall not be used to assist the advance of the borehole above the water table unless approved by the AMAR Engineer. Where drilling takes place below the water table a positive head of water shall be maintained to prevent disturbance of soils during drilling operations. The Contractor is responsible for monitoring and recording the volume of any water added to assist drilling.

Where artesian water is encountered in a borehole, AMAR's Engineer shall be immediately advised and an attempt to contain the artesian head by extending the casing shall be made. Where the artesian head exceeds the extended casing the borehole shall be capped and a pressure gauge and bypass to measure the pressure head of the artesian water fitted. On completion the exploratory hole shall be grouted.

1.10.4. Rotary Core Drilling Equipment and Core Diameter

Refer to 1.10.2 and Clauses 5.4.1 and 5.4.2.

1.10.5. Core Logging

The description of soils and logging of continuous samples shall be carried out by an Engineer or Engineering Geologist with at least 3 years post graduate experience in the examination and logging of soils in accordance with BS EN 1997-2:2007, BS 5930:2015 and BS EN ISO 14688-1:2002. That person shall have an appropriate degree.

1.10.6. Core Sub-Samples for Laboratory Testing

See 1.13.

1.10.7. Address for Delivery of Selected Cores

Sample storage and transportation shall be in accordance with BS EN ISO 22475-1:2006.

1.10.8. Rotary Open-Hole Drilling General Requirements

Rotary open hole drilling may be used where an adjacent dynamic sampling hole has been undertaken.

It is anticipated however that rotary holes will follow on form the base of the dynamic sampling therefore open hole drilling is not anticipated.

1.10.9. Rotary Open-Hole Drilling for Locating Mineral Seams, Mine Workings etc.

N/A.

1.10.10. Open-Hole Resonance (Sonic) Drilling

N/A.

1.10.11. Resonance (Sonic) Drilling with Sampling or Continuous Coring

N/A.

1.10.12. Backfilling

The Contractor shall backfill all the boreholes not intended for installation using a cement/bentonite grout mix of equal weight proportions in accordance to clause 2602 of the Specification of Highway Works (except where installations are required – in this case the AMAR Engineer will provide details on Site).

Boreholes that are positioned on the highway shall be reinstated to the condition prior to the investigation with a smoothed tarmacadam surface with no defects apparent in accordance with the New Roads and Steelworks Act (1992) and the Specification for the Reinstatement of Openings in Highways (2006).

The Site shall be left in clean and tidy conditions on completion of the works. All reinstatement shall be to the satisfaction of the AMAR Engineer.

1.10.13. Core Photographic Requirements

All extracted material will be photographed both prior to destructive logging/sub-sampling

As specified, except that prior to photography, labelling of the core is to be added to show where it has or may have been affected by SPT's. All sub-specimen locations are to be identified by spacers with clear labelling of the depth range and sub-sample number.

1.11. Pitting and Trenching

1.11.1. Indirect Detection of Buried Services and Inspection Pits

The Contractor shall satisfy himself as to the position of publicly and privately owned services or supplies affected by the investigation through STATS plans provided by AMAR and/or the Principal Contractor. Prior to any excavation the Contractor will carry out a CAT and GENE scan at each location. When the operator is satisfied that the location is clear of any services a hand dug inspection pit will be excavated to a depth of 1.20m bgl or natural ground level whichever is the shallower. The base of the inspection pit shall have a minimum base area of 0.2m by 0.2m. When the inspection pit is complete the base of the pit shall be scanned again to confirm that no services are present prior to drilling or further excavation.

The Contractor will operate under their own 'permit to dig' system. A copy of each completed 'permit to dig' shall be provided to the AMAR Engineer within 48 hours of mobilising for investigation.

The Contractor shall, during the progress of the works, take all measures required by the management of other publicly or privately owned services or supplies

1.11.2. Restrictions on Plant or Pitting/Trenching Methods

Hand tools are to be used for the excavation of inspection pits and to comply with the method of excavation described in Clause 6.2.

1.11.3. Entry of Personnel

N/A.

1.11.4. Alternative Pit and Trench Dimensions

N/A.

1.11.5. Abstracted Groundwater from Land Affected by Contamination

N/A.

1.11.6. Backfilling

All inspection pits are to be backfilled with compacted arisings.

1.11.7. Photographic Requirements

Colour photographs of each pit to be taken with a colour board indicating Site, date, exploratory hole and depth.

1.11.8. Artificial Lighting

Lighting is to be supplied by the Contractor for use during night shift works..

1.11.9. Provision of Pitting Equipment and Crew for Investigation Supervisor's Use

N/A.

1.12. Sampling and Monitoring During Intrusive Investigation

All samples taken from exploratory holes shall, at the end of each shift, be stored in a suitable environment to preserve the original moisture and physical conditions as in-situ, and protected from excessive heat or freezing conditions. Samples for chemical analysis shall also be stored in appropriate refrigerated conditions or collected from Site by courier on a daily basis.

All samples shall be removed from Site so as to reach the laboratory within 48hours for chemical analysis and 48hours for geotechnical testing.

Long-term storage conditions are to be in accordance with the applicable guidance to preserve samples.

1.12.1. Address for Delivery of Selected Geotechnical Samples

Sample storage and transportation shall be in accordance with BS EN ISO 22475-1:2006..

1.12.2. Retention and Disposal of Geotechnical Samples

Geotechnical samples shall not be disposed of until 2 months after submission of the approved final Factual Report..

1.12.3. Frequency of Sampling for Geotechnical Purposes

All sampling will be undertaken in accordance with the requirements of BS EN 1997-1:2004+A1:2013, BS EN 1997-2:2007 and BS EN ISO 22475-1:2006.

Bulk samples should be taken at every stratum change as well as disturbed samples. Within the inspection pits, bulk disturbed samples should be taken at 0.5m depth and again at the base of the inspection pits.

Bulk samples should be of sufficient volume to undertake a particle size distribution envelope to BS EN ISO 22475-1:2006.

Within cohesive material take 1 No. small disturbed sample at each change in stratum followed by a UT100/UT70 sample at 1m intervals within first 5m and then at 1.5m intervals thereafter to final depth.

In granular material take 1 No. small disturbed sample at each change in stratum followed by SPT tests at 1m intervals within the first 5m and then at 1.5m intervals thereafter to final depth. Take 1 No. bulk sample at each SPT test.

All undisturbed samples shall be protected from moisture changes immediately after sampling and shall be handled with utmost care to prevent harm during storage and transport.

The Contractor will be responsible for the protection of all samples and for their transport to the laboratories. The samples should be retained until AMAR gives written notification that the samples can be disposed of.

Geotechnical samples shall not be disposed of until 2 months after submission of the approved final Factual Report.

1.12.4. Open-Tube and Piston Sample Diameters

N/A.

1.12.5. Retention of Cutting Shoe Samples

Cutting shoe material shall be retained as a small disturbed sample.

1.12.6. Delft and Mostap Sampling

N/A.

1.12.7. Groundwater Level Measurements during Exploratory Hole Construction

Upon encountering groundwater the depth that it is struck should be recorded, all drilling works will cease and the level of the groundwater monitored for any rises for a period of 20minutes and the findings recorded on the exploratory hole log.

1.12.8. Special Geotechnical Sampling

N/A.

1.12.9. Address for Delivery of Selected Samples

N/A.

1.12.10. Retention and Disposal of Contamination Samples

Contamination samples will be disposed of once chemical testing laboratories deem them to be no longer suitable for testing.

Samples are to be stored on Site in accordance with protocols agreed with the Engineer, and will be arranged by the Contractor to be collected each day from Site by a courier provided by the laboratory, to be agreed by the Engineer, or preserved under refrigerated conditions on Site.

All samples for contamination analyses shall be stored and transported in cool boxes with pre-frozen ice packs and submitted directly to the laboratory from Site within 48hourrs of sampling. ‘Chain of Custody’ form shall accompany each batch of samples with a copy retained on Site during works and submitted to the Engineer with the exploratory hole logs. The ‘Chain of Custody’ shall include the sample details in full combined with any special instructions indicated by the Engineer.

1.12.11. Frequency of Sampling

The following Contamination testing will be required in accordance with BS 10175:2011+ A1:2013:

2 No. representative samples from 0.5m and 1.2m depth in trial pits undertaken before drilling. Samples are to include:

- 2 No. 1kg plastic plain/500g plastic plain tubs (depending on laboratory requirements) for the inorganics (metals and asbestos).
- 2 No. 250g glass amber jar for PAH, EPH (hydrocarbons). Full to brim no headspace.
- 2 No. 60g glass amber jar for gasoline range organics and volatiles. Full to brim no headspace.

1 No. representative sample from each exploratory hole per every 1m of Made Ground in each of the exploratory holes. Samples are to include:

- 2 No. 1000g plastic plain/500g plastic plain tubs (depending on laboratory requirements) for the inorganics (metals and asbestos).
- 2 No. 250g glass amber jar for PAH, EPH (hydrocarbons). Full to brim no headspace.
- 2 No. 60g glass amber jar for gasoline range organics and volatiles. Full to brim no headspace.

1 No. sample (as above) to be taken at any distinct change in Made Ground composition or visual or olfactory contamination.

1 No. sample within natural stratum after proving for a minimum of 1m length.

The Contractor must ensure that the samples collected are representative of the area or material being sampled and that the example is homogenized across the sample containers used as far as practicable.

All containers must be cleaned of excess soil/water and ensure all lids have been securely fastened (as this helps to minimise transcription errors and potential cross-contamination issues)

The Contractor must ensure that all containers must be labelled clearly with the appropriate sample reference and that to reduce potential cross contamination or loss of contaminants sampling equipment will be cleaned in between sampling.

Contamination Samples must be stored out of direct sunlight in cool boxes or refrigerated unit until same day collection. Temperature must be regulated between 3 and 7°C for both on Site storage and transport to a UKAS/MCERTS accredited laboratory.

Laboratory schedules will be sent to the AMAR Engineer for scheduling on receipt of the samples to the accredited laboratory.

1.12.12. Sampling Method

Samples are to be taken in accordance with BS 10175:2011.

1.12.13. Headspace Testing

To be undertaken in accordance with BS 10175:2011.

1.13. Probing and Cone Penetration Testing

1.13.1. Type(s) and Reporting of Dynamic Probing

N/A.

1.13.2. Capacity of and Equipment Requirements for Cone Penetration Testing

N/A.

1.13.3. Reporting of Cone Penetration Testing Parameters

Cone Penetration Testing (CPT) is required for 6 No. locations, as specified in Schedule 2.

1.13.4. Seismic Cone Equipment Requirements
N/A.

1.13.5. Interpretation of Seismic Cone Tests
N/A.

1.13.6. Other Cone or Specialist Probes
N/A.

1.14. Geophysical Testing

1.14.1. Geophysical Survey Objectives
N/A.

1.14.2. Requirements for Ground Specialist Geophysicist
N/A.

1.14.3. Trials of Geophysical Methods
N/A.

1.14.4. Types of Geophysics Required
N/A.

1.14.5. Information Provided
N/A.

1.14.6. Horizontal Data Density
N/A.

1.14.7. Level Datum
N/A.

1.14.8. Geophysical Survey Report
N/A.

1.15. In Situ Testing

1.15.1. Tests in Accordance with British Standards
Standard penetration testing (SPT's) at 1.0m intervals within all exploratory holes within first 5 metres and 1.5 metres thereafter to final depth (unless deemed 'hard stratum' by the Engineer) and shall be in accordance with Clauses 7.6.4 and 7.6.6.

The borehole casing and water level shall be recorded with each SPT. SPTs shall be undertaken in accordance with EN ISO 22476-3:2005.

When an SPT is carried out, the Contractor shall record and include in their report the blow count for each 75mm increment of penetration (or part-thereof). The seating drive shall be the initial 150mm of penetration or 50 blows. Where the seating drive comprises 50 blows, the length of penetration shall be recorded and reported. The test drive shall comprise a further 100 blows. If within 100 blows, a penetration of 300mm is not achieved, the penetration ignoring the seating drive blows shall be recorded.

Calibration certification for the energy ratio for the SPT hammer shall be provided.

UT100 samples shall be taken in plastic tubes. The tubes should be waxed on the day of sampling and appropriately labelled. Blow counts shall be recorded for each UT100 sample taken.

Hand vane shear tests shall be carried out by the Contractor in fine grained soils where possible/suitable and in accordance with BS EN ISO 22476-9:2014.

1.15.2. Hand Penetrometer and Hand Vane for Shear Strength

Hand shear vane testing within fine grained deposits encountered at 0.5m intervals or where practicable. An average of three readings shall be recorded where possible.

1.15.3. Self-Boring Pressuremeter and High-Pressure Dilatometer Testing and Reporting

N/A.

1.15.4. Driven of Push-In Pressuremeter Testing and reporting Requirements

N/A.

1.15.5. Menard Pressuremeter Tests

N/A.

1.15.6. Soil Infiltration Tests

N/A.

1.15.7. Special In Situ Testing and Reporting Requirements

Thermal conductivity/resistivity of the soil will be tested using a thermal needle probe (KD2 probe or similar device) at 6 No. locations as specified in Schedule 2.

Exact testing depth and specification to be followed will be confirmed at a later date.

1.15.8. Interface Probes

N/A.

1.15.9. Contamination Screening Tests

N/A.

1.15.10. Metal Detection

N/A.

1.16. Instrumentation

1.16.1. Protective Covers for Installations
N/A.

1.16.2. Protective Fencing
N/A.

1.16.3. Standpipe and Standpipe Piezometer Installation
N/A.

1.16.4. Other Piezometer Installation
N/A.

1.16.5. Development of Standpipes and Standpipe Piezometers
N/A.

1.16.6. Ground Gas Standpipes
N/A.

1.16.7. Inclinometer Installations
N/A.

1.16.8. Slip Indicators
N/A.

1.16.9. Extensometers and Settlement Gauges
N/A.

1.16.10. Settlement Monuments
N/A.

1.16.11. Removal of Installations
N/A.

1.16.12. Other Instrumentation
N/A.

1.17. Installation Monitoring and Sampling

1.17.1. Groundwater Level Readings in Installations
N/A.

1.17.2. Groundwater Sampling From Installations

N/A.

1.17.3. Purging/micro-purging

N/A.

1.17.4. Ground Gas Monitoring

N/A.

1.17.5. Sampling From Ground Gas Installations

N/A.

1.17.6. Other Monitoring

N/A.

1.17.7. Sampling and Testing of Surface Water Bodies

N/A.

1.18. Daily Records

Daily exploratory hole records shall be submitted to the AMAR Engineer at the end of each shift.

Daily reports are to be submitted to the Engineer within 48hours of completion of each shift. Information to be provided on each report shall include plant, labour and machinery, activities undertaken for that day, progress for that day, tests undertaken, and instrumentation installed. Driller's logs for the completed holes are to be issued electronically within 48hours of completion of each exploratory hole.

The depth at which any water is added, together with the volume added and the reason for its addition shall be recorded on the driller's daily log.

1.18.1. Information for Daily Records

The Contactor is to submit a proforma or example record for approval by the AMAR Engineer.

The Factual Report shall be in accordance with the requirements of BS EN ISO 22475-1:2006.

1.18.2. Special In Situ Tests and Instrumentation Records

N/A.

1.19. Geotechnical Laboratory Testing

The testing laboratory chosen shall be UKAS accredited. All testing shall be scheduled by the Engineer.

The Contractor shall provide the following:

- List of MCERTs accredited tests including rates.
- List of UKAS accredited tests including rates.
- Name of laboratory to be used.

Testing shall be carried out on the appropriate class of sample as defined in BS EN ISO 22475-1:2006 and BS EN1997-2:2007.

1.19.1. Investigation Supervisor or Contractor to Schedule Testing

The AMAR Engineer will schedule all laboratory testing. The Contractor will notify AMAR of any unsuitable samples within 48hours of receipt of the relevant testing schedule to enable replacement tests to be scheduled.

The Contractor shall prepare blank testing schedules showing all samples taken, their depth, sample number and sample type, for the AMAR Engineer. Blank testing schedules for each exploratory hole will be presented within 48hours of completion.

1.19.2. Tests Required

Laboratory geotechnical tests are likely to include, but may not be necessarily limited to, the following:

- Natural moisture content;
- Atterberg Limits;
- Particle size distribution (dry sieve);
- Sedimentation;
- BRE SD1 extended suite.

1.19.3. Specification for Tests not covered by BS 1377 and Options under BS 1377

N/A.

1.19.4. UKAS Accreditation to be Adopted

Geotechnical testing to be carried out by UKAS accredited laboratory. All testing must be UKAS accredited. Documentation must be supplied with the Tender.

1.19.5. Rock Testing Requirements

N/A.

1.19.6. Chemical Testing for Aggressive Ground/Groundwater for Concrete

Sulphate and pH testing to BRE Special Digest 1 (2005) will be undertaken on soil samples taken during the works. To be specified by the Engineer.

1.19.7. Laboratory Testing On Site

N/A.

1.19.8. Special Laboratory Testing

N/A.

1.20. Geoenvironmental Laboratory Testing

1.20.1. Investigation Supervisor or Contractor to Schedule Testing

The AMAR Engineer will schedule all laboratory testing. The Contractor will notify AMAR of any unsuitable samples within 2 working days of receipt of the relevant testing schedule to enable replacement tests to be scheduled.

The Contractor shall prepare blank testing schedules showing all samples taken, their depth, sample number and sample type, for the AMAR Engineer. Blank testing schedules for each hole/pit will be presented within 2 days of completion of the exploratory hole.

1.20.2. Accreditation Required

Environmental testing to be carried out by a laboratory possessing UKAS approval for all analytical methods specified in the Contract. Documentation must be supplied with the Tender.

1.20.3. Chemical Testing for Contamination

The expected contaminant tests are indicated (but not limited to) below:

- USEPA 16 PAHs;
- CLEA metals;
- Speciated Chromium;
- Free, Complex and Total Cyanide;
- TPH CWG, with Chromatographs;
- pH;
- SVOCs/VOCs;
- Suite of chemical testing for concrete classification (to BRE Special Digest 1, 2005, Box C10);
- midi-s(As, Cd, Cr, Cu, Ni, Zn, Pb, Hg, Se, WSB, hex chromium, total cyanide, free cyanide, total sulphate, sulphide, total sulphur, pH, total PAH, phenols, thiocyanate);
- Asbestos Screen;
- WAC Single Stage 1:10 Leachate tests; and
- WAC Stable Non-Reactive Hazardous Waste Landfill suite (BS EN 12457-2: As, Ba, Cd, Cr, Cu, Hg, Mo, Ni, Pb, Sb, Se, Zn, Cl, F, SO4, TDS, Phenol Index, DOC. Solid: TOC, pH, Acid Neutralisation Capacity)mg/kg and 10:1 mg/kg.

1.20.4. Waste Characterisation

N/A.

1.20.5. Waste Acceptance Criteria Testing

N/A.

1.20.6. Laboratory Testing

N/A.

1.21. Reporting

1.21.1. Form of Exploratory Hole Logs

Final exploratory hole logs shall be provided in PDF format and in The Association of Geotechnical Specialists (AGS) Revision 3 or 4 format for review and comment with each log showing the name of the Contract and the names of the Employer, Engineer and Principal Contractor. Upon approval of the exploratory hole logs the Contractor will receive an XML Toolkit File that they should use to prepare the final PDF indexed version of the logs in accordance with the Highways Agency Geotechnical Database Management System (HAGDMS) requirements.

1.21.2. Information on Exploratory Hole Logs

As specified.

1.21.3. Variations to Final Digital Data Supply Requirements

Digital Data shall be provided for checking and shall be error free; if errors are present the Contractor shall revise the data package so that it is free from errors. The Contractor shall ensure the format of the data complies with the requirements of the most recent revision of The Association of Geotechnical Specialists (AGS) format.

The Contractor shall submit the digital data for approval in draft format along with the output from an AGS data checking software as proof that the data is error free and complies with all AGS rules. Until copies of the third party checking software output are received the AGS data submission will not be considered complete.

1.21.4. Preliminary Digital Data

Preliminary exploratory hole logs to be issued when completed for review by the Engineer.

1.21.5. Type(s) of Report Required

Factual Report.

1.21.6. Electronic Report Requirements

Digital data will be required in an agreed format, to include but not necessarily be limited to:

- All exploratory hole logs, including in-situ testing, and all laboratory testing results to be presented in the latest version of AGS standard data files.
- The complete Factual Report including all appendices and drawings as one complete PDF submission.

1.21.7. Format and Contents of Desk Study Report

N/A.

1.21.8. Contents of Ground Investigation Report

The factual data shall meet the requirements of EN ISO 22475-1:2006. The Factual Report should contain as a minimum:

- The brief agreed with the procurer for the work;
- Presentation of all factual data; and
- A summary of the ground and groundwater conditions.

All exploratory holes shall be surveyed and related to Ordnance Datum and the Ordnance Survey National Grid.

1.21.9. Contents of Geotechnical Design Report

N/A.

1.21.10. Times for Supply of Electronic Information

Complete set of digital data to be supplied with draft and approved final copies of the report.

1.21.11. Electronic Information Transmission Media

DVD ROM.

1.21.12. Report Approval

One hard and one electronic copy of the draft Factual Report required for submission 4 weeks after the completion of the GI.AMAR Engineer comments on the draft Factual Report and associated digital data to be issued within 2 weeks from the receipt of the draft. One hard and one electronic copy of an approved final Factual Report to be submitted by the Contractor within a further 2weeks.

Schedule 2 – Schedule of Exploratory Hole

The exact locations will be confirmed on Site.

Exploratory Hole Reference	Northbound/ Southbound	Drilling Type	Chainage (m)	Scheduled maximum depth (m bgl)	Cutting/ Embankment
BH – G101	NB	DS/RC	181930	16	At Grade
TP - NW12	SB On-slip	TP + Thermal Resistivity Probe	182290	TBC	TBC
TP - NW11	SB	TP + Thermal Resistivity Probe	183274	TBC	Embankment
TP - NW1	SB	TP + Thermal Resistivity Probe	183646	TBC	Cutting
CPT-01	SB	CPT	183875	6	Cutting
BH-R-FTPSB5_800y	SB	DS/RC	184672	10	Embankment
BH – G112	SB	DS/RC (slope climbing)	185180	33	Cutting
BH – E1-A1.1	NB	DS/RC (slope climbing)	185195	10	Cutting
BH – E1-A1.2	NB	DS/RC (slope climbing)	185305	12	Cutting
SP-01	NB (M1 onslip west)	DS/RC	186057	10	Embankment
BH – G202A	NB	DS/RC	186240	19	Embankment
BH – G202B	SB	DS/RC	186240	19	Embankment
CPT-02-NB2_1m	NB	CPT	186340	5	Embankment

Exploratory Hole Reference	Northbound/ Southbound	Drilling Type	Chainage (m)	Scheduled maximum depth (m bgl)	Cutting/ Embankment
BH – G203	SB	DS/RC	186400	30	At Grade
BH – G204	NB	DS/RC	186517	24	Embankment
BH – G301A	NB	DS/RC	186847	18	At Grade
BH – G301B	SB	DS/RC	186847	18	Embankment
BH-FTP-NB2_1m_2	NB	DS/RC	186950	10	Embankment
BH – G302	SB	DS/RC	187073	26	Embankment
BH-FTP-NB2-800y	NB	DS/RC	187215	10	Embankment
BH – G326	SB	DS/RC	187300	22	Embankment
BH-R-FTNB2_600y	NB	DS/RC	187368	11	Embankment
CPT-03-NB2_400y	NB	CPT	187551	6	Embankment
BH – G303	SB	DS/RC	187608	25	Embankment
BH – G304	NB	DS/RC	187650	18	Embankment
CPT-04-NB2_200y	NB	CPT	187767	6	Embankment
BH – G305	SB	DS/RC	187818	14	Embankment
BH - R - FTPSB4_200y	SB	DS/RC	187923	13	Embankment
BH-FTP-SB4-400y	SB	DS/RC	188116	10	Embankment

Exploratory Hole Reference	Northbound/ Southbound	Drilling Type	Chainage (m)	Scheduled maximum depth (m bgl)	Cutting/ Embankment
BH-FTP-SB4-600y	SB	DS/RC	188240	10	Embankment
BH - R - FTPSB4_800y	SB	DS/RC	188395	15	Embankment
BH – E3-B1.1	SB	DS/RC	188425	14	Embankment
BH – E3-B1.2	SB	DS/RC	188525	11	Embankment
BH – G307	NB	DS/RC	188529	20	Embankment
BH – G308	SB	DS/RC	188760	31	Embankment
BH – E3-A1	NB	DS/RC	188865	11	Embankment
BH – G309	SB	DS/RC	188947	17	Embankment
BH – G310	SB	DS/RC	189160	11	Embankment
BH-FTP-SB4_1m	SB	DS/RC	189299	8	Embankment
BH – G311A	NB	DS/RC	189780	21	Embankment
BH – G311B	SB	DS/RC	189780	21	Embankment
TP - NW4	SB	TP + Thermal Resistivity Probe	190120	TBC	Embankment
BH - R - NB4_1m	NB	DS/RC	190541	13	Embankment
BH-G312	SB	DS/RC	190605	21	Embankment
CPT-06-SB3_600y	SB	CPT	190749	6	Embankment

Exploratory Hole Reference	Northbound/ Southbound	Drilling Type	Chainage (m)	Scheduled maximum depth (m bgl)	Cutting/ Embankment
BH – G313	NB	DS/RC	190771	13	Embankment
CPT-07-SB3_800y	SB	CPT	190932	6	Embankment
BH – G314	NB	DS/RC	191096	16	At Grade
BH – G315	NB	DS/RC	191296	30	Bund
BH – G316	SB	DS/RC	191430	16	Embankment
TP - NW5	SB	TP + Thermal Resistivity Probe	191642	TBC	At Grade
BH – G318	NB	DS/RC	191801	18	Bund
BH – G319	NB	DS/RC	192101	30	Embankment
BH-FTP-SB2_200y	SB	DS/RC	192176	10	Embankment
BH – G320	SB	DS/RC	192285	18	Embankment
BH-FTP-SB2_400y	SB	DS/RC	192357	15	Embankment
BH – G321	NB	DS/RC	192476	20	Embankment
SP-02	SB	DS/RC	192502	13	Embankment
BH-FTP-SB2_600y	SB	DS/RC	192564	10	Embankment
BH - R - SB2_800y	SB	DS/RC	192731	13	Embankment
SP-03	SB	DS/RC	192790	10	Embankment

Exploratory Hole Reference	Northbound/ Southbound	Drilling Type	Chainage (m)	Scheduled maximum depth (m bgl)	Cutting/ Embankment
BH – G322	NB	DS/RC	192906	20	At Grade
TP - NW6	NB Off-slip	TP + Thermal Resistivity Probe	193096	TBC	TBC
BH – G323	SB	DS/RC	193300	11	At Grade
BH – G324	NB	DS/RC (slope climbing)	193331	12	Cutting
BH - SB98	SB	DS/RC	196220	12	Embankment

Schedule 3 – Engineer's Offices, Equipment, Transport, Protective Clothing and Survey Equipment

3.1 Accommodation

Welfare facilities, contractors store and skip (or suitable alternative) required.

3.2 Furnishings

Not required.

3.3 Services

The Engineer shall have access to the welfare facilities provided by the Contractor for his staff.

3.4 Equipment

Not required.

3.5 Transport

Not required.

3.6 Personal Protective Equipment for Investigation Supervisor

Not required.

Schedules 4 – Specification Amendments

None.

Schedules 5 – Specification Additions

None.

ANNEX 1 – Bill of Quantities for Ground Investigation

(To Follow)

Appendix A – Drawings

Figure 1 – Exploratory Hole Location Plan

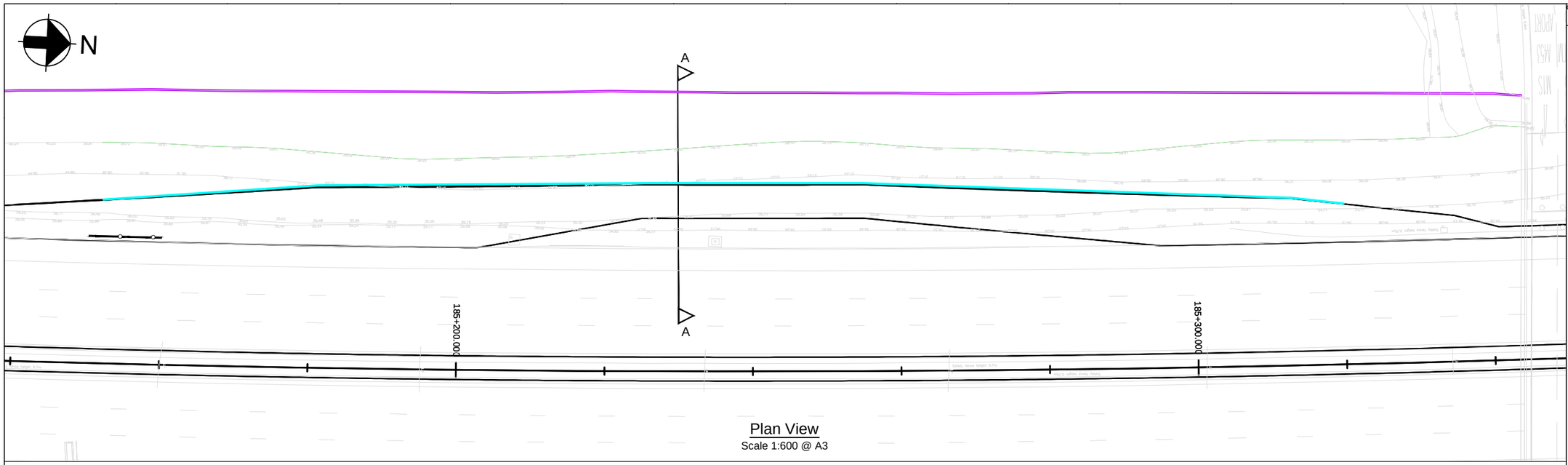
Appendix B – Services Location Plans

Contact name
Amey Arup Joint Venture

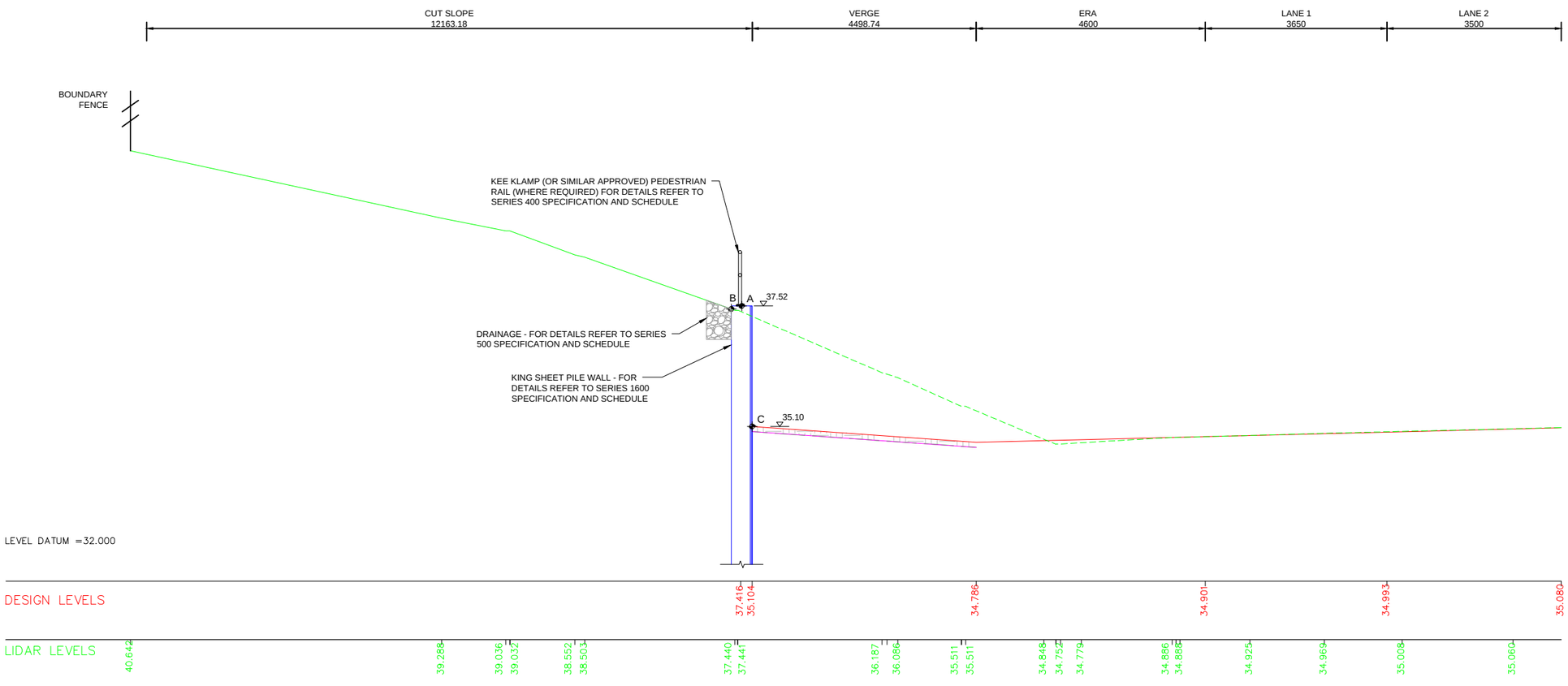
Amey
International Design Hub
5th Floor
The Colmore Building
20 Colmore Circus
Birmingham
B4 6AT

Email: IDH.Reception@amey.co.uk
Telephone: 0121 212 5000
Fax: 0121 236 1160

Appendix C. Drawings



Plan View
Scale 1:600 @ A3



SECTION A-A
ERA E1-A1 (Ch185230)
SHEET PILE CUT
SCALE 1:100 @ A3

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9. WORST CASE SCENARIOS INDICATED IN SECTION A-A.
10. FOR ELEVATION PLANS PLEASE REFER TO DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-001603 TO HA549342-AMAR-HGT-SWI-DR-CE-001645.
11. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001601.

PLAN LEGEND
- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION
- SHEET PILE

P04.1	---	---	---	---

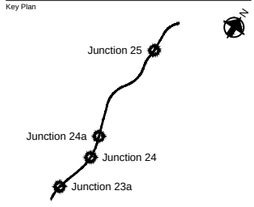
Rev	Date	By	Chkd	Appd

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Tel 0121 214 2000

Client: highways england driving forward

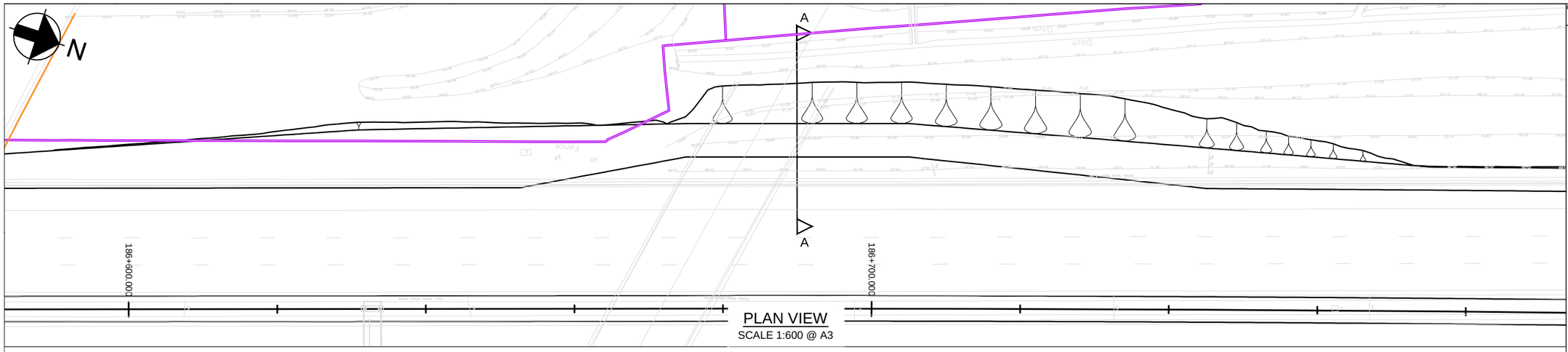
Project Title
SMP M1 J23a - J25

Key Plan

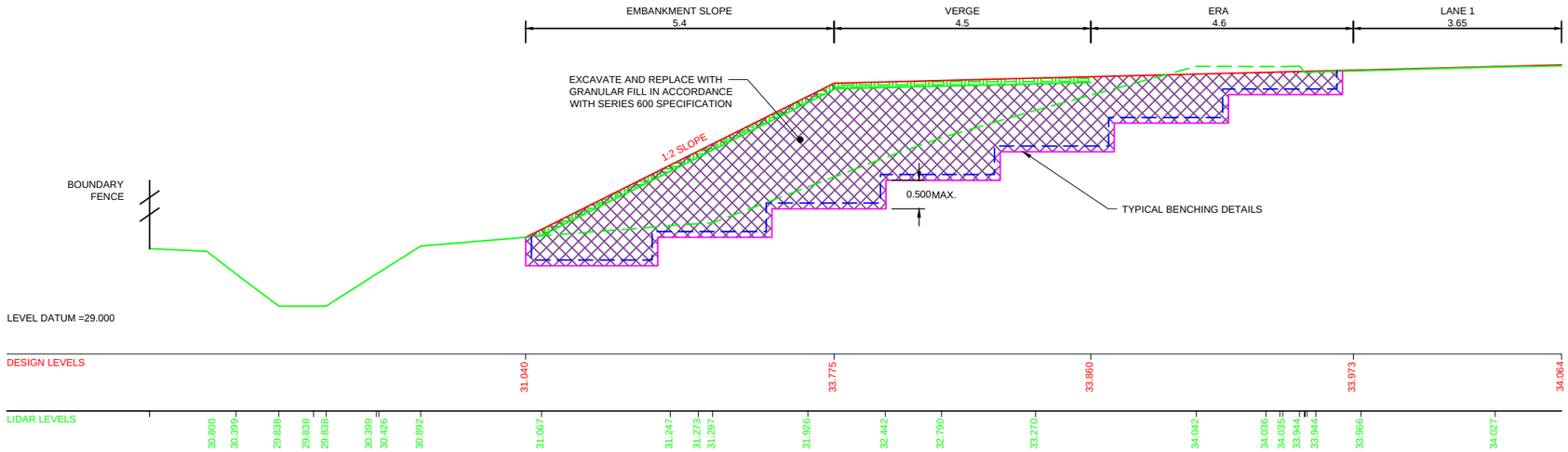


Drawing Title
EARTHWORKS DESIGN SOLUTION
ERA E1-A1 CH. 185250
CH. 185195 TO CH. 185305
SHEET 01 OF 01

Scale at A1: NA
Role: Civil - Earthworks and Geotech
Suitability: S0 - Initial non-contractual
Job No: **244508-00**
Rev: **P04.1**
Name: **HA549342-AMAR-HGT-E1A1-DR-CE-000001**



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
ERA E2-A1 (CH186690)
FULL HEIGHT EMBANKMENT WIDENING
SCALE 1:100 @ A3

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PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
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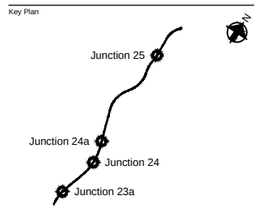
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Client: highways england driving forward

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SMP M1 J23a - J25

Key Plan



Drawing Title
EARTHWORKS DESIGN SOLUTION
ERA E2-A1 CH. 186700
CH. 186645 to CH. 186755
SHEET 01 OF 01

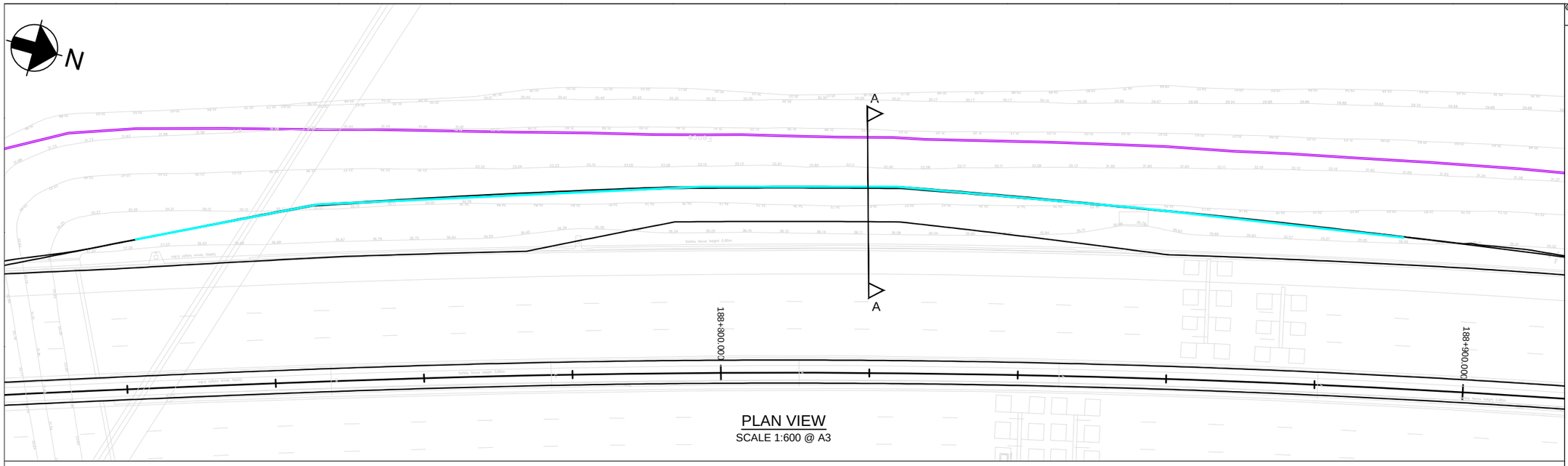
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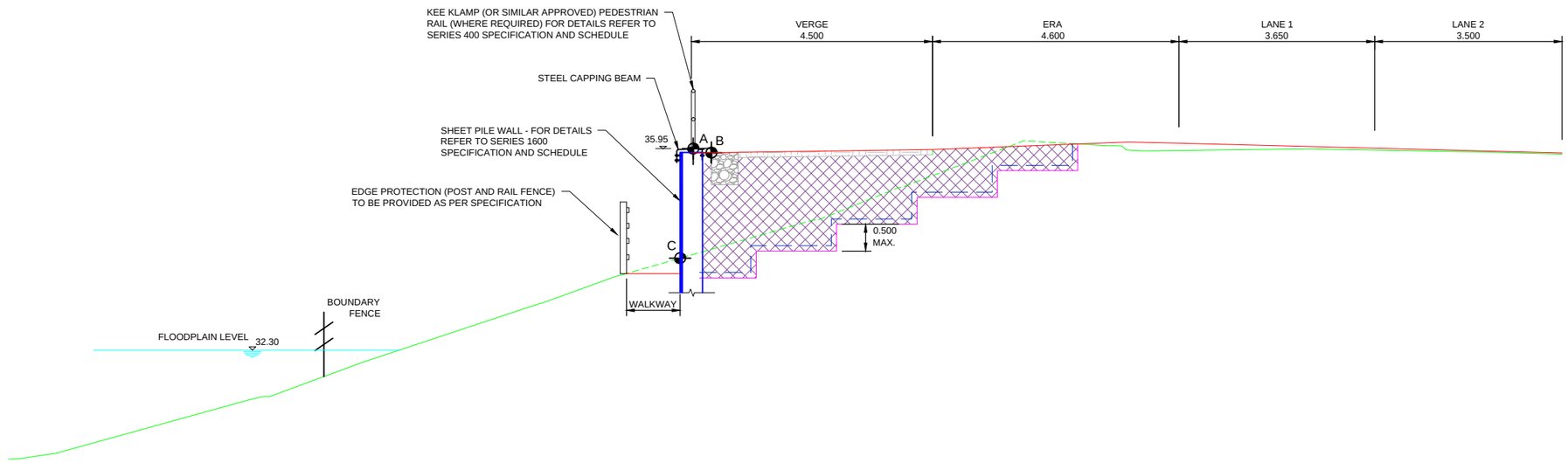
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Job No	Rev
244508-00	**P03**

Name
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PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
ERA E3-A1 (CH188820)
SHEET PILE EMBANKMENT
SCALE 1:100 @ A3

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11. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001601.

PLAN LEGEND
- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
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- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION
- SHEET PILE

P03	17/04/17	LP	---	SV

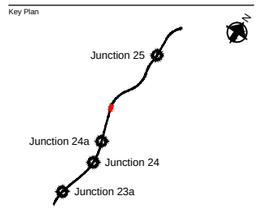
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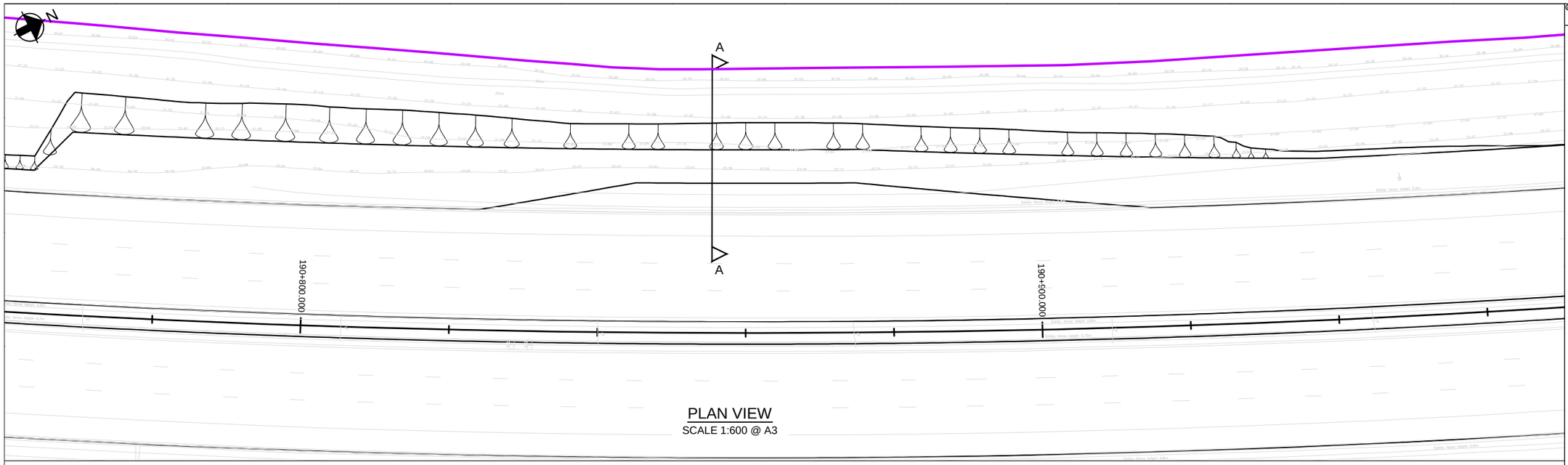
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Project Title
SMP M1 J23a - J25

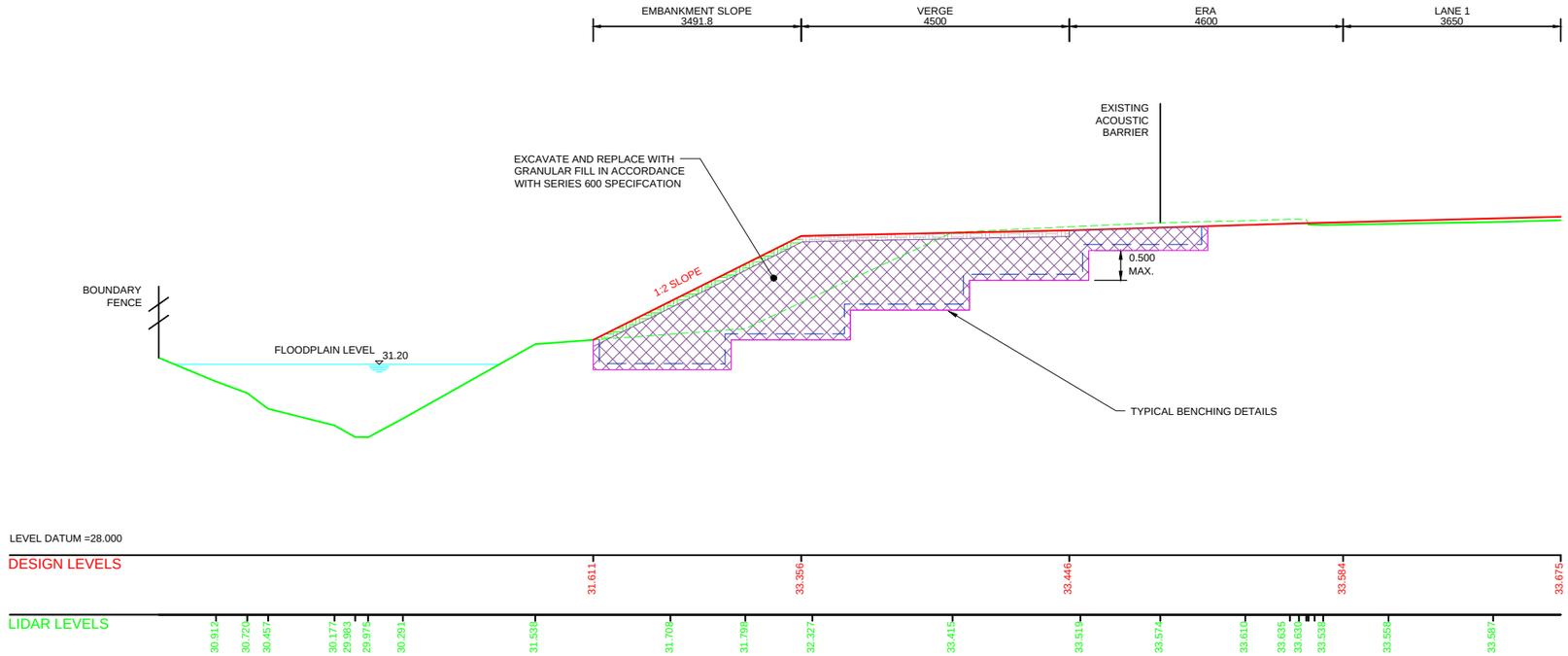
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Drawing Title
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ERA E3-A1 CH. 188820
CH. 188765 TO CH. 188865
SHEET 01 OF 01

Scale at A1: NA
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P03**
Name: **HA549342-AMAR-HGT-E3A1-DR-CE-000001**



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
ERA E3-A2 (CH190850)
GRANULAR WEDGE AT EMBANKMENT
SCALE 1:100 @ A3

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PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
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- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
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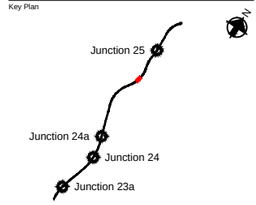
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Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
EARTHWORKS DESGIN SOLUTION
ERA E3-A2 CH. 190850
CH. 190800 TO CH. 190900
SHEET 01 OF 01

Scale at A1: NA

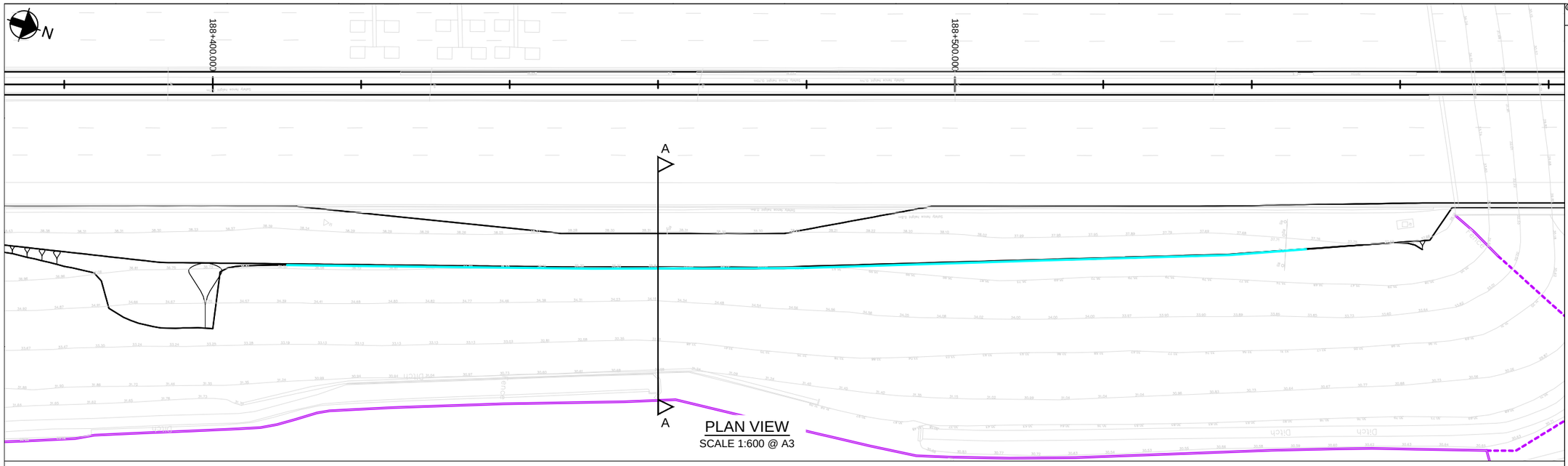
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Suitability: S4 - Fit for construction approval

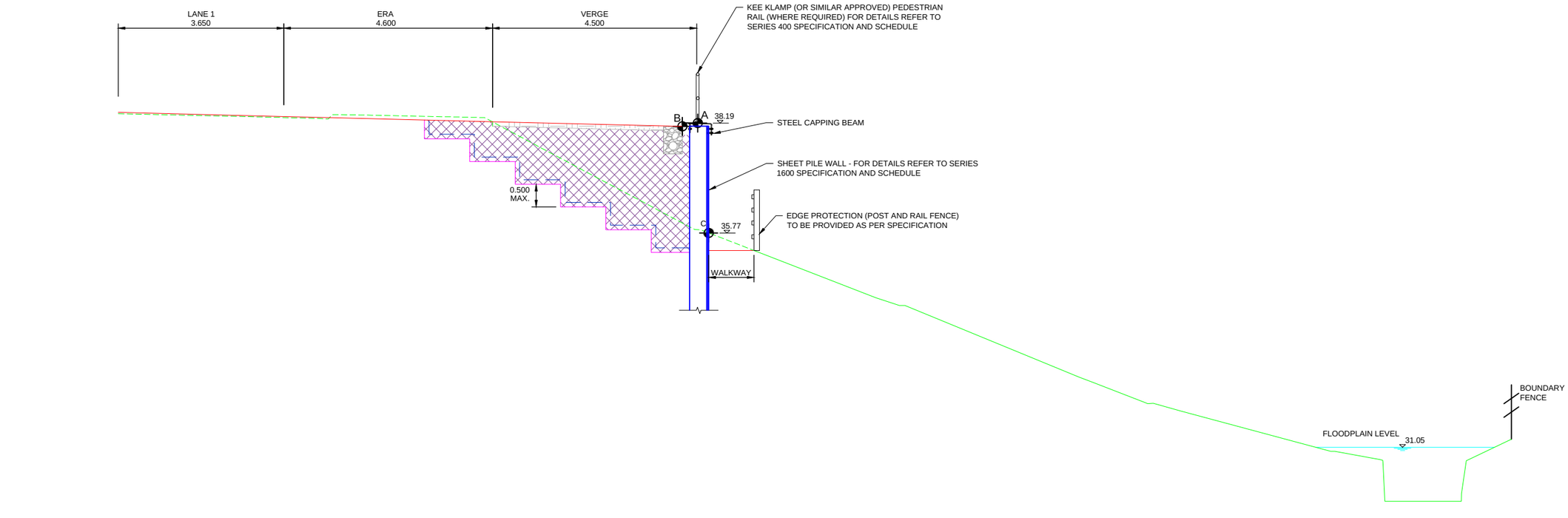
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Rev: **P03**

Name
HA549342-AMAR-HGT-E3A2-DR-CE-000001



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
ERA E3-B1 (Ch188460)
SHEET PILE EMBANKMENT
SCALE 1:100 @ A3

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PLAN LEGEND
- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION
- SHEET PILE

Rev	Date	By	Chkd	Appd
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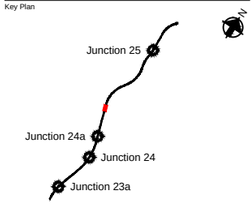
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Client: highways england driving forward

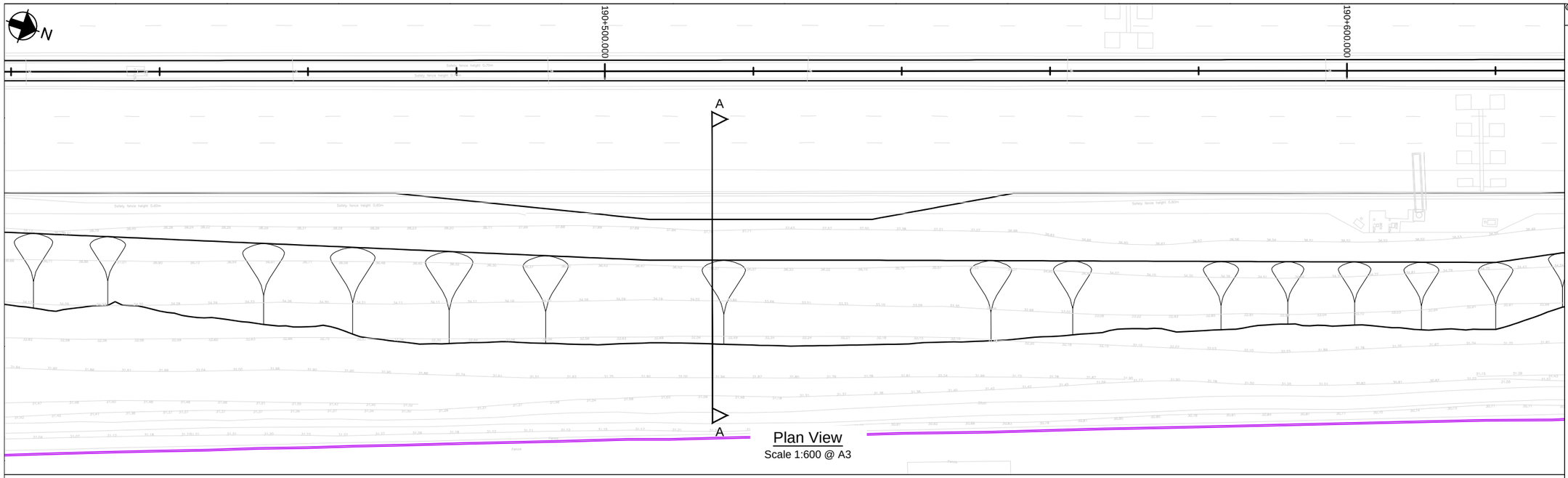
Project Title
SMP M1 J23a - J25

Key Plan

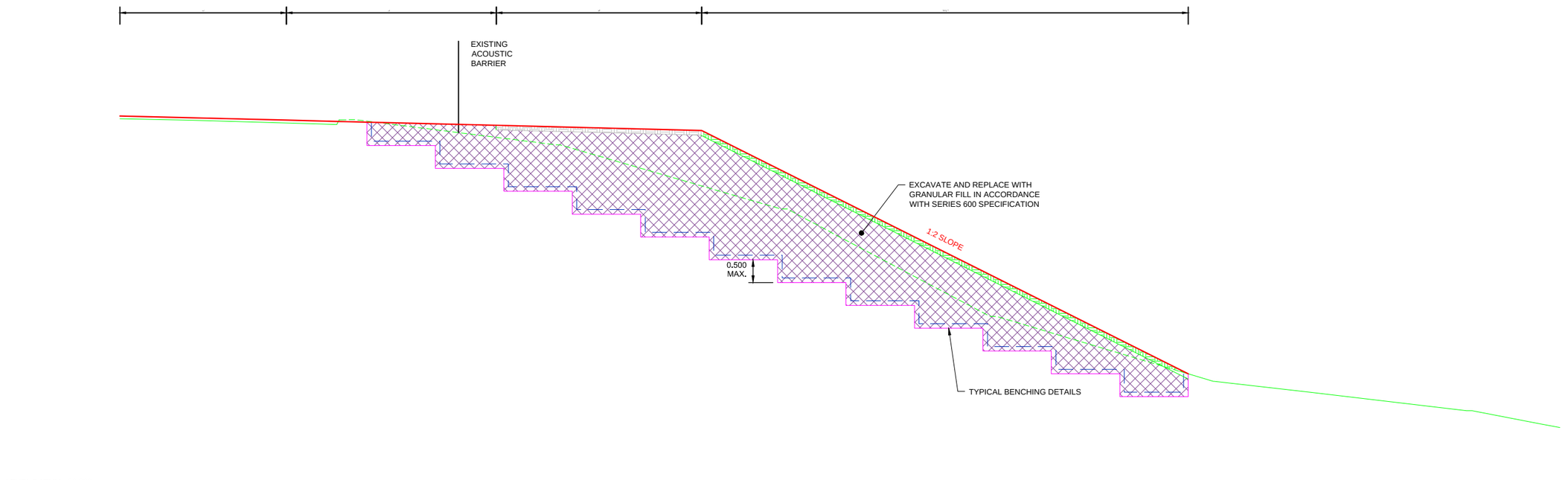


Drawing Title
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ERA E3-B1 CH. 188452
CH. 188425 to CH. 188525
SHEET 01 OF 01

Scale at A1: NA
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P03**
Name: **HA549342-AMAR-HGT-E3B1-DR-CE-000001**



Plan View
Scale 1:600 @ A3



SECTION A-A
ERA E3-B2 (CH190510)
GRANULAR WEDGE AT EMBANKMENT CREST
SCALE 1:100 @ A3

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NOTES

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2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000002).
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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
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7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. WORST CASE SCENARIOS INDICATED IN SECTION A-A.
10. FOR TYPICAL DETAILS OF EARTHWORK SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000601.

PLAN LEGEND

SECTION LINE

HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

PROPOSED GROUND PROFILE
EXISTING GROUND PROFILE
EXISTING GROUND PROFILE TO BE REMOVED
INDICATIVE EXCAVATION PROFILE
GEOTEXTILE SEPARATOR LAYER
TOPSOIL (MINIMUM 0.1m)
VERGE SURFACE
GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

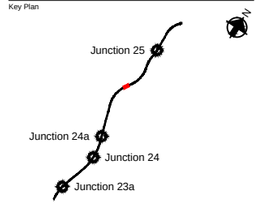
Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: EARTHWORKS DESIGN SOLUTION
ERA E3-B2 CH.190511
CH. 190465 to CH. 190565
SHEET 01 OF 01

Scale at A1: NA

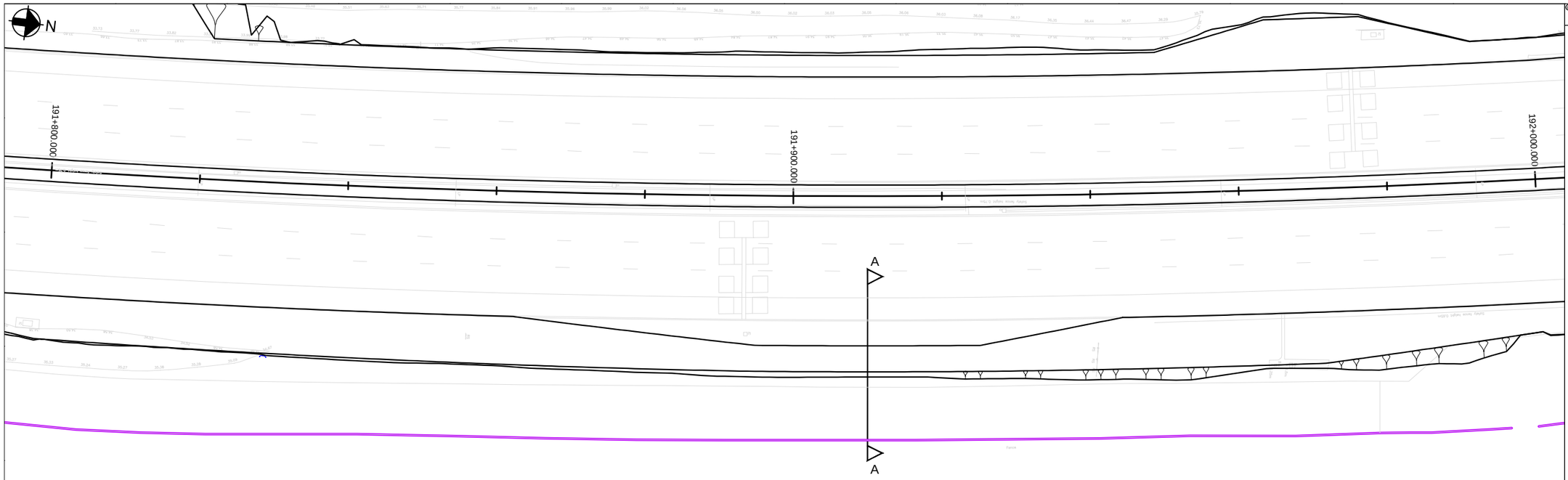
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Suitability: S4 - Fit for construction approval

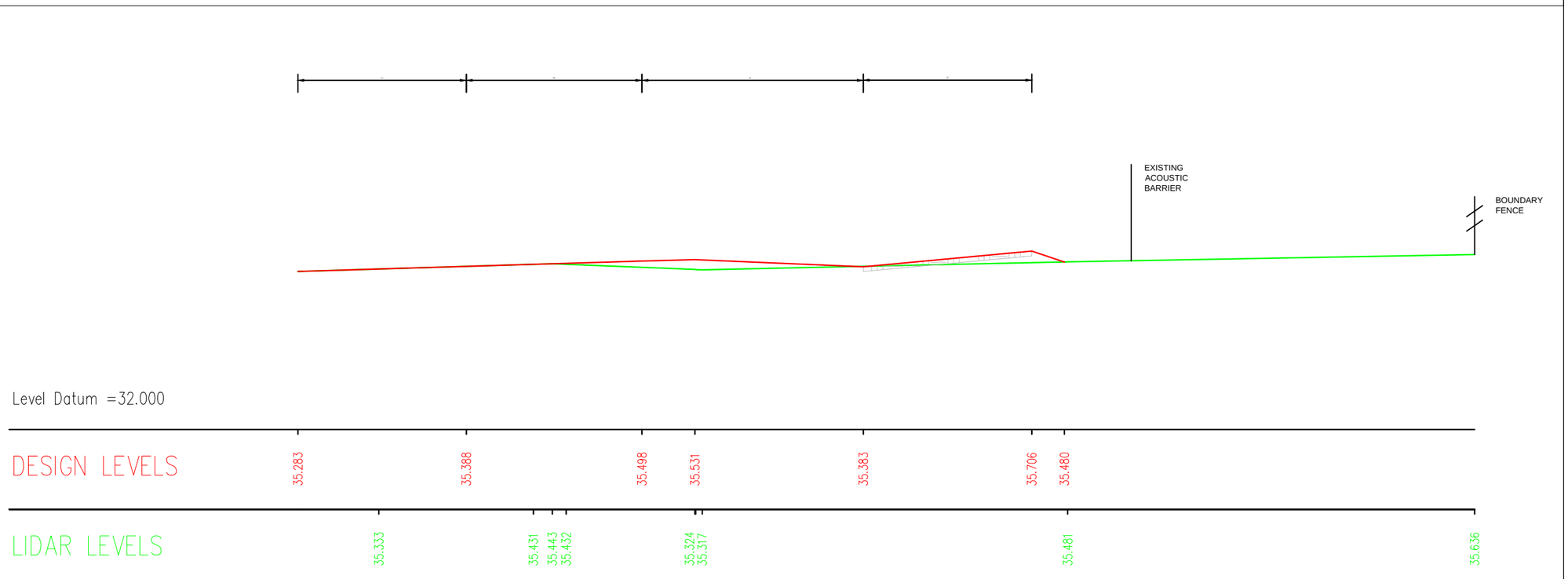
Job No: **244508-00**

Rev: **P03**

Name: **HA549342-AMAR-HGT-E3B2-DR-CE-000001**



Plan View
Scale 1:600 @ A3



SECTION A-A
ERA E3-B3 (CH191910)
NO SOLUTION
SCALE 1:100 @ A3

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11. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001601.

PLAN LEGEND
- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION
- SHEET PILE

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

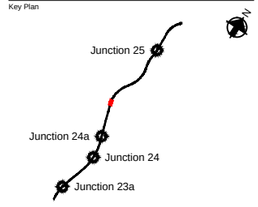
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: EARTHWORKS DESIGN SOLUTION
ERA E3-B3 CH. 191900
CH. 191845 to CH. 191955
SHEET 01 OF 01

Scale at A1: NA

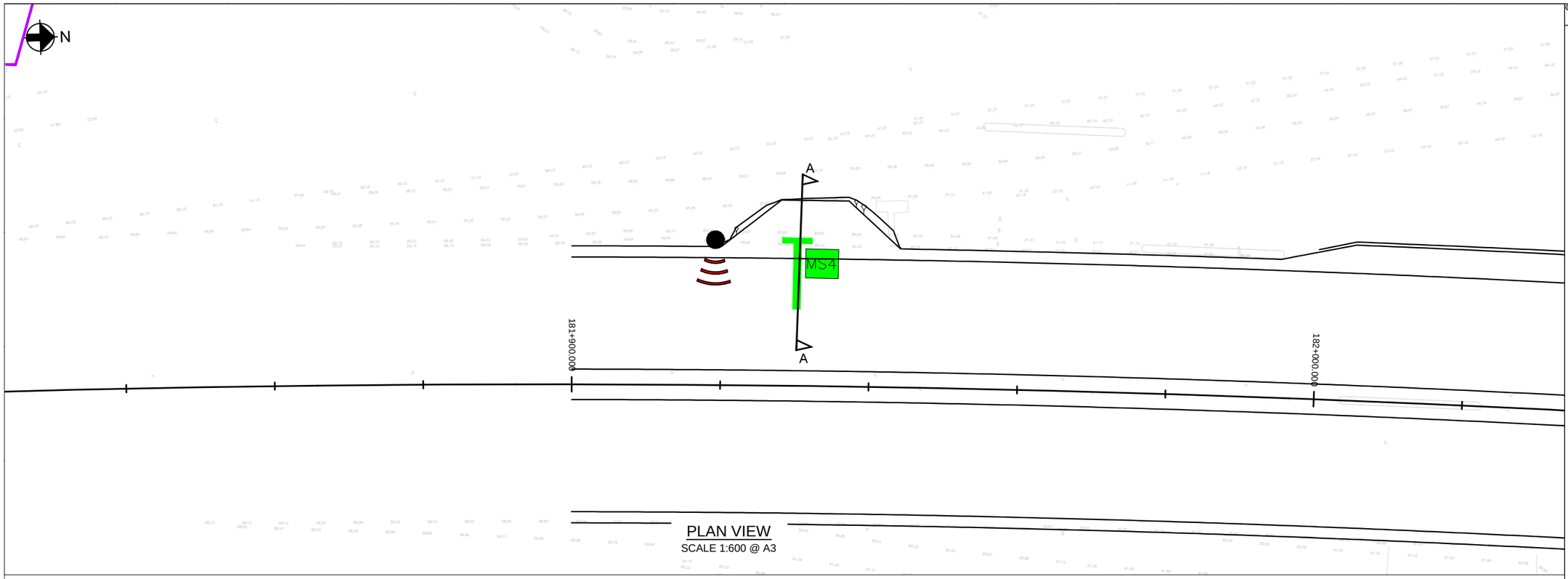
Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

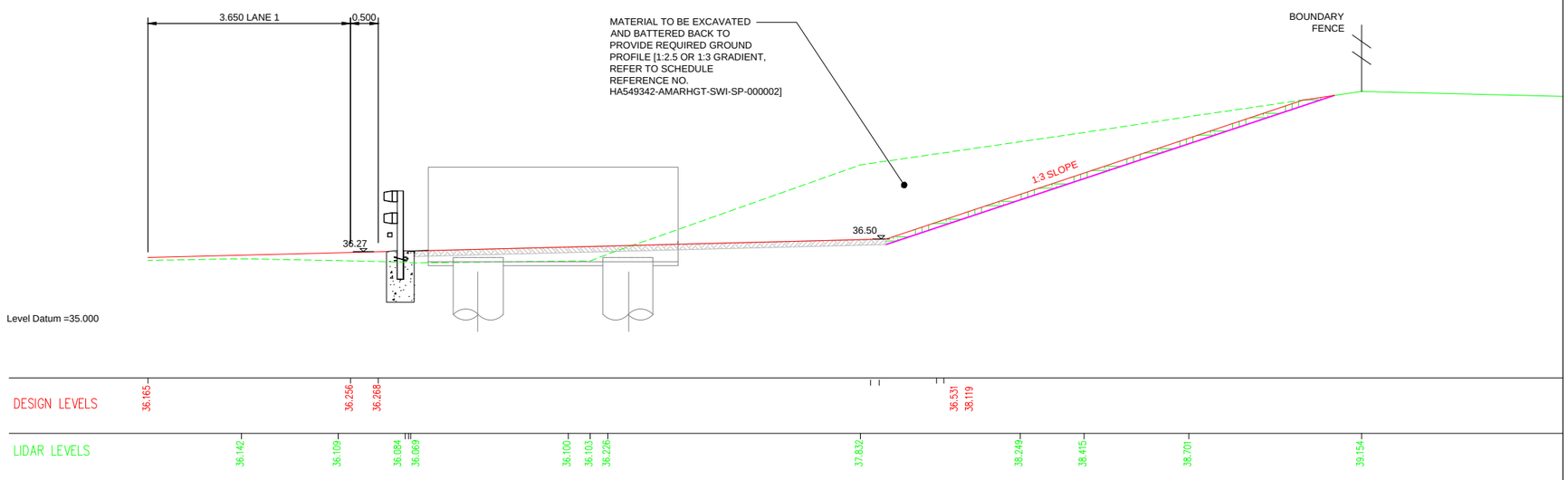
Job No: **244508-00**

Rev: **P03**

Name: **HA549342-AMAR-HGT-E3B3-DR-CE-000001**



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

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PLAN LEGEND

SECTION LINE

HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

PROPOSED GROUND PROFILE
EXISTING GROUND PROFILE
EXISTING GROUND PROFILE TO BE REMOVED
INDICATIVE EXCAVATION PROFILE
GEOTEXTILE SEPARATOR LAYER

TOPSOIL (MINIMUM 0.1m)

VERGE SURFACE

GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

P03	17/04/17	LP	---	SV

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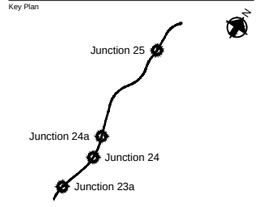
Rev	Date	By	Chkd	Appd

amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 112 CH. 185180
SHEET 01 OF 01

Scale at A1: NA

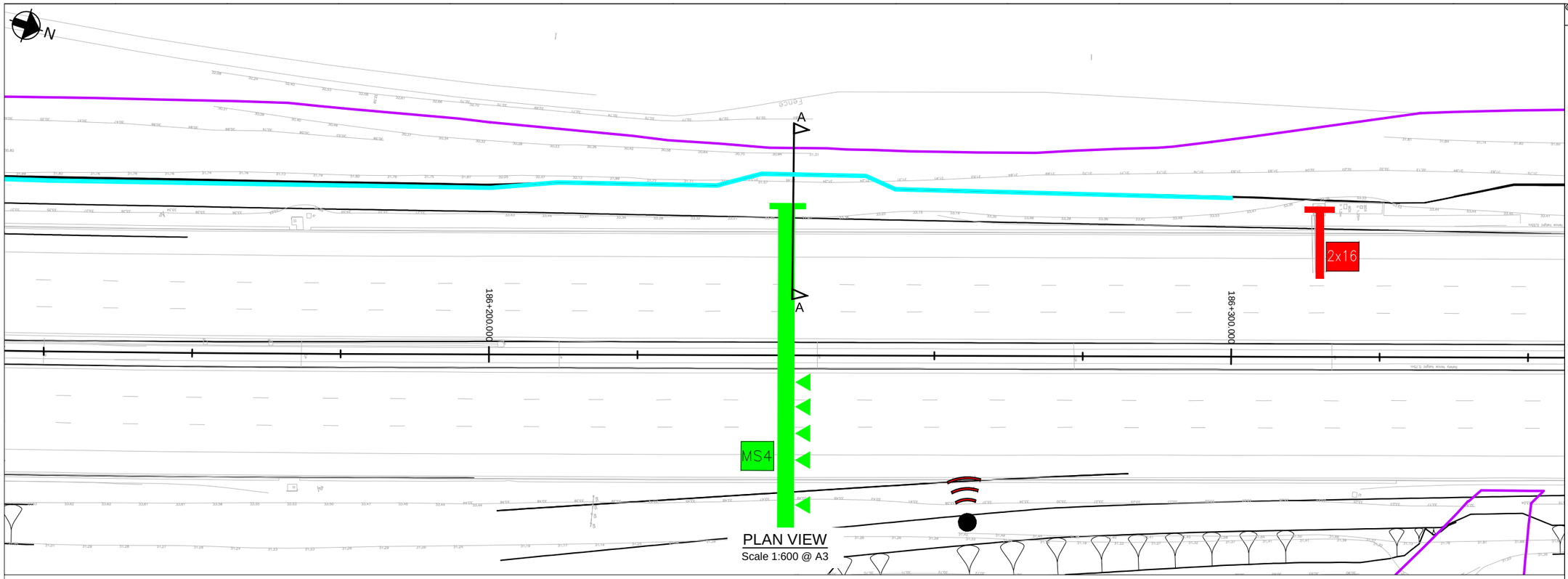
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Suitability: S4 - Fit for construction approval

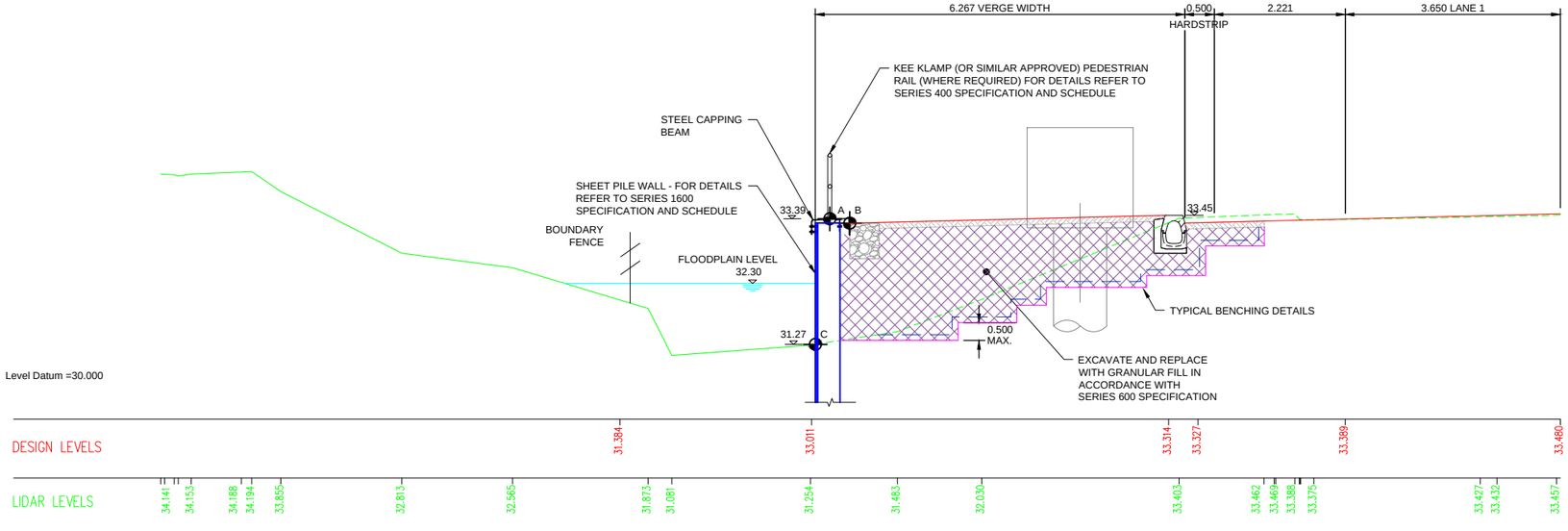
Job No: **244508-00**

Rev: **P03**

Name
HA549342-AMAR-HGT-G112-DR-CE-000001



PLAN VIEW
Scale 1:600 @ A3



SECTION
Scale 1:100 @ A3

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11. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001601.

PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION
- SHEET PILE

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

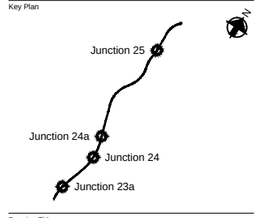
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

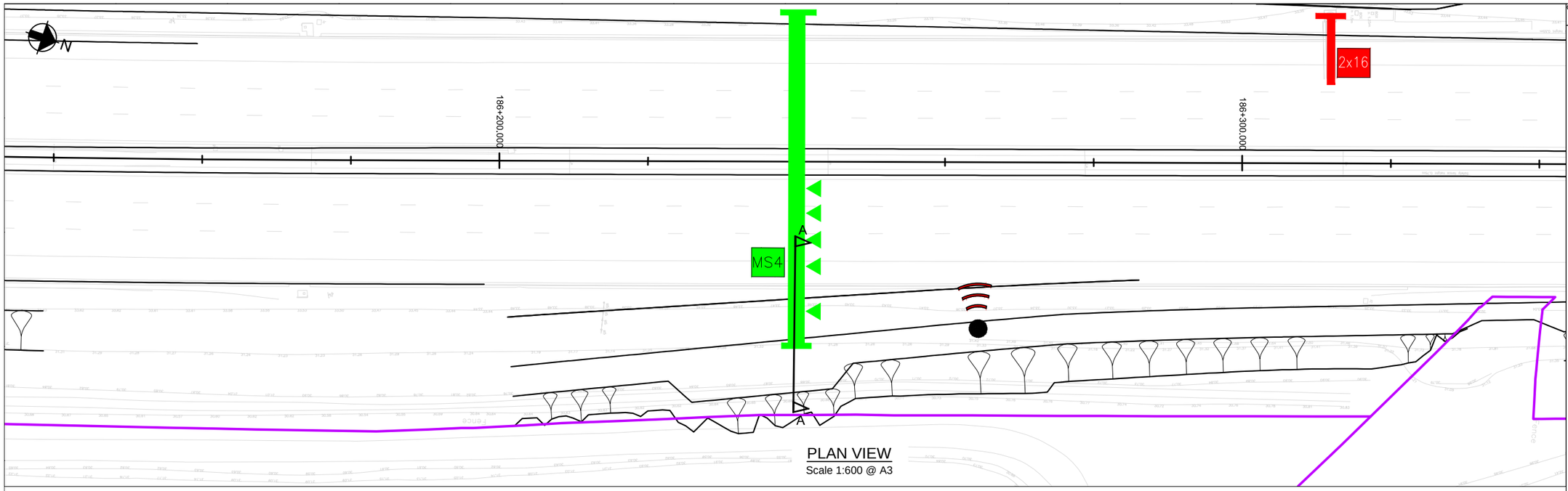
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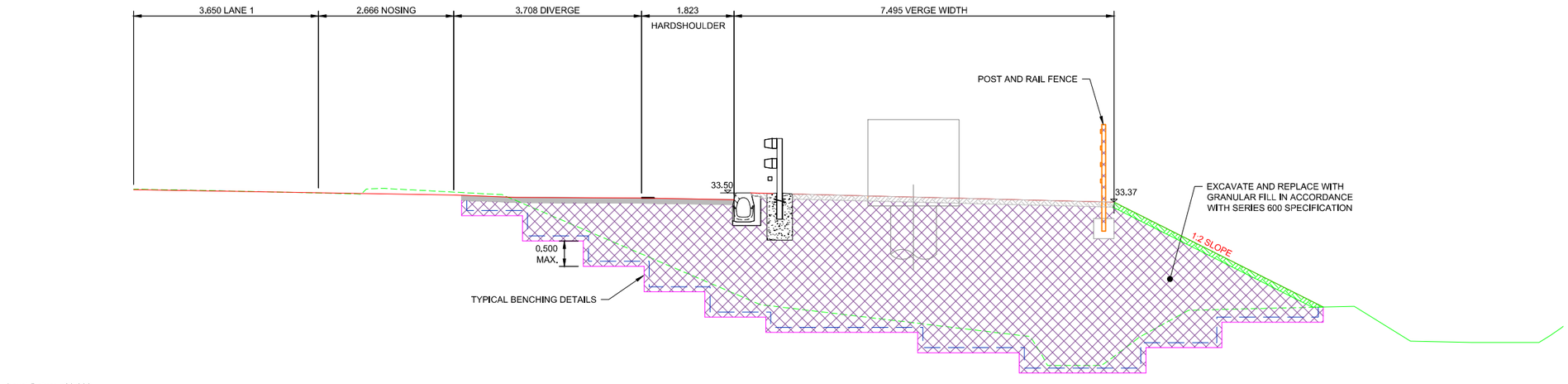
Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 202 NB CH.186240
SHEET 01 OF 02

Scale at A1	NA
Role	Civil - Earthworks and Geotech
Suitability	S4 - Fit for construction approval
Job No	244508-00
Rev	P03
Name	HA549342-AMAR-HGT-G202-DR-CE-000001

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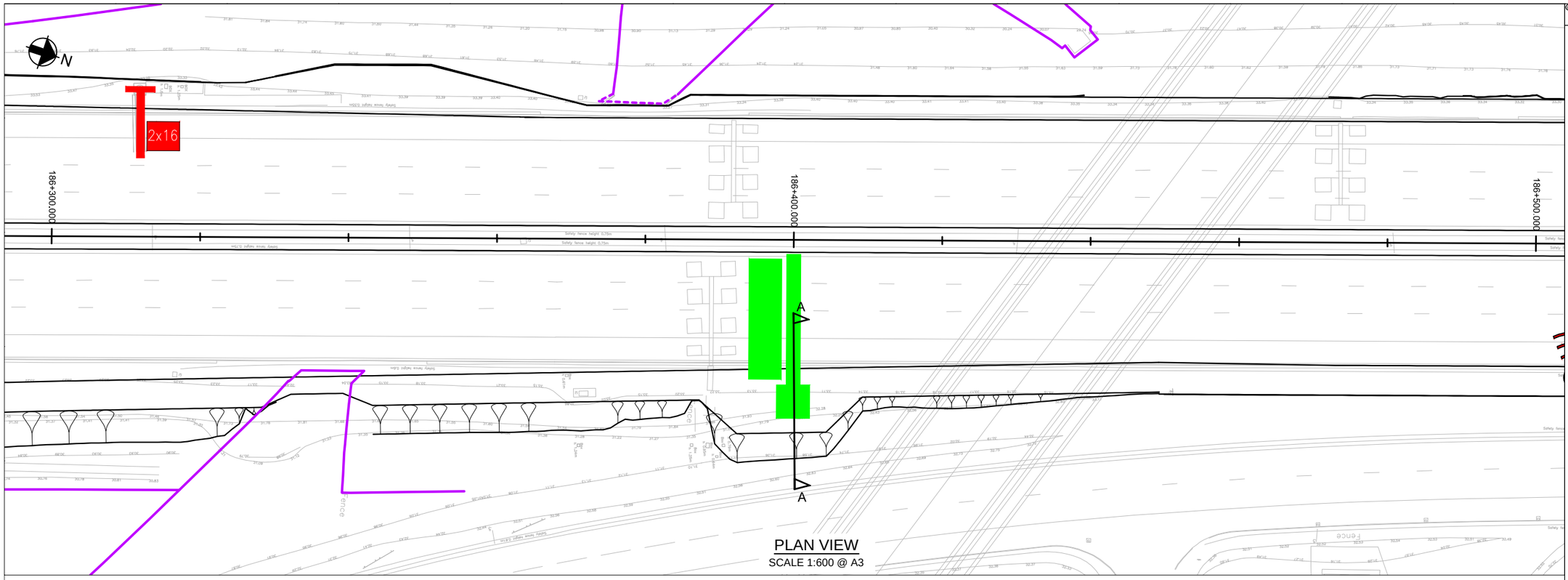
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Scale 1:600 @ A3

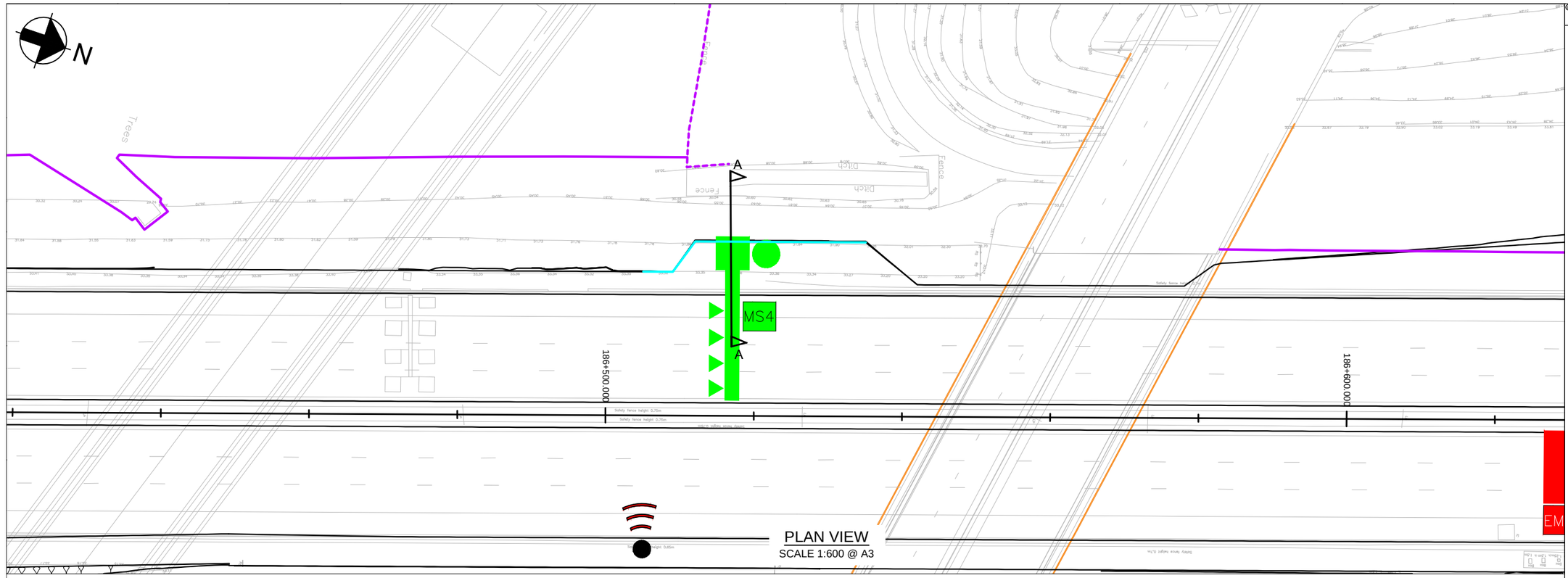


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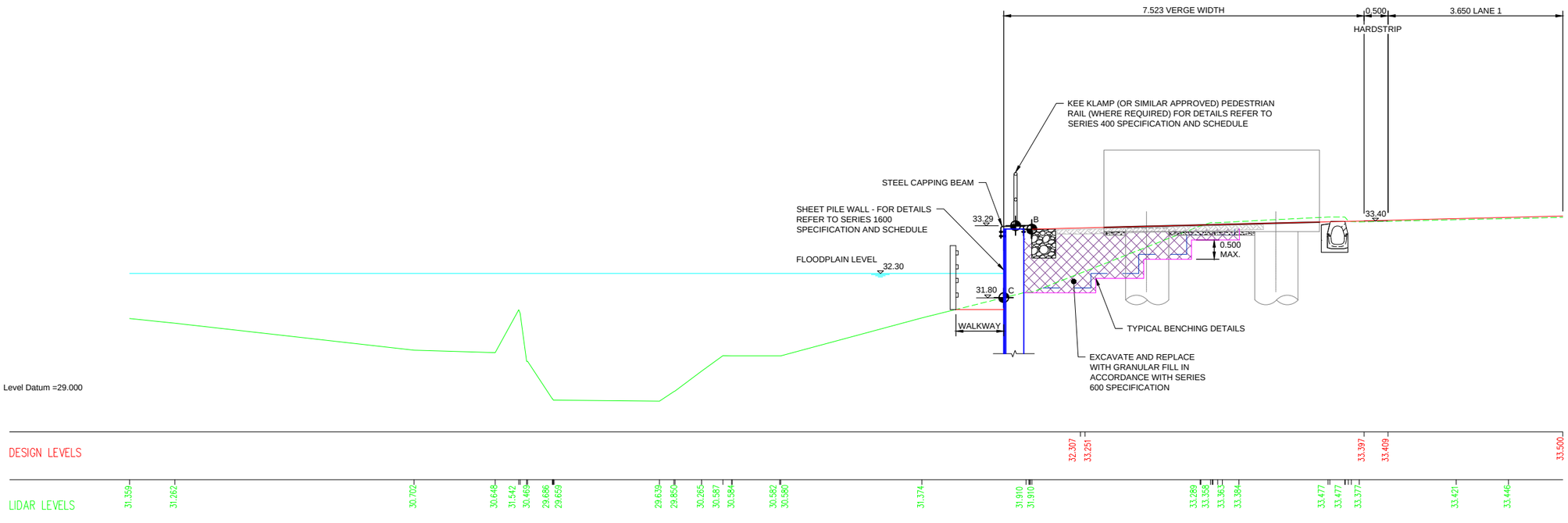
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N
2x16
186+300.000
186+400.000
186+500.000
A
A
Safety fence height 0.25m
Safety fence height 0.25m
Safety fence height 0.25m



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

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PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION
- SHEET PILE

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

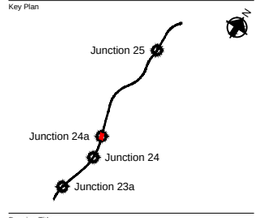
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

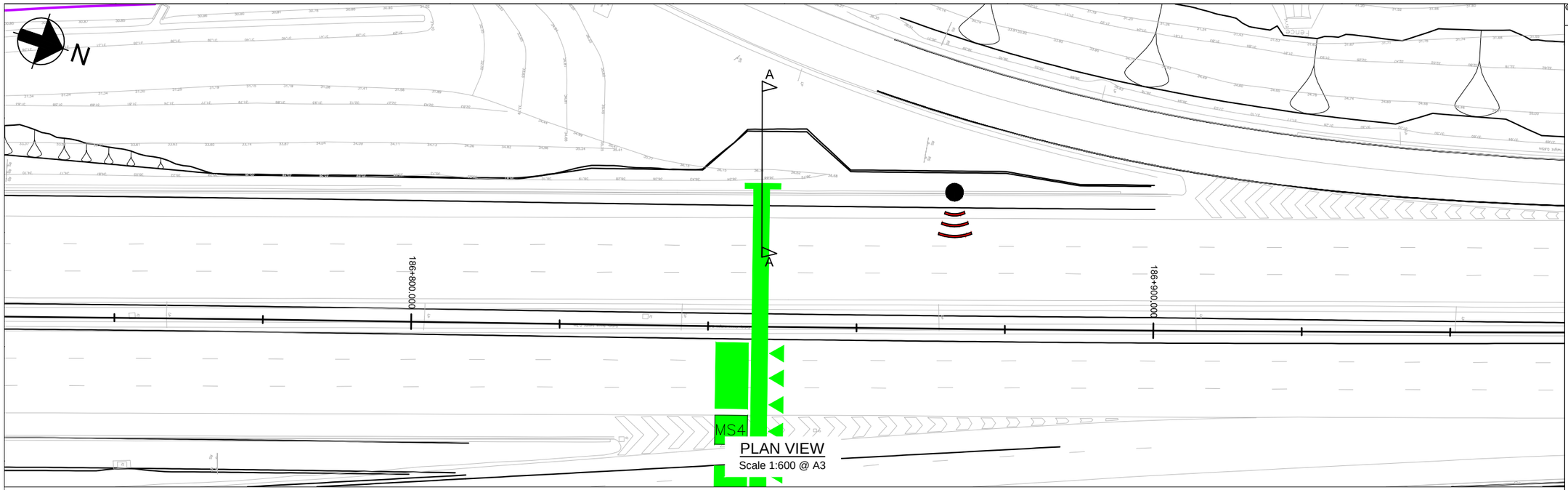
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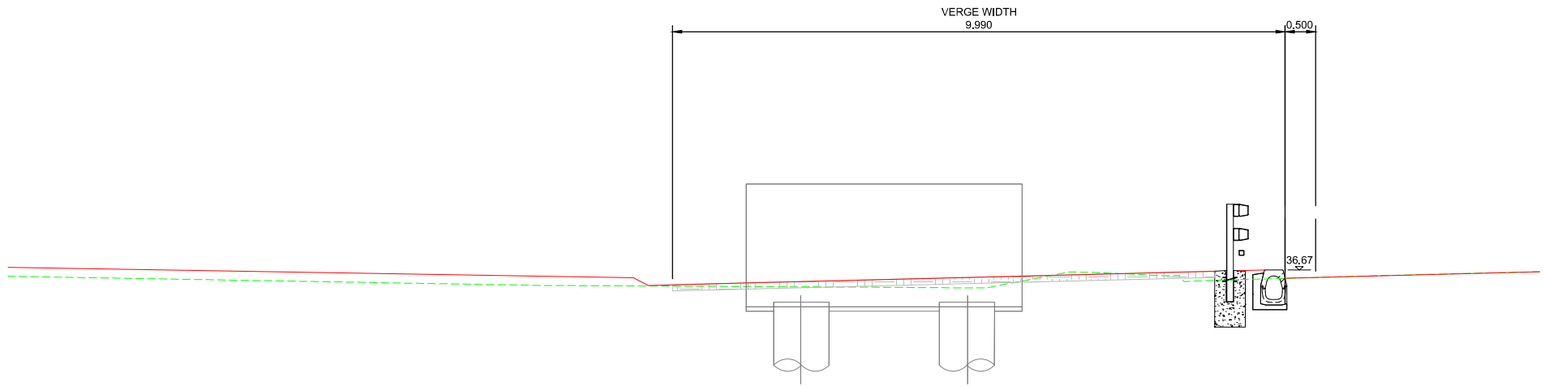
Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 204 CH. 186517
SHEET 01 OF 01

Scale at A1	NA
Role	Civil - Earthworks and Geotech
Suitability	S4 - Fit for construction approval
Job No	244508-00
Rev	P03

Name
HA549342-AMAR-HGT-G204-DR-CE-000001



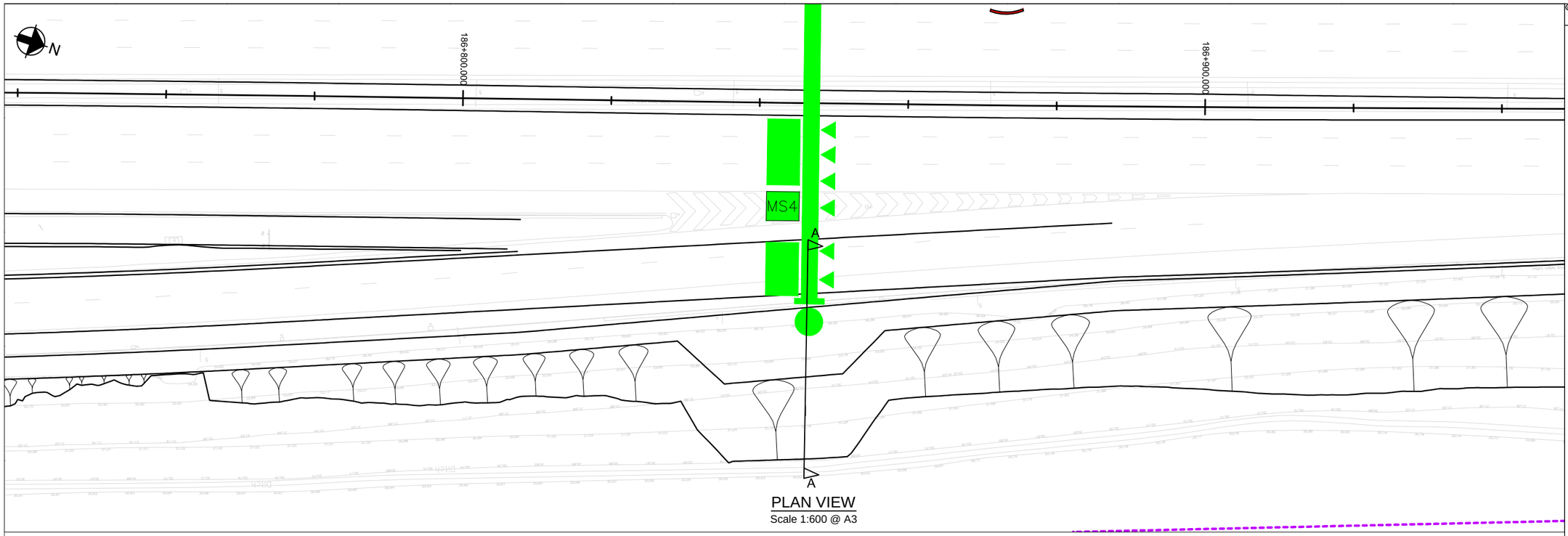
PLAN VIEW
Scale 1:600 @ A3



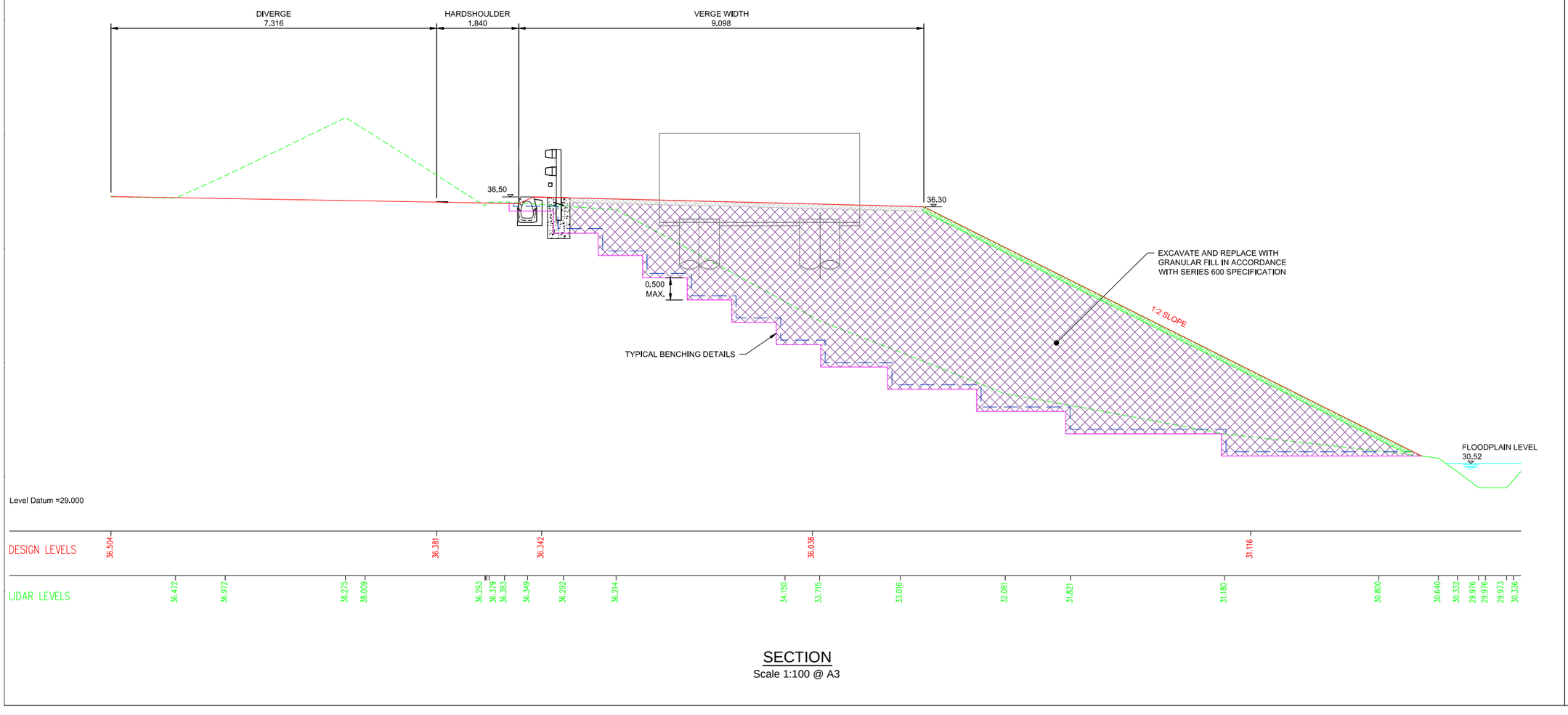
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PLAN VIEW
Scale 1:600 @ A3



SECTION
Scale 1:100 @ A3

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PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

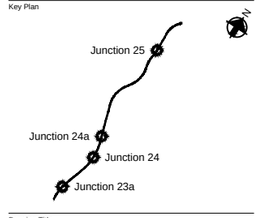
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Colmore Plaza
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Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

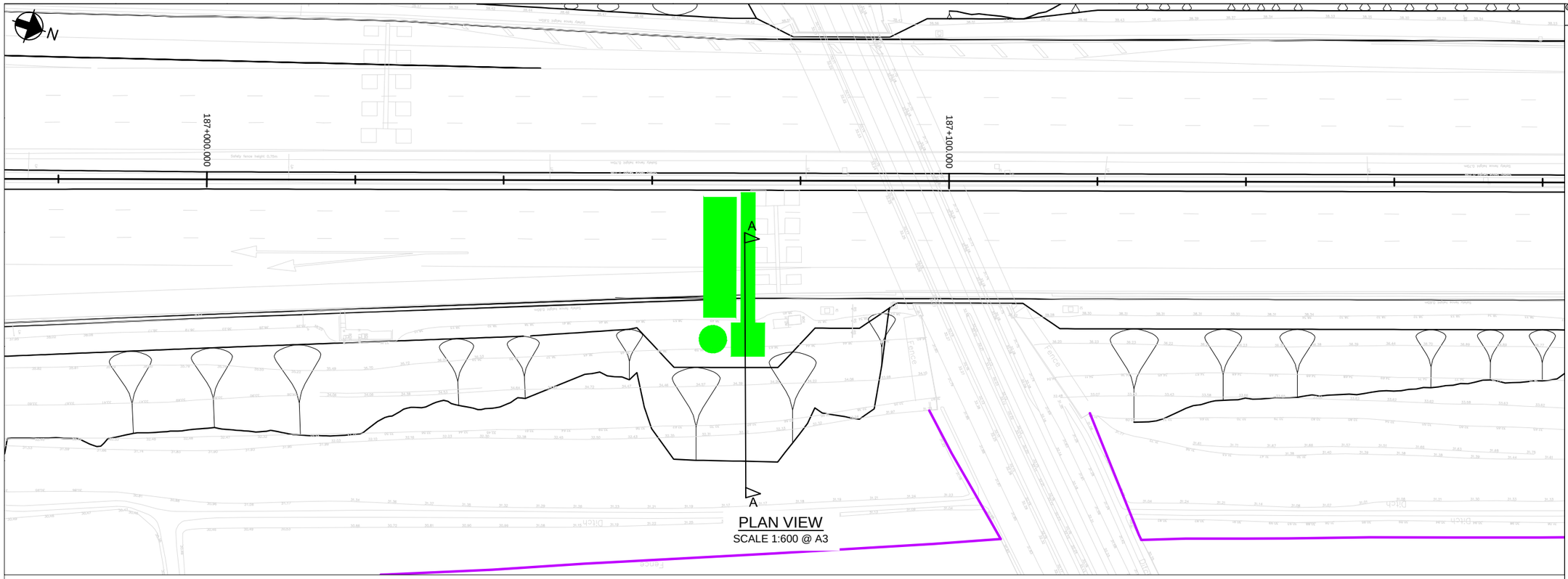
Key Plan



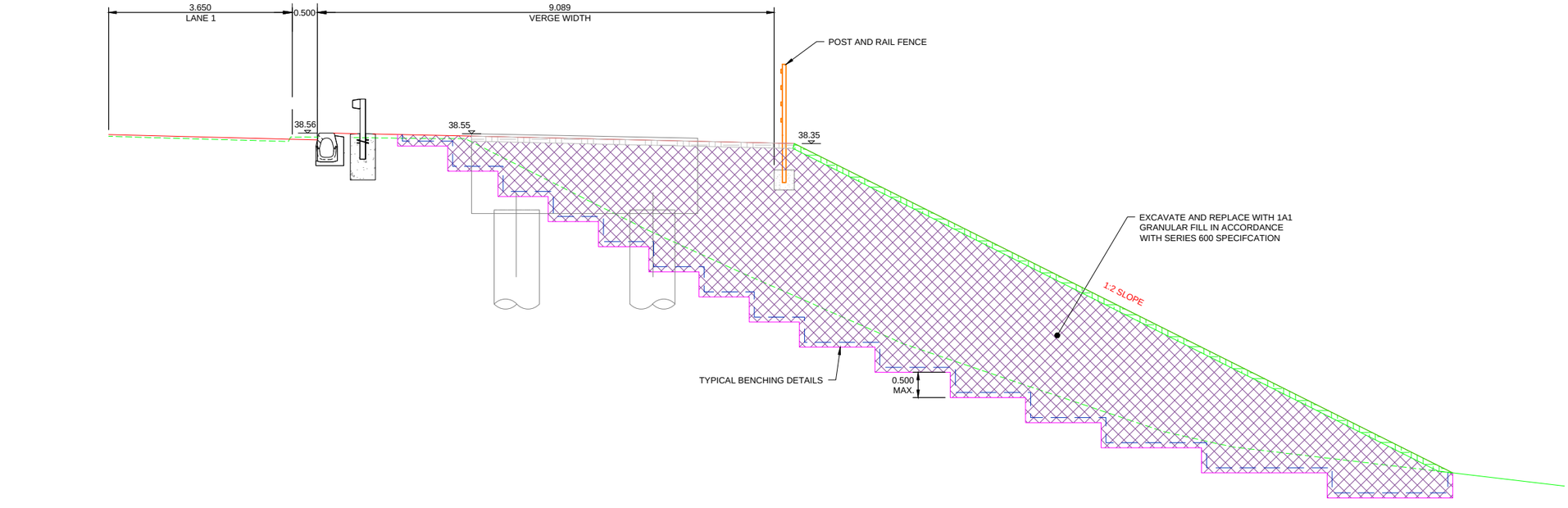
Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 301 SB CH.186847
SHEET 02 OF 02

Scale at A1: NA
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P03**
Name: **HA549342-AMAR-HGT-G301-DR-CE-000002**

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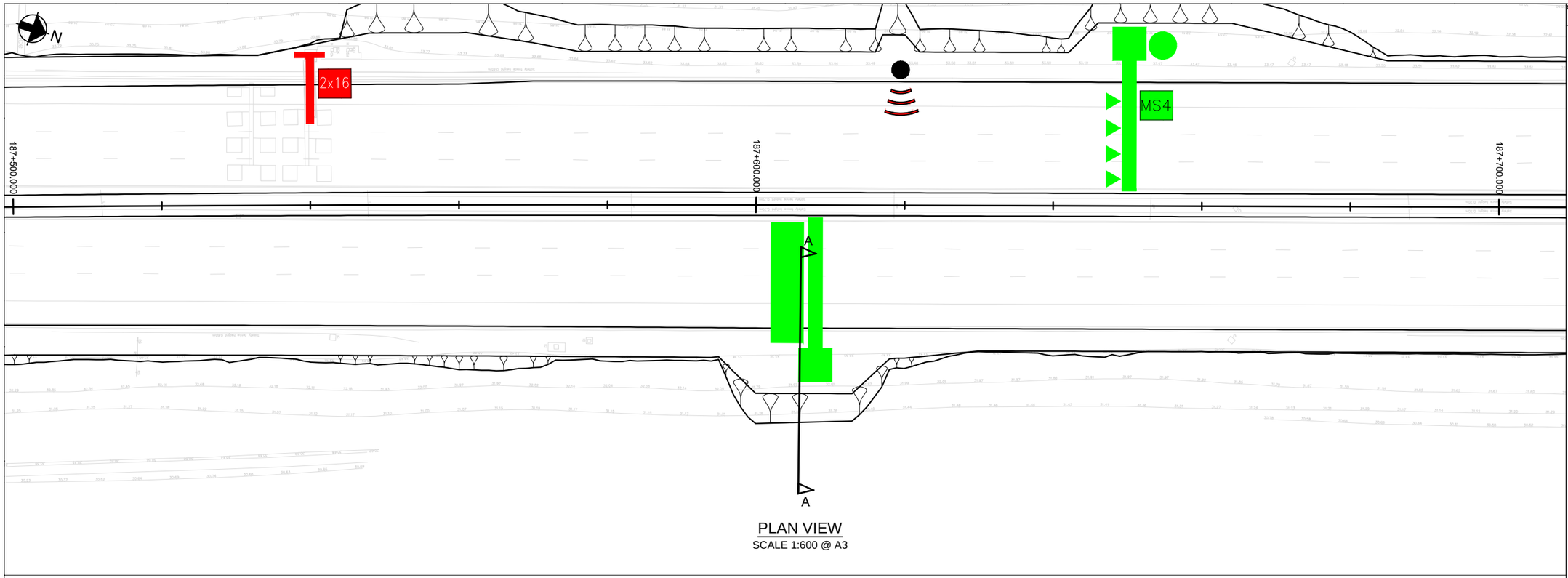


PLAN VIEW
SCALE 1:600 @ A3

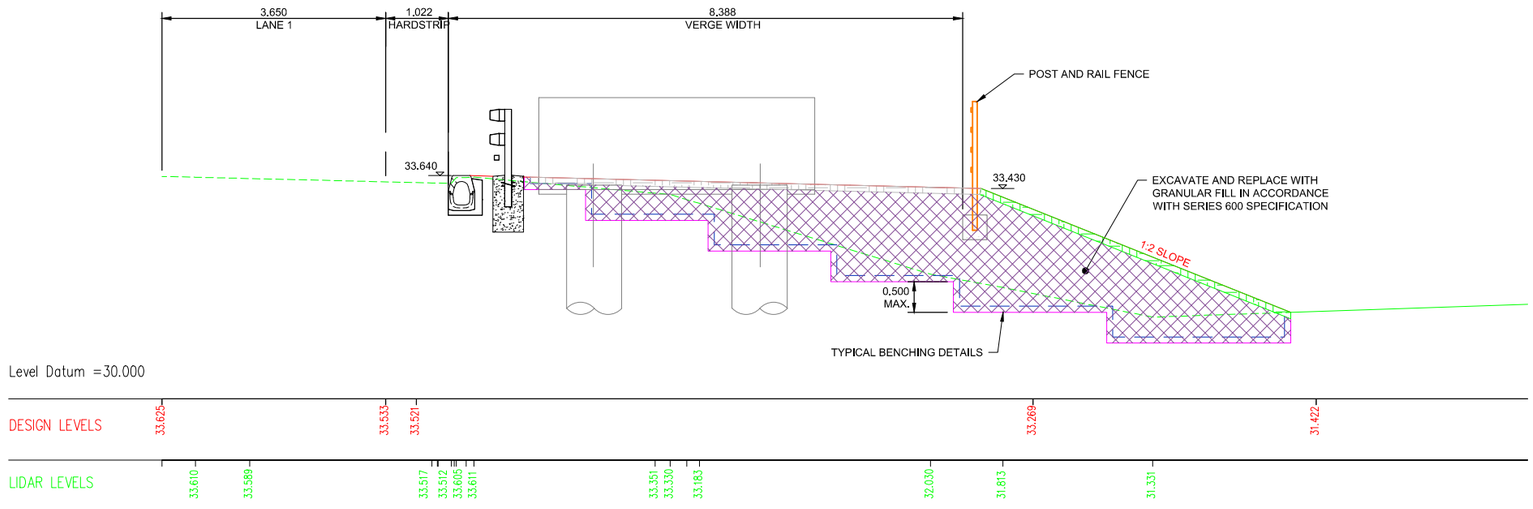


Level Datum =30.000

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PLAN VIEW
SCALE 1:600 @ A3



SECTION
SCALE 1:100 @ A3

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NOTES

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7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. WORST CASE SCENARIOS INDICATED IN SECTION A-A.
10. FOR TYPICAL DETAILS OF EARTHWORK SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000601.

PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

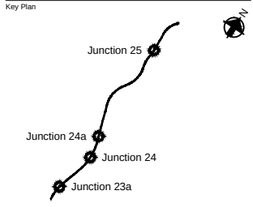
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20 Colmore Circus Queensway
Birmingham B4 6AT
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Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: EARTHWORKS DESIGN SOLUTION
GANTRY 303 CH. 187608
SHEET 01 OF 01

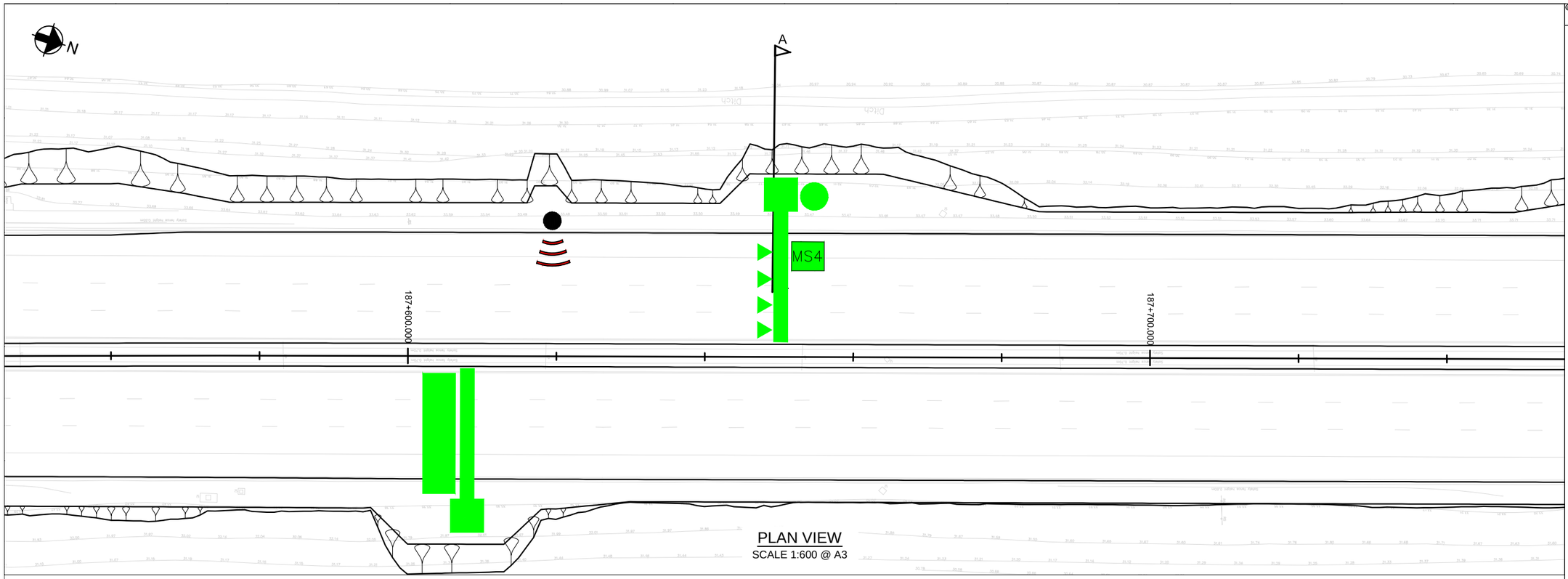
Scale at A1: NA

Role: Civil - Earthworks and Geotech

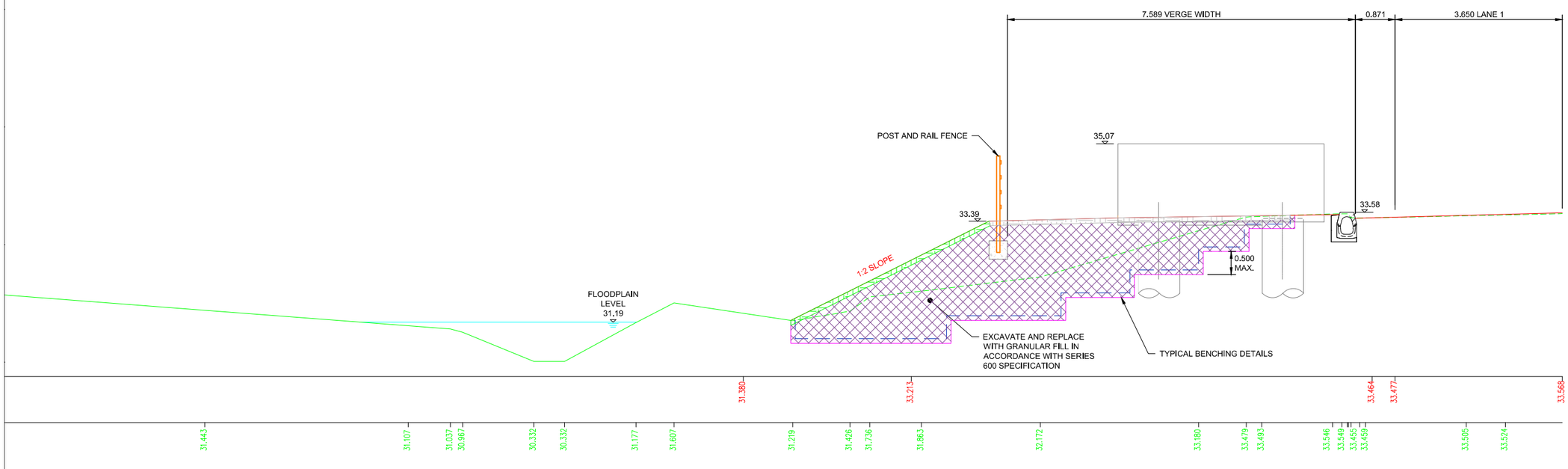
Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P03**

Name: **HA549342-AMAR-HGT-G303-DR-CE-000001**



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

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PLAN LEGEND

SECTION LINE

HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

PROPOSED GROUND PROFILE
EXISTING GROUND PROFILE
EXISTING GROUND PROFILE TO BE REMOVED
INDICATIVE EXCAVATION PROFILE
GEOTEXTILE SEPARATOR LAYER

TOPSOIL (MINIMUM 0.1m)

VERGE SURFACE

GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
P02	24/04/17	TB	---	SV

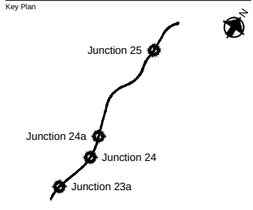
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Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 304 CH. 187650
SHEET 01 OF 01

Scale at A1: NA

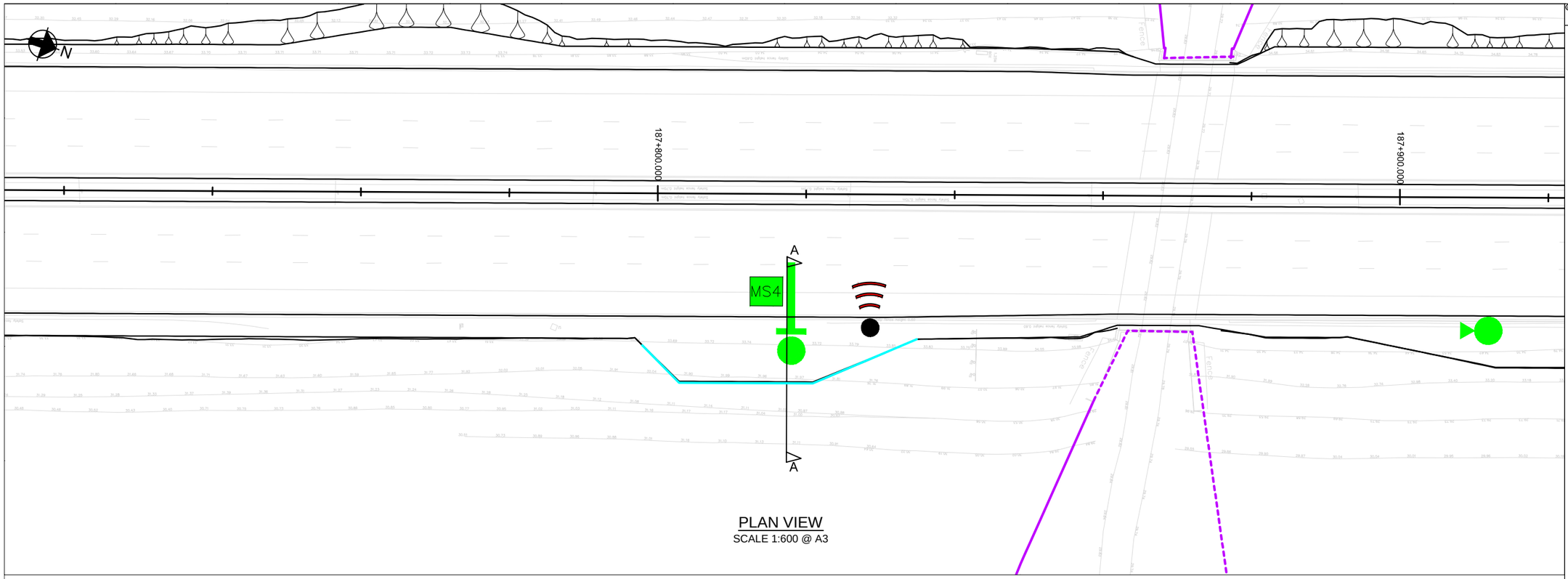
Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

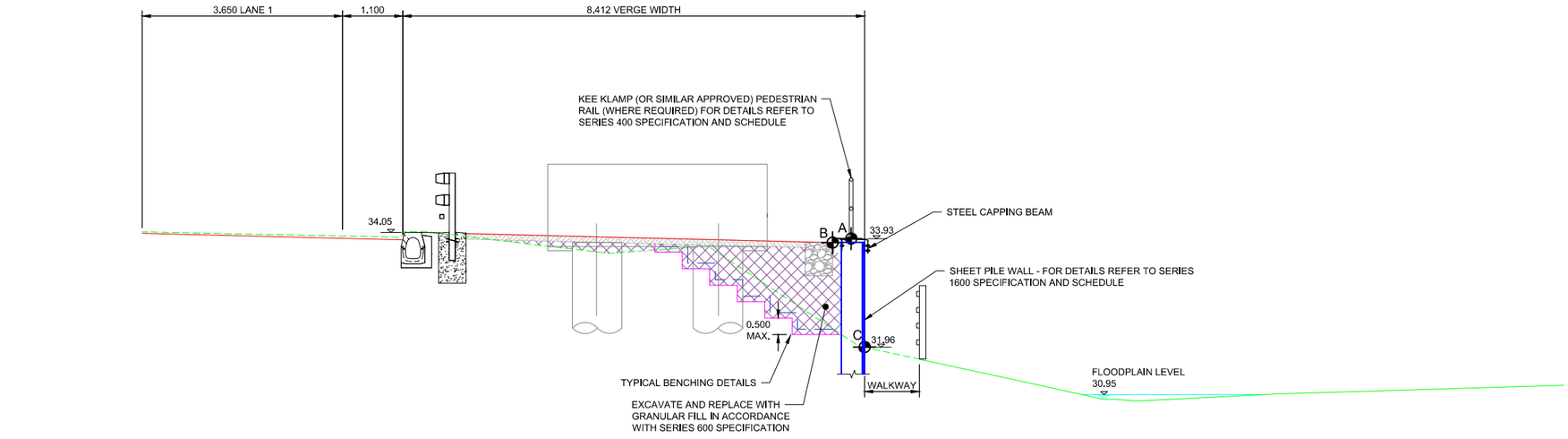
Job No: **244508-00**

Rev: **P02**

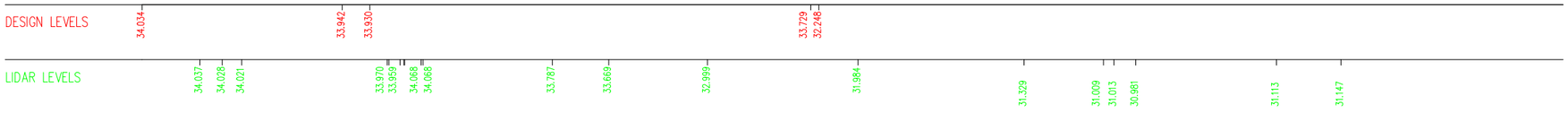
Name
HA549342-AMAR-HGT-G304-DR-CE-000001



PLAN VIEW
SCALE 1:600 @ A3



Level Datum =29.000



SECTION A-A
SCALE 1:100 @ A3

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9. WORST CASE SCENARIOS INDICATED IN SECTION A-A.
10. FOR ELEVATION PLANS PLEASE REFER TO DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-001603 TO HA549342-AMAR-HGT-SWI-DR-CE-001645.
11. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001601.

PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION
- SHEET PILE

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

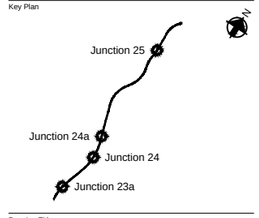
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan

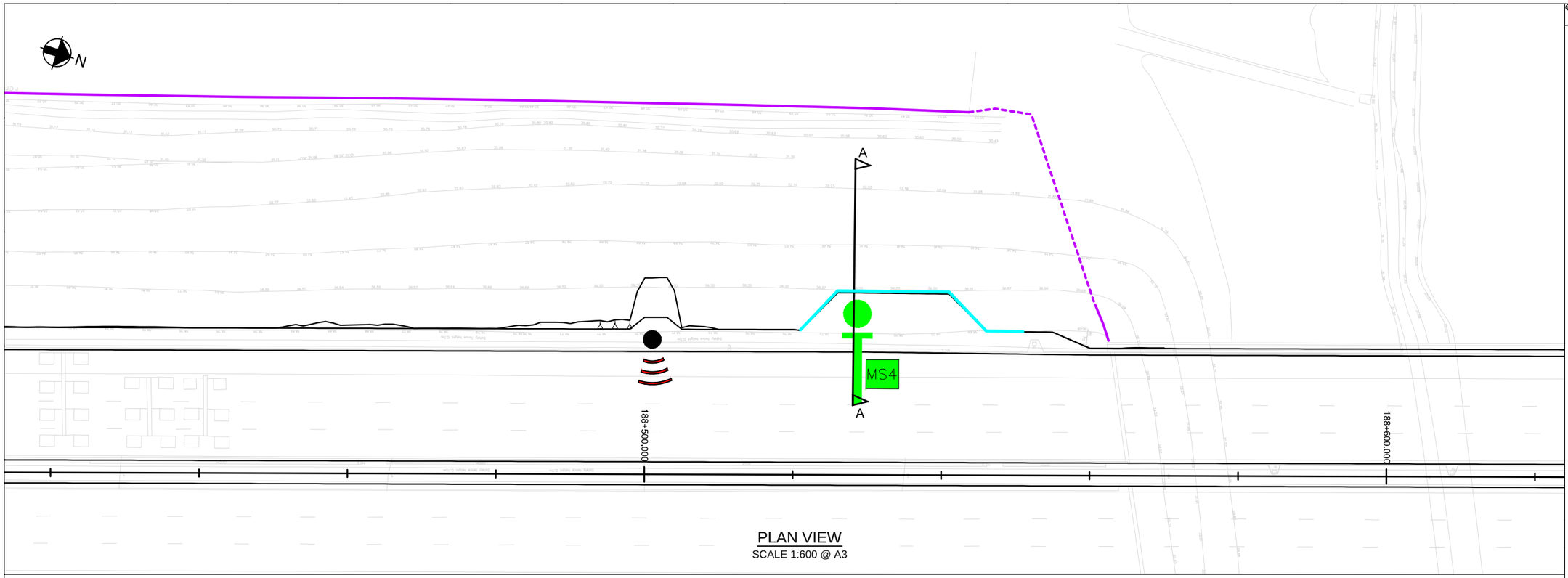


Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 305 CH. 187818
SHEET 01 OF 01

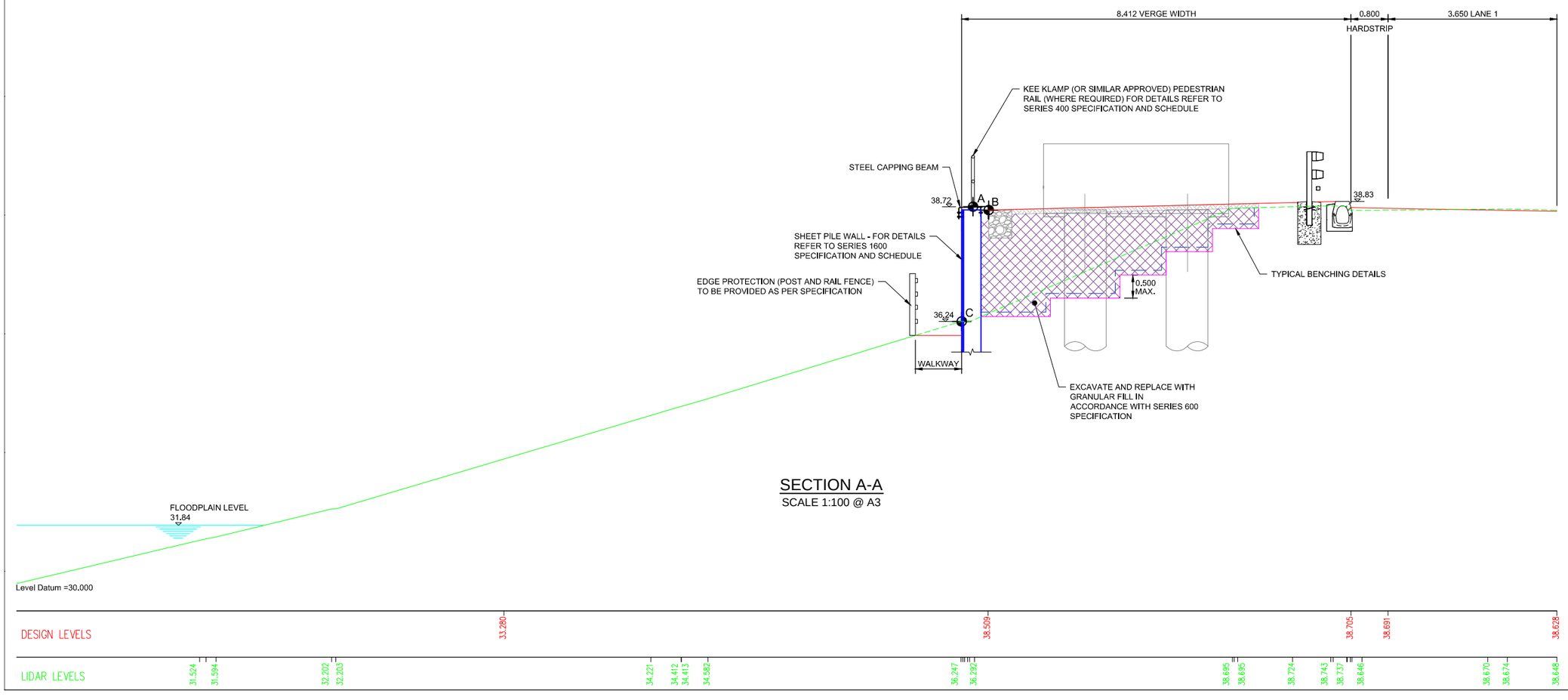
Scale at A1	NA
Role	Civil - Earthworks and Geotech
Suitability	S4 - Fit for construction approval
Job No	244508-00
Rev	P03

Name
HA549342-AMAR-HGT-G305-DR-CE-000001

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PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

NOTES

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10. FOR TYPICAL DETAILS OF EARTHWORK SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000601.

PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

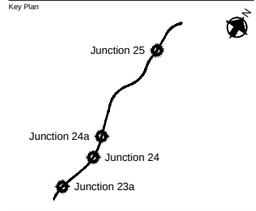
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Client: highways england driving forward

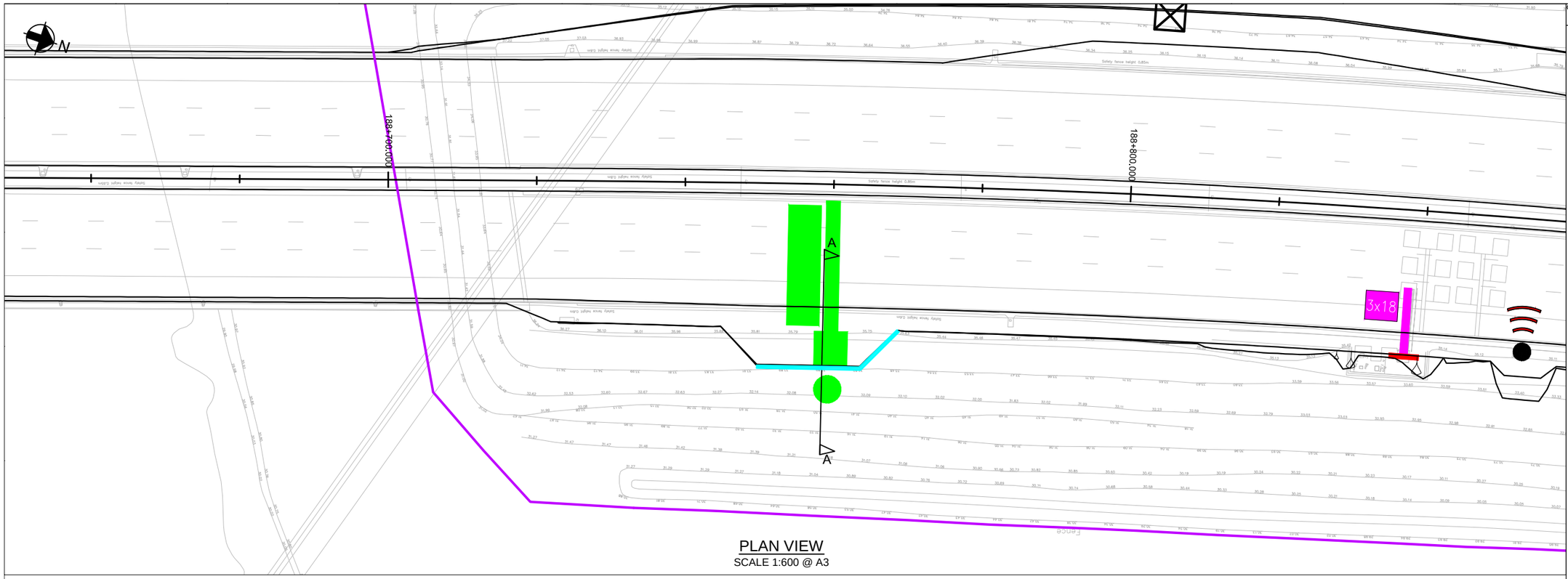
Project Title
SMP M1 J23a - J25

Key Plan

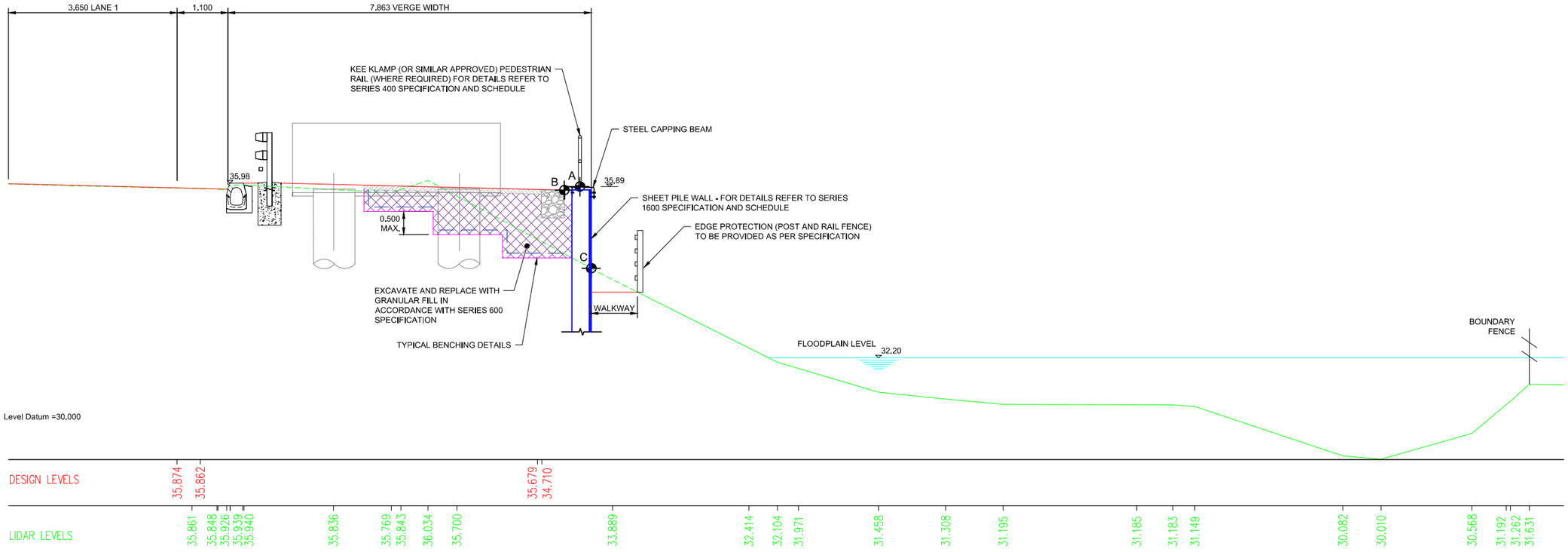


Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 307 CH. 188529
SHEET 01 OF 01

Scale at A1: NA
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P03**
Name: **HA549342-AMAR-HGT-G307-DR-CE-000001**



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

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11. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001601.

PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
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- VERGE SURFACE
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- SHEET PILE

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

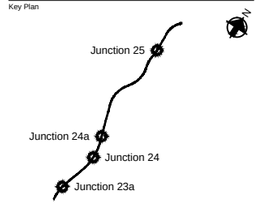
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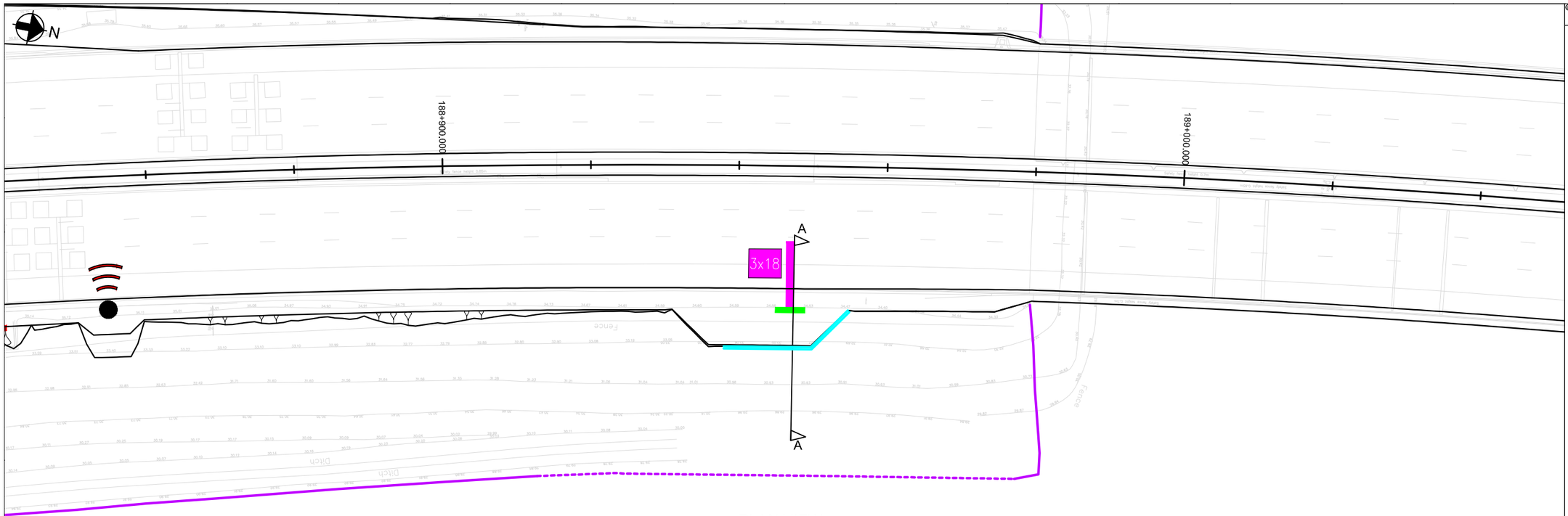
Project Title
SMP M1 J23a - J25

Key Plan

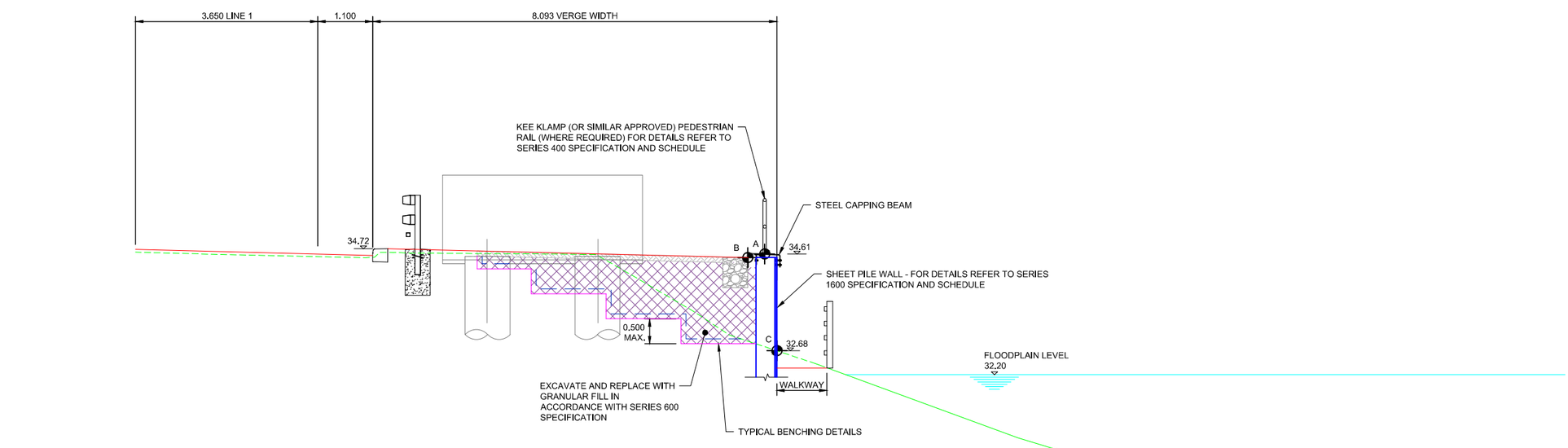


Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 308 CH. 188760
SHEET 01 OF 01

Scale at A1: NA
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P03
Name: HA549342-AMAR-HGT-G308-DR-CE-000001



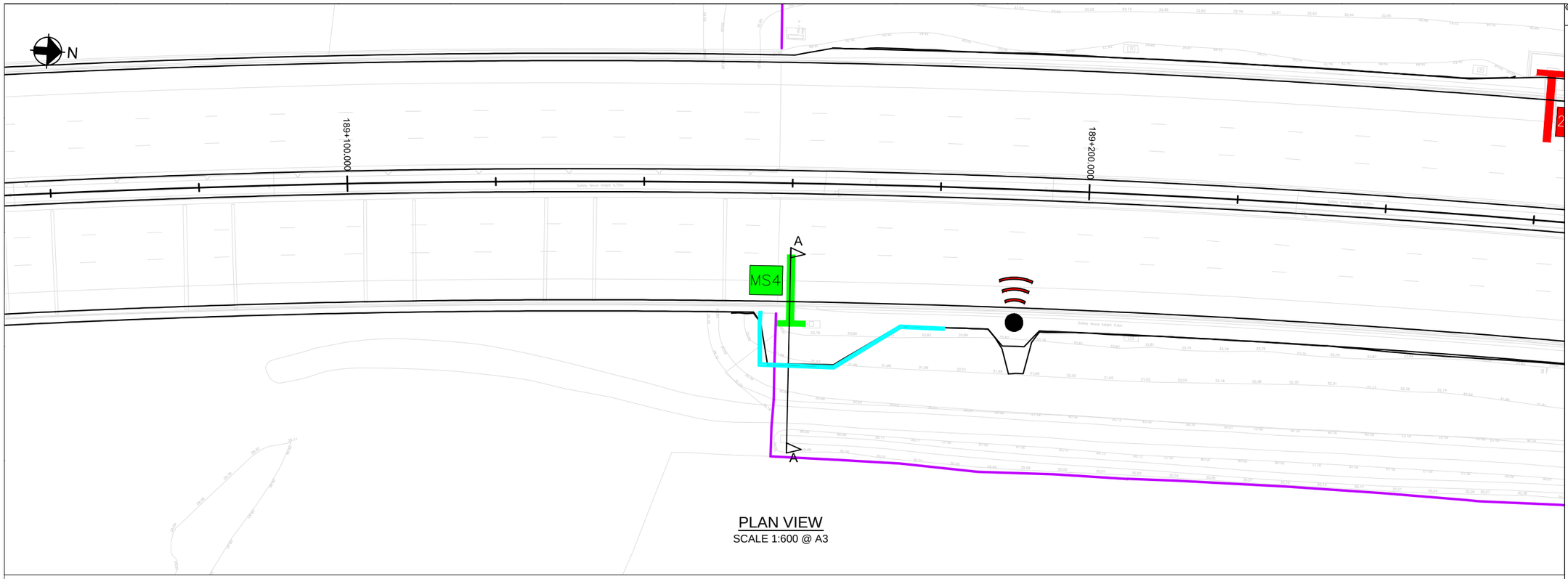
PLAN VIEW
SCALE 1:600 @ A3



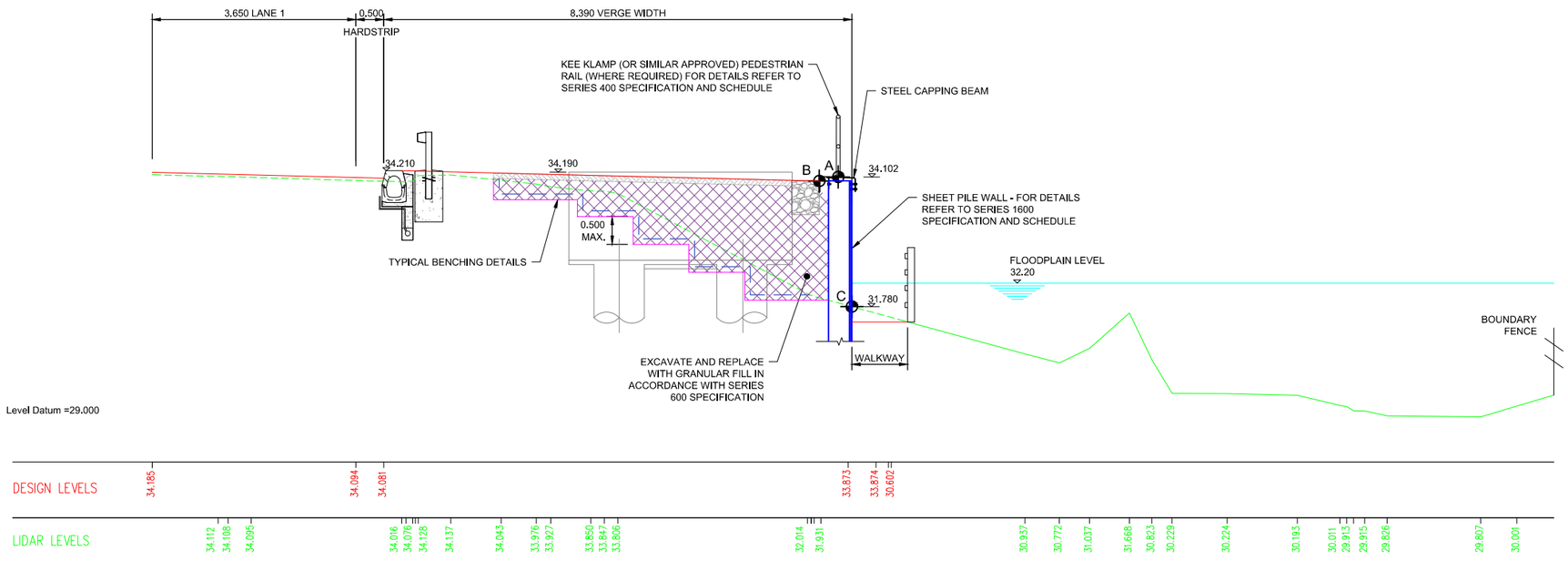
SECTION A-A
SCALE 1:100 @ A3

Level Datum =29.000

| | | |



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

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6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150mm FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300mm FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.EXCAVATION PROFILES WILL VARY,
9. WORST CASE SCENARIOS INDICATED IN SECTION A-A.
10. FOR ELEVATION PLANS PLEASE REFER TO DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-001603 TO HA549342-AMAR-HGT-SWI-DR-CE-001645.
11. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001601.

PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION
- SHEET PILE

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

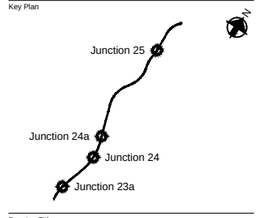
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

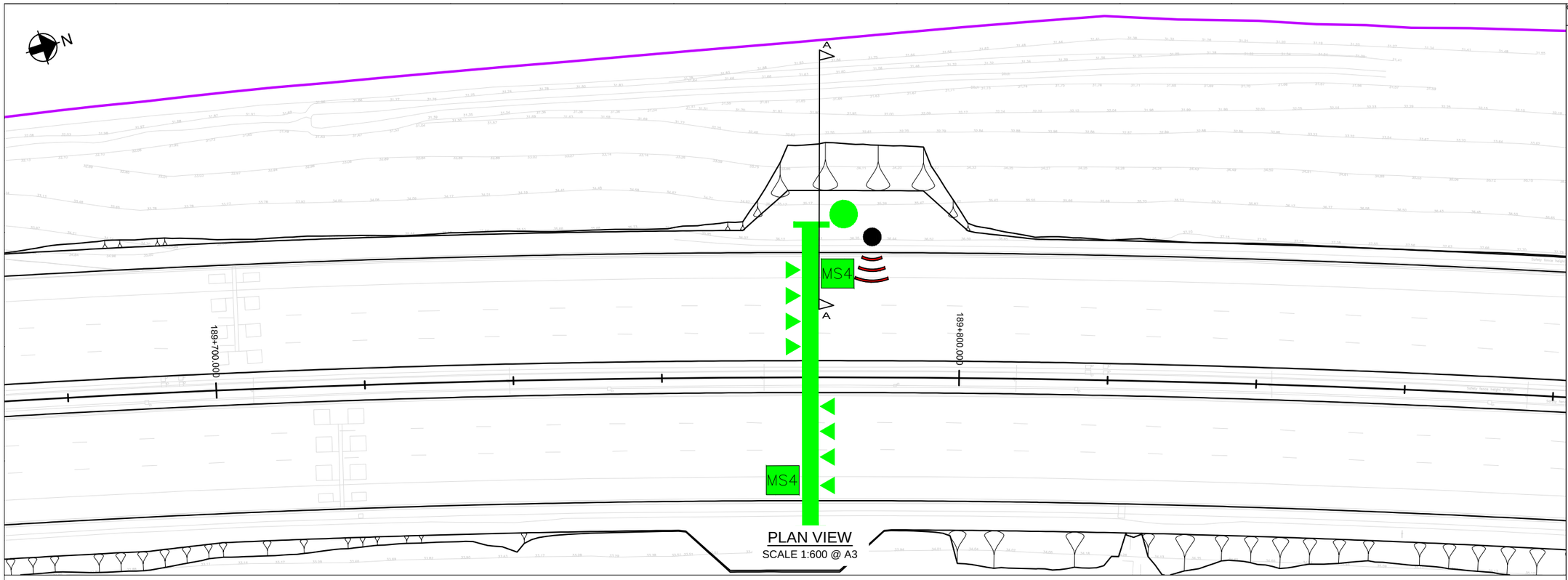
Key Plan



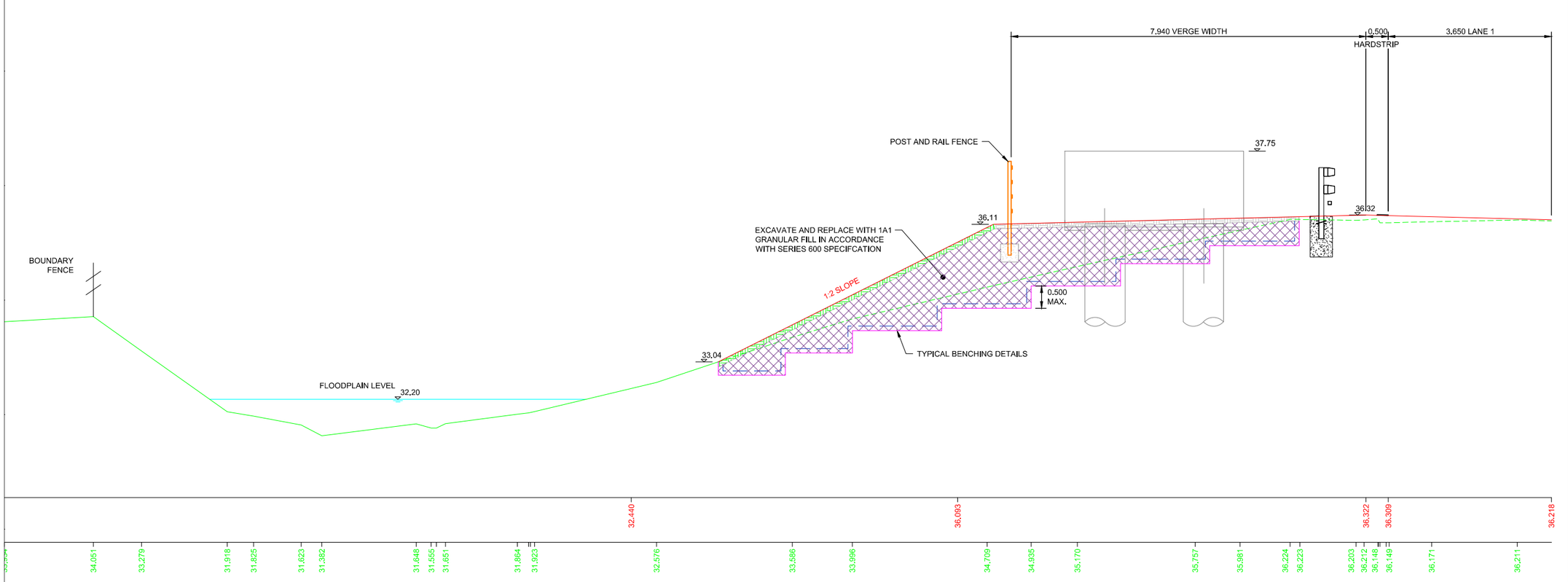
Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 310 CH. 189160
SHEET 01 OF 01

Scale at A1: NA
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P03
Name: HA549342-AMAR-HGT-G310-DR-CE-000001

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PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

NOTES

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000002).
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8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. WORST CASE SCENARIOS INDICATED IN SECTION A-A.
10. FOR TYPICAL DETAILS OF EARTHWORK SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000601.

PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

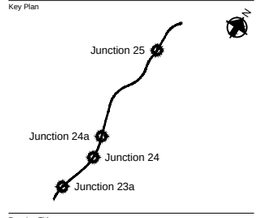
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Client: highways england driving forward

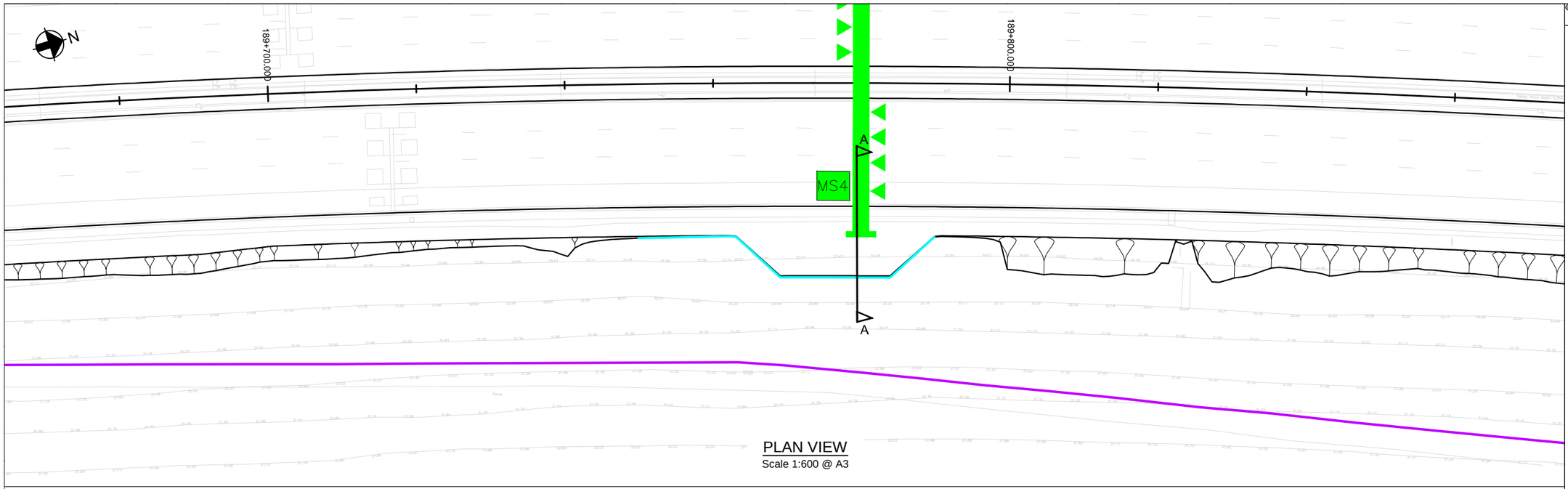
Project Title
SMP M1 J23a - J25

Key Plan

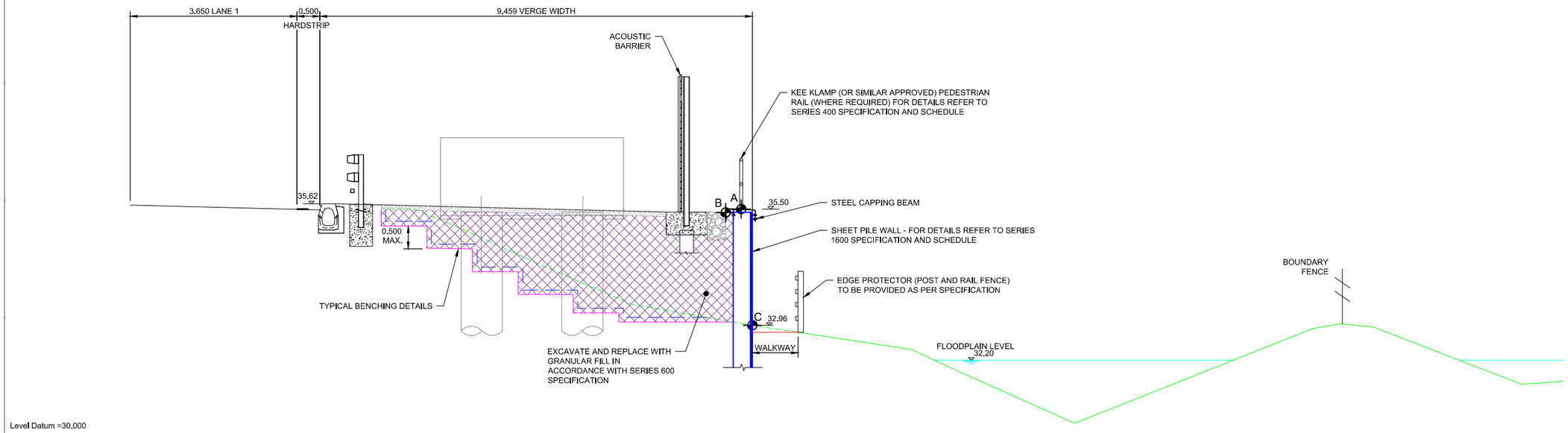


Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 311 NB CH. 189780
SHEET 01 OF 02

Scale at A1: NA
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P03
Name: HA549342-AMAR-HGT-G311-DR-CE-000001



PLAN VIEW
Scale 1:600 @ A3



SECTION A-A
Scale 1:100 @ A3

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11. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001601.

PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION
- SHEET PILE

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

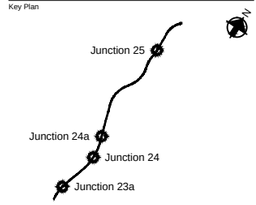
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Client: highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 311 SB CH.189780
CH. TO CH.
SHEET 01 OF 01

Scale at A1: NA

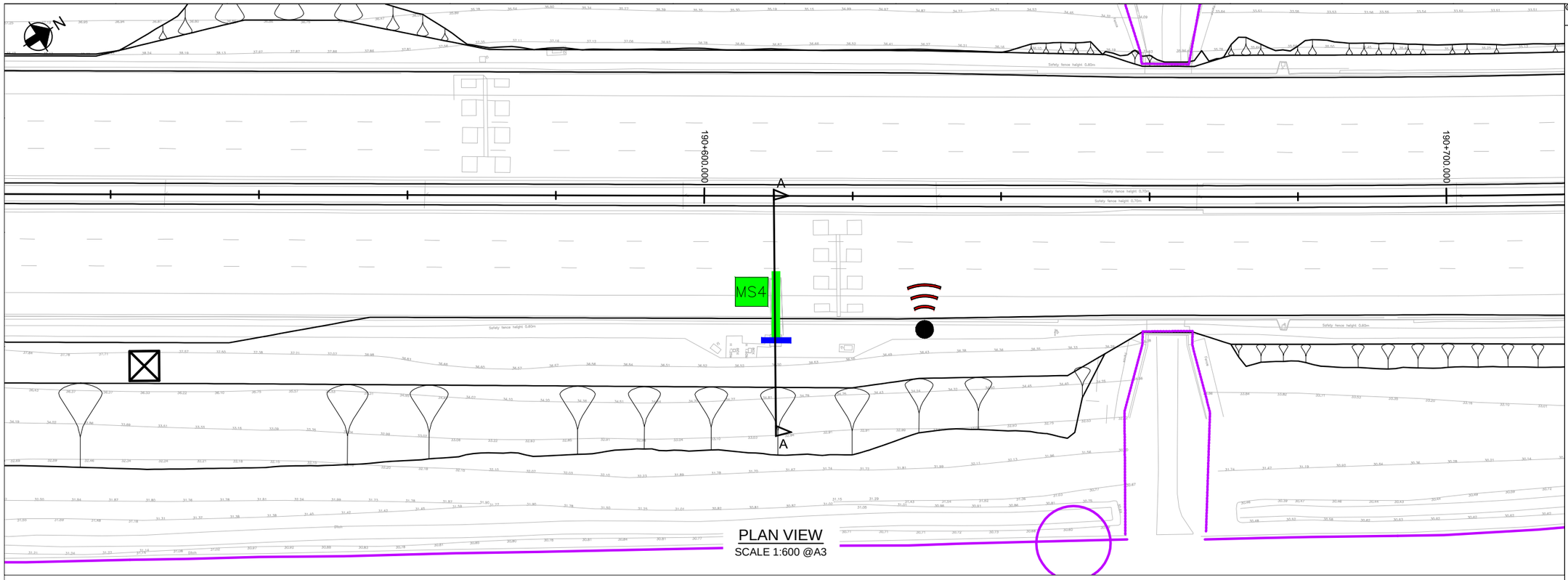
Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

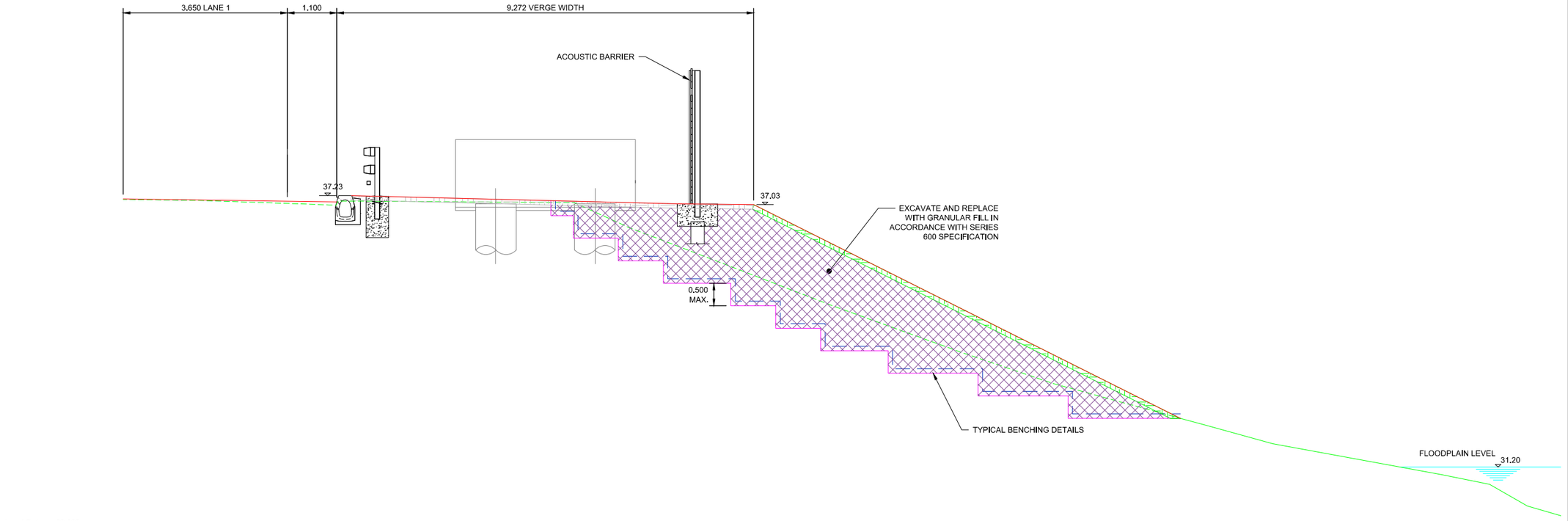
Job No: **244508-00**

Rev: **P03**

Name
HA549342-AMAR-HGT-G311-DR-CE-000002



PLAN VIEW
SCALE 1:600 @A3



SECTION
SCALE 1:100 @A3

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NOTES

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10. FOR TYPICAL DETAILS OF EARTHWORK SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000601.

PLAN LEGEND

SECTION LINE

HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

PROPOSED GROUND PROFILE
EXISTING GROUND PROFILE
EXISTING GROUND PROFILE TO BE REMOVED
INDICATIVE EXCAVATION PROFILE
GEOTEXTILE SEPARATOR LAYER
TOPSOIL (MINIMUM 0.1m)
VERGE SURFACE
GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

P02	17/04/17	LP	---	SV

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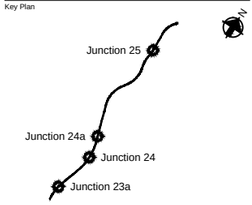
Rev	Date	By	Chkd	Appd

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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

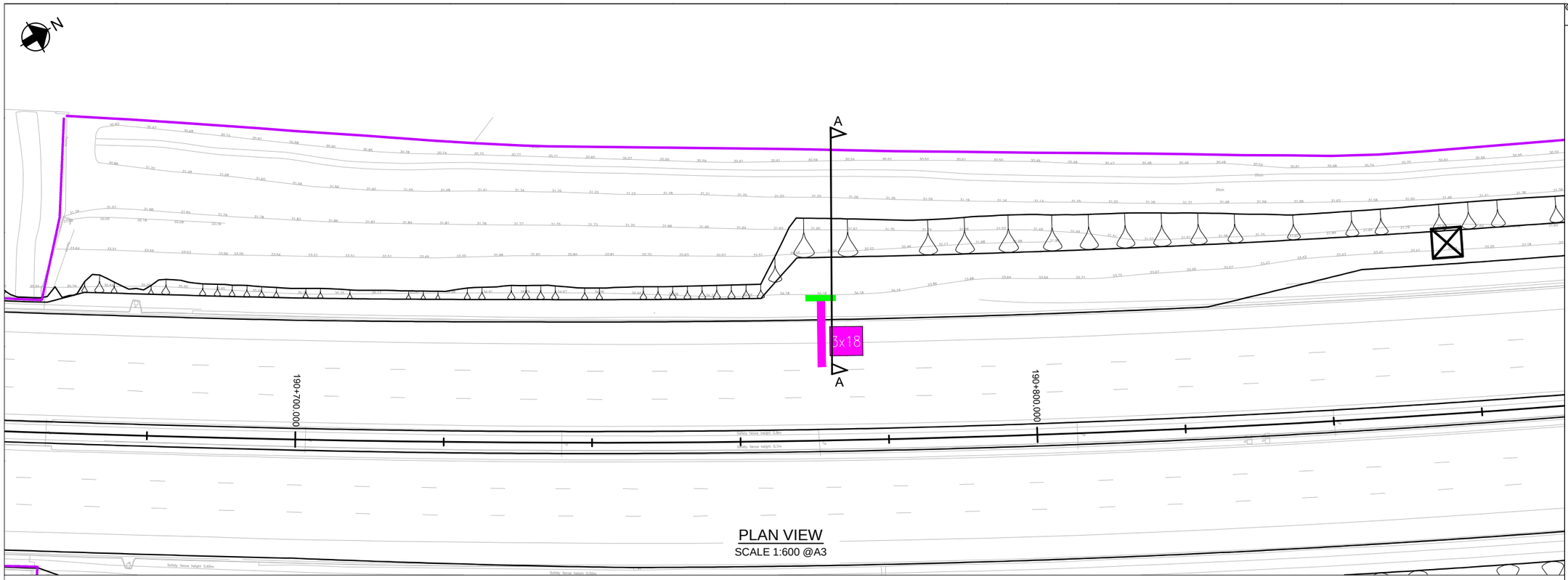
Project Title
SMP M1 J23a - J25

Key Plan

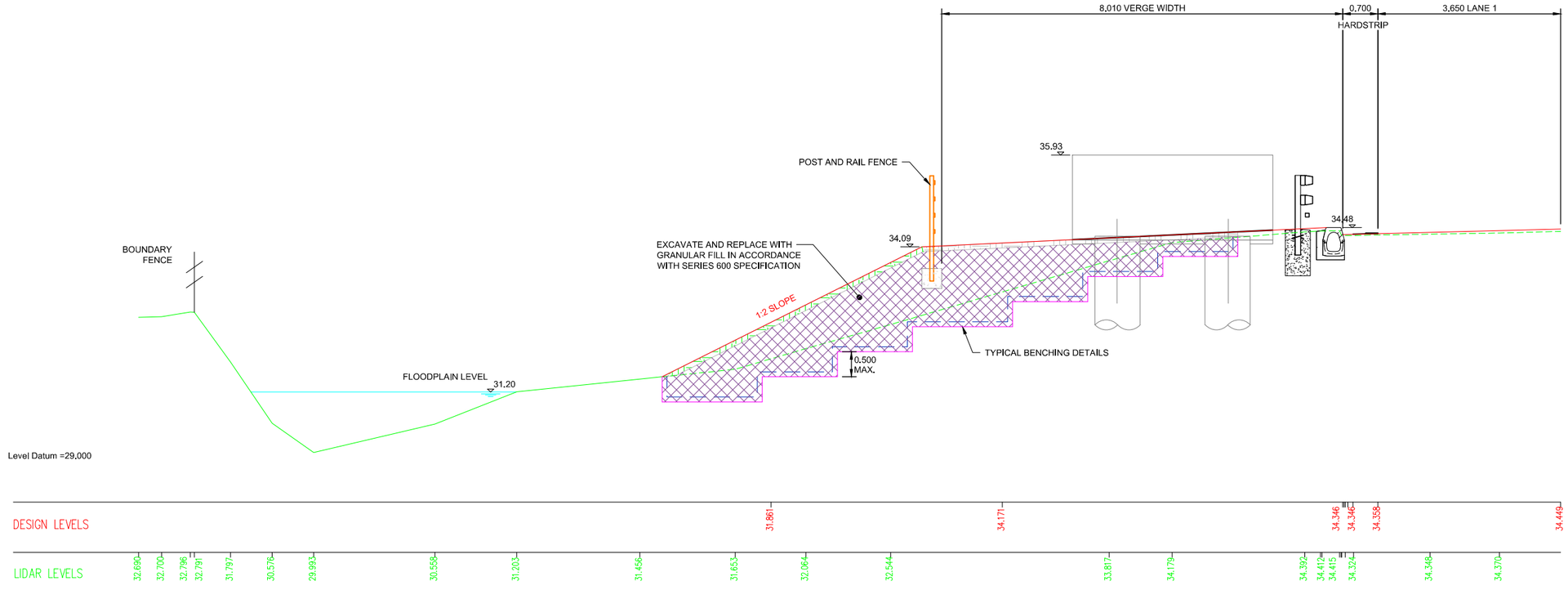


Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 312 CH. 190605
SHEET 01 OF 01

Scale at A1	NA
Role	Civil - Earthworks and Geotech
Suitability	S4 - Fit for construction approval
Job No	244508-00
Rev	P02
Name	HA549342-AMAR-HGT-G312-DR-CE-000001



PLAN VIEW
SCALE 1:600 @A3



SECTION
SCALE 1:100 @A3

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PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

P03	17/04/17	LP	---	SV

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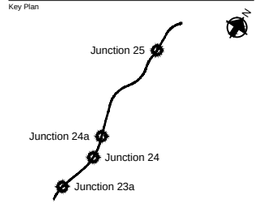
Rev	Date	By	Chkd	Appd

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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

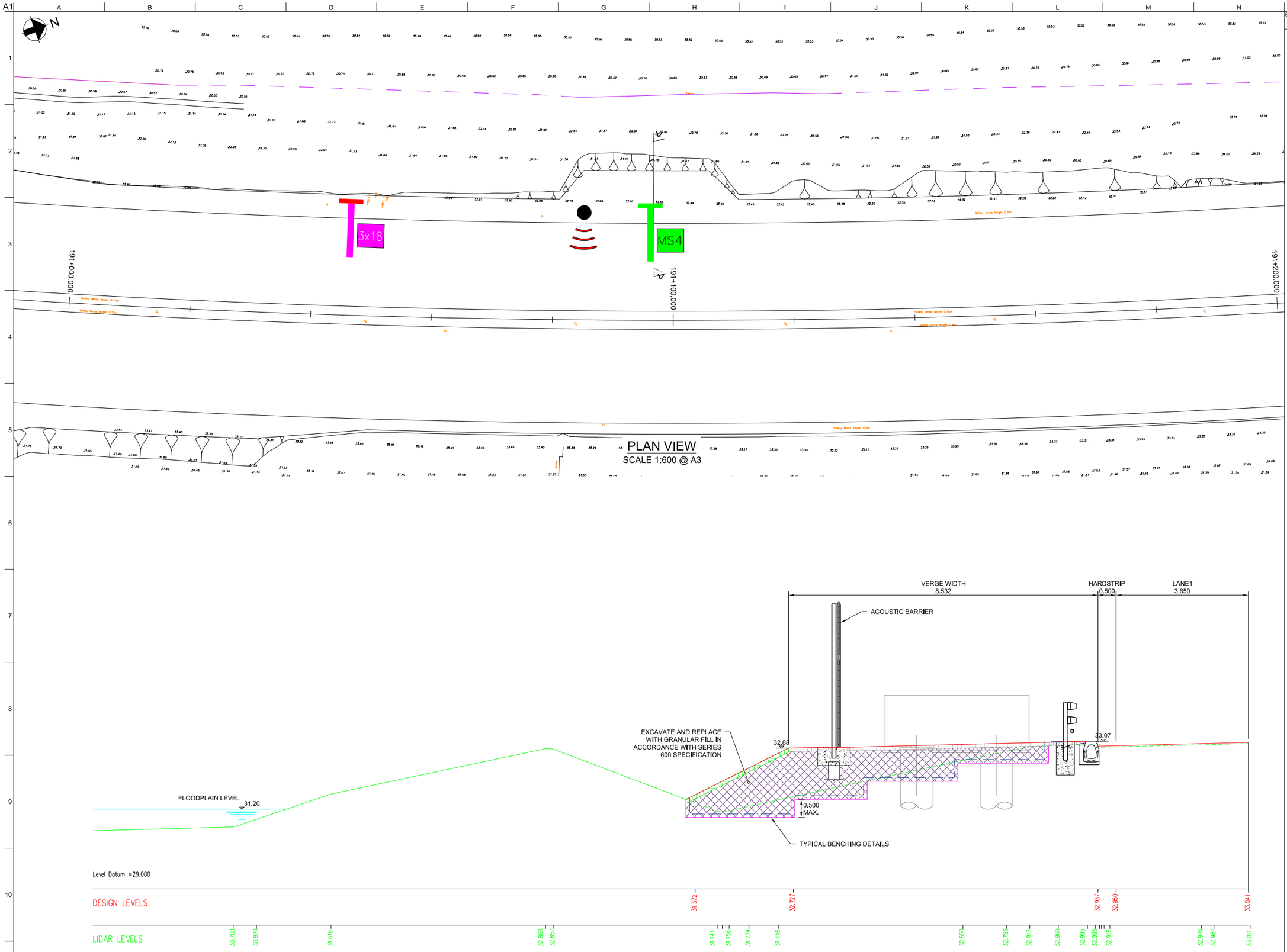
Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 313 CH. 190771
SHEET 01 OF 01

Scale at A1	NA
Role	Civil - Earthworks and Geotech
Suitability	S4 - Fit for construction approval
Job No	244508-00
Rev	P03
Name	HA549342-AMAR-HGT-G313-DR-CE-000001



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NOTES

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PLAN LEGEND

SECTION LINE

HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

PROPOSED GROUND PROFILE
EXISTING GROUND PROFILE
EXISTING GROUND PROFILE TO BE REMOVED
INDICATIVE EXCAVATION PROFILE
GEOTEXTILE SEPARATOR LAYER
TOPSOIL (MINIMUM 0,1m)
VERGE SURFACE
GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

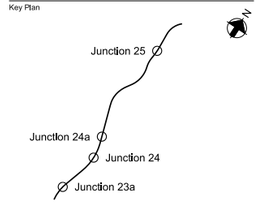
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Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: EARTHWORKS DESIGN SOLUTION GANTRY 314 CH. 191096 SHEET 01 OF 01

Scale at A1: NA

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

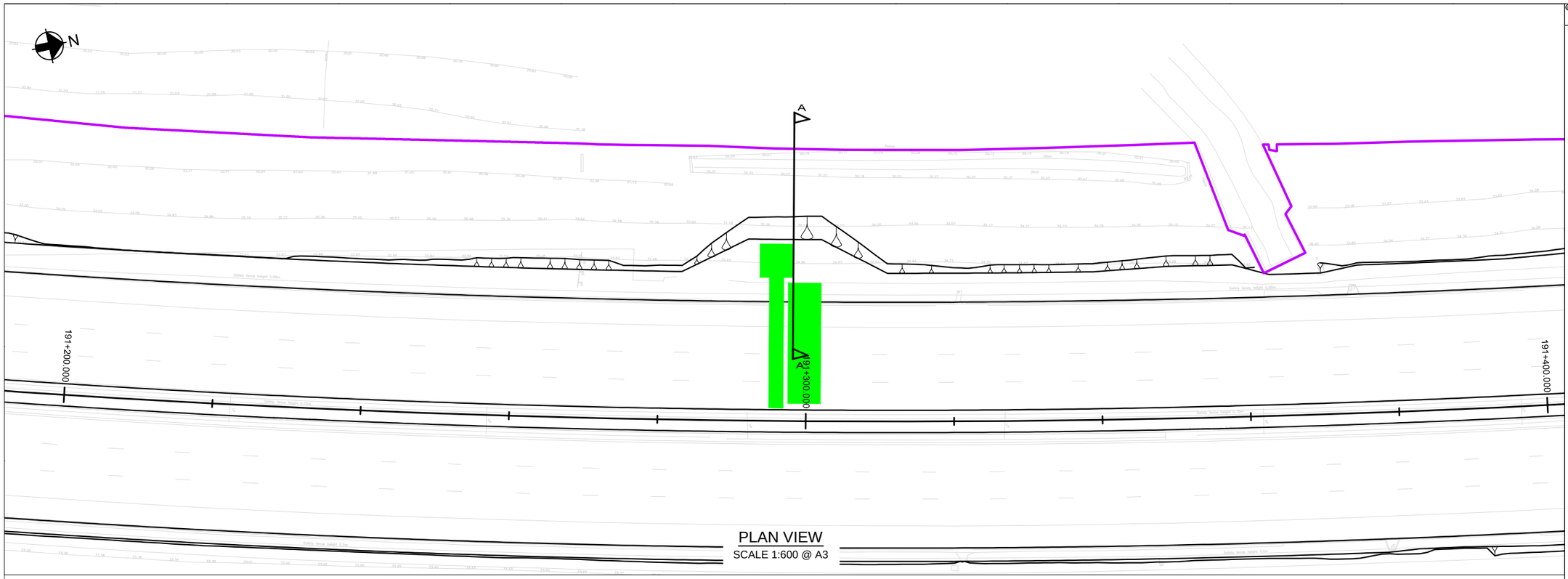
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Rev: P03

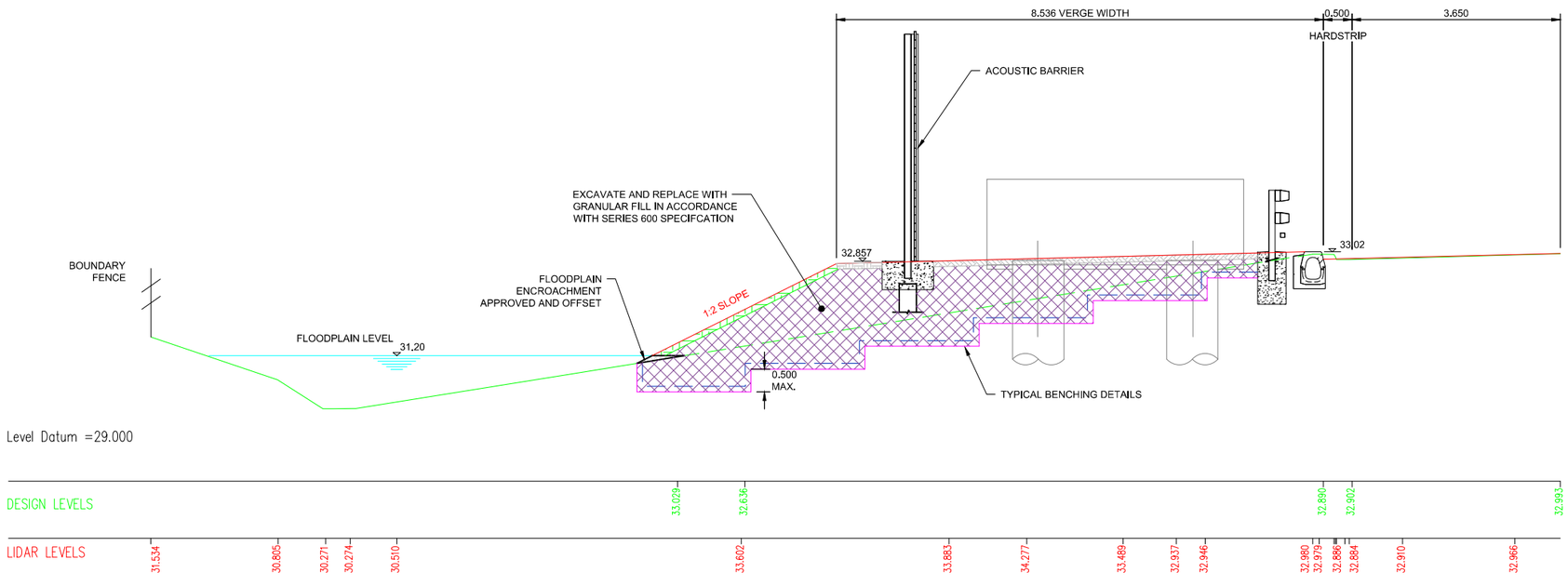
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Do not scale



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

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PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

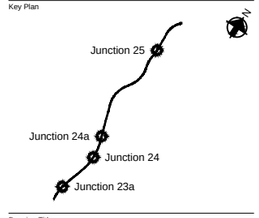
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Tel 0121 214 2000

Client: highways england driving forward

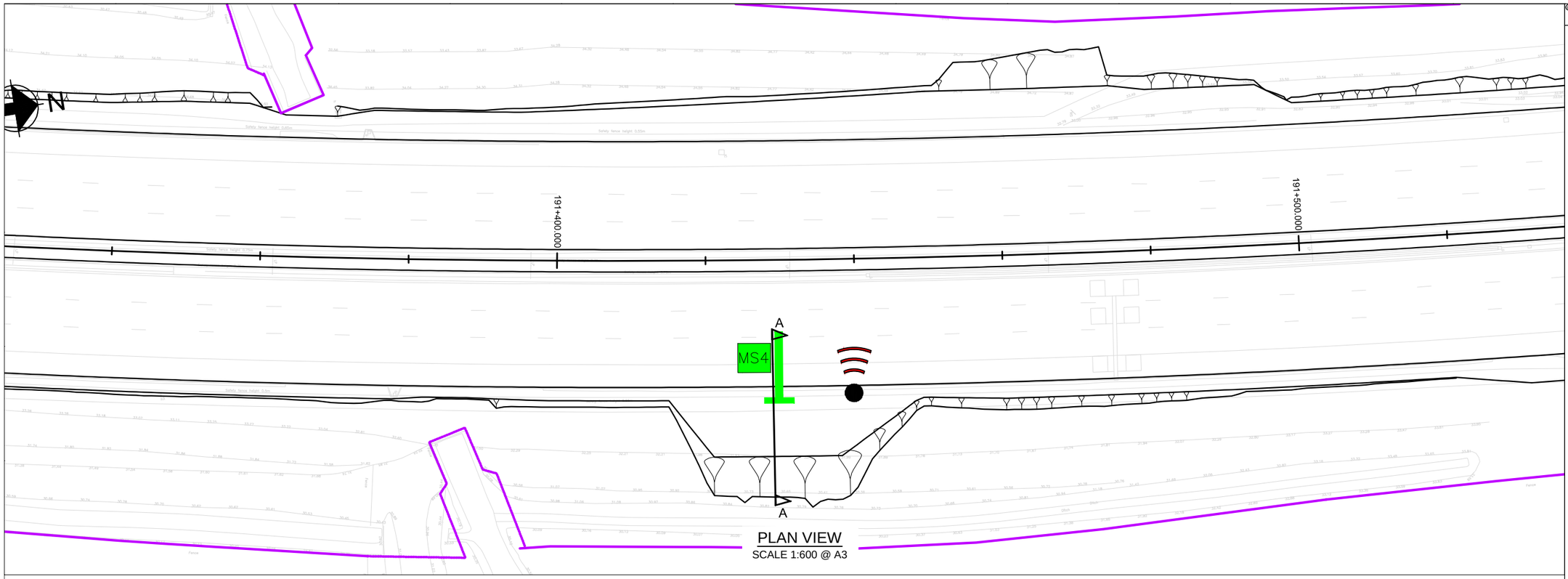
Project Title
SMP M1 J23a - J25

Key Plan

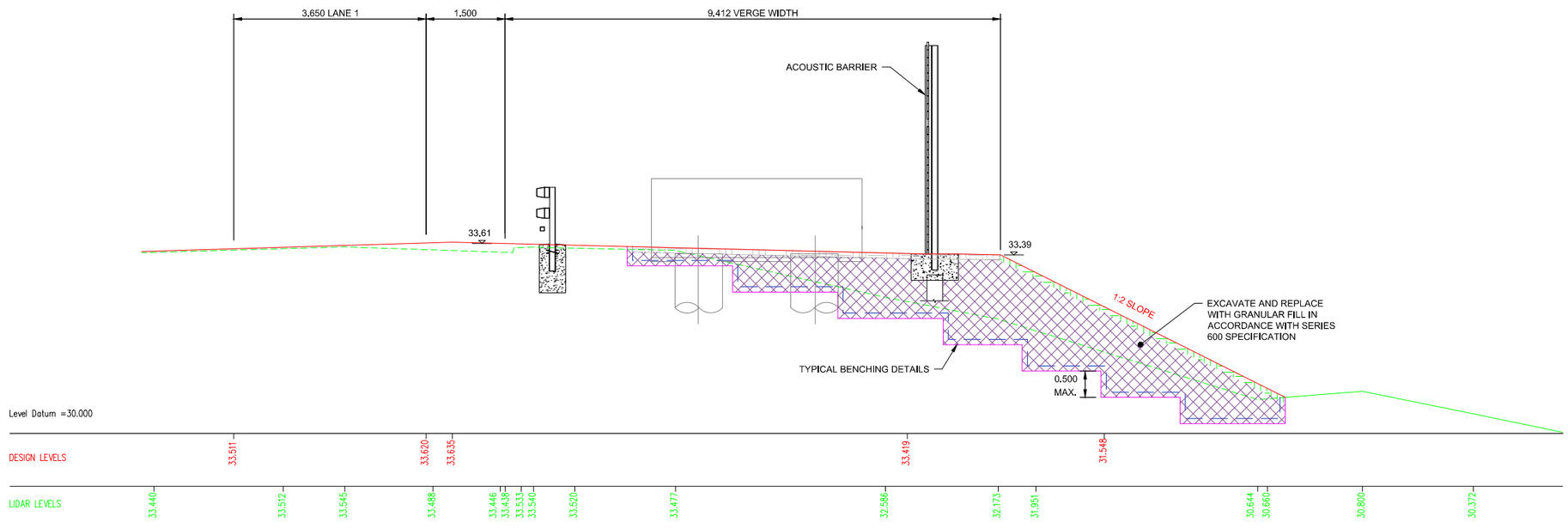


Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 315 CH. 191296
SHEET 01 OF 01

Scale at A1: NA
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P03
Name: HA549342-AMAR-HGT-G315-DR-CE-000001



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

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NOTES

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3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
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6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150mm FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300mm FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. WORST CASE SCENARIOS INDICATED IN SECTION A-A.
10. FOR TYPICAL DETAILS OF EARTHWORK SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000601.

PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

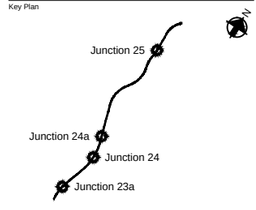
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: EARTHWORKS DESIGN SOLUTION GANTRY 316 CH. 191430 SHEET 01 OF 01

Scale at A1: NA

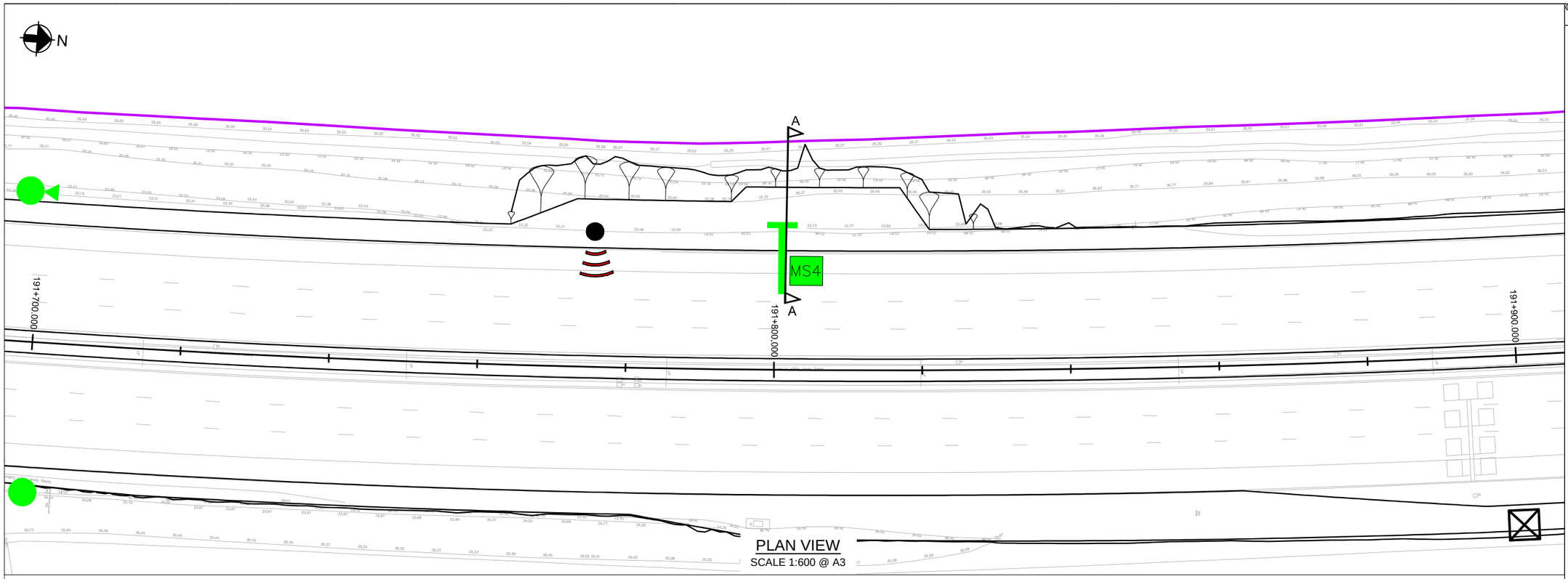
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Suitability: S4 - Fit for construction approval

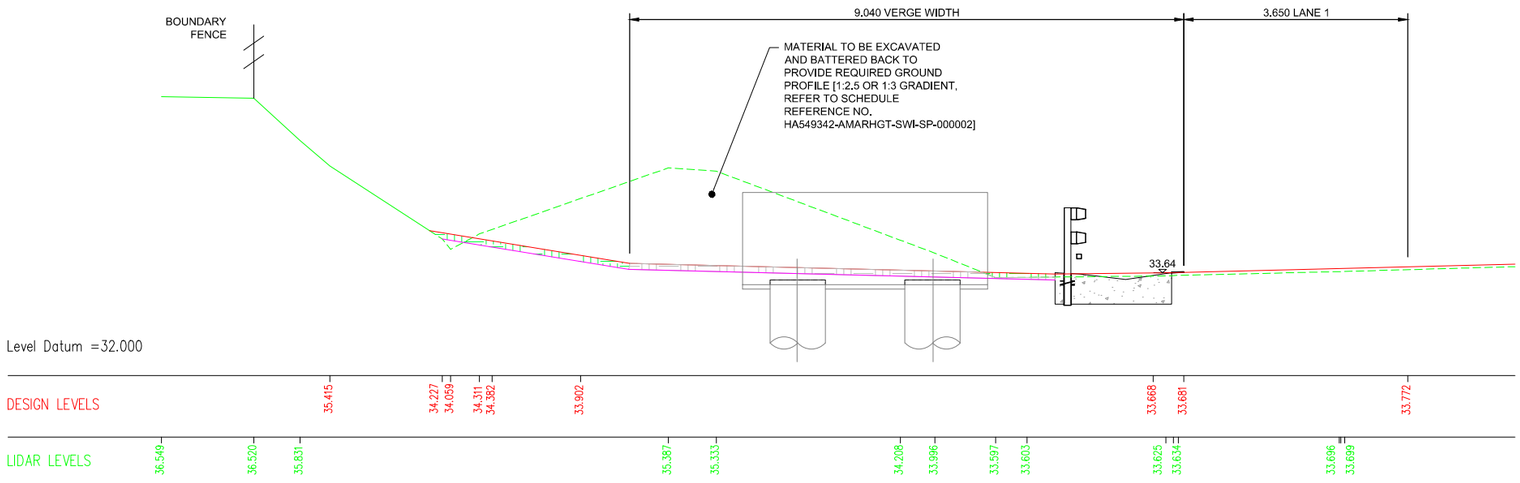
Job No: 244508-00

Rev: P03

Name: HA549342-AMAR-HGT-G316-DR-CE-000001



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

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PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

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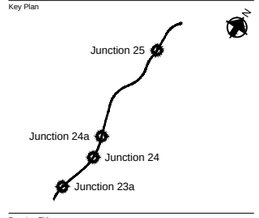
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 318 CH. 191801
SHEET 01 OF 01

Scale at A1: NA

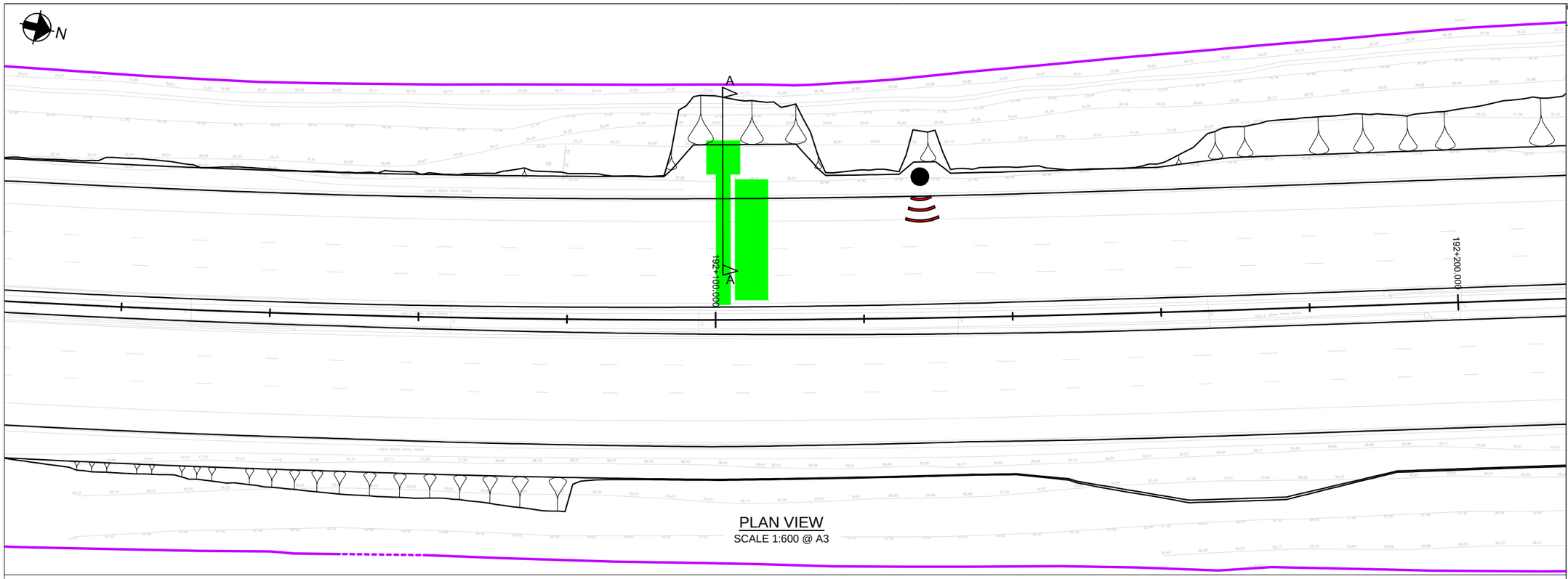
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Suitability: S4 - Fit for construction approval

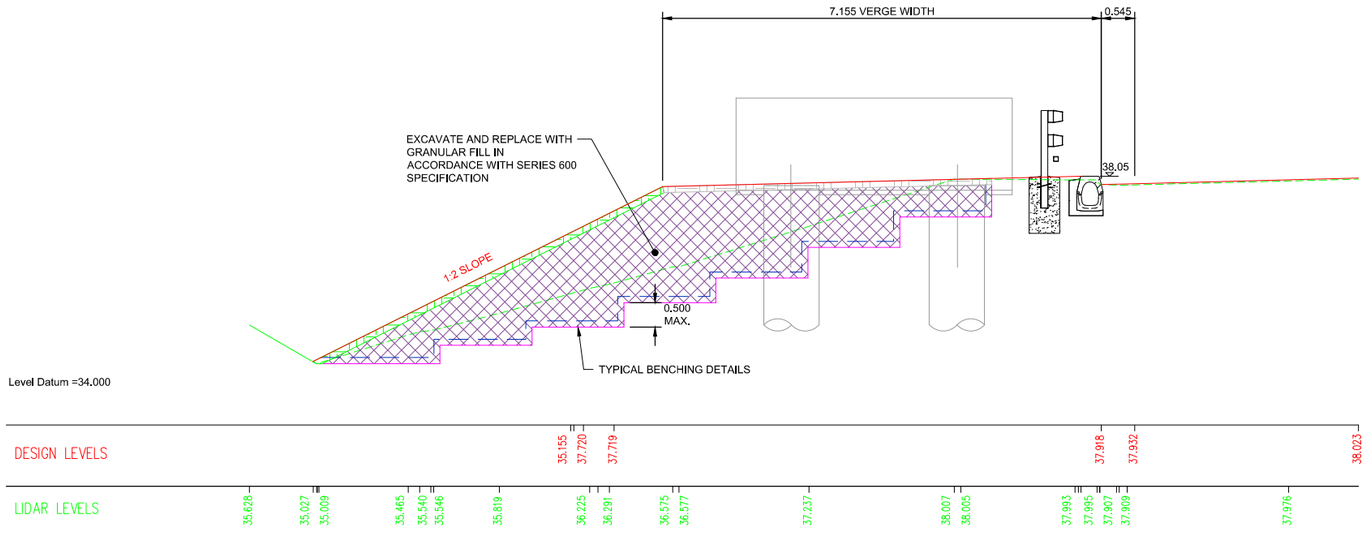
Job No: **244508-00**

Rev: **P03**

Name
HA549342-AMAR-HGT-G318-DR-CE-000001



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

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PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

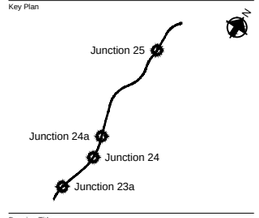
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Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: EARTHWORKS DESIGN SOLUTION
GANTRY 319 CH. 192101
SHEET 01 OF 01

Scale at A1: NA

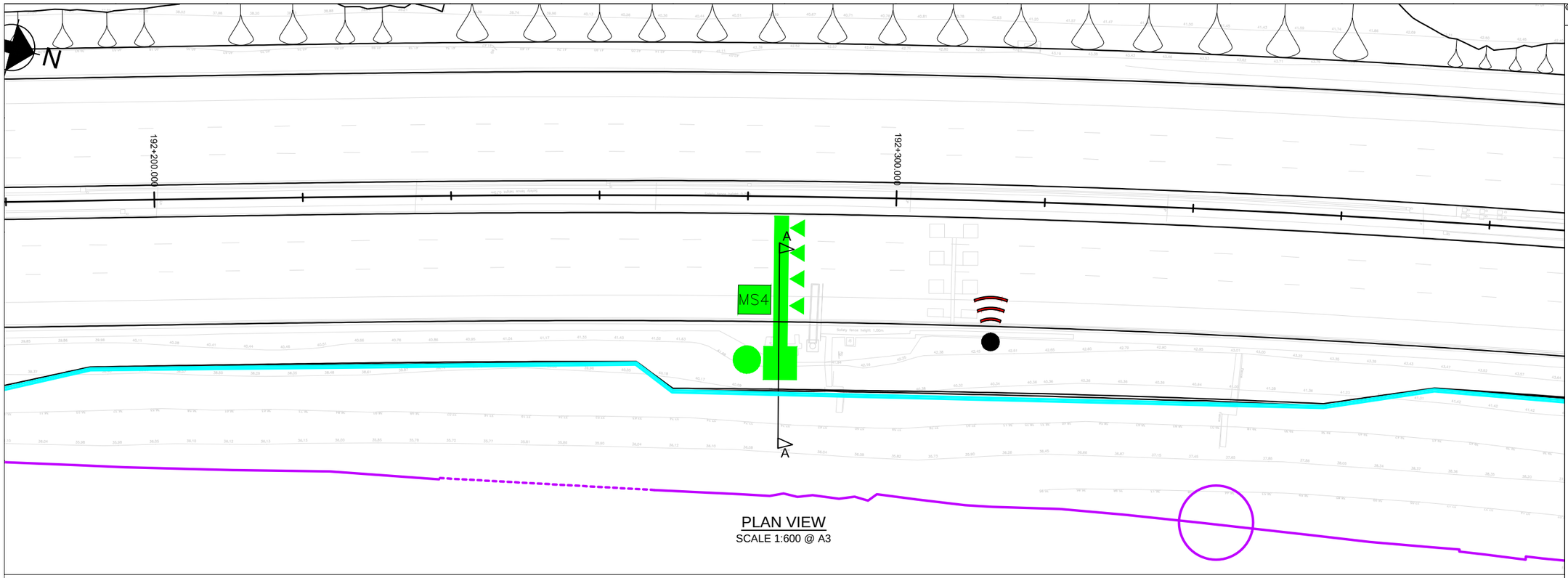
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Suitability: S4 - Fit for construction approval

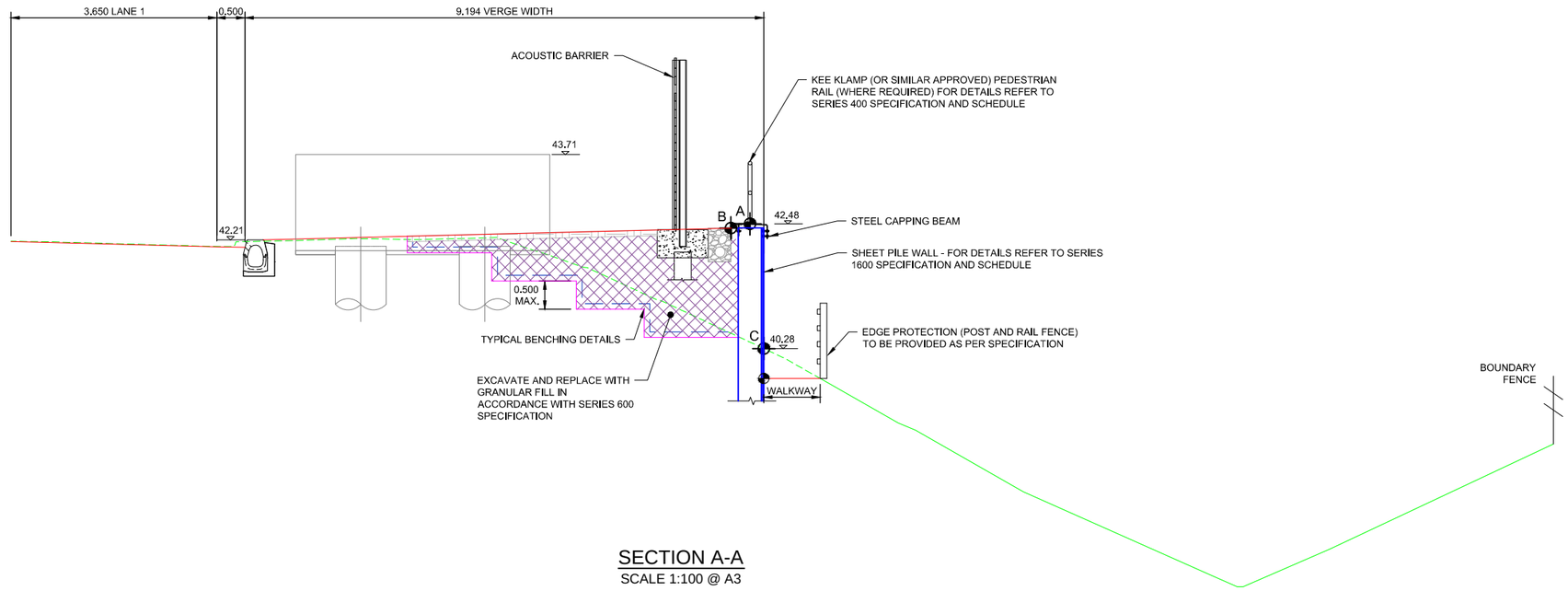
Job No: **244508-00**

Rev: **P03**

Name: **HA549342-AMAR-HGT-G319-DR-CE-000001**

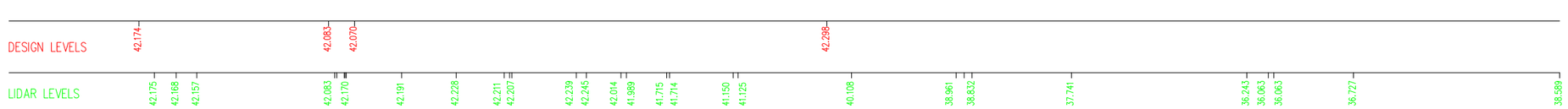


PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

Level Datum =34.000



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10. FOR ELEVATION PLANS PLEASE REFER TO DRAWING SERIES HA549342-AMAR-HGT-SWI-DR-CE-001603 TO HA549342-AMAR-HGT-SWI-DR-CE-001645.
11. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001601.

PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION
- SHEET PILE

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

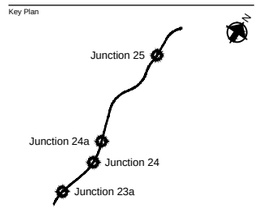
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan

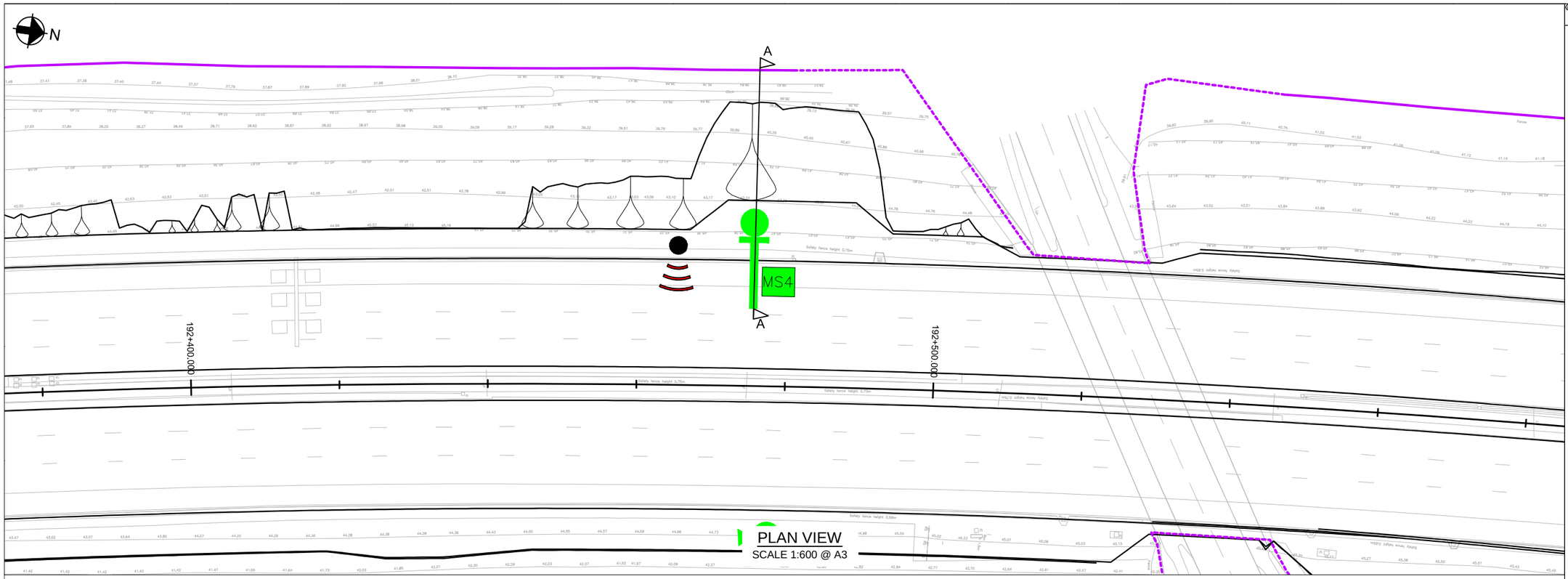


Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 320 CH. 192285
SHEET 01 OF 01

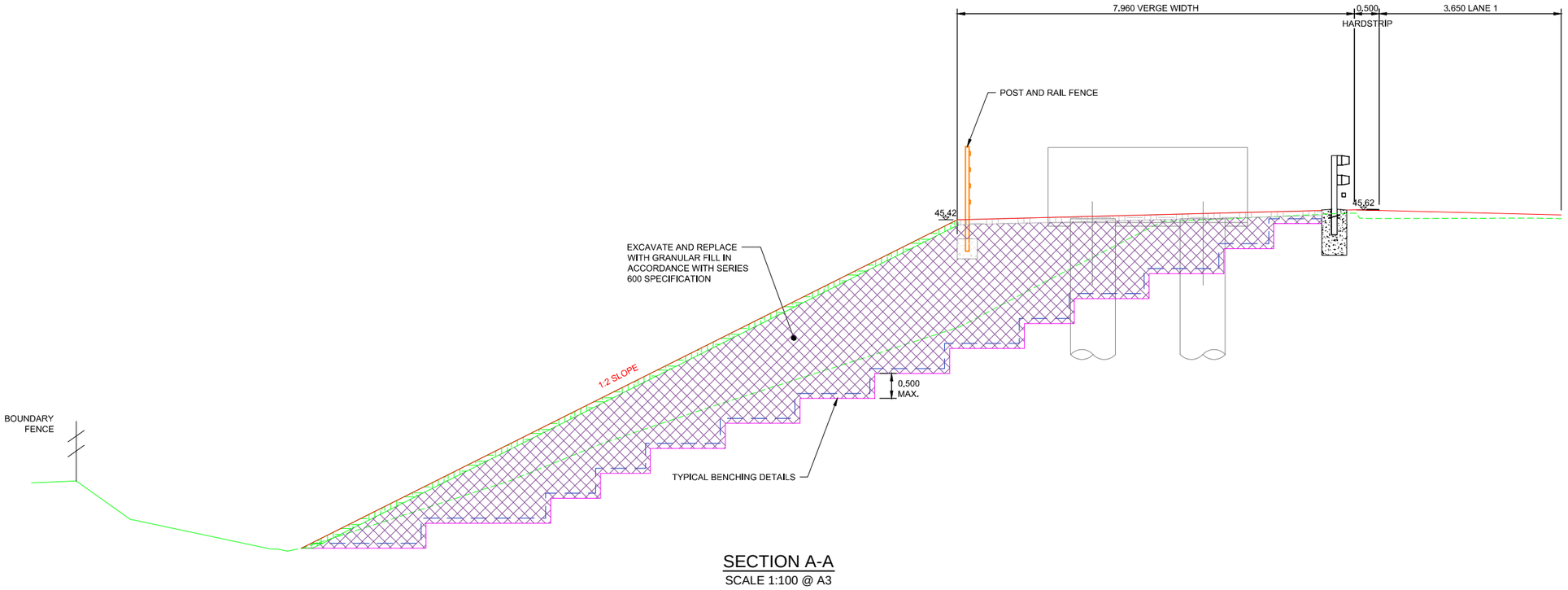
Scale at A1	NA
Role	Civil - Earthworks and Geotech
Suitability	S4 - Fit for construction approval
Job No	244508-00
Rev	P03

Name
HA549342-AMAR-HGT-G320-DR-CE-000001

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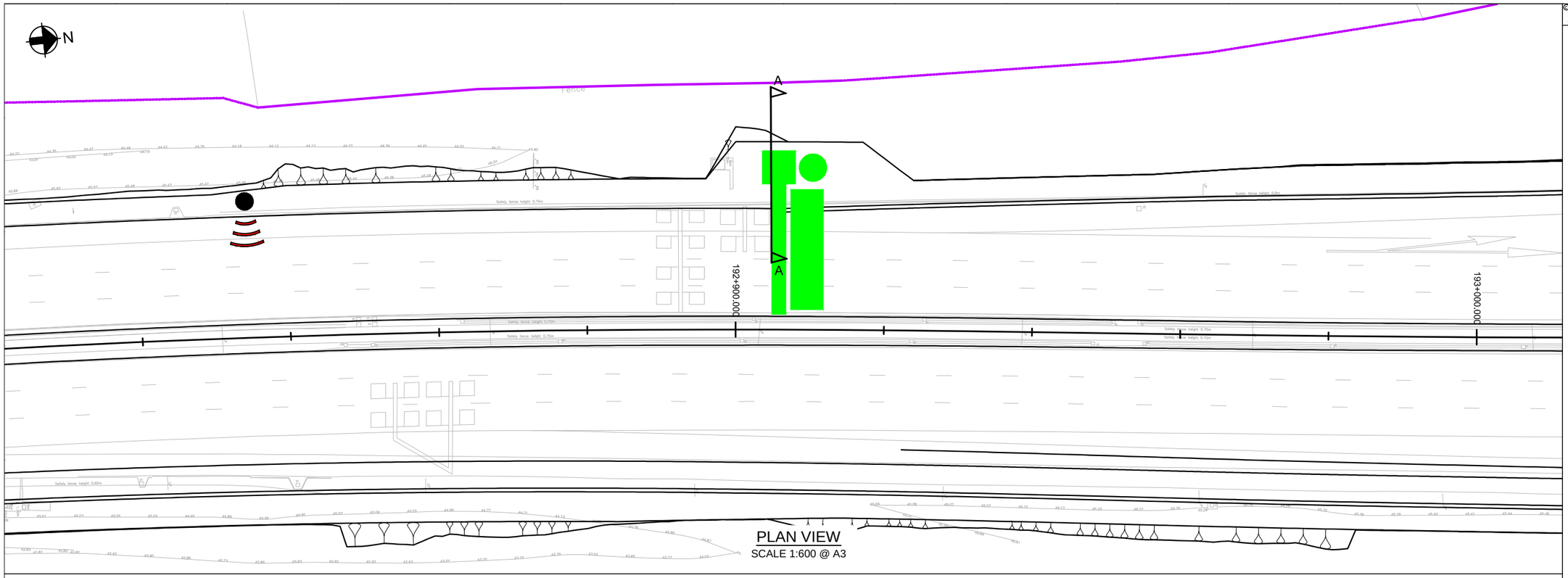
PLAN VIEW
SCALE 1:600 @ A3



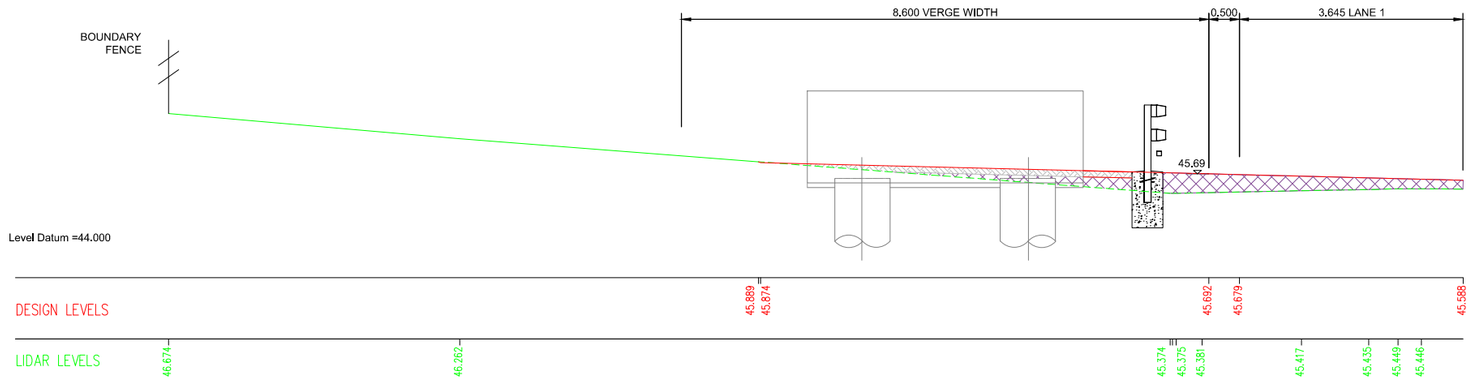
SECTION A-A
SCALE 1:100 @ A3

Level Datum =37.000

| | | |



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

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PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

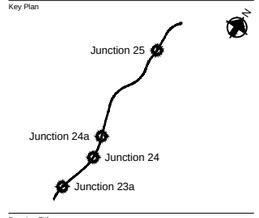
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: EARTHWORKS DESIGN SOLUTION
GANTRY 322 CH. 192906
CH. to CH.
SHEET 01 OF 01

Scale at A1: NA

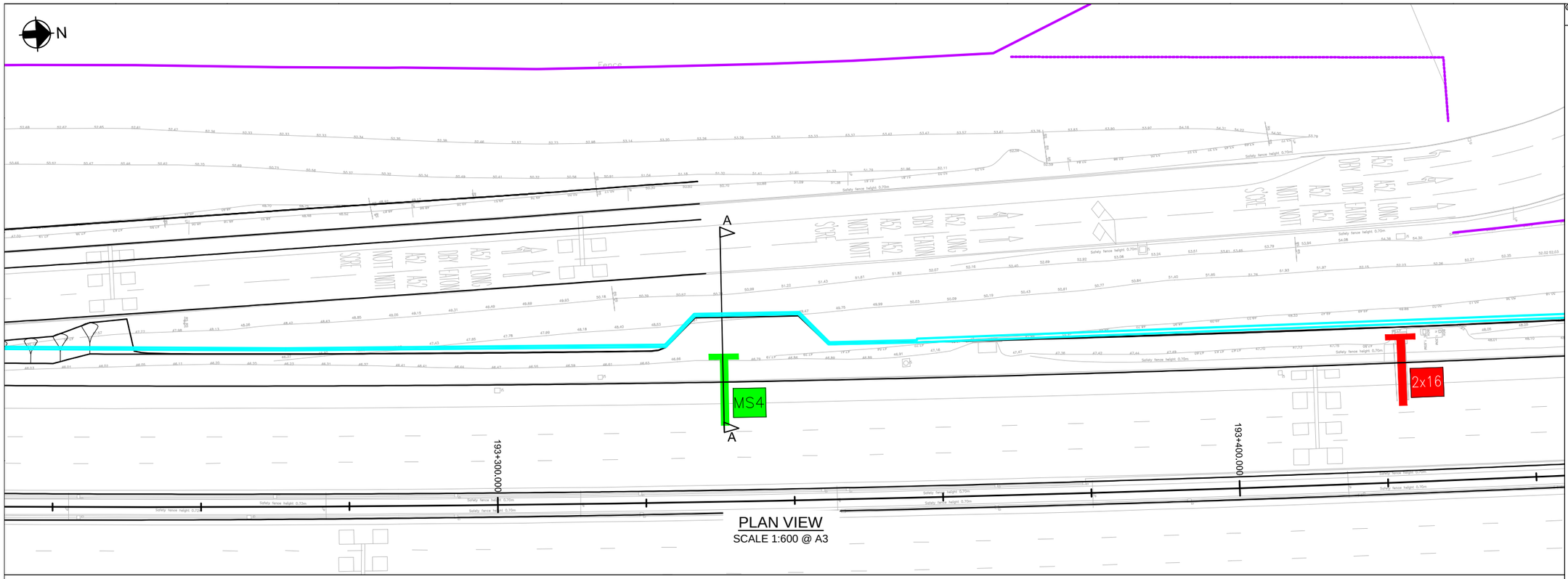
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Suitability: S4 - Fit for construction approval

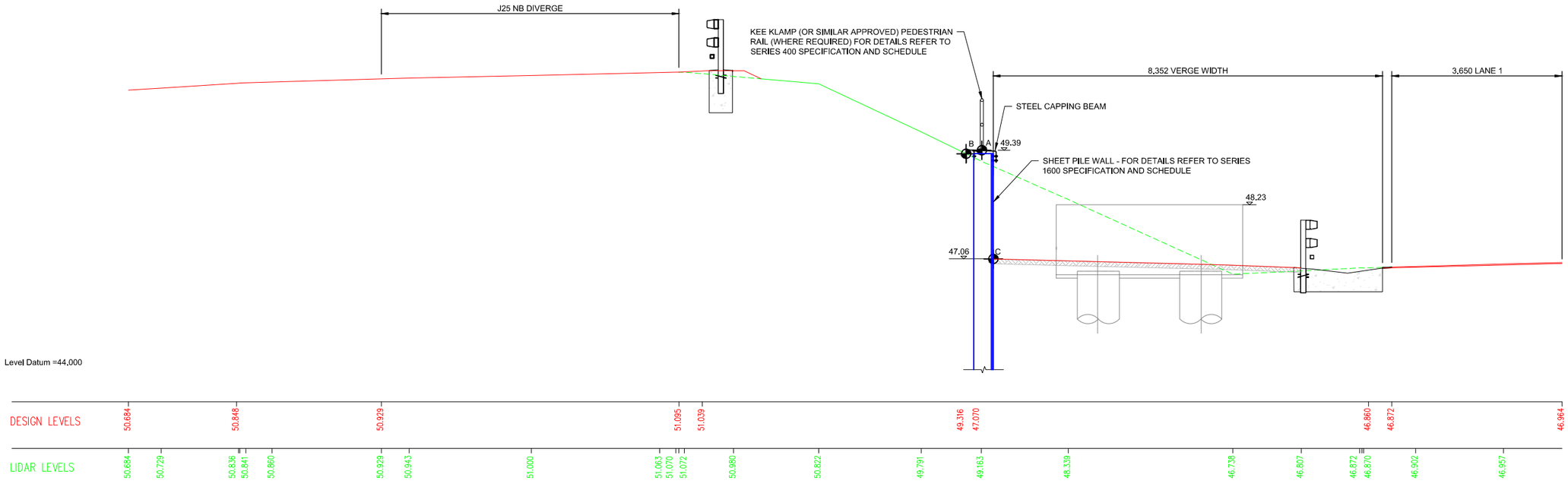
Job No: **244508-00**

Rev: **P03**

Name: **HA549342-AMAR-HGT-G322-DR-CE-000001**



PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

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PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
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- GRANULAR FILL (REFER TO SERIES 600 SPECIFICATION
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Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

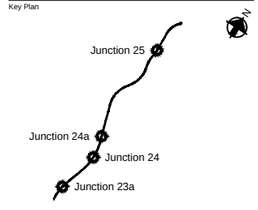
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Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 324 CH. 193331
CH. to CH.
SHEET 01 OF 01

Scale at A1: NA

Role: Civil - Earthworks and Geotech

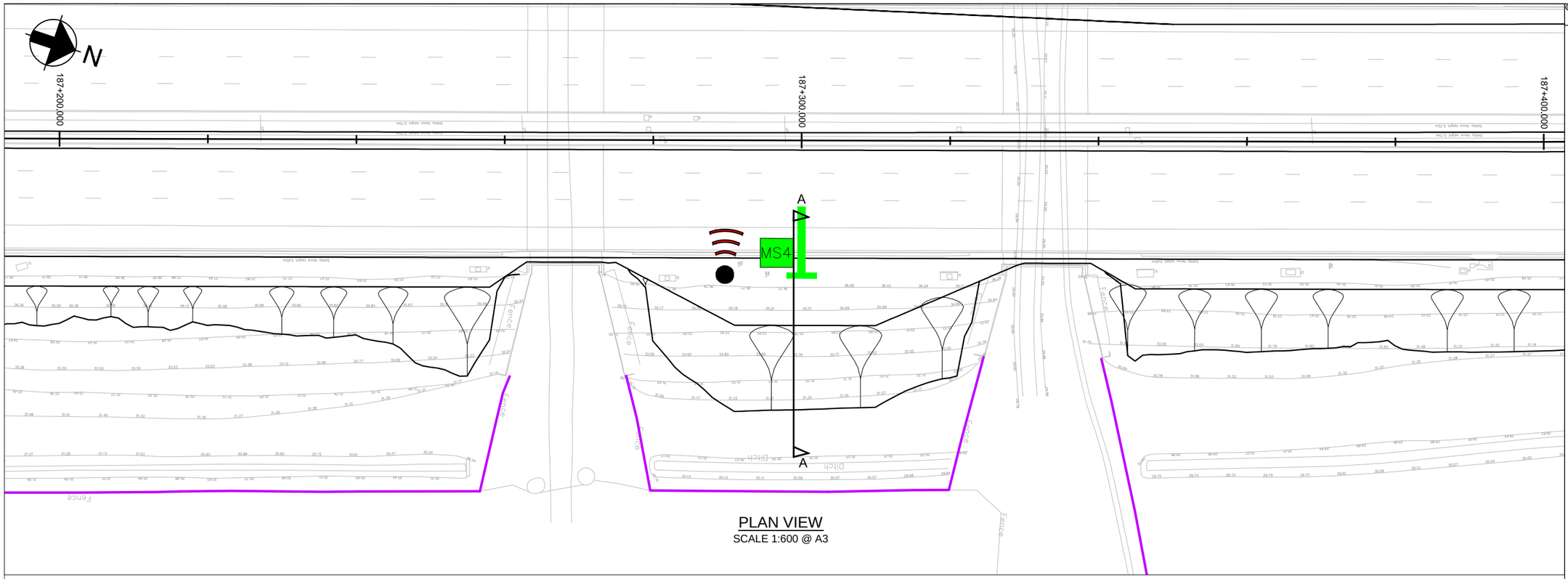
Suitability: S4 - Fit for construction approval

Job No: **244508-00**

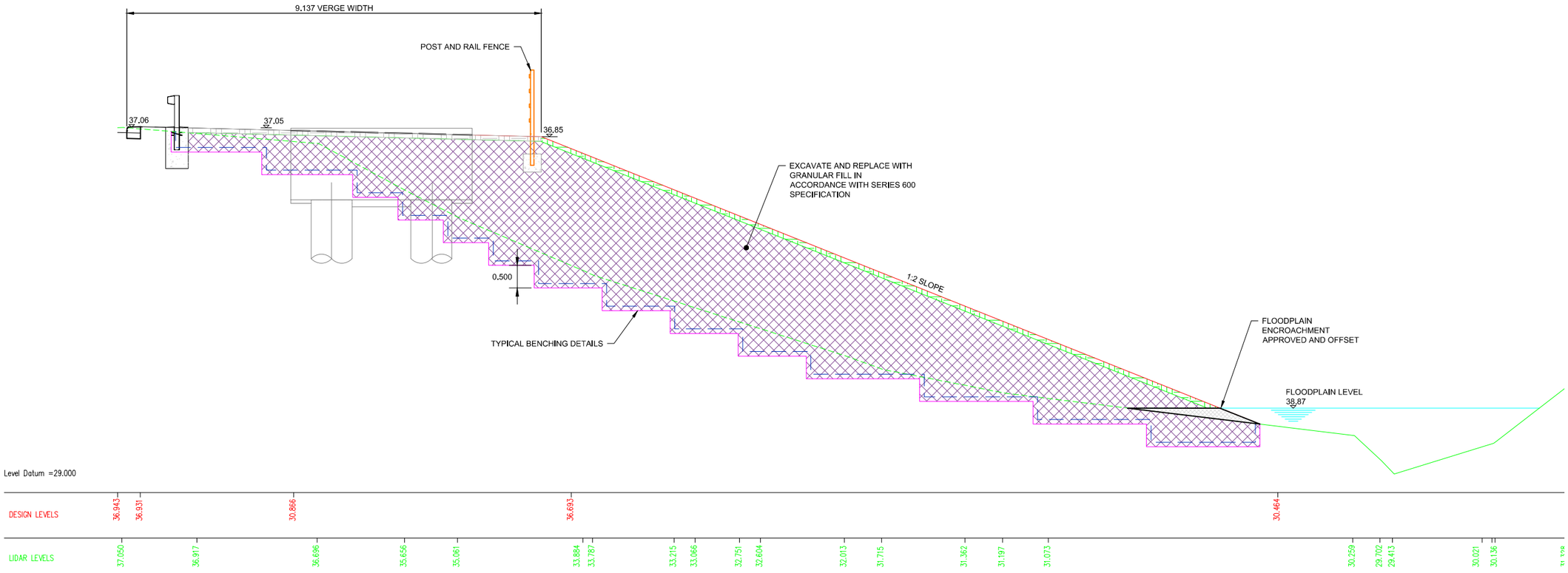
Rev: **P03**

Name
HA549342-AMAR-HGT-G324-DR-CE-000001

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PLAN VIEW
SCALE 1:600 @ A3



SECTION A-A
SCALE 1:100 @ A3

NOTES

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150mm FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300mm FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. WORST CASE SCENARIOS INDICATED IN SECTION A-A.
10. FOR TYPICAL DETAILS OF EARTHWORK SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000601.

PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

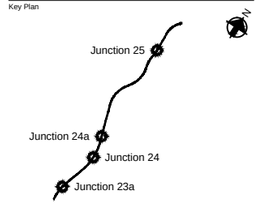
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
EARTHWORKS DESIGN SOLUTION
GANTRY 326 CH. 187300
CH. to CH.
SHEET 01 OF 01

Scale at A1: NA
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P03
Name: HA549342-AMAR-HGT-G326-DR-CE-000001

HIGHWAY EARTHWORKS GENERAL ARRANGEMENT DRAWINGS

KEY:

- REGRADE FULL HEIGHT SLOPE
- REGRADE PARTIAL HEIGHT SLOPE
- FULL HEIGHT EMBANKMENT WIDENING
- GRANULAR WEDGE AT EMBANKMENT CREST
- LESS THAN 500mm CUT
- LESS THAN 500mm FILL
- SHEET PILE EMBANKMENT
- SHEET PILE CUTTING
- PLASTIC SHEET PILE
- GABION WALLS
- TRANSITION ZONE
- EXISTING HIGHWAY FENCE LINE
- ASSUMED HIGHWAY FENCE LINE
- PROPOSED ENVIRONMENTAL BARRIER
- EXISTING ENVIRONMENTAL BARRIER
- RAIL FREIGHT TERMINAL WORKS
- EXISTING GANTRY RETAINED IN SITU
- EXISTING GANTRY REMOVED
- PROPOSED GANTRY
- EXISTING ADVANCED MOTORWAY INDICATOR RETAINED IN SITU
- PROPOSED ADVANCED MOTORWAY INDICATOR
- EXISTING MATRIX INDICATOR RETAINED IN SITU
- EXISTING MATRIX INDICATOR REMOVED
- EMS — EXISTING MESSAGE SIGN 2X12 RETAINED IN SITU
- 3x18 — EXISTING STRATEGIC MS3 3X18 RETAINED IN SITU
- 3x18 — EXISTING STRATEGIC MS3 3X18 RETAINED AND RELOCATED
- 2x16 — EXISTING MS3 2X16 REMOVED
- EMS — EXISTING MESSAGE SIGN 2X12 REMOVED
- MS4 — PROPOSED MS4
- EXISTING ADS RETAINED
- EXISTING ADS REMOVED
- PROPOSED ADS
- EXISTING ENTRY SLIP SIGNALS RETAINED
- PROPOSED POST MOUNTED EVA
- SLIP ROAD SIGNALS

- EXISTING CCTV RETAINED
- PROPOSED CCTV
- ROTTM SIGN
- OBXXX — EXISTING OVERBRIDGE
- UBXXX — EXISTING UNDERBRIDGE
- CXXXX — EXISTING CULVERT
- RXXXX — EXISTING RETAINING WALL
- EXXXX — PROPOSED ERA
- EXISTING UTILITIES

NOTES

GENERAL

1. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO HA549342-AMAR-HGT-SWI-SP-CE-000002).
2. THE CURRENT STAGE OF EARTHWORKS DESIGN (DF5) IS BASED ON LIMITED CURRENTLY AVAILABLE TOPOGRAPHIC DATA.
3. NEW TOPOGRAPHIC SURVEY BECOMING AVAILABLE MAY RESULT IN DESIGN CHANGES.
4. THERE IS A RISK THAT STRUCTURES MAY MOVE DUE TO DESIGN CHANGES BY OTHER DISCIPLINES.
5. THE MAINLINE DESIGN HAS BEEN BASED ON CURRENTLY AVAILABLE 10m SECTIONS.
6. MERGES AND DIVERGES HAVE BEEN DESIGNED WITH A DEGREE OF UNCERTAINTY DUE TO MISSING TOPOGRAPHICAL DATA.
7. JUST IN TIME VALIDATION GROUND INVESTIGATION WILL BE UNDERTAKEN TO AID IN CONFIRMING DESIGN PRIOR TO CONSTRUCTION.

DESIGN

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS MUST BE READ WITH REFERENCE TO TYPICAL EARTHWORK SOLUTIONS (HA549342-AMAR-HGT-SWI-DR-CE-00601) AND TYPICAL RETAINING SOLUTIONS (HA549342-AMR-HGT-SWI-DR-CE-001601).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.

Rev	Date	By	Chkd	Appd
P06	17/04/17	LP	---	SV

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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england — driving forward

Project Title: SMP M1 J23a - J25

Drawing Title: General Notes For Earthworks
General Arangement Drawings
Sheet 1 of 13

Scale at A1: NTS

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

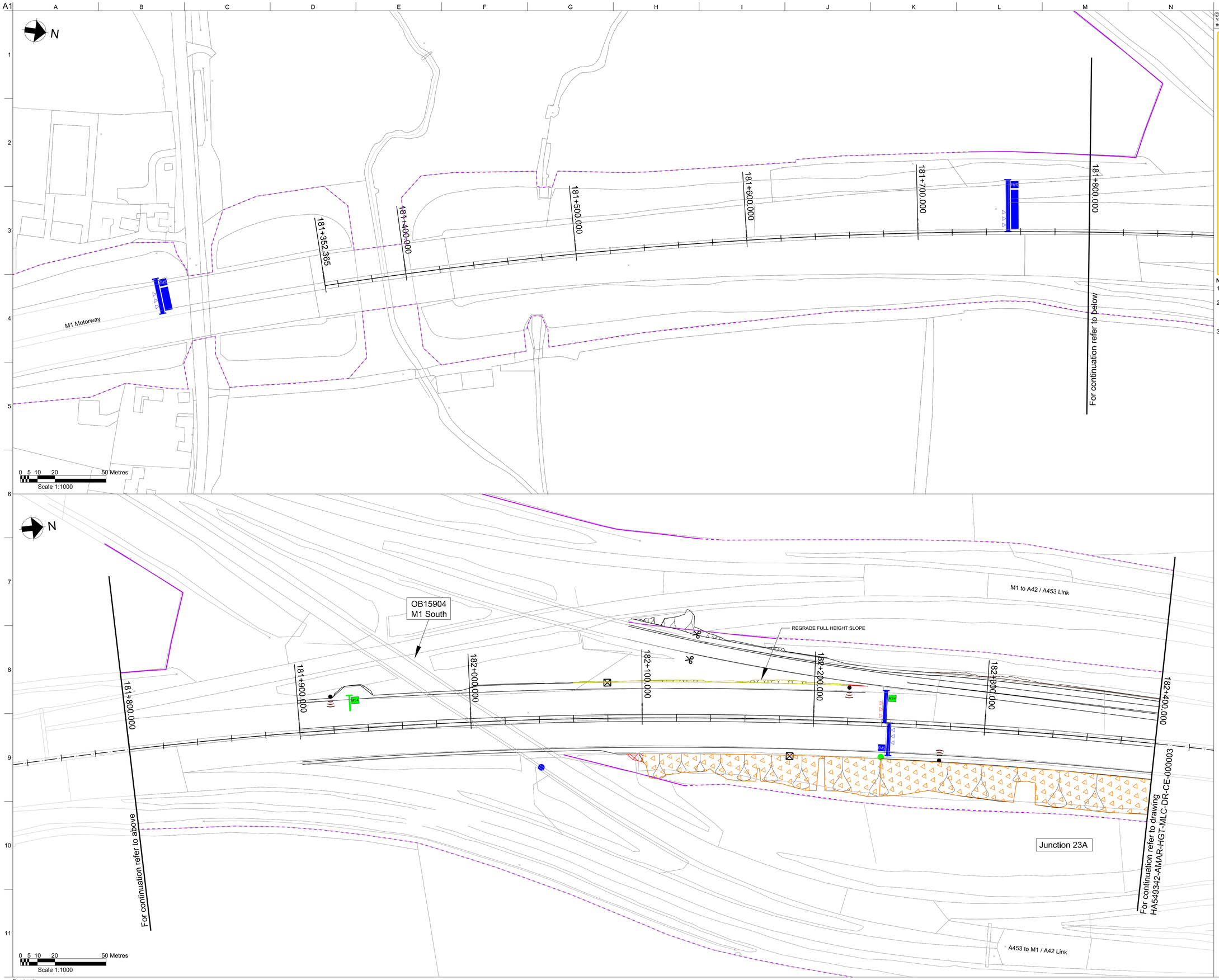
Job No: 244508-00

Rev: P06

Name: HA549342-AMAR-HGT-MLC-DR-CE-000001

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DESIGN HAZARDS

Warning Hazards Applicable to All Drawings

1. Risk of working in close proximity to live traffic
2. Risk of moving construction vehicles and plant around workforce
3. Risk of working on slopes
4. Risk of working at heights
5. Risk of underground cable strikes
6. Risk of asbestos within structures
7. Redundant BT cable throughout scheme extents in Northbound verge and shown locations

Warning Hazards Applicable to set locations

8. Risk of overhead and underground utilities crossing carriageway
9. Risk of working within close proximity of live railway
10. Risk of striking live existing and proposed Electricity Interface (EIs) points will be present on site during works
11. Culvert
12. Rock Fill
13. Sand Trenches
14. Hard Ground at Shallow Depth
15. Adjacent Structure
16. Existing Retaining Wall

Notes:

1. ALL DIMENSIONS AND MEASUREMENTS TO BE IN METRES (m) UNLESS OTHERWISE STATED.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE EARTHWORKS GENERAL ARRANGEMENT KEY AND NOTES: HA549342-AMAR-HGT-MLC-DR-CE-000001.
3. WHERE HATCHING IS UNCLEAR DESCRIPTION BOX ADDED TO INDICATE SOLUTION FOR CLARITY.

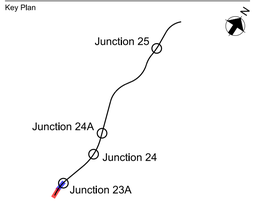
Rev	Date	By	Chkd	Appd
P10	17/04/17	LP	---	SV
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title
M1 Mainline
Earthwork General Arrangement
Chainage 181+352.365 - 182+400
Sheet 2 of 13

Scale at A1: 1:1000

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

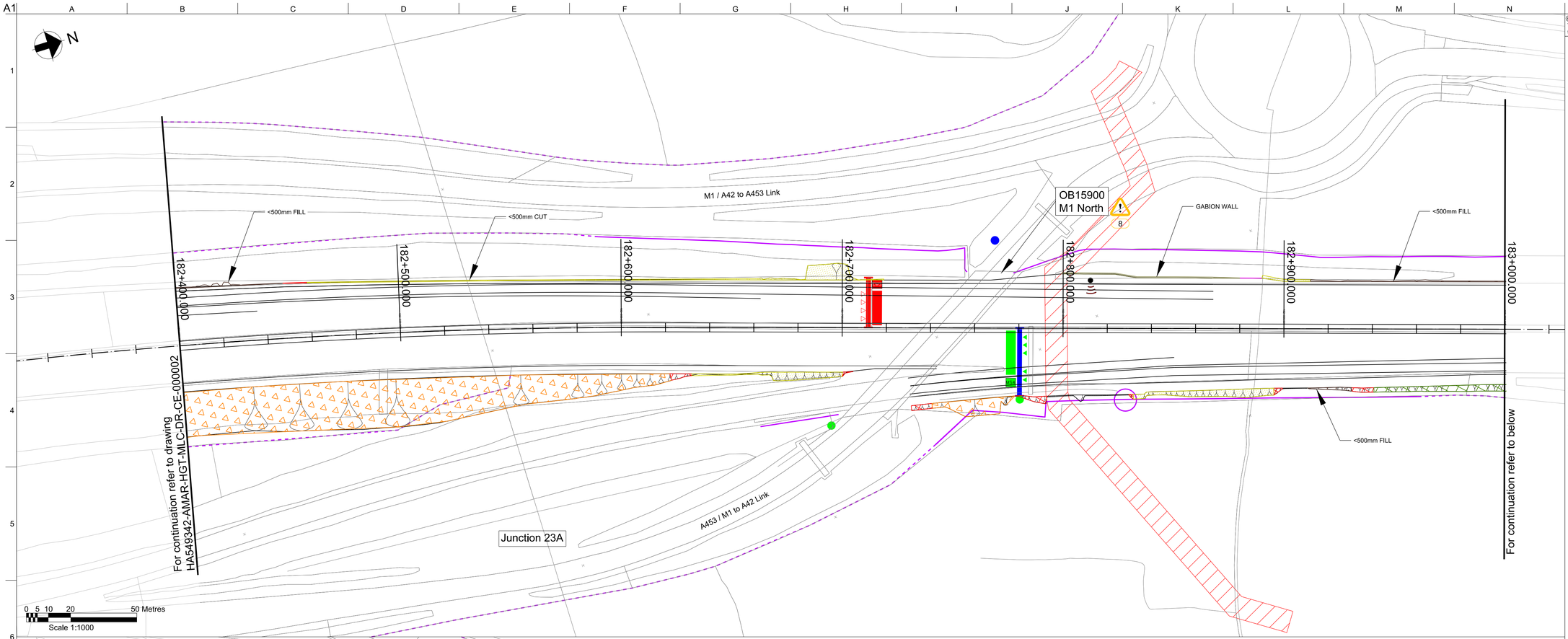
Job No: **244508-00** Rev: **P10**

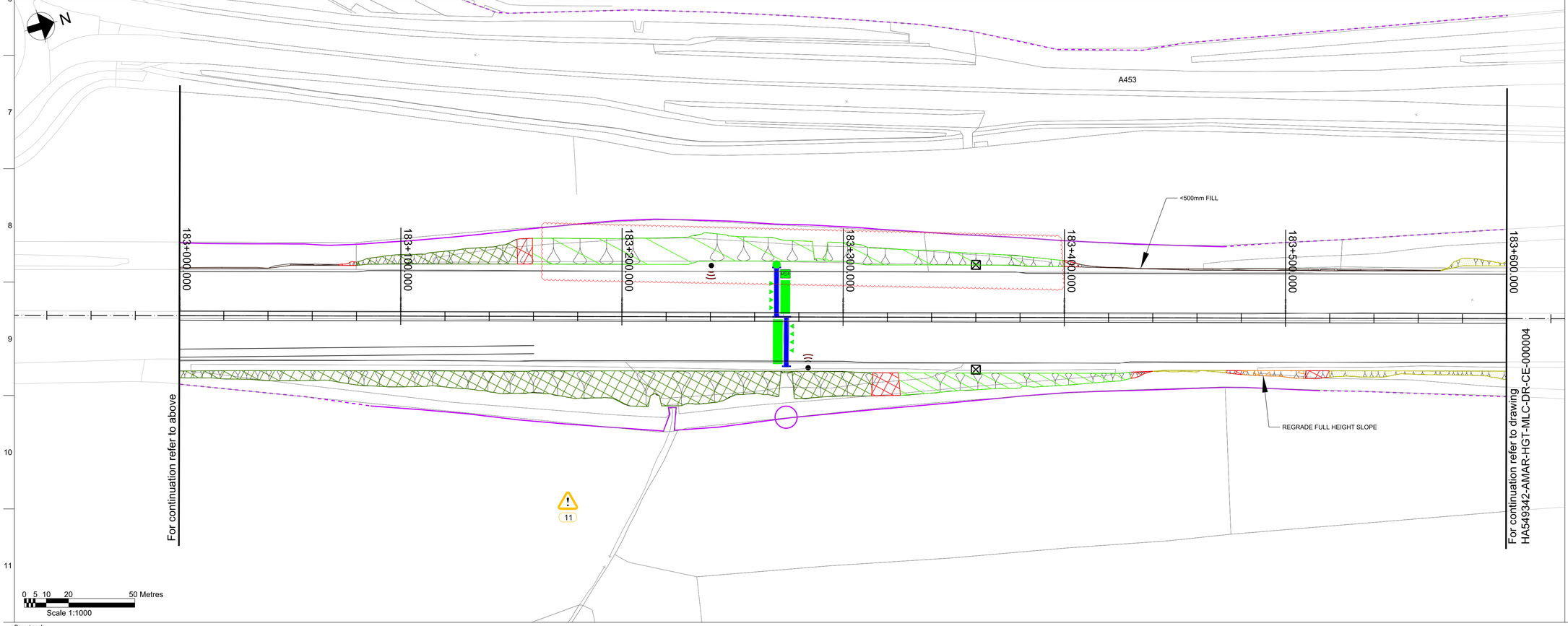
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DESIGN HAZARDS

Warning Hazards Applicable to All Drawings

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2. Risk of moving construction vehicles and plant around workforce
3. Risk of working on slopes
4. Risk of working at heights
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6. Risk of asbestos within structures
7. Redundant BT cable throughout scheme extents in Northbound verge and shown locations

Warning Hazards Applicable to set locations

8. Risk of overhead and underground utilities crossing carriageway
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12. Rock Fill
13. Sand Trenches
14. Hard Ground at Shallow Depth
15. Adjacent Structure
16. Existing Retaining Wall

Notes:

1. ALL DIMENSIONS AND MEASUREMENTS TO BE IN METRES (m) UNLESS OTHERWISE STATED.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE EARTHWORKS GENERAL ARRANGEMENT KEY AND NOTES: HA549342-AMAR-HGT-MLC-DR-CE-000001.
3. WHERE HATCHING IS UNCLEAR DESCRIPTION BOX ADDED TO INDICATE SOLUTION FOR CLARITY.

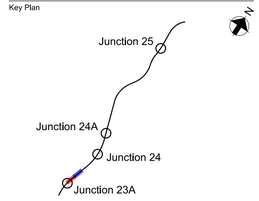
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P10	17/04/17	LP	---	SV
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: M1 Mainline
Earthworks General Arrangement
Chainage 182+400 - 183+600
Sheet 3 of 13

Scale at A1: NTS

Role: Civil - Earthworks and Geotech

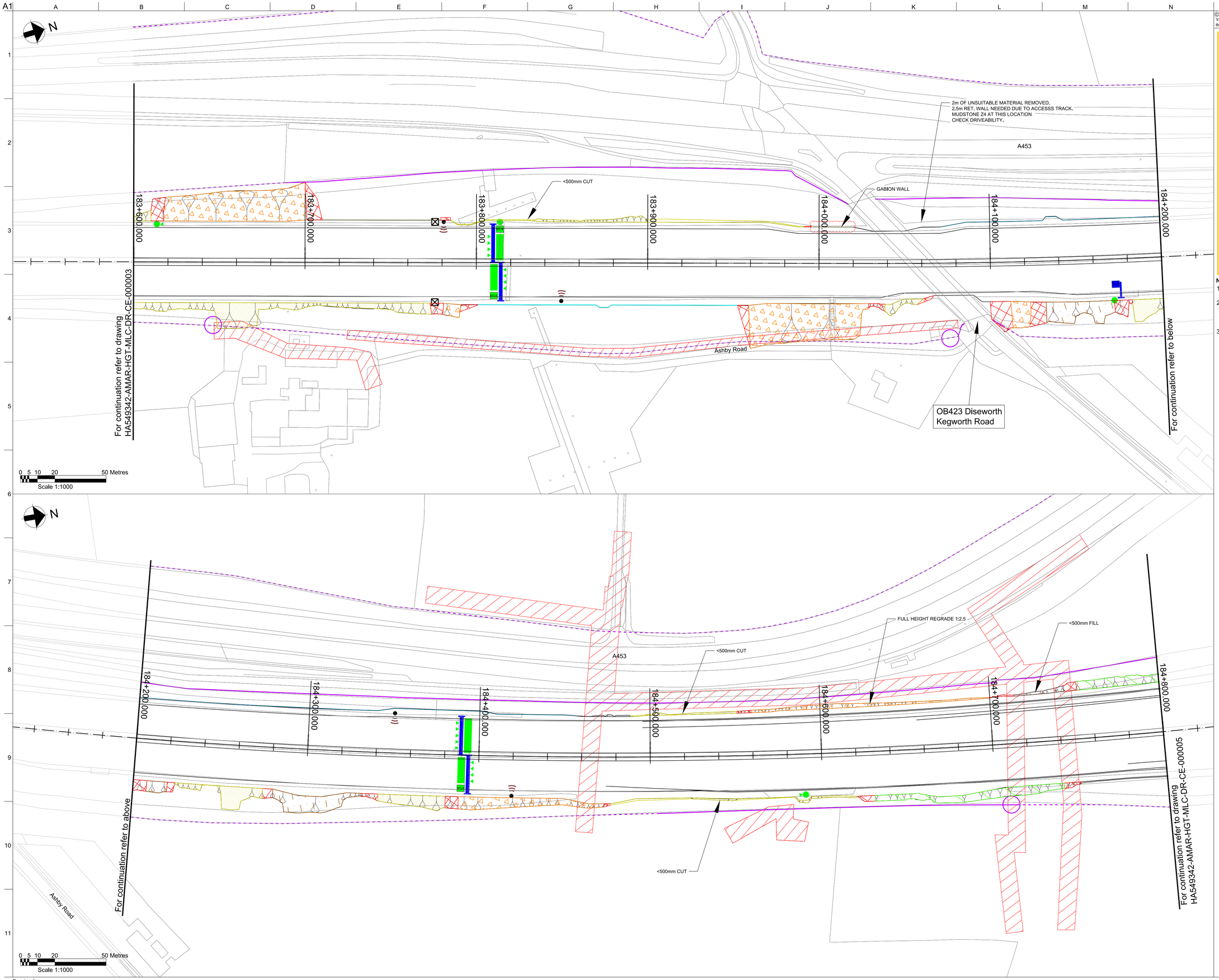
Suitability: S4 - Fit for construction approval

Job No: **244508-00**

Rev: **P10**

Name: **HA549342-AMAR-HGT-MLC-DR-CE-000003**

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DESIGN HAZARDS

Warning Hazards Applicable to All Drawings

1. Risk of working in close proximity to live traffic
2. Risk of moving construction vehicles and plant around workforce
3. Risk of working on slopes
4. Risk of working at heights
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Warning Hazards Applicable to set locations

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13. Sand Trenches
14. Hard Ground at Shallow Depth
15. Adjacent Structure
16. Existing Retaining Wall

Notes:

1. ALL DIMENSIONS AND MEASUREMENTS TO BE IN METRES (m) UNLESS OTHERWISE STATED.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE EARTHWORKS GENERAL ARRANGEMENT KEY AND NOTES: HA549342-AMAR-HGT-MLC-DR-CE-000001.
3. WHERE HATCHING IS UNCLEAR DESCRIPTION BOX ADDED TO INDICATE SOLUTION FOR CLARITY.

Rev	Date	By	Chkd	Appd
P10	17/04/17	LP	---	SV

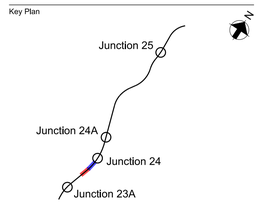
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: M1 Mainline
Earthworks General Arrangement
Chainage 183+600 - 184+800
Sheet 4 of 13

Scale at A1: 1:1000

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

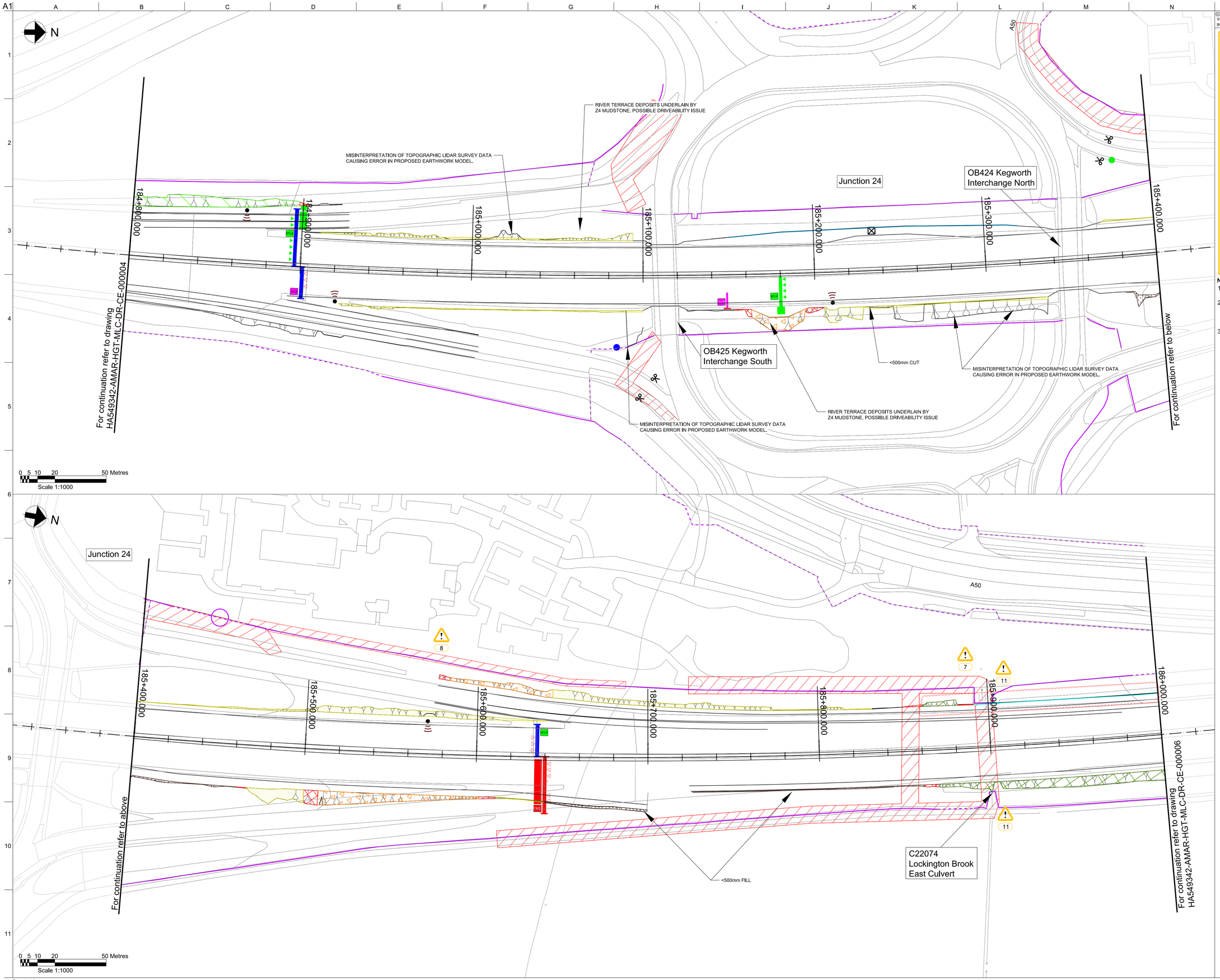
Job No: **244508-00**

Rev: **P10**

Name: **HA549342-AMAR-HGT-MLC-DR-CE-000004**

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DESIGN HAZARDS

Warning Hazards Applicable to All Drawings

1. Risk of working in close proximity to live traffic
2. Risk of moving construction vehicles and plant around workforce
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16. Existing Retaining Wall

Notes:

1. ALL DIMENSIONS AND MEASUREMENTS TO BE IN METRES (m) UNLESS OTHERWISE STATED.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE EARTHWORKS GENERAL ARRANGEMENT KEY AND NOTES: HA549342-AMAR-HGT-MLC-DR-CE-000001.
3. WHERE HATCHING IS UNCLEAR DESCRIPTION BOX ADDED TO INDICATE SOLUTION FOR CLARITY.

Rev	Date	By	Chkd	Appd
P10	17/04/17	LP	---	SV

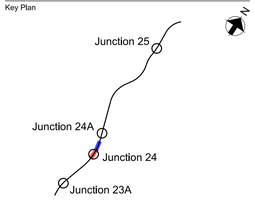
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: M1 Mainline
Earthworks General Arrangement
Chainage 184+800 - 186+000
Sheet 5 of 13

Scale at A1: 1:1000

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00**

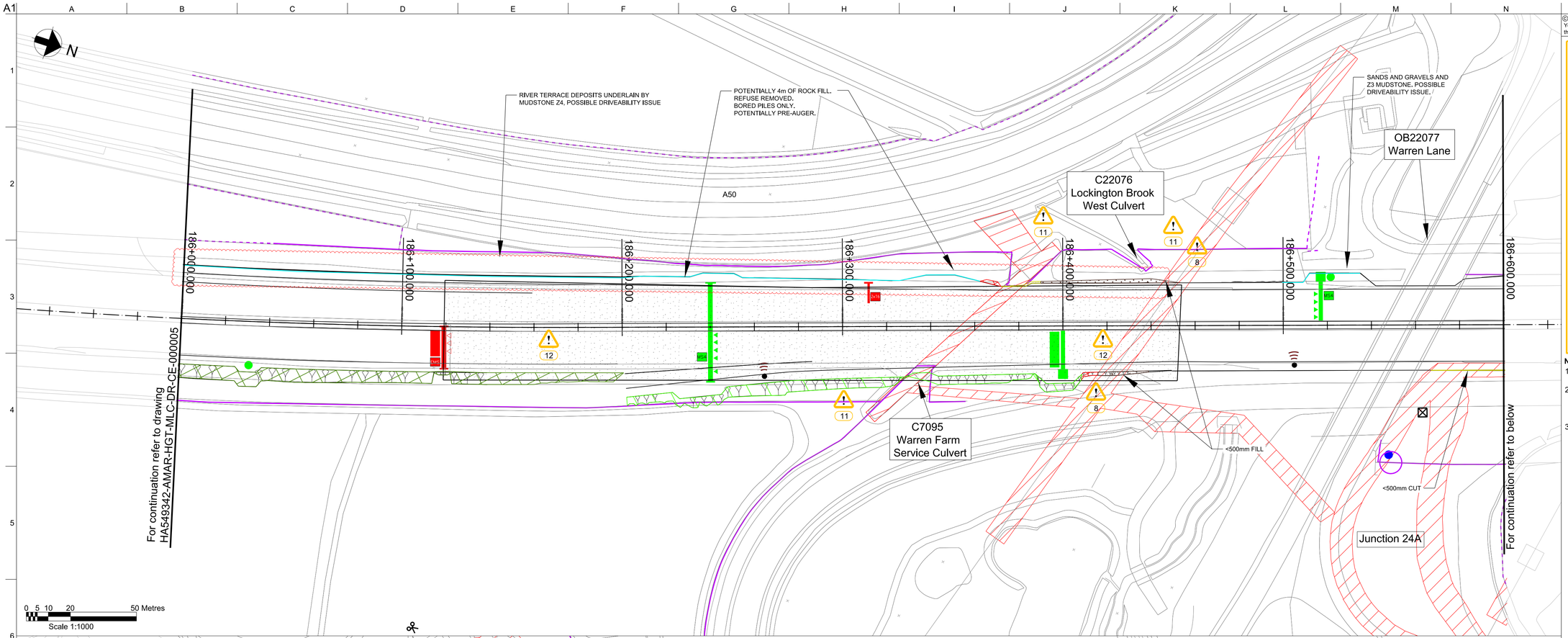
Rev: **P10**

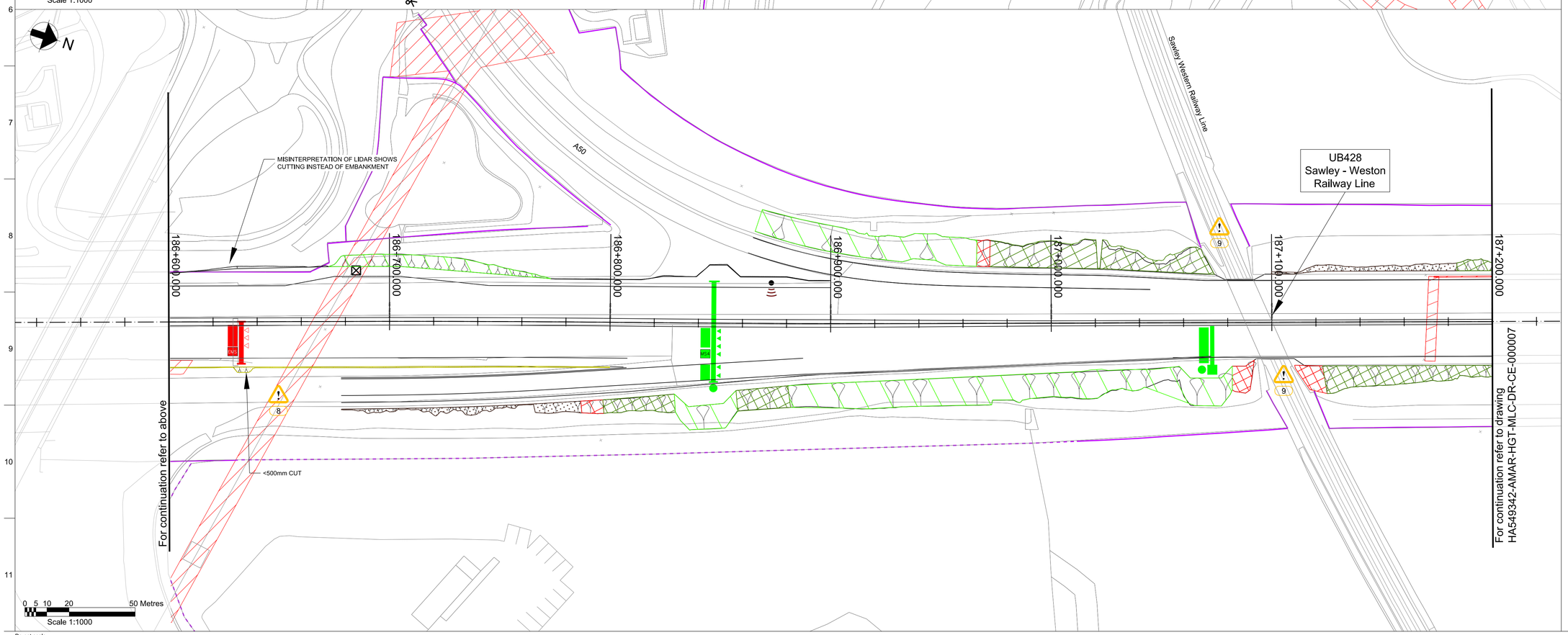
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DESIGN HAZARDS

Warning Hazards Applicable to All Drawings

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Notes:

1. ALL DIMENSIONS AND MEASUREMENTS TO BE IN METRES (m) UNLESS OTHERWISE STATED.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE EARTHWORKS GENERAL ARRANGEMENT KEY AND NOTES: HA549342-AMAR-HGT-MLC-DR-CE-000001.
3. WHERE HATCHING IS UNCLEAR DESCRIPTION BOX ADDED TO INDICATE SOLUTION FOR CLARITY.

Rev	Date	By	Chkd	Appd
P10	17/04/17	LP	---	SV

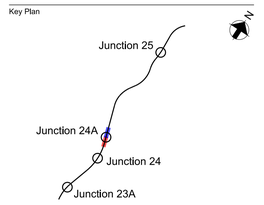
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: M1 Mainline Earthworks General Arrangement Chainage 186+000 - 187+200 Sheet 6 of 13

Scale at A1: 1:1000

Role: Civil - Earthworks and Geotech

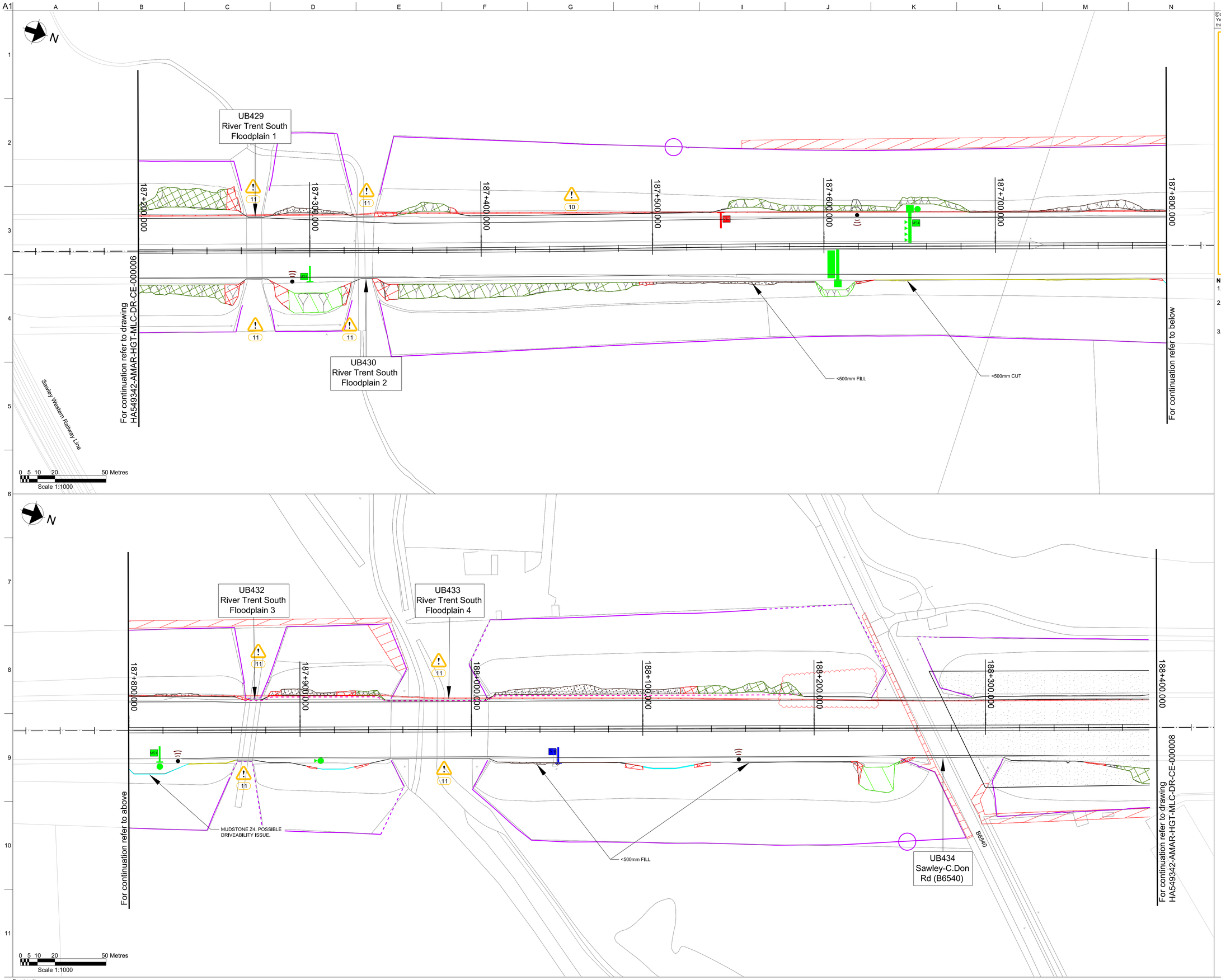
Suitability: S4 - Fit for construction approval

Job No: **244508-00**

Rev: **P10**

Name: **HA549342-AMAR-HGT-MLC-DR-CE-000006**

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DESIGN HAZARDS

Warning Hazards Applicable to All Drawings

1. Risk of working in close proximity to live traffic
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14. Hard Ground at Shallow Depth
15. Adjacent Structure
16. Existing Retaining Wall

Notes:

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3. WHERE HATCHING IS UNCLEAR DESCRIPTION BOX ADDED TO INDICATE SOLUTION FOR CLARITY.

Rev	Date	By	Chkd	Appd
P10	17/04/17	LP	---	SV

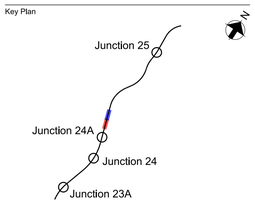
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: M1 Mainline
Earthworks General Arrangement
Chainage 187+200 - 188+400
Sheet 7 of 13

Scale at A1: 1:1000

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P10**

Name: **HA549342-AMAR-HGT-MLC-DR-CE-000007**

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A1

N

188+400.000
188+500.000
188+600.000
188+700.000
188+800.000
188+900.000
189+000.000

UB435
River Trent

UB436
River Trent North
Floodplain 1

RIVER TERRACEE DEPOSITS AND
ROCK FILL. POTENTIALLY PRE-AUGUR.

<500mm FILL

For continuation refer to drawing
HA549342-AMAR-HGT-MLC-DR-CE-000007

For continuation refer to below

River Trent

0 5 10 20 50 Metres
Scale 1:1000

N

UB436
River Trent North
Floodplain 1

189+000.000
189+100.000
189+200.000
189+300.000
189+400.000
189+500.000
189+600.000

UB7177
River Trent North
Floodplain 2

OB438
Wilne-Sawley
Road

Wilne Lane

<500mm CUT

<500mm FILL

UB437
River Trent North
Floodplain 3

<500mm CUT

GRANULAR WEDGE AT
EMBANKMENT CREST

For continuation refer to above

For continuation refer to drawing
HA549342-AMAR-HGT-MLC-DR-CE-000009

0 5 10 20 50 Metres
Scale 1:1000

Do not scale

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DESIGN HAZARDS

Warning Hazards Applicable to All Drawings

1. Risk of working in close proximity to live traffic
2. Risk of moving construction vehicles and plant around workforce
3. Risk of working on slopes
4. Risk of working at heights
5. Risk of underground cable strikes
6. Risk of asbestos within structures
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Warning Hazards Applicable to set locations

8. Risk of overhead and underground utilities crossing carriageway
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10. Risk of striking live existing and proposed Electricity Interface (EIs) points will be present on site during works
11. Culvert
12. Rock Fill
13. Sand Trenches
14. Hard Ground at Shallow Depth
15. Adjacent Structure
16. Existing Retaining Wall

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P10	17/04/17	LP	---	SV

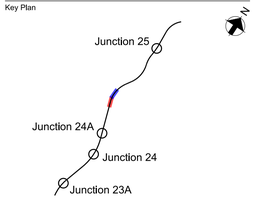
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title
M1 Mainline
Earthworks General Arrangement
Chainage 188+400 - 189+600
Sheet 8 of 13

Scale at A1: 1:1000

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

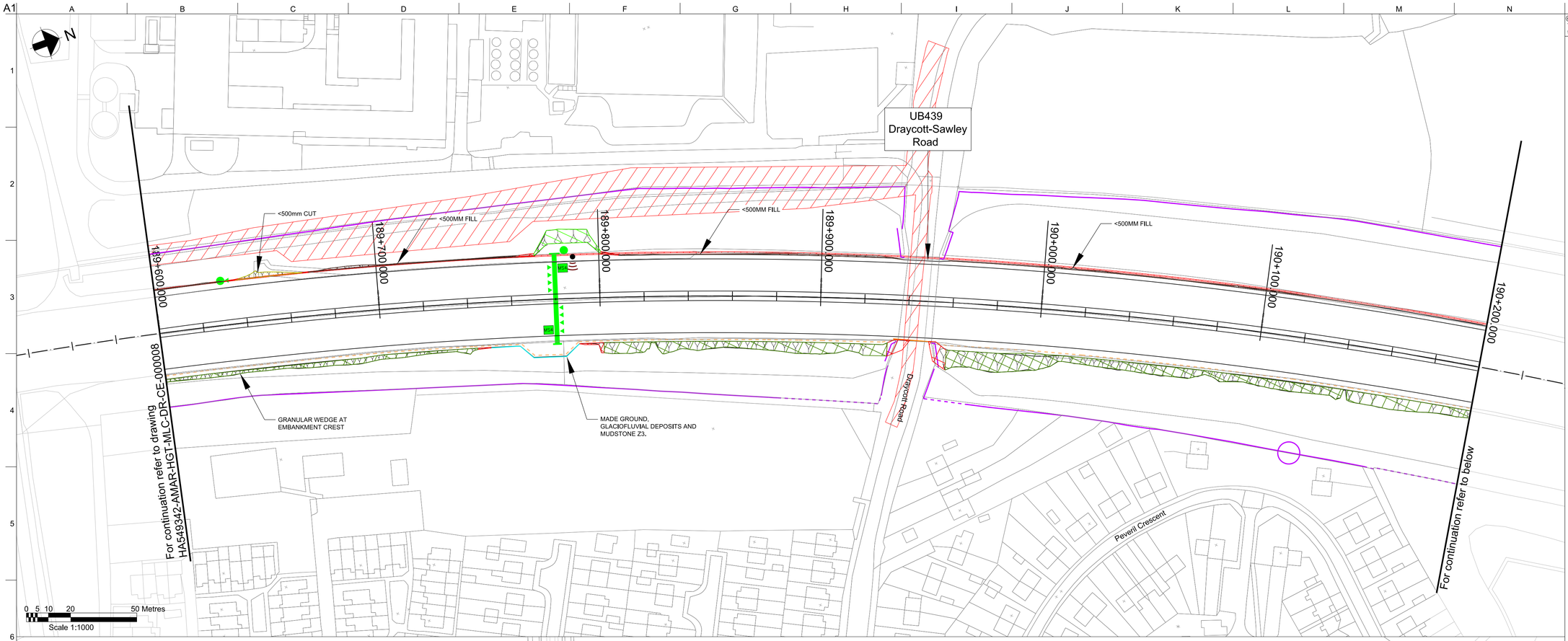
Job No: **244508-00**

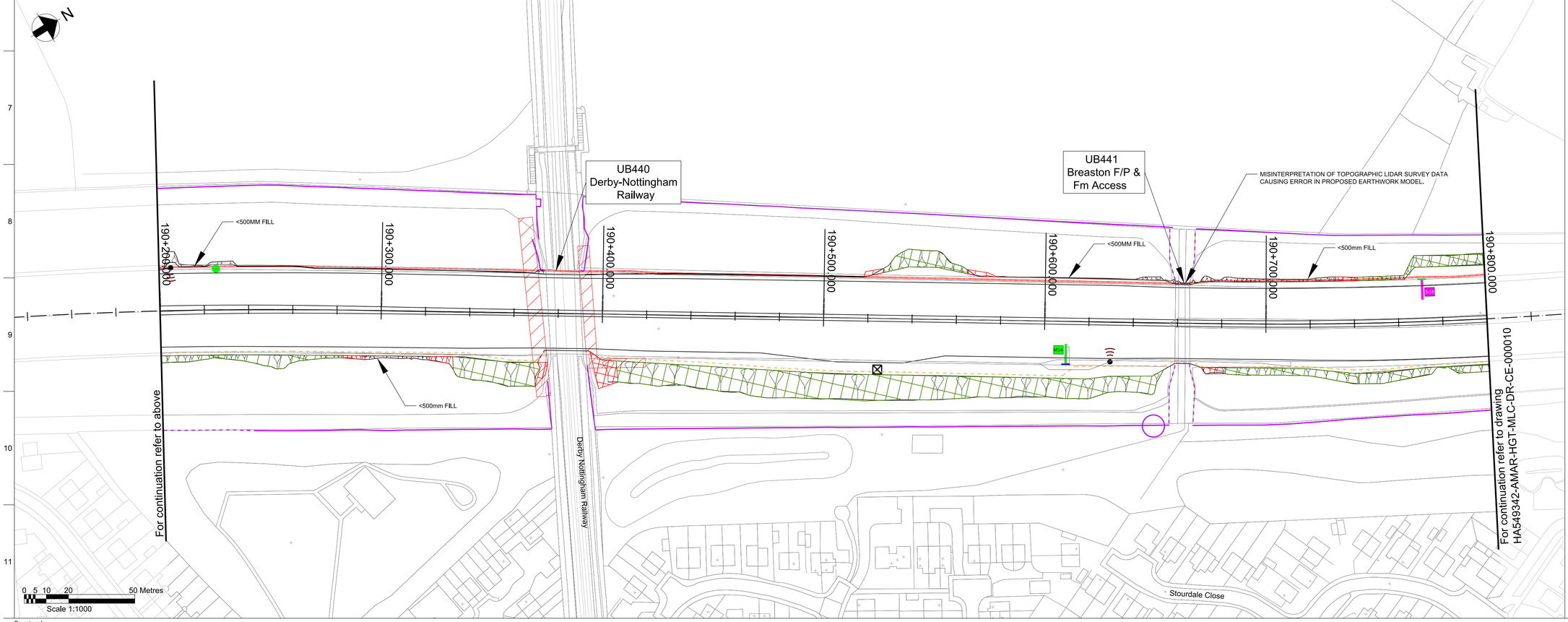
Rev: **P10**

Name: **HA549342-AMAR-HGT-MLC-DR-CE-000008**

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DESIGN HAZARDS

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15. Adjacent Structure
16. Existing Retaining Wall

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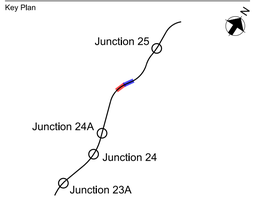
Client

highways england driving forward

Project Title

SMP M1 J23a - J25

Key Plan

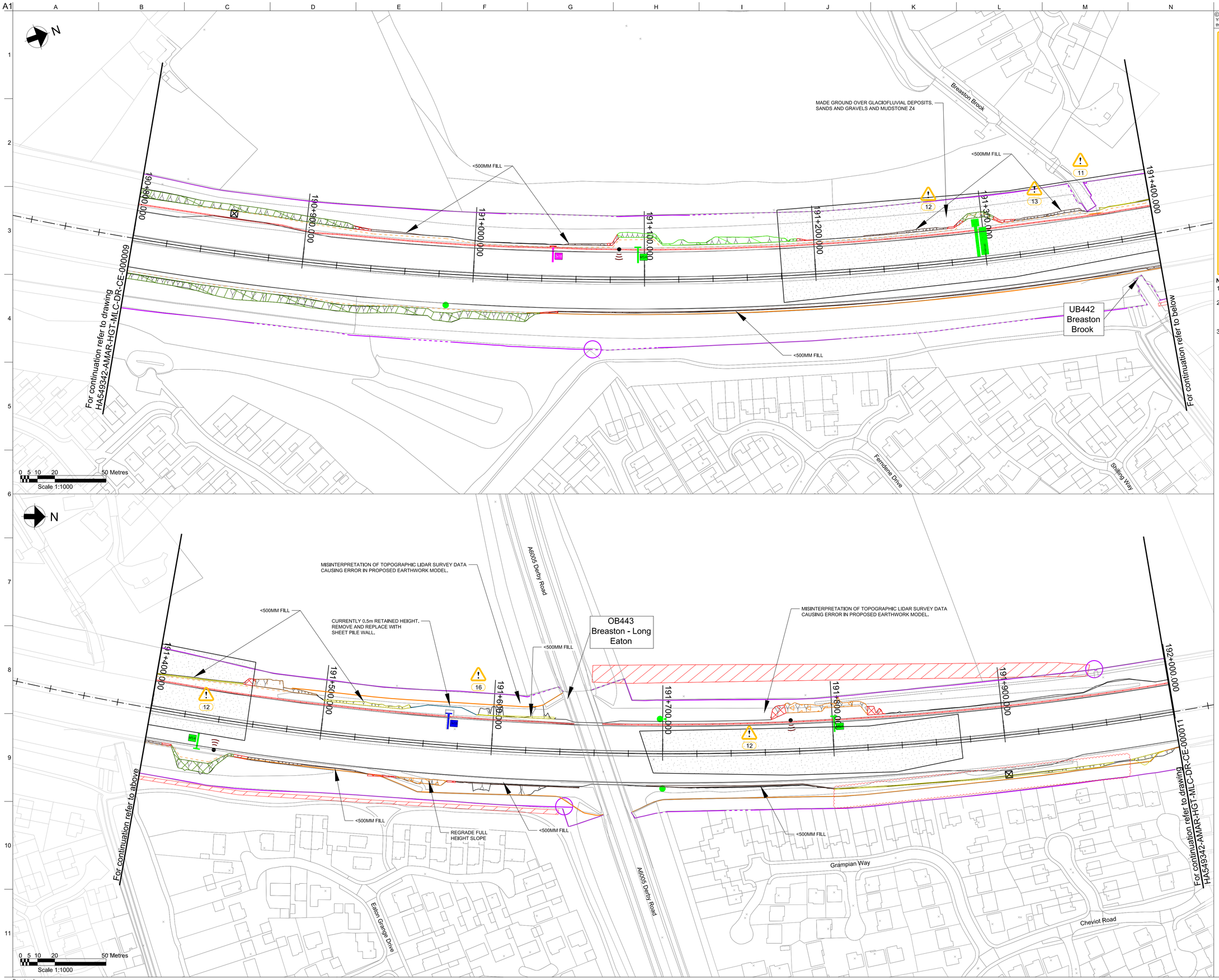


Drawing Title

M1 Mainline
Earthworks General Arrangement
Chainage 189+600 - 190+800
Sheet 9 of 13

Scale at A1	1:1000
Role	Civil - Earthworks and Geotech
Suitability	S4 - Fit for construction approval
Job No	244508-00
Rev	P10
Name	HA549342-AMAR-HGT-MLC-DR-CE-000009

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DESIGN HAZARDS

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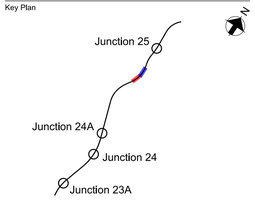
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P10	17/04/17	LP	---	SV
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Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: M1 Mainline
Earthworks General Arrangement
Chainage 190+800 - 192+000
Sheet 10 of 13

Scale at A1: 1:1000

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P10**

Name: **HA549342-AMAR-HGT-MLC-DR-CE-000010**

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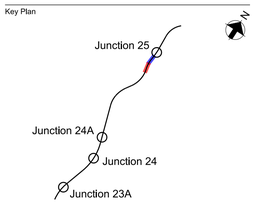
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: M1 Mainline
Earthworks General Arrangement
Chainage 192+000 - 193+200
Sheet 11 of 13

Scale at A1: 1:1000

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00**

Rev: **P10**

Name: **HA549342-AMAR-HGT-MLC-DR-CE-000011**

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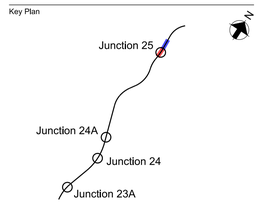
Amey ARUP

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: M1 Mainline
Earthworks General Arrangement
Chainage 193+200 - 194+400
Sheet 12 of 13

Scale at A1: 1:1000

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00**

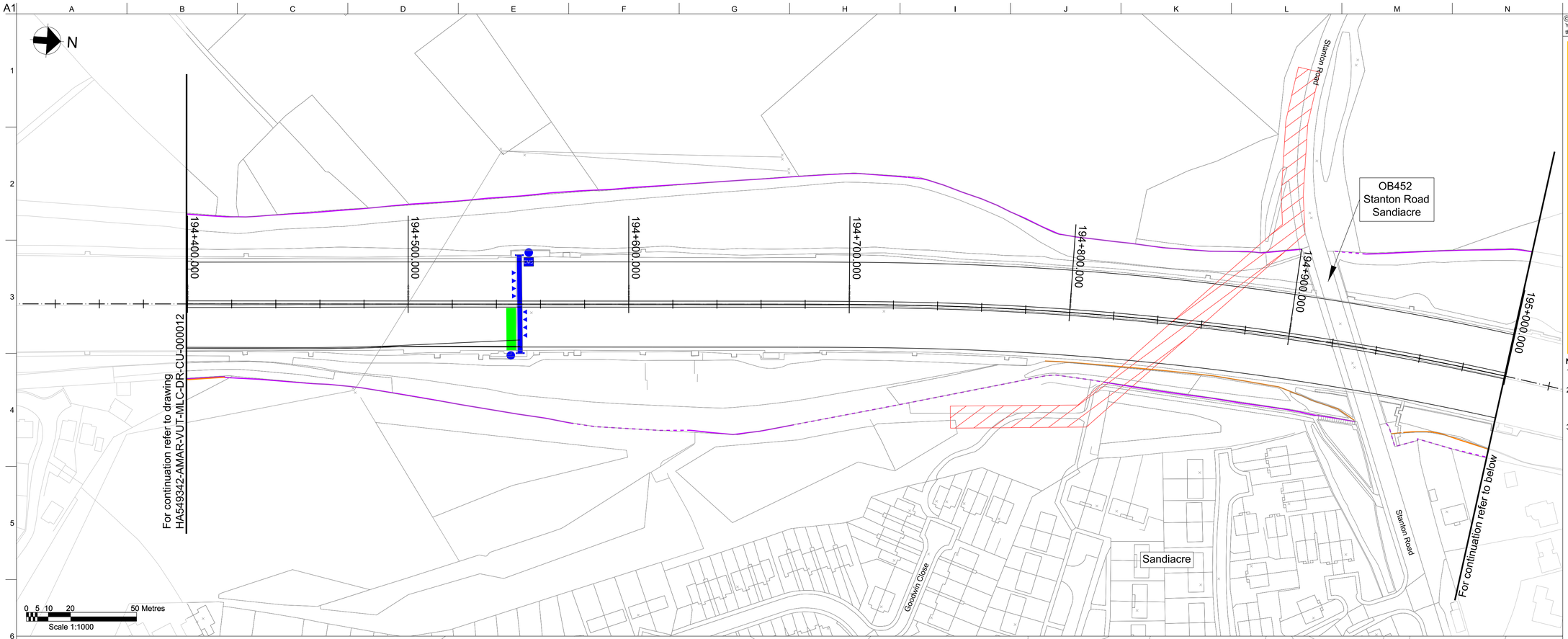
Rev: **P10**

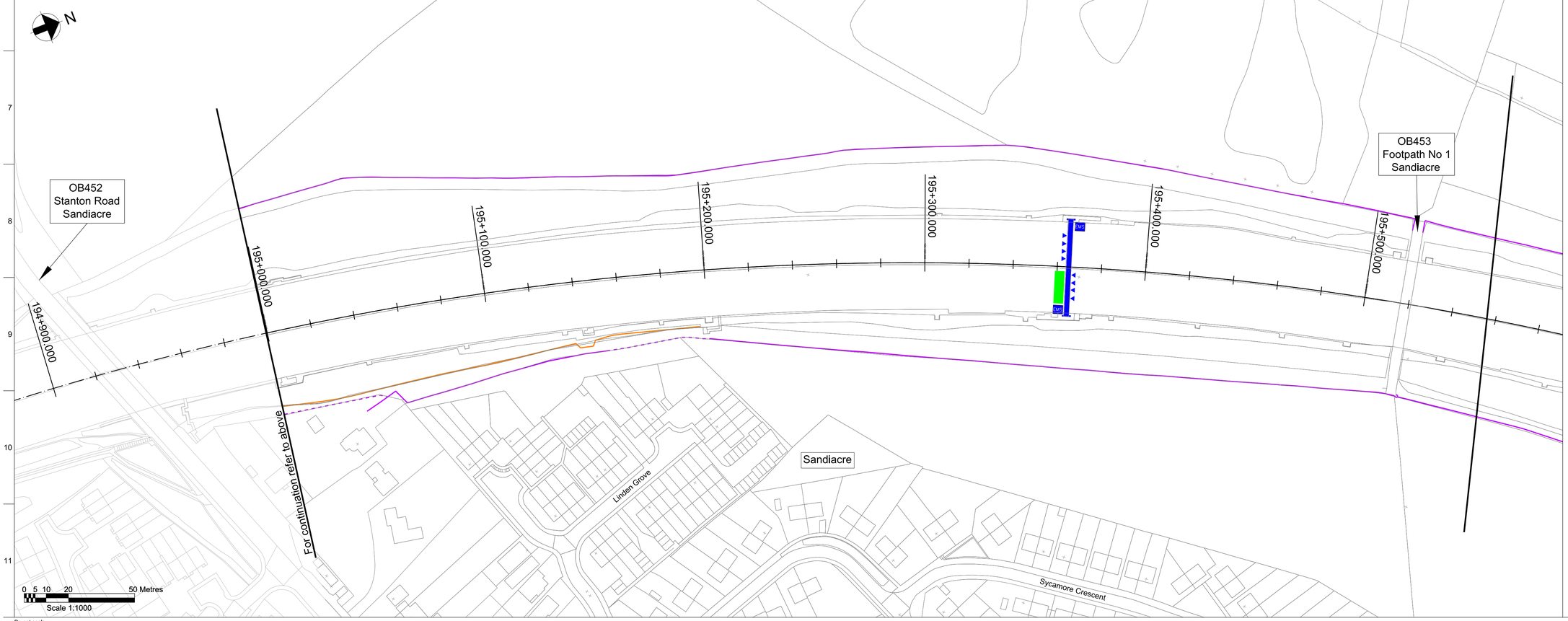
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DESIGN HAZARDS

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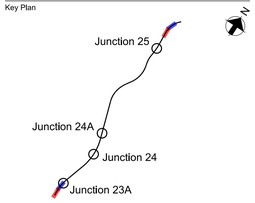
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P10	17/04/17	LP	---	SV
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: M1 Mainline
Earthworks General Arrangement
Chainage 194+400 - 195+933.059
Sheet 13 of 13

Scale at A1: 1:1000

Role: Civil - Earthworks and Geotech

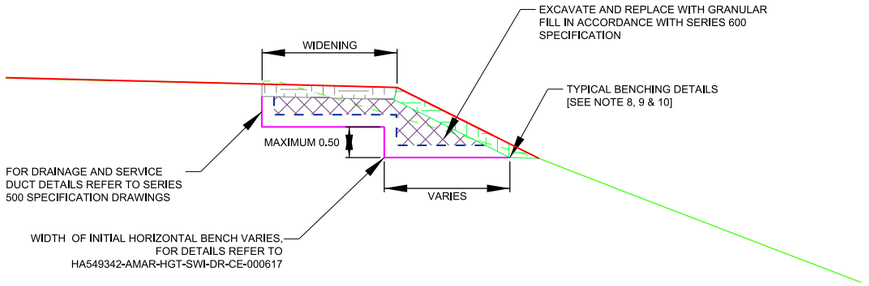
Suitability: S4 - Fit for construction approval

Job No: **244508-00**

Rev: **P10**

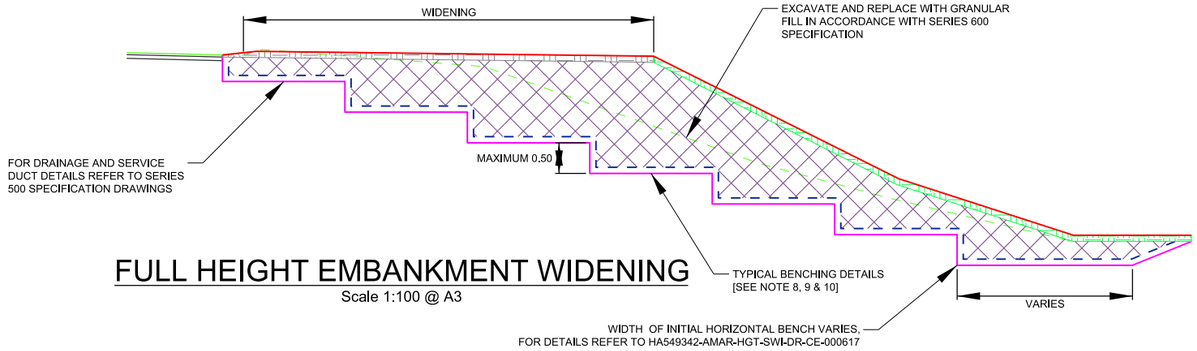
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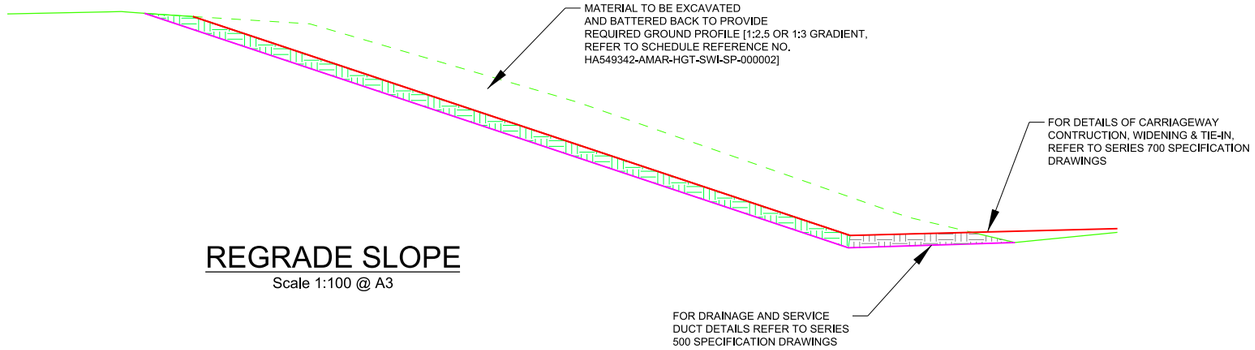
GRANULAR WEDGE AT EMBANKMENT CREST

Scale 1:50 @ A3



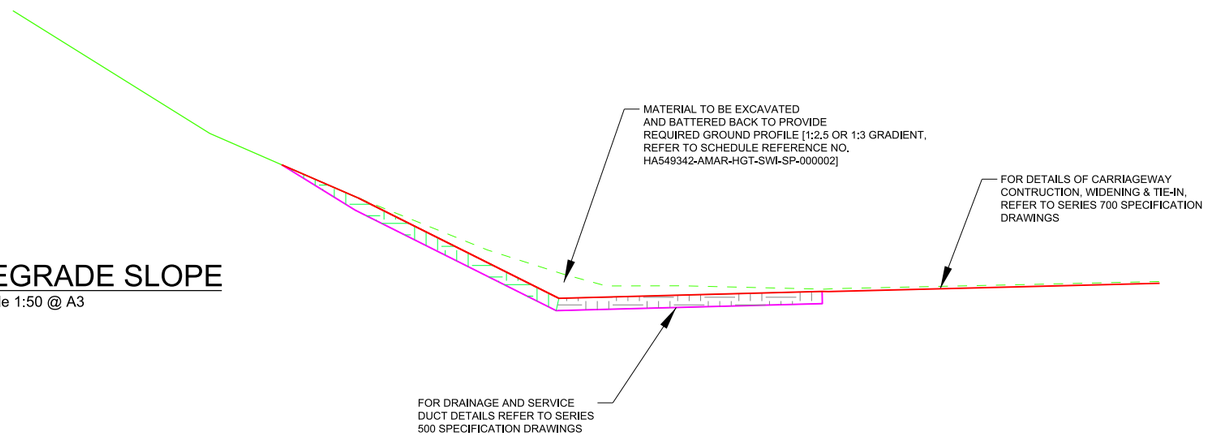
FULL HEIGHT EMBANKMENT WIDENING

Scale 1:100 @ A3



REGRADE SLOPE

Scale 1:100 @ A3



PARTIAL REGRADE SLOPE

Scale 1:50 @ A3

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2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRAWING SEIRES HA549342-AMAR HGT-MLC-DR-CE-C000001 TO HA549342-AMAR-HGT-MLC-DR-CE-000013.
3. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SP-CE-000002.
4. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
5. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
6. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
7. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. EXCAVATION PROFILES WILL VARY, DEPENDING ON GEOMETRY.
10. FOR DETAILS OF BENCHING AT INDIVIDUAL LOCATIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000617.
11. FOR TYPICAL DETAILS OF GABION WALL SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000602.
12. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001601.
13. FOR TYPICAL DETAILS OF LOW HEIGHT RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-1602

LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1m)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPEC]

Rev	Date	By	Chkd	Appd
P05	17/04/17	LP	---	SV
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Drawing Title: Earthworks Solutions

Scale at A1: NA

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: 244508-00

Rev: P05

Name: HA549342-AMAR-HGT-SWI-DR-CE-000601

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Northbound Embankment Widening Benching Details

Start Chainage	End Chainage	Topography	Geotechnical Solution	Benching Details	
				Base width (m)	Batter Angle (°)
183080	183150	Embankment	Granular Wedge at Embankment Crest 1:2	4.0	26.6
183160	183400	Embankment	Full Height Embankment Widening 1:2	5.0	26.6
184750	184900	Embankment	Full Height Widening 1:2	4.0	26.6
185860	185880	Embankment	Granular Wedge at Embankment Crest 1:2	2.0	26.6
186680	186760	Embankment	Full Height Embankment Widening 1:2	3.2	26.6
187180	187250	Embankment	Granular Wedge at Embankment Crest 1:2	5.0	26.6
187350	187380	Embankment	Granular Wedge at Embankment Crest 1:2	2.5	26.6
187550	187790	Embankment	Granular Wedge at Embankment Crest 1:2	4.5	45.0
187930	187940	Embankment	Granular Wedge at Embankment Crest 1:2	2.1	26.6
188180	188230	Embankment	Granular Wedge at Embankment Crest 1:2	5.0	26.6
188500	188500	Embankment	Granular Wedge at Embankment Crest 1:2	3.0	26.6
189780	189800	Embankment	Granular Wedge at Embankment Crest 1:2	4.2	22.0
190530	190560	Embankment	Granular Wedge at Embankment Crest 1:2	4.5	26.6
190740	190930	Embankment	Full Height Embankment Widening 1:2	8.2	26.6
191090	191190	Embankment	Full Height Embankment Widening 1:2	3.4	11.0*
191290	191310	Embankment	Full Height Embankment Widening 1:2	3.4	11.0*
192100	192110	Embankment	Full Height Embankment Widening 1:2	2.4	26.6
192130	192140	Embankment	Granular Wedge at Embankment Crest 1:2	3.5	45.0
192210	192400	Embankment	Granular Wedge at Embankment Crest 1:2	6.8	45.0
192470	192500	Embankment	Full Height Embankment Widening 1:2	4.9	26.6

* Note: This Batter Angle is shallow due to the existing profile of the slope.

Southbound Embankment Widening Benching Details

Start Chainage	End Chainage	Topography	Geotechnical Solution	Benching Details	
				Base width (m)	Batter Angle (°)
182940	183310	Embankment	Granular Wedge At Embankment Crest 1:2	7.3	27
183320	183430	Embankment	Full Height Embankment Widening 1:2	4.5	27
184630	184740	Embankment	Full Height Embankment Widening 1:2	2.0	27
185870	185900	Embankment	Granular Wedge At Embankment Crest 1:2	4.5	45
185900	186200	Embankment	Granular Wedge At Embankment Crest 1:2	4.5	45
186210	186400	Embankment	Full Height Embankment Widening 1:2	10.4	27
186800	186830	Embankment	Granular Wedge At Embankment Crest 1:2	9.0	45
186830	186860	Embankment	Full Height Embankment Widening 1:2	6.6	27
186860	186880	Embankment	Granular Wedge At Embankment Crest 1:2	9.0	45
186890	187080	Embankment	Full Height Embankment Widening 1:2	6.1	27
187120	187250	Embankment	Granular Wedge At Embankment Crest 1:2	6.5	27
187280	187320	Embankment	Full Height Embankment Widening 1:2	4.0	27
187350	187490	Embankment	Granular Wedge At Embankment Crest 1:2	6.5	27
187600	187620	Embankment	Full Height Embankment Widening 1:2	4.0	27
188230	188250	Embankment	Full Height Embankment Widening 1:2	6.2	45
188380	188400	Embankment	Granular Wedge At Embankment Crest 1:2	4.0	27
189560	189740	Embankment	Granular Wedge At Embankment Crest 1:2	4.5	45
189800	189930	Embankment	Granular Wedge At Embankment Crest 1:2	4.5	45
189960	190280	Embankment	Granular Wedge At Embankment Crest 1:2	3.5	27
190330	190370	Embankment	Granular Wedge At Embankment Crest 1:2	3.5	27
190400	190650	Embankment	Granular Wedge At Embankment Crest 1:2	3.9	27
190680	191040	Embankment	Granular Wedge At Embankment Crest 1:2	3.8	27
191420	191450	Embankment	Granular Wedge At Embankment Crest 1:2	3.0	27
192030	192080	Embankment	Granular Wedge At Embankment Crest 1:2	2.4	27
192560	192710	Embankment	Full Height Embankment Widening 1:2	5.0	27

NOTES

1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE SERIES 600 SPECIFICATION (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SP-CE-000002).
2. THE BASE BENCH WIDTH AND BATTER ANGLES INDICATED IN THESE TABLES ARE SHOWN AS VARIABLES IN THE STANDARD DETAIL DRAWING (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-DR-CE-000601).

Rev	Date	By	Chkd	Appd
P02	20/04/17	TB	---	SV

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amey ARUP

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client

highways england driving forward

Project Title

SMP M1 J23a - J25

Drawing Title

Benching Required at Each Regrade

Scale at A1: NTS

Role: Civil - Earthworks and Geotech

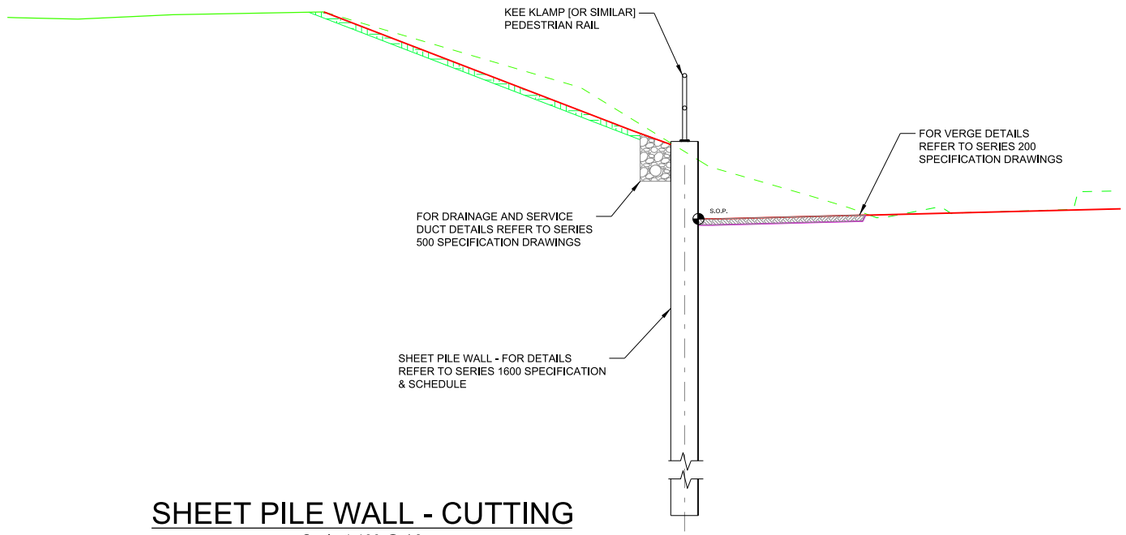
Suitability: S4 - Fit for construction approval

Job No: **244508-00**

Rev: **P02**

Name

HA549342-AMAR-HGT-SWI-DR-CE-000617



SHEET PILE WALL - CUTTING

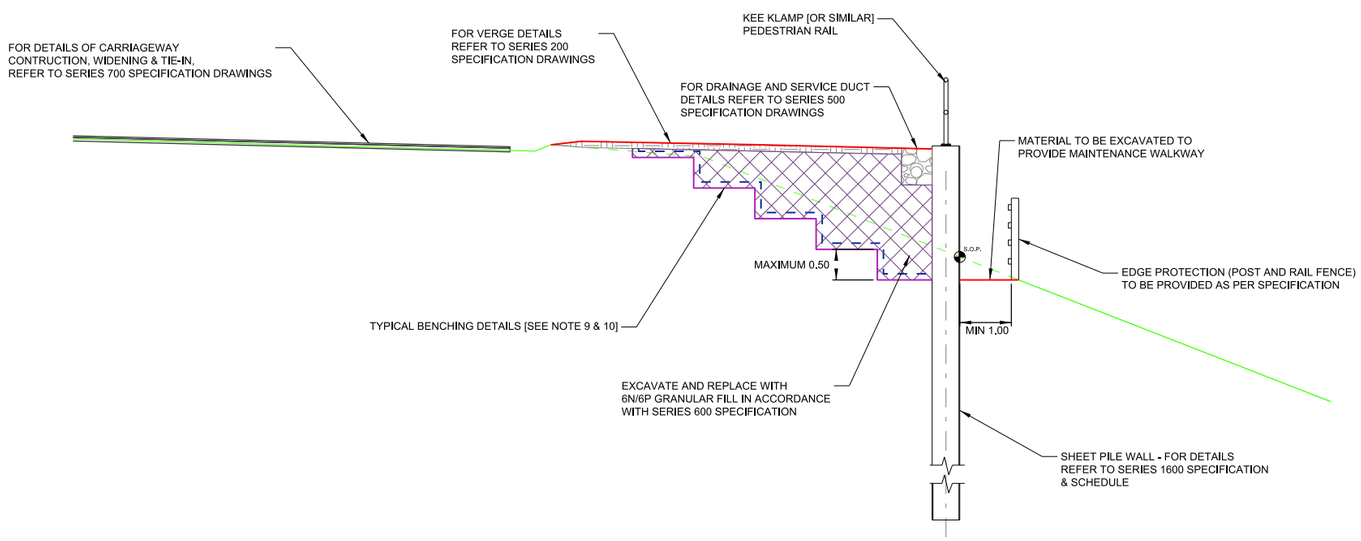
Scale 1:100 @ A3

SHEET PILE SECTION
(VARIES, REFER TO SERIES 1600
SPECIFICATION AND SCHEDULE)



SHEET PILE PLAN DETAIL

Scale 1:20 @ A3



SHEET PILE WALL - EMBANKMENT

Scale 1:100 @ A3

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NOTES:

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRAWING SERIES HA549342-AMAR HGT-MLC-DR-CE-C000001 TO HA549342-AMAR-HGT-MLC-DR-CE-000013.
3. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SP-CE-000002).
4. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
5. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
6. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
7. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V):2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. EXCAVATION PROFILES WILL VARY, DEPENDING ON GEOMETRY.
10. FOR TYPICAL DETAILS OF EARTHWORKS SOLUTION REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000601.
11. FOR TYPICAL DETAILS OF GABION WALL SOLUTIONS REFER TO HA5493432-AMAR-HGT-SWI-DR-CE-000602.
12. FOR TYPICAL DETAILS OF LOW HEIGHT RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-0001602.

LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL (MINIMUM 0.1M)
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPEC]
- S.O.P. SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P10	22/05/17	LP	---	SV

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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Drawing Title: RETAINING SOLUTIONS SHEET PILE

Scale at A1: NTS

Role: Civil - Earthworks and Geotech

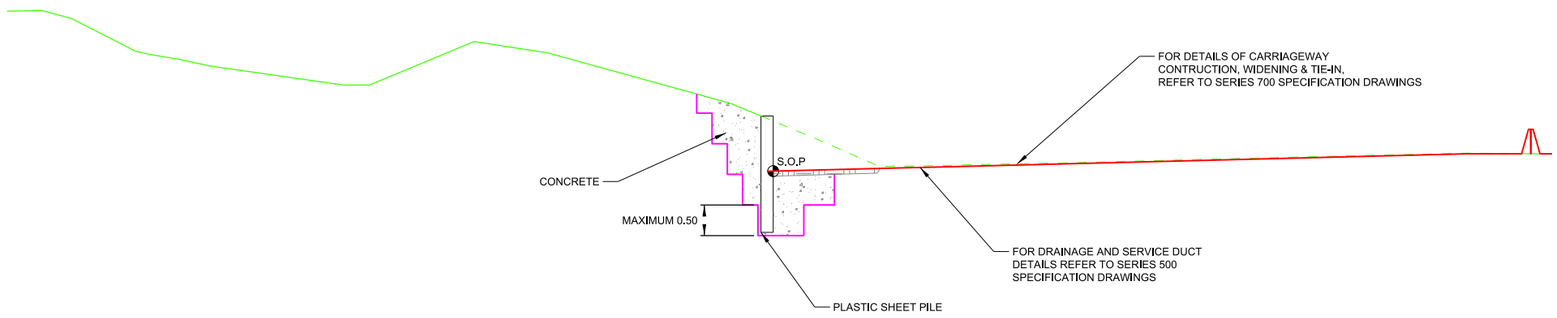
Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P10**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001601**

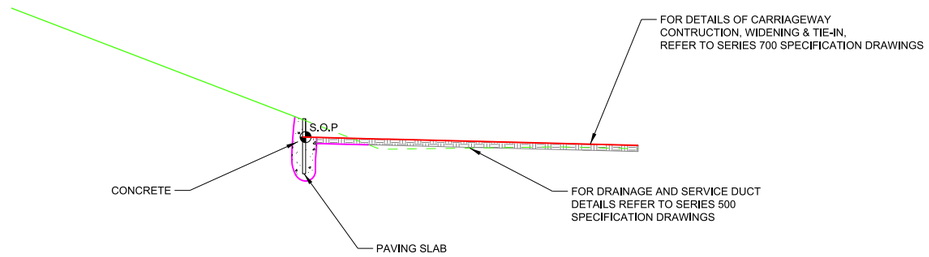
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Do not scale



PLASTIC SHEET PILE

Scale 1:50



SLAB-ON-EDGE

Scale 1:50

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NOTES

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2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRAWING SERIES HA549342-AMAR-HGT-MLC-DR-CE-000001 TO HA549342-AMAR-HGT-MLC-DR-CE-000013.
3. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR HGT-SWI-SP-CE-000002.)
4. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
5. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
6. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
7. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150mm FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300mm FOR SHALLOWER GRADIENTS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
9. EXCAVATION PROFILES WILL VARY DEPENDING ON TOPOGRAPHY.
10. FOR TYPICAL DETAILS OF EARTHWORKS SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000601.
11. FOR TYPICAL DETAILS OF SHEET PILE SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001601.

LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- VERGE SURFACE
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
P03	24/04/17	TB	---	LP

Issued for Client Sharing

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Drawing Title: RETAINING SOLUTIONS
LOW HEIGHT RETAINING WALL

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

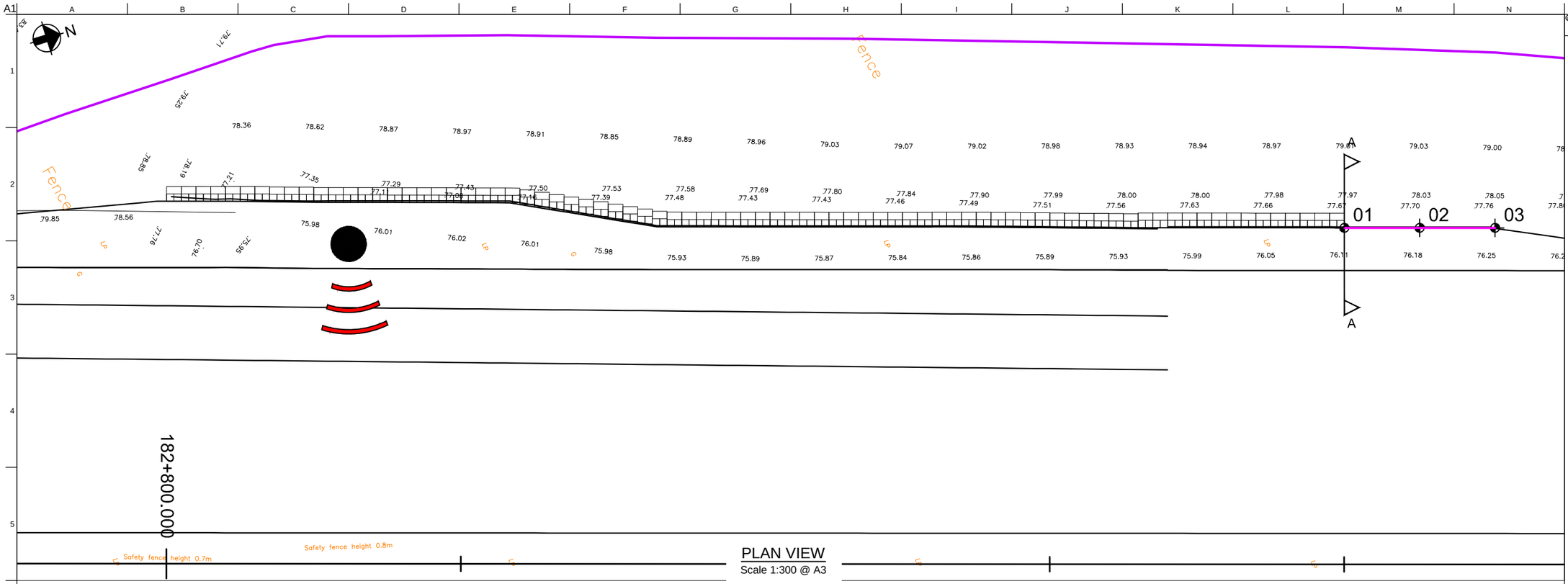
Suitability: S4 - Fit for construction approval

Job No: **244508-00** | Rev: **P03**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001602**

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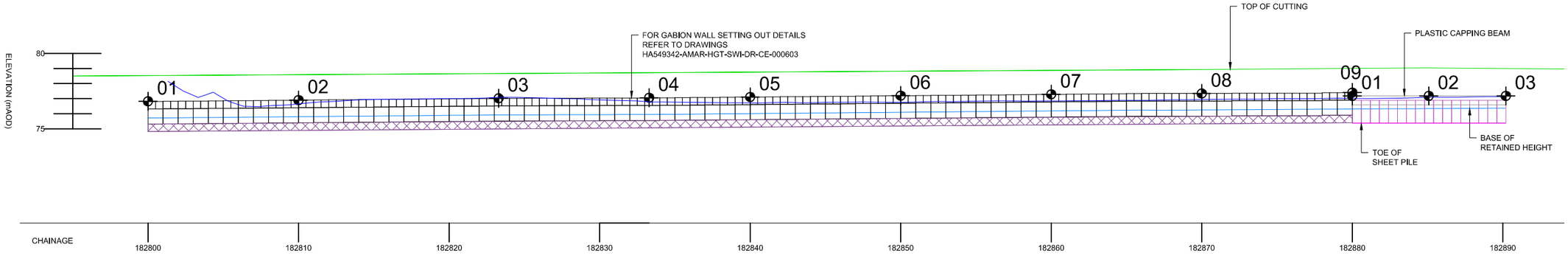
Do not scale



PLAN VIEW
Scale 1:300 @ A3

SHEET PILE SETTING OUT POINTS						RET. WALL DETAILS	
REFERENCE	EASTING	NORTHING	TOP OF PILE CAP (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	TOTAL RETAINED HIEGHT	TOTAL SHEET PILE LENGTH
001	447024.19	325334.92	77.18	77.00	76.45	0.55	1.50
002	447025.7	325339.82	77.18	77.10	76.60	0.50	1.50
003	447027.21	325344.71	77.18	77.13	76.65	0.48	1.50

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:300 @ A3

ELEVATION LEGEND

- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- TOE OF SHEET PILE
- PLASTIC CAPPING BEAM
- PLASTIC SHEET PILES
- GABION WALL
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

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NOTES

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- PLASTIC SHEET PILE LOCATION
- GABION WALL
- SECTION LINE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P04	17/04/17	LP	---	LP

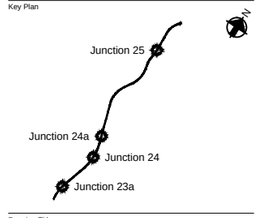
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: PLASTIC SHEET PILE SOLUTION PLAN
CH.182880 TO CH.182890 (NB)
SHEET 01 OF 02

Scale at A1: 1:150

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

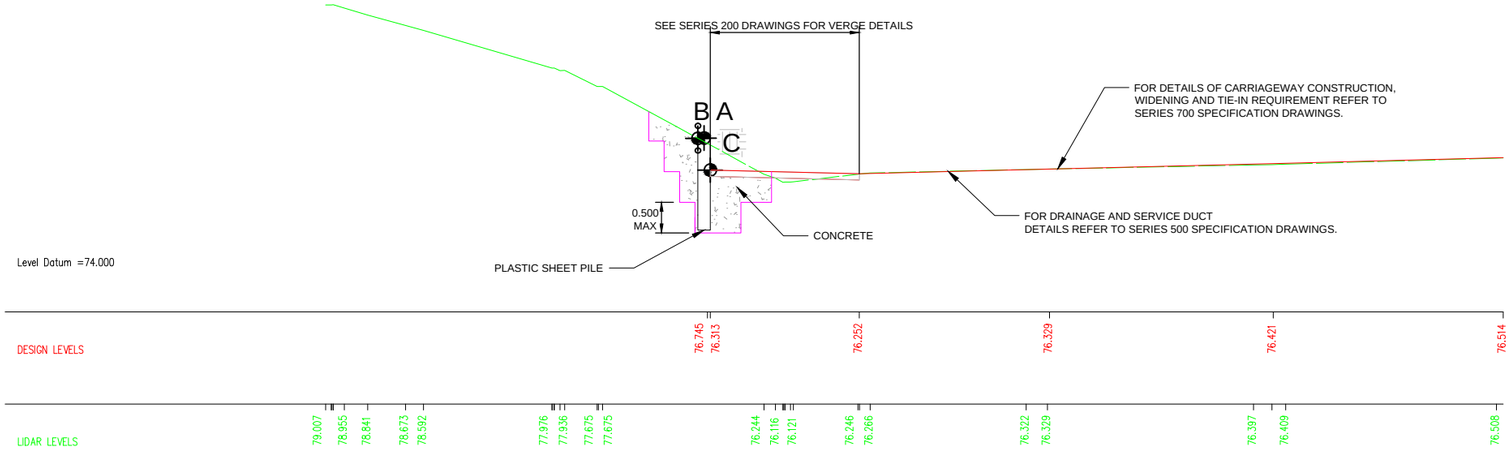
Job No: **244508-00**

Rev: **P04**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001603**

Do not scale

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SECTION A-A
CH. 182880
Scale 1:100 @ A3

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NOTES
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2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- PLASTIC SHEET PILE
- SETTING OUT POINT
- CONCRETE

Rev	Date	By	Chkd	Appd
P04	17/04/17	LP	---	LP

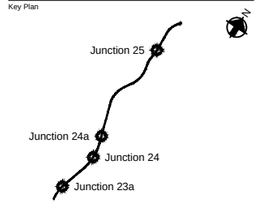
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: SHEET PILE DESIGN SOLUTION CROSS SECTION CH.182880 TO CH.182890 (NB) SHEET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

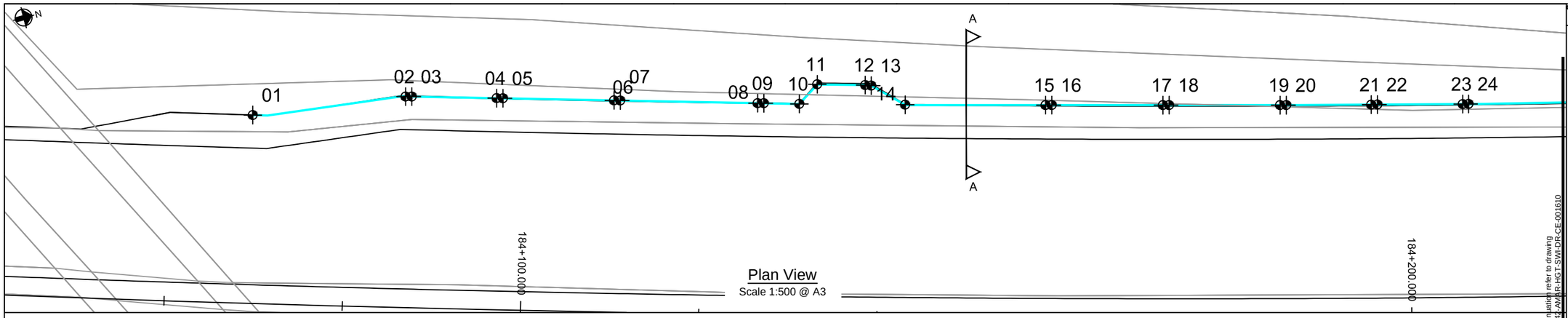
Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P04**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001604**

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Do not scale



Plan View
Scale 1:500 @ A3

For continuation refer to drawing HA549342-AMAR-HGT-SWI-DR-CE-001610

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

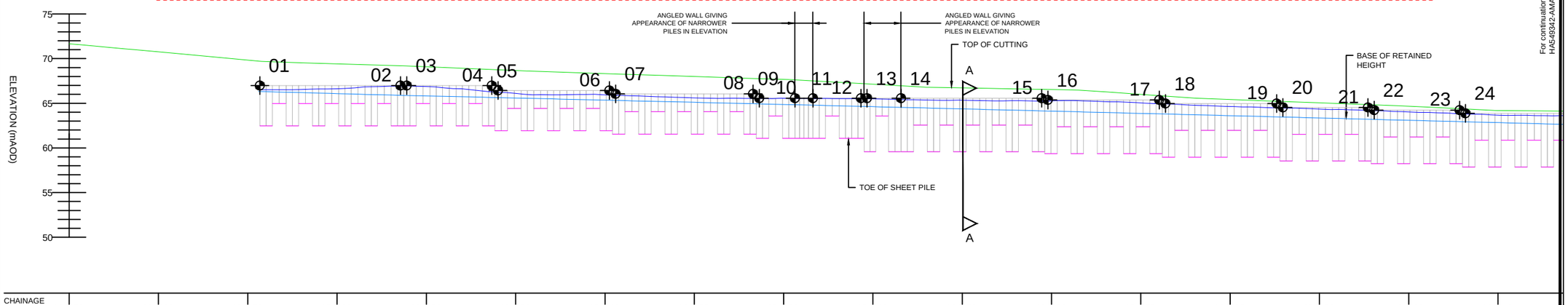
EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION

SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)
01	447376.58	326470.58	66.98	66.51	66.32
02	447378.95	326487.69	66.98	66.93	65.87
03	447379.13	326488.36	66.98	66.93	65.87
04	447381.73	326497.53	66.98	66.28	65.66
05	447381.92	326498.2	66.43	66.22	65.64
06	447385.31	326510.19	66.43	65.92	65.34
07	447385.51	326510.87	66.55	66.40	65.82
08	447389.71	326525.69	66.55	66.04	65.45
09	447389.9	326526.36	65.57	65.52	64.91
10	447390.99	326530.19	65.57	65.52	64.81
11	447389.38	326532.7	65.57	65.52	64.78
12	447390.83	326537.88	65.57	65.50	64.66
13	447391.06	326538.51	65.57	65.50	64.64
14	447394.1	326541.65	65.57	65.42	64.55
15	447398.14	326556.87	65.57	65.25	64.16
16	447398.32	326557.54	65.37	65.25	64.14
17	447401.5	326569.6	65.37	64.98	63.83
18	447401.67	326570.27	64.97	64.92	63.76
19	447404.85	326582.32	64.97	64.49	63.49
20	447405.03	326583	64.53	64.48	63.48
21	447407.4	326592.22	64.53	64.20	63.20
22	447407.57	326592.89	64.24	64.18	63.20
23	447409.95	326602.17	64.24	64.19	63.30
24	447410.1	326602.8	63.87	63.81	62.93

RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
0.19	4.50	2.00
1.06	4.50	2.00
1.06	4.50	2.00
0.62	4.50	2.00
0.58	4.50	2.00
0.58	4.50	2.00
0.58	4.50	2.00
0.59	4.50	2.00
0.61	4.50	2.00
0.71	4.50	2.00
0.74	4.50	2.00
0.84	4.50	2.00
0.86	4.50	2.00
0.87	6.00	3.00
1.09	6.00	3.00
1.11	6.00	3.00
1.15	6.00	3.00
1.16	6.00	3.00
1.00	6.00	3.00
1.00	6.00	3.00
1.00	6.00	3.00
0.98	6.00	3.00
0.89	6.00	3.00
0.88	6.00	3.00



ELEVATION
Scale 1:500 @ A3

For continuation refer to drawing HA549342-AMAR-HGT-SWI-DR-CE-001610

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NOTES

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2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- TOE OF SHEET PILE
- SHEET PILES

Rev	Date	By	Chkd	Appd
P06	22/05/17	LP	---	SV

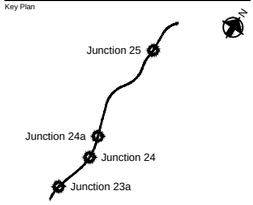
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Client: highways england driving forward

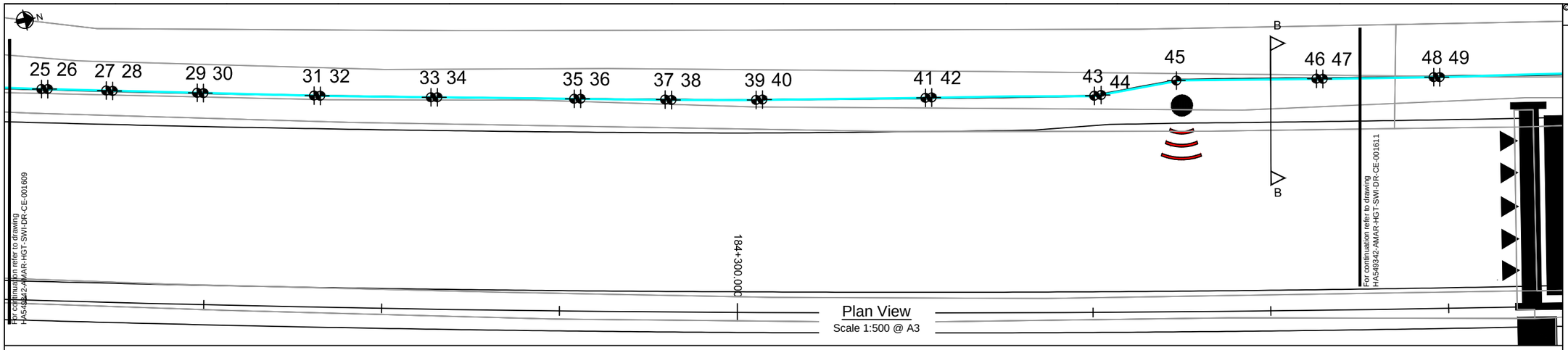
Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
KING SHEET PILE SOLUTION PLAN
CH. 184071 TO CH. 1844553 (NB)
SHEET 01 OF 04

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P06
Name: HA549342-AMAR-HGT-SWI-DR-CE-001609



Plan View
Scale 1:500 @ A3

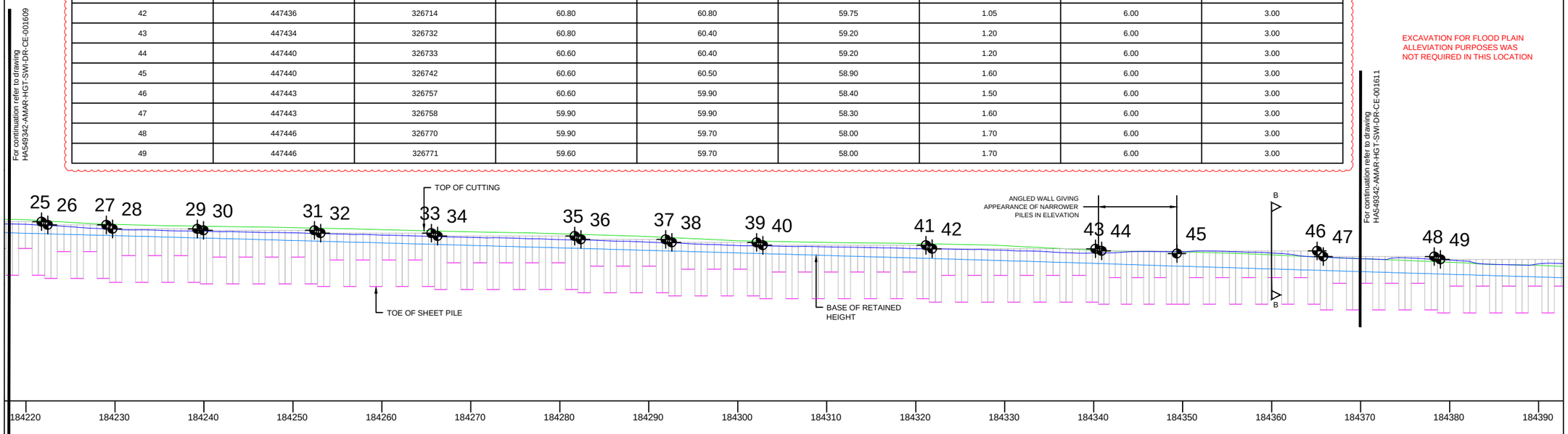
SHEET PILE SETTING OUT POINTS

RET. WALL DETAILS

REFERENCE	EASTING	NORTHING	TOP OF PILE CAP (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
25	447413	326617	63.90	63.50	62.50	1.00	6.00	3.00
26	447414	326617	63.50	63.40	62.50	0.90	6.00	3.00
27	447415	326624	63.50	63.00	62.30	0.70	6.00	3.00
28	447416	326625	63.00	63.00	62.30	0.70	6.00	3.00
29	447418	326634	63.00	62.80	62.00	0.80	6.00	3.00
30	447418	326634	62.90	62.80	62.00	0.80	6.00	3.00
31	447421	326647	62.90	62.50	61.70	0.80	6.00	3.00
32	447421	326647	62.50	62.50	61.70	0.80	6.00	3.00
33	447424	326659	62.50	62.20	61.30	0.90	6.00	3.00
34	447424	326660	62.20	62.20	61.30	0.90	6.00	3.00
35	447428	326675	62.20	61.80	60.90	0.90	6.00	3.00
36	447428	326675	62.90	61.80	60.90	0.90	6.00	3.00
37	447430	326685	62.90	61.50	60.70	0.80	6.00	3.00
38	447430	326686	61.60	61.60	60.60	1.00	6.00	3.00
39	447432	326694	61.60	61.20	60.30	0.90	6.00	3.00
40	447432	326696	61.20	61.20	60.20	1.00	6.00	3.00
41	447436	326714	61.20	60.80	59.75	1.05	6.00	3.00
42	447436	326714	60.80	60.80	59.75	1.05	6.00	3.00
43	447434	326732	60.80	60.40	59.20	1.20	6.00	3.00
44	447440	326733	60.60	60.40	59.20	1.20	6.00	3.00
45	447440	326742	60.60	60.50	58.90	1.60	6.00	3.00
46	447443	326757	60.60	59.90	58.40	1.50	6.00	3.00
47	447443	326758	59.90	59.90	58.30	1.60	6.00	3.00
48	447446	326770	59.90	59.70	58.00	1.70	6.00	3.00
49	447446	326771	59.60	59.70	58.00	1.70	6.00	3.00

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:500 @ A3

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NOTES

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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
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7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- TOE OF SHEET PILE
- SHEET PILES

Rev	Date	By	Chkd	Appd
P06	22/05/17	LP	---	SV

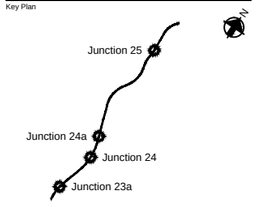
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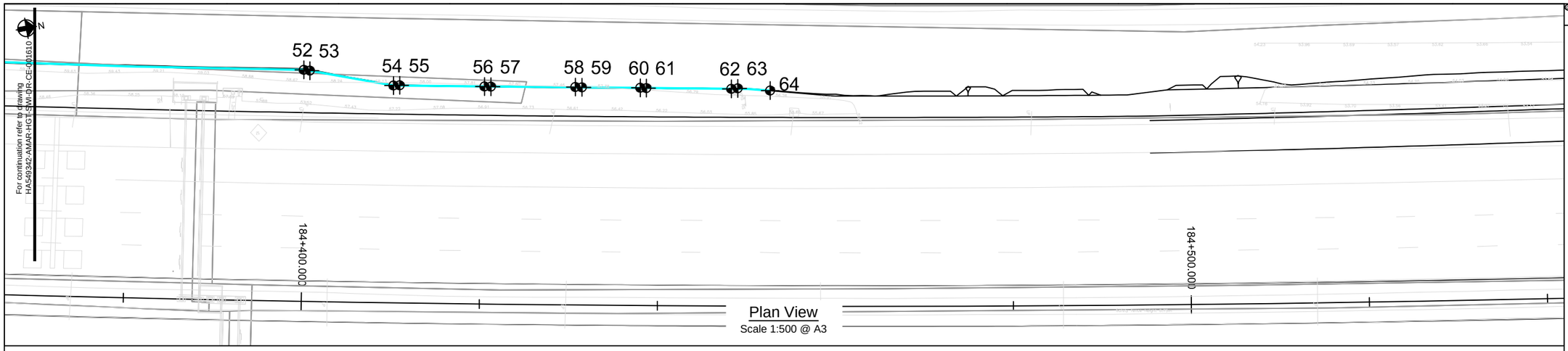
Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
KING SHEET PILE DESIGN SOLUTION PLAN
CH. 184071 TO CH. 1844553 (NB)
SHEET 02 OF 04

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P06**
Name: **HA549342-AMAR-HGT-SWI-DR-CE-001610**

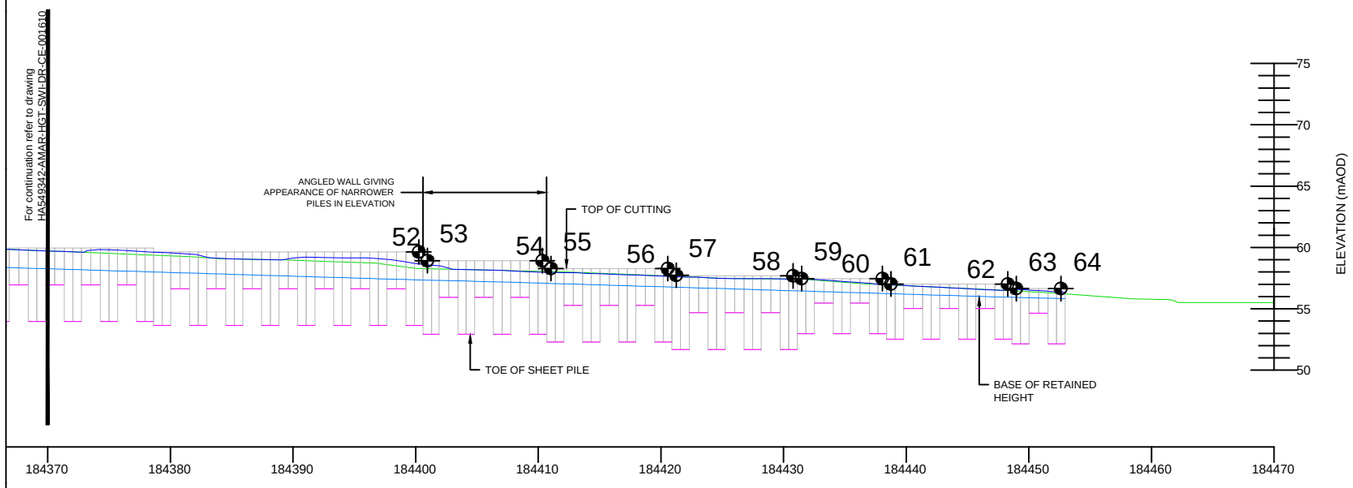


Plan View
Scale 1:500 @ A3

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

SHEET PILE SETTING OUT POINTS						RET. WALL DETAILS		
REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
52	447449.84	326790.48	59.60	58.70	57.40	1.30	6.00	3.00
53	447450.05	326791.12	58.90	58.60	57.30	1.30	6.00	3.00
54	447453.34	326800.09	58.90	58.00	57.10	0.90	6.00	3.00
55	447453.43	326800.79	58.30	58.00	57.00	1.00	6.00	3.00
56	447455.22	326810.13	58.30	57.70	56.80	0.90	6.00	3.00
57	447455.37	326810.84	57.70	57.60	56.80	0.80	6.00	3.00
58	447457.05	326820.19	57.70	57.40	56.50	0.90	6.00	3.00
59	447457.21	326820.89	57.50	57.40	56.50	0.90	4.50	2.00
60	447458.41	326827.36	57.50	57.00	56.30	0.70	4.50	2.00
61	447458.55	326828.02	57.00	57.00	56.20	0.80	4.50	2.00
62	447460.3	326837.4	57.00	56.60	55.90	0.70	4.50	2.00
63	447460.38	326838.12	56.70	56.60	55.90	0.70	4.50	2.00
64	447461.25	326841.66	56.70	56.40	55.80	0.60	4.50	2.00

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:500 @ A3

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NOTES

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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- TOE OF SHEET PILE
- SHEET PILES

Rev	Date	By	Chkd	Appd
P06	22/05/17	LP	---	SV

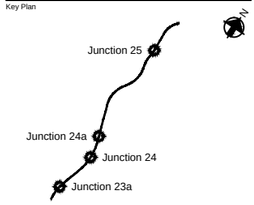
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Client: highways england driving forward

Project Title: SMP M1 J23a - J25

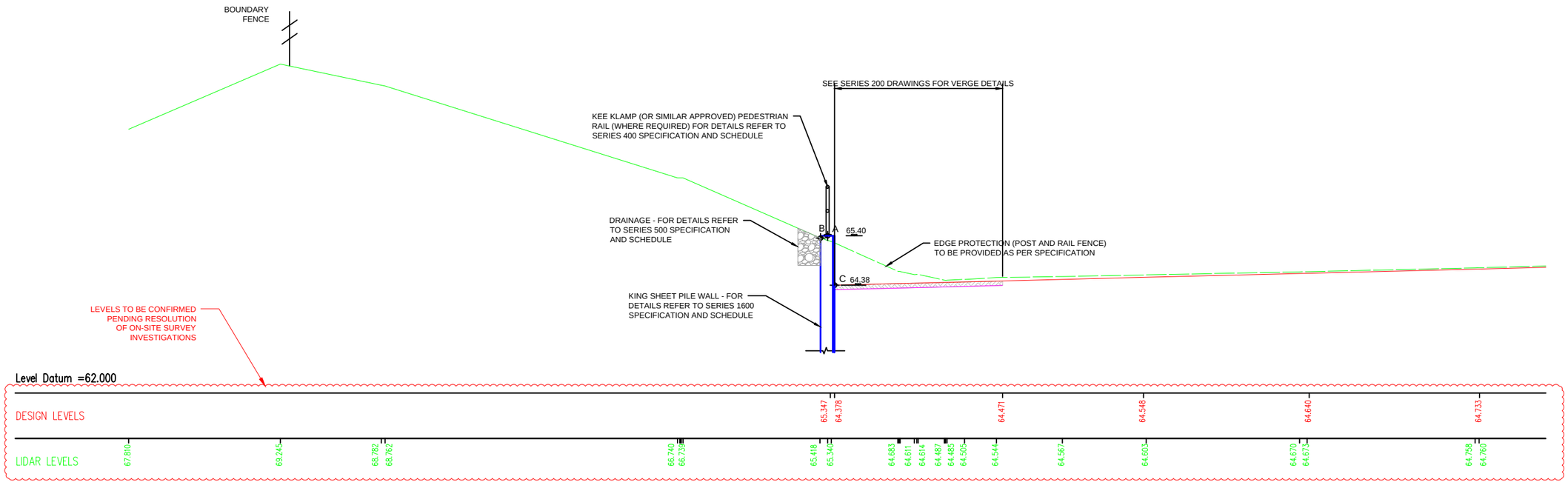
Key Plan



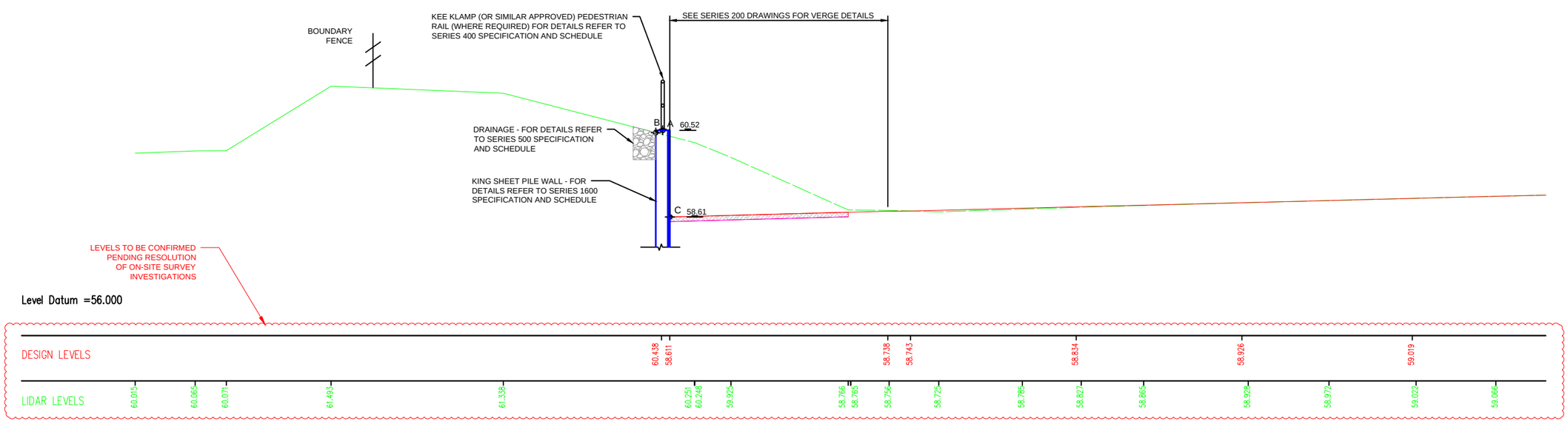
Drawing Title: KING SHEET PILE DESIGN SOLUTION PLAN
CH. 184071 TO CH. 1844553 (NB)
SHEET 03 OF 04

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P06**
Name: **HA549342-AMAR-HGT-SWI-DR-CE-001611**

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SECTION A-A
CH.184150
Scale 1:100 @ A3



SECTION B-B
CH. 184360
Scale 1:100 @ A3

NOTES
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2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
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4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P06	22/05/17	LP	---	SV

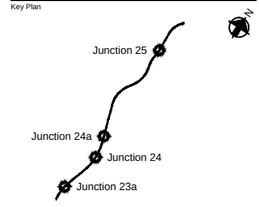
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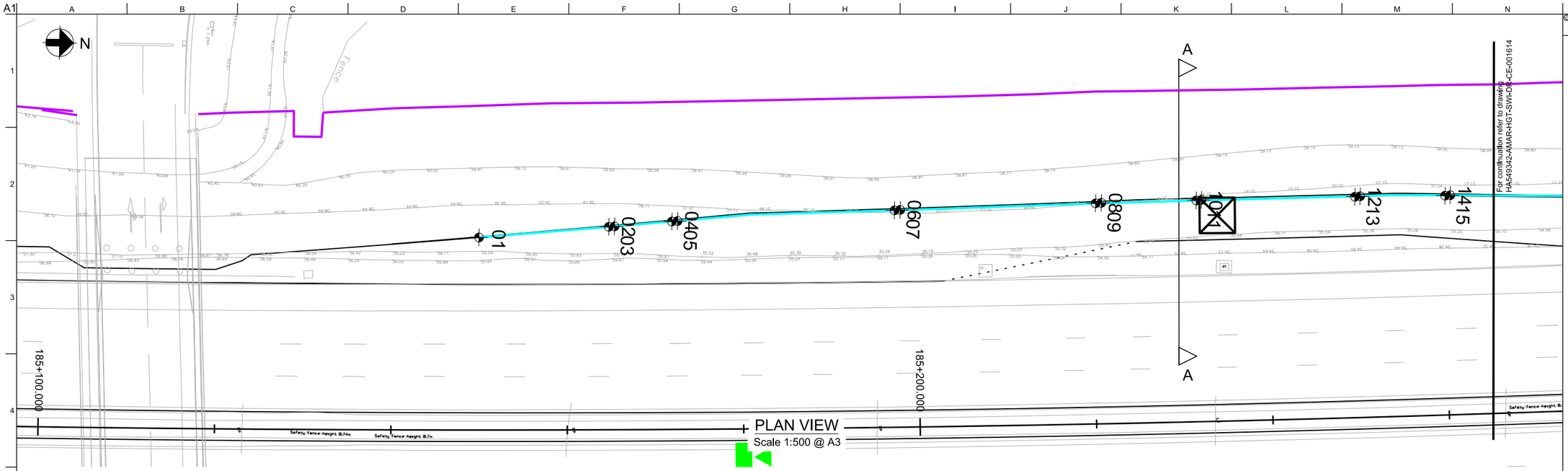
Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
KING SHEET PILE SOLUTION
CROSS SECTION
CH.184071 CH.184453 (NB)
SHEET 04 OF 04

Scale at A1: 1:50
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P06
Name: HA549342-AMAR-HGT-SWI-DR-CE-001612

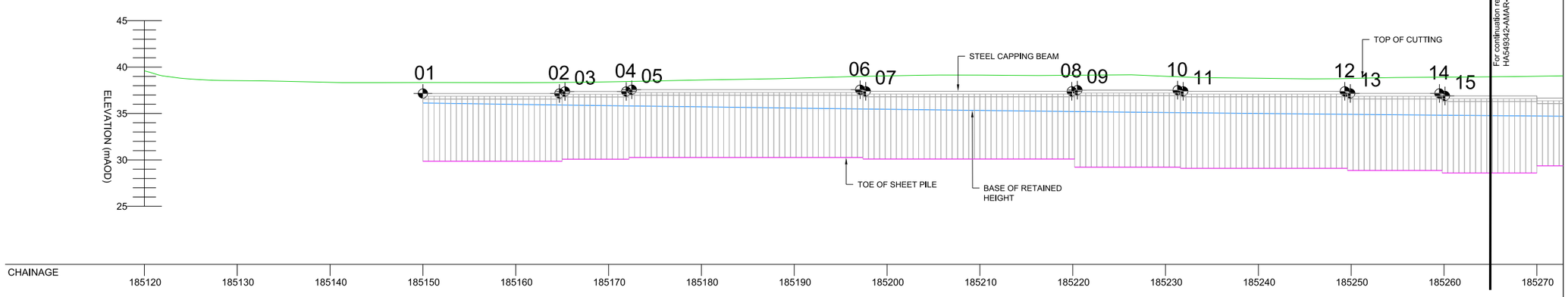


PLAN VIEW
Scale 1:500 @ A3

SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE CAP (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	RET. WALL DETAILS: TOTAL RETAINED HIEGHT	RET. WALL DETAILS: TOTAL SHEET PILE LENGTH
01	447517.39	327531.01	36.86	36.81	36.10	0.71	7.00
02	447515.86	327545.69	37.16	37.11	35.92	1.19	7.00
03	447515.79	327546.33	37.37	37.09	35.90	1.19	7.00
04	447515.09	327552.82	37.37	37.31	35.82	1.49	7.00
05	447515.03	327553.47	37.55	37.32	35.79	1.53	7.00
06	447513.27	327578.01	37.55	37.33	35.48	1.85	7.00
07	447513.2	327578.66	37.39	37.32	35.44	1.88	7.00
08	447511.96	327600.79	37.39	37.17	35.21	1.96	7.00
09	447511.9	327601.44	37.52	37.19	35.21	1.98	7.00
010	447511.38	327612.18	37.52	37.35	35.09	2.26	8.00
011	447511.31	327612.77	37.39	37.34	35.08	2.26	8.00
012	447510.57	327630.16	37.39	37.12	34.90	2.22	8.00
013	447510.5	327630.75	37.16	37.10	34.90	2.20	8.00
014	447510.21	327640.37	37.16	36.84	34.81	2.03	8.00
015	447510.15	327640.96	36.89	36.84	34.81	2.03	8.00

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:500 @ A3

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7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY. WORST CASE SCENARIOS INDICATED IN SECTION A-A.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- TOE OF SHEET PILE
- STEEL CAPPING BEAM
- SHEET PILES

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	LP

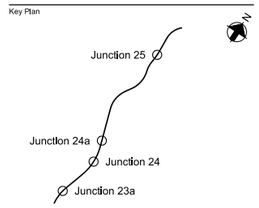
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan

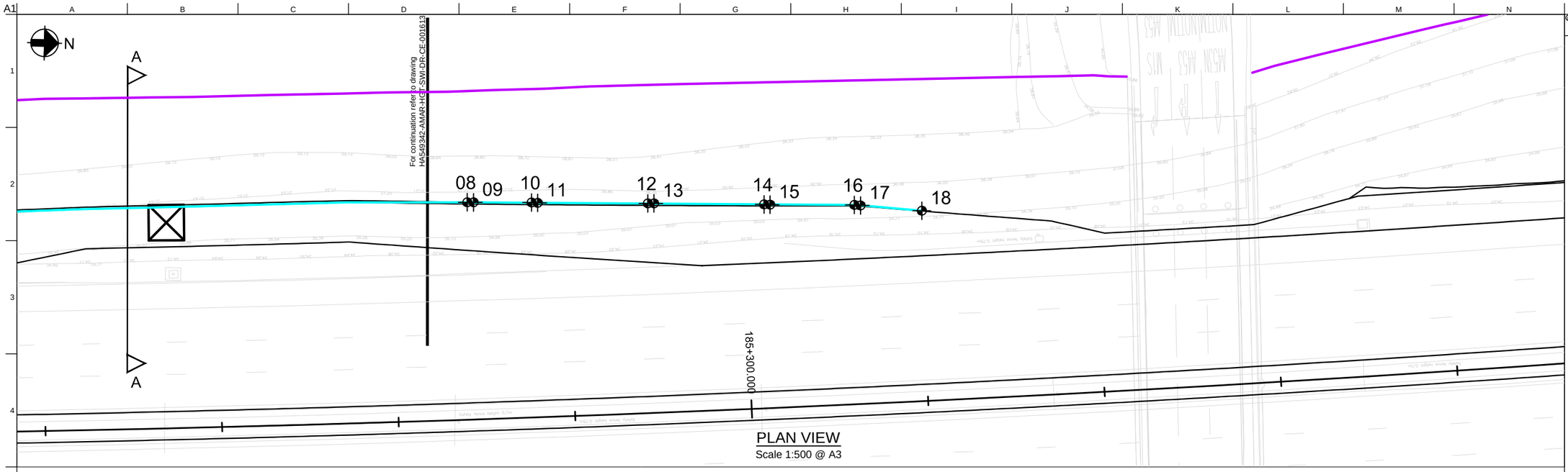


Drawing Title: SHEET PILE DESIGN SOLUTION PLAN
CH.185150 TO CH.185321 (NB)
SHEET 01 OF 03

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P03
Name: HA549342-AMAR-HGT-SWI-DR-CE-001613

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Do not scale



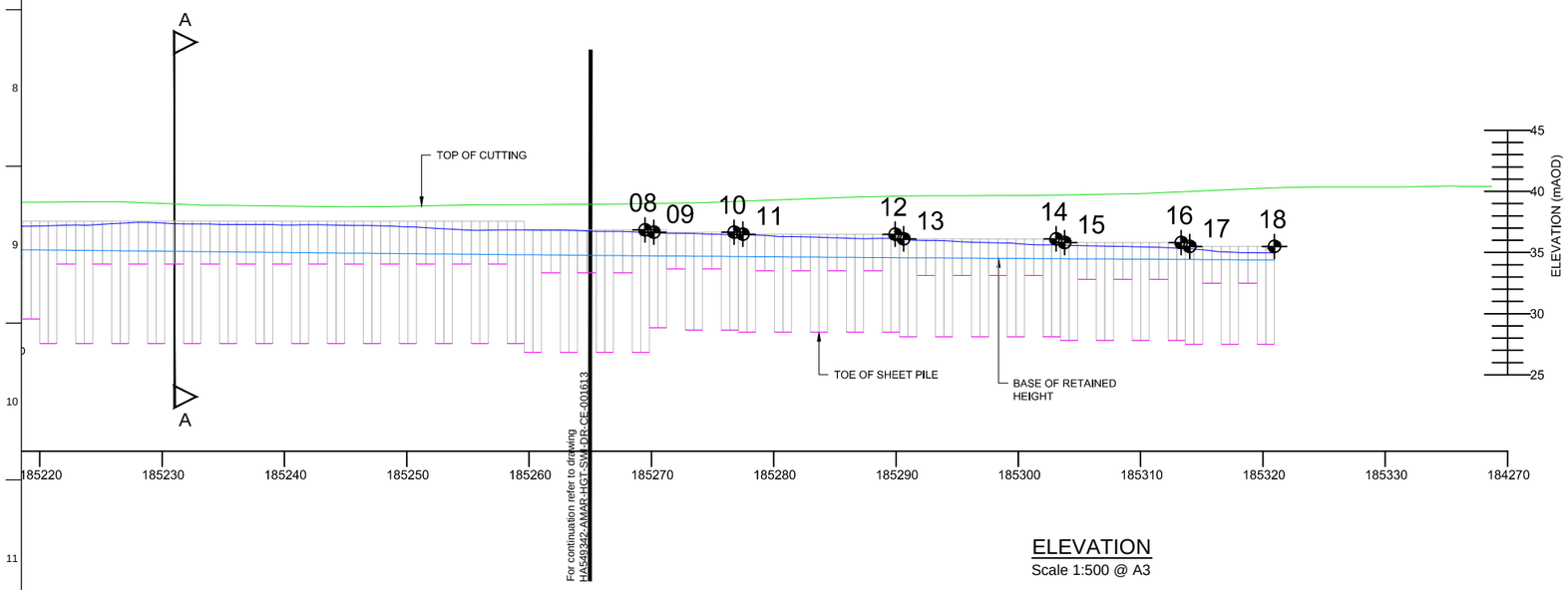
PLAN VIEW
Scale 1:500 @ A3

SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	RET. WALL DETAILS: TOTAL RETAINED HEIGHT	RET. WALL DETAILS: TOTAL KING SHEET PILE LENGTH	RET. WALL DETAILS: TOTAL INTERMEDIATE PILE LENGTH
08	447509.95	327648.62	36.84	36.62	34.72	1.90	10.00	3.50
09	447509.95	327649.32	36.60	36.55	34.67	1.88	8.00	3.00
10	447509.81	327655.9	36.60	36.39	34.61	1.78	8.00	3.00
11	447509.84	327656.6	36.50	36.45	34.67	1.78	8.00	3.00
12	447509.62	327669.05	36.50	36.11	34.58	1.53	8.00	3.00
13	447509.6	327669.76	36.11	36.05	34.57	1.48	8.00	3.00
14	447509.44	327682.23	36.11	36.06	34.94	1.12	8.00	3.00
15	447509.45	327682.91	35.81	35.60	34.49	1.11	8.00	3.00
16	447509.27	327692.43	35.81	35.33	34.43	0.90	8.00	3.00
17	447509.32	327693.14	35.49	35.29	34.42	0.87	8.00	3.00
18	447509.76	327700.09	35.49	34.97	34.39	0.58	8.00	3.00

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:500 @ A3

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NOTES

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- TOE OF SHEET PILE
- SHEET PILES

Rev	Date	By	Chkd	Appd
P06	02/06/17	LP	---	SV

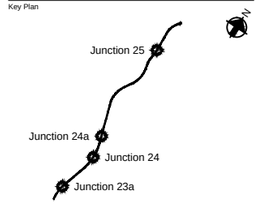
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN
CH.185139 TO CH.185321 (NB)
SHEET 02 OF 03

Scale at A1: 1:250

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

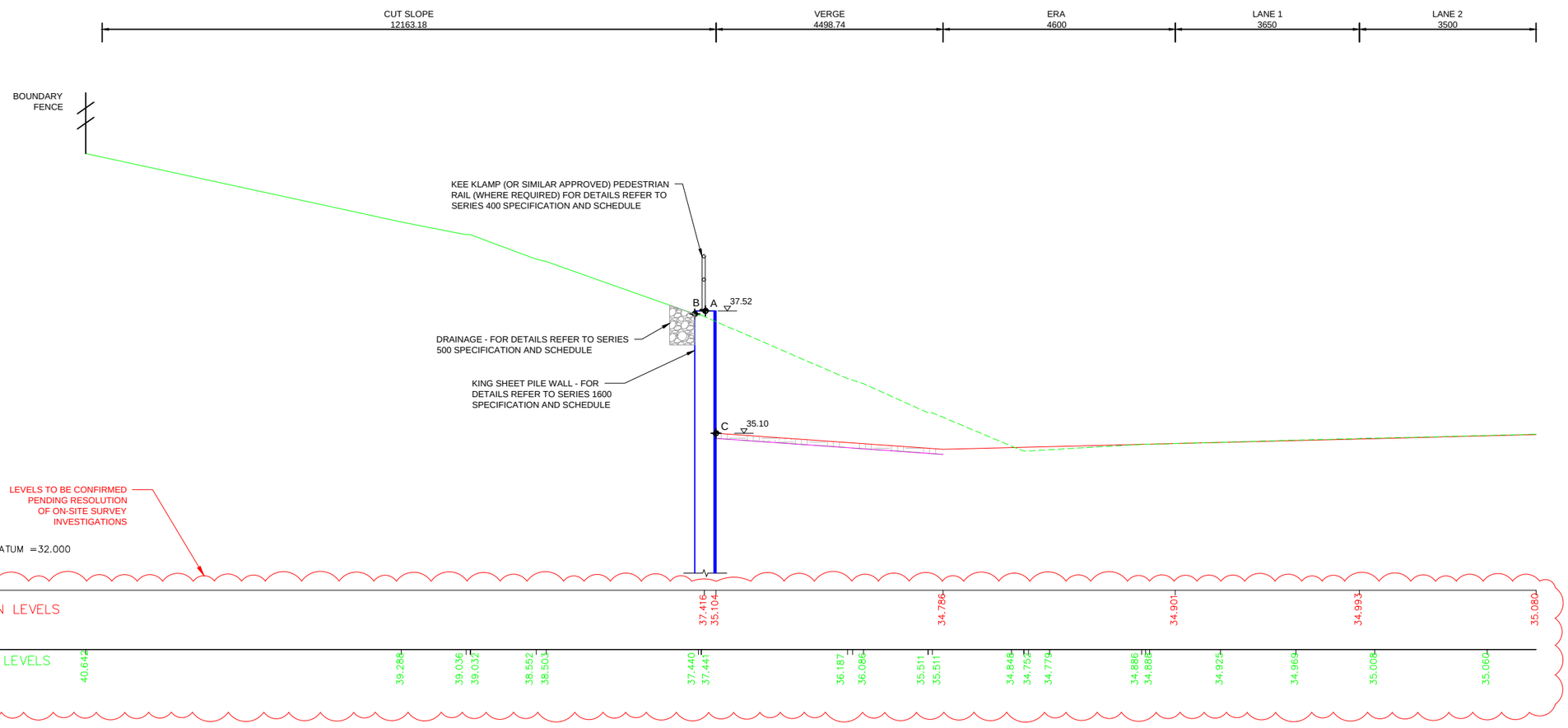
Job No: 244508-00

Rev: P06

Name: HA549342-AMAR-HGT-SWI-DR-CE-001614

Do not scale

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SECTION A-A
CH. 185230
Scale 1:100 @ A3

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NOTES
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3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P06	02/06/17	LP	---	SV

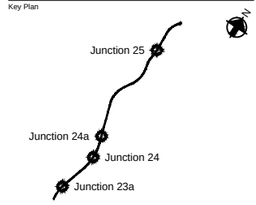
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH.185139 TO CH.185321 (NB) SHEET 03 OF 03

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

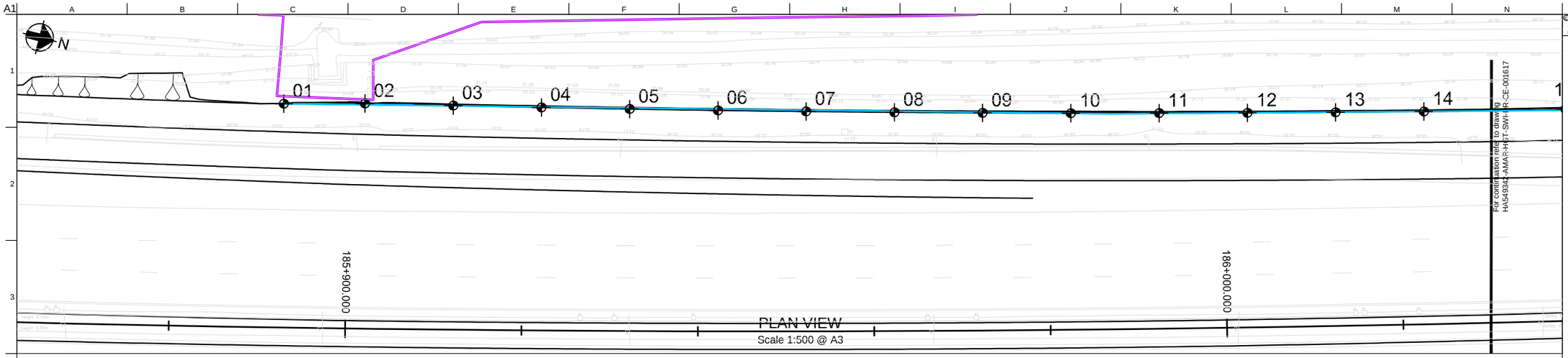
Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P06**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001615**

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Do not scale



PLAN VIEW
Scale 1:500 @ A3

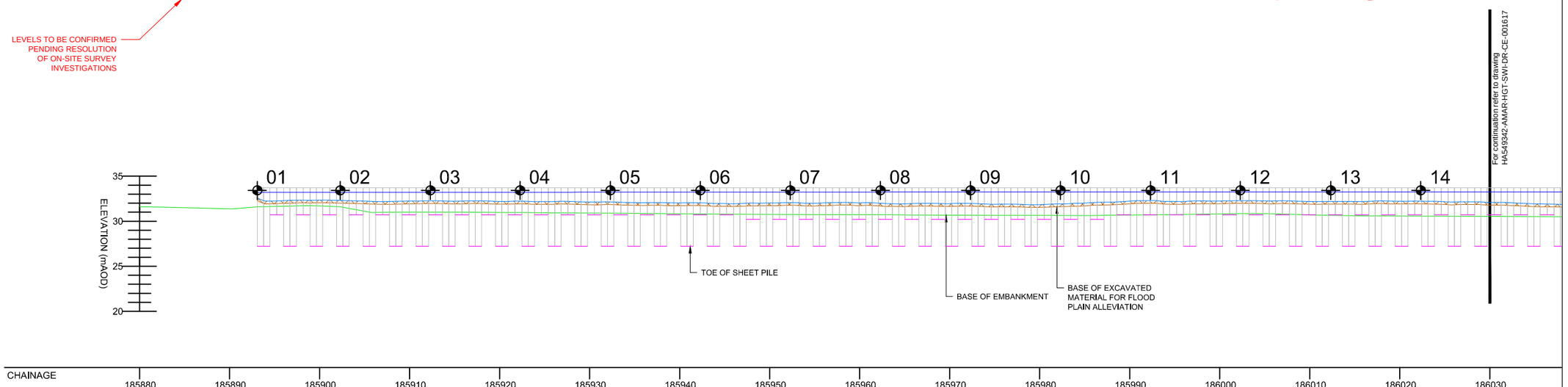
SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)
01	447419.46	328260.73	33.41	33.20	32.57	32.42
02	447417.16	328269.65	33.41	33.20	32.31	32.04
03	447414.91	328279.4	33.41	33.21	32.26	31.96
04	447412.63	328289.14	33.41	33.21	32.22	32.12
05	447410.33	328298.86	33.41	33.22	32.14	32.04
06	447407.99	328308.6	33.41	33.23	32.04	31.94
07	447405.63	328318.32	33.41	33.23	32.06	31.96
08	447403.24	328328.04	33.41	33.24	31.98	31.78
09	447400.82	328337.74	33.41	33.52	31.98	31.88
10	447398.37	328347.44	33.41	33.25	31.92	31.72
11	447395.88	328357.13	33.41	33.25	32.29	31.99
12	447393.37	328366.83	33.41	33.25	32.28	31.98
13	447390.83	328376.5	33.41	33.25	32.19	31.89
14	447388.26	328386.17	33.41	33.25	32.22	32.02

RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
0.78	6.50	3.00
1.16	6.50	3.00
1.25	6.50	3.00
1.09	6.50	3.00
1.18	6.50	3.00
1.29	6.50	3.00
1.27	6.50	3.00
1.46	6.50	3.50
1.64	6.50	3.50
1.53	6.50	3.50
1.26	6.50	3.50
1.27	6.50	3.00
1.36	6.50	3.00
1.23	6.50	3.00

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS



ELEVATION
Scale 1:500 @ A3

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NOTES

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2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINTS
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR FLOOD PLAIN ALLEVIATION PURPOSES)

Rev	Date	By	Chkd	Appd
P06	02/06/17	LP	---	SV

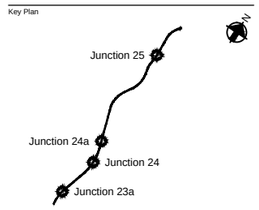
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan

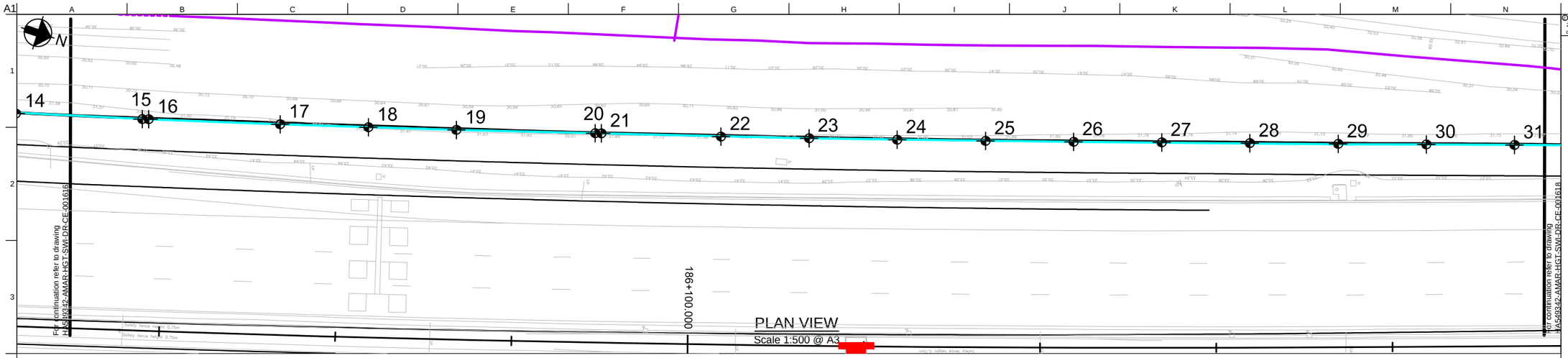


Drawing Title: KING SHEET PILE SOLUTION PLAN
CH.185893 CH.186360 (NB)
SHEET 01 OF 04

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P06
Name: HA549342-AMAR-HGT-SWI-DR-CE-001616

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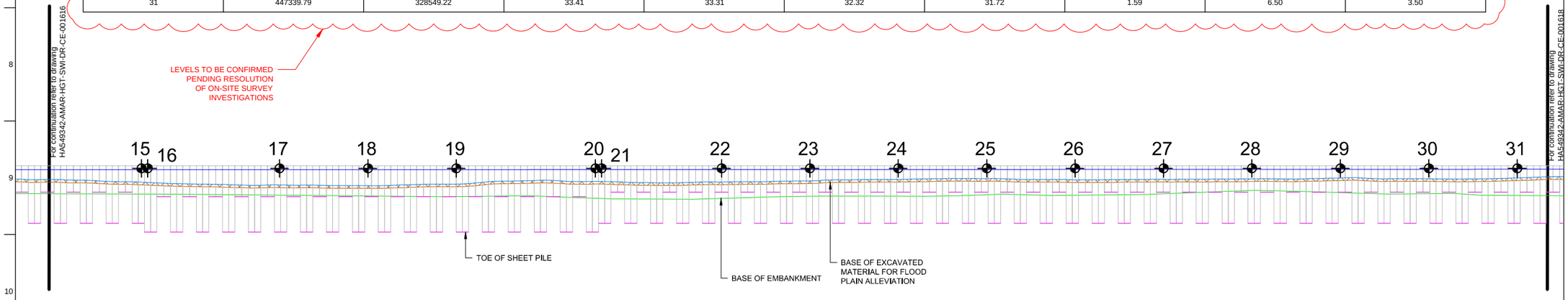
Do not scale



PLAN VIEW
Scale 1:500 @ A3

SHEET PILE SETTING OUT POINTS							RET. WALL DETAILS		
REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
15	447384.48	328400.04	33.41	33.26	31.86	31.66	1.60	6.50	3.00
16	447384.28	328400.71	33.41	33.26	31.83	31.63	1.63	7.50	3.50
17	447380.27	328415.1	33.41	33.26	31.54	31.34	1.92	7.50	3.50
18	447377.54	328424.73	33.41	33.26	31.45	31.15	2.11	7.50	3.50
19	447374.79	328434.35	33.41	33.26	31.63	31.23	2.03	7.50	3.50
20	447370.34	328449.46	33.41	33.27	31.94	31.54	1.73	7.50	3.50
21	447370.14	328450.13	33.41	33.27	31.93	31.73	1.54	6.50	3.50
22	447366.35	328463.17	33.41	33.28	31.88	31.48	1.80	6.50	3.50
23	447363.48	328472.75	33.41	33.28	31.99	31.69	1.59	6.50	3.50
24	447360.59	328482.32	33.41	33.28	32.16	31.76	1.52	6.50	3.50
25	447357.66	328491.91	33.41	33.29	32.25	31.95	1.34	6.50	3.50
26	447354.71	328501.45	33.41	33.29	32.12	31.82	1.47	6.50	3.50
27	447351.73	328511.02	33.41	33.30	32.18	31.88	1.42	6.50	3.50
28	447348.76	328520.56	33.41	33.30	32.23	31.83	1.47	6.50	3.50
29	447345.78	328530.13	33.41	33.30	32.32	31.92	1.38	6.50	3.50
30	447342.79	328539.68	33.41	33.31	32.23	31.83	1.48	6.50	3.50
31	447339.79	328549.22	33.41	33.31	32.32	31.72	1.59	6.50	3.50

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS



ELEVATION
Scale 1:500 @ A3

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NOTES

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4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINTS
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR FLOOD PLAIN ALLEVIATION PURPOSES)

Rev	Date	By	Chkd	Appd
P06	02/06/17	LP	---	SV

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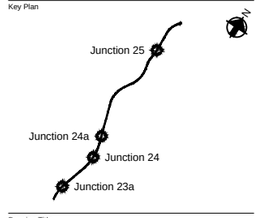
Rev	Date	By	Chkd	Appd

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan

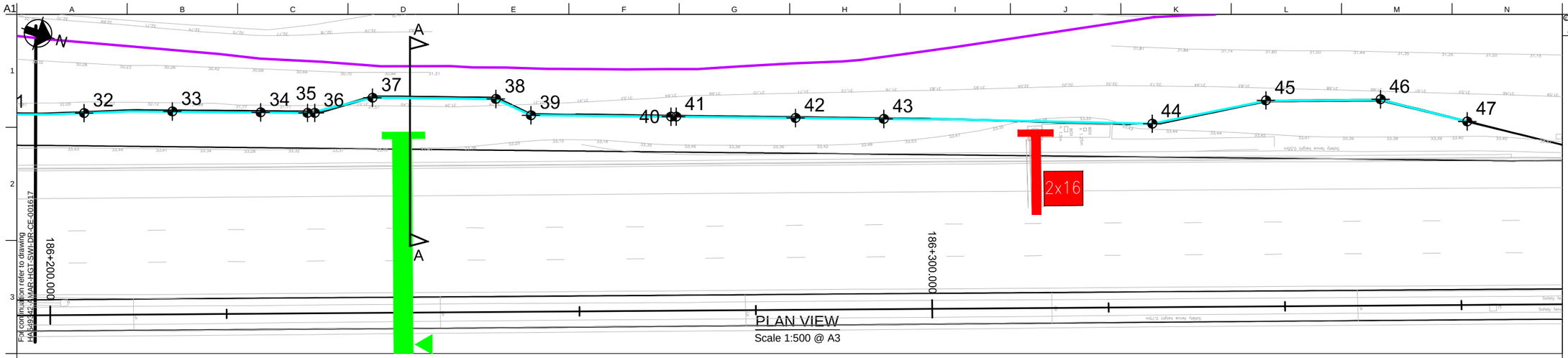


Drawing Title: KING SHEET PILE SOLUTION PLAN CH.185893 CH.186360 (NB) SHEET 02 OF 04

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P06
Name: HA549342-AMAR-HGT-SWI-DR-CE-001617

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Do not scale



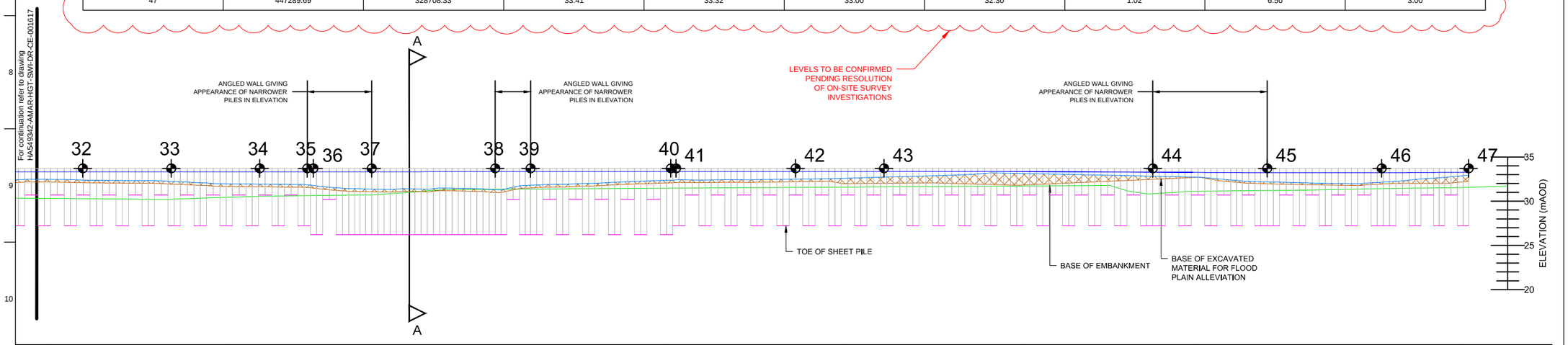
PLAN VIEW
Scale 1:500 @ A3

SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE CAP (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)
32	447336.61	328558.69	33.41	33.31	32.38	31.78
33	447333.38	328568.17	33.41	33.32	32.23	31.93
34	447330.43	328577.73	33.41	33.33	31.93	31.43
35	447328.87	328582.81	33.41	33.33	31.84	31.84
36	447328.62	328583.59	33.31	33.33	31.78	31.28
37	447324.98	328589.29	33.41	33.33	31.37	31.17
38	447320.85	328602.67	33.41	33.34	31.30	30.80
39	447321.39	328607.02	33.41	33.34	31.80	31.40
40	447316.71	328622.18	33.41	33.34	32.36	31.76
41	447316.53	328622.75	33.41	33.35	32.41	31.81
42	447312.54	328635.69	33.41	33.35	32.50	31.70
43	447309.59	328645.25	33.41	33.35	32.73	31.43
44	447300.83	328674.41	33.41	33.28	32.83	32.63
45	447294.38	328685.87	33.41	33.27	32.22	32.02
46	447290.3	328698.21	33.41	33.27	32.20	32.20
47	447289.69	328708.33	33.41	33.32	33.00	32.30

RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
1.53	6.50	3.00
1.39	6.50	3.00
1.90	6.50	3.00
1.49	6.50	3.00
2.05	7.50	3.50
2.16	7.50	3.50
2.54	7.50	3.50
1.94	7.50	3.50
1.58	7.50	3.50
1.54	6.50	3.00
1.65	6.50	3.00
1.92	6.50	3.00
0.65	6.50	3.00
1.25	6.50	3.00
1.07	6.50	3.00
1.02	6.50	3.00



ELEVATION
Scale 1:500 @ A3

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NOTES

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3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINTS
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR FLOOD PLAIN ALLEVIATION PURPOSES)

Rev	Date	By	Chkd	Appd
P06	02/06/17	LP	---	SV

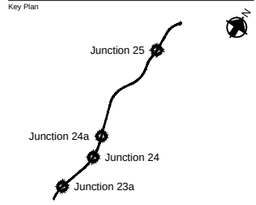
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN
CH.185893 CH.186360 (NB)
SHEET 03 OF 04

Scale at A1: 1:250

Role: Civil - Earthworks and Geotech

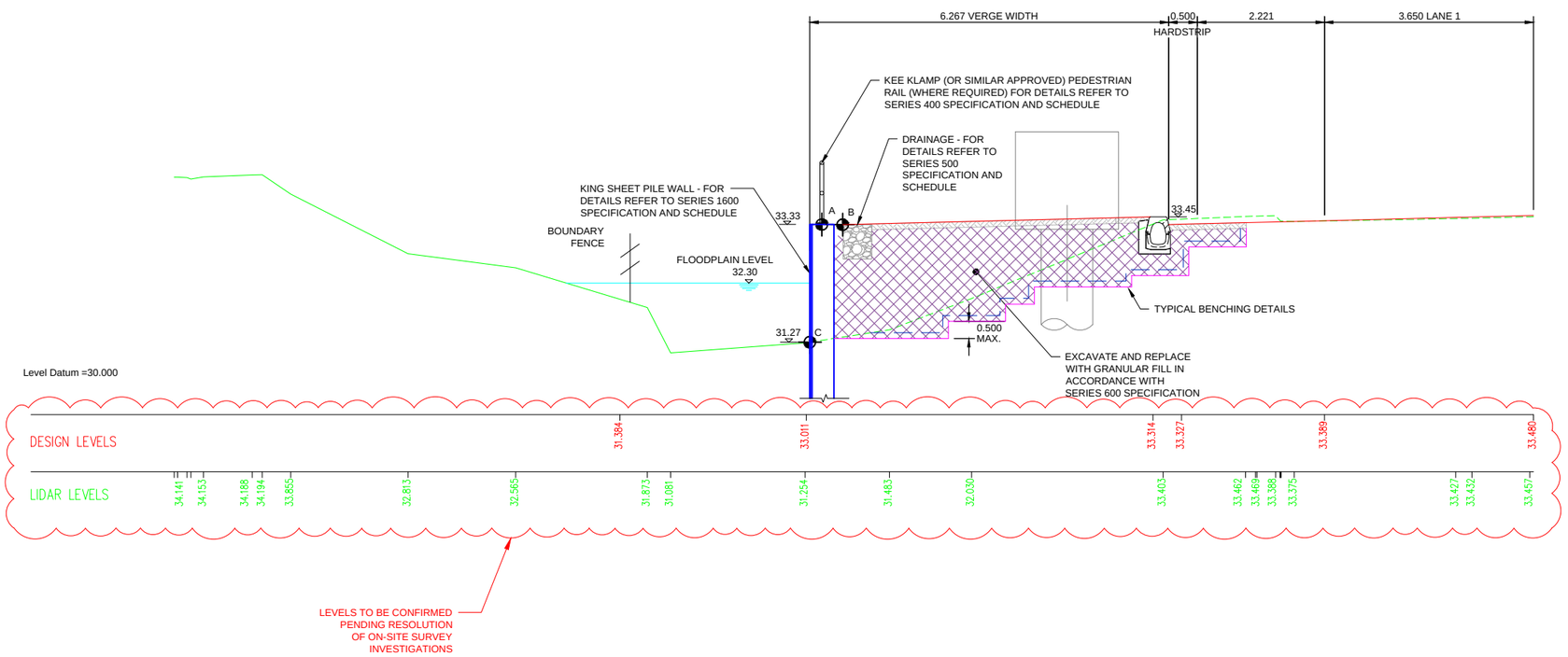
Suitability: S4 - Fit for construction approval

Job No: **244508-00** | Rev: **P06**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001618**

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SECTION A-A
CH. 186240
Scale 1:100 @ A3

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7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P06	02/06/17	LP	---	SV

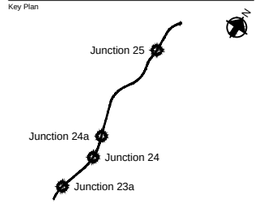
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH.185893 CH.186360 (NB) SHEET 04 OF 04

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

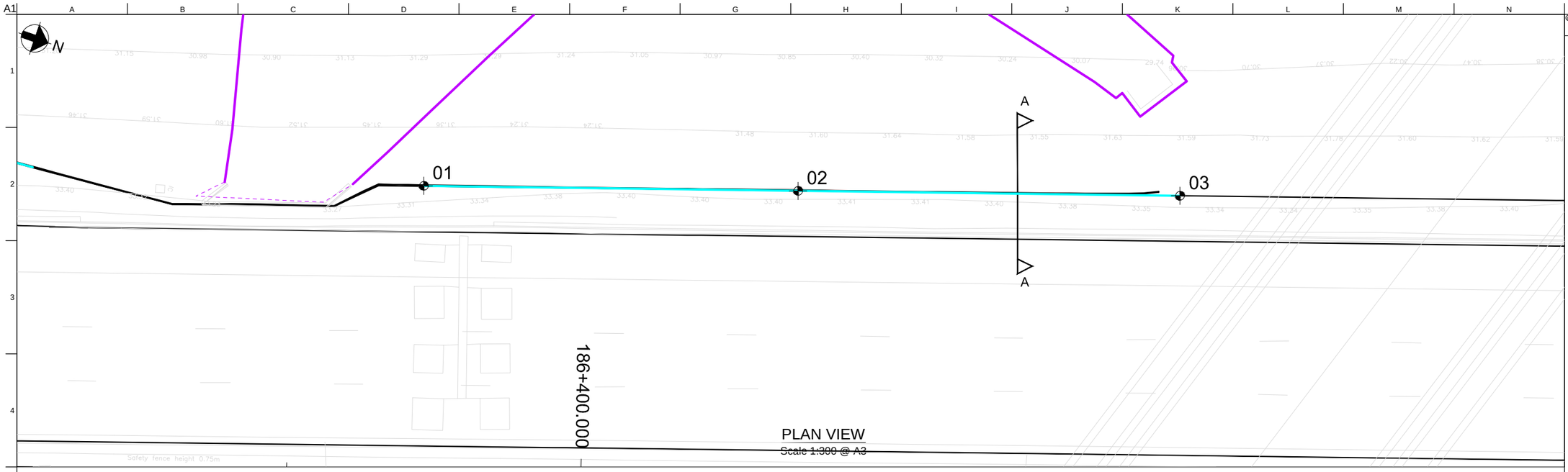
Suitability: S4 - Fit for construction approval

Job No: **244508-00** | Rev: **P06**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001619**

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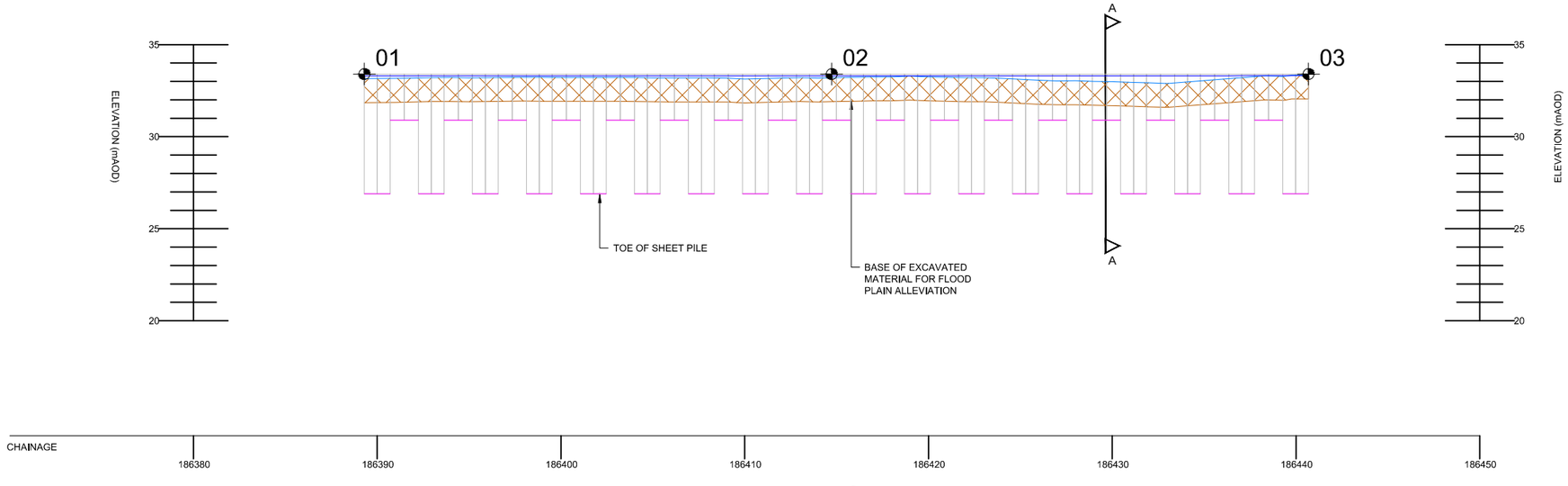
Do not scale



PLAN VIEW
Scale 1:300 @ A3

SHEET PILE SETTING OUT POINTS							RET. WALL DETAILS		
REFERENCE	EASTING	NORTHING	TOP OF PILE CAP (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BOTTOM OF EXCAVATION (D)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
01	447282.18	328735.62	33.36	33.31	33.15	31.84	1.47	6.50	2.50
02	447274.28	328759.78	33.36	33.31	33.31	31.95	1.36	6.50	2.50
03	447266.2	328784.45	33.36	33.31	33.31	32.05	1.26	6.50	2.50

LEVELS TO BE CONFIRMED
PENDING RESOLUTION
OF ON-SITE SURVEY
INVESTIGATIONS



ELEVATION
Scale 1:300 @ A3

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NOTES

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4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINTS
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR FLOOD PLAIN ALLEVIATION PURPOSES)

Rev	Date	By	Chkd	Appd
P06	02/06/17	LP	---	SV

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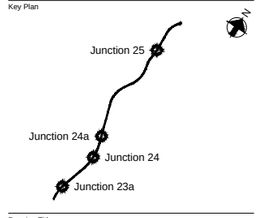
Rev	Date	By	Chkd	Appd

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client

Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
KING SHEET PILE SOLUTION PLAN
CH.186390 CH.186443 (NB)
SHEET 01 OF 02

Scale at A1 1:150

Role Civil - Earthworks and Geotech

Suitability S4 - Fit for construction approval

Job No **244508-00**

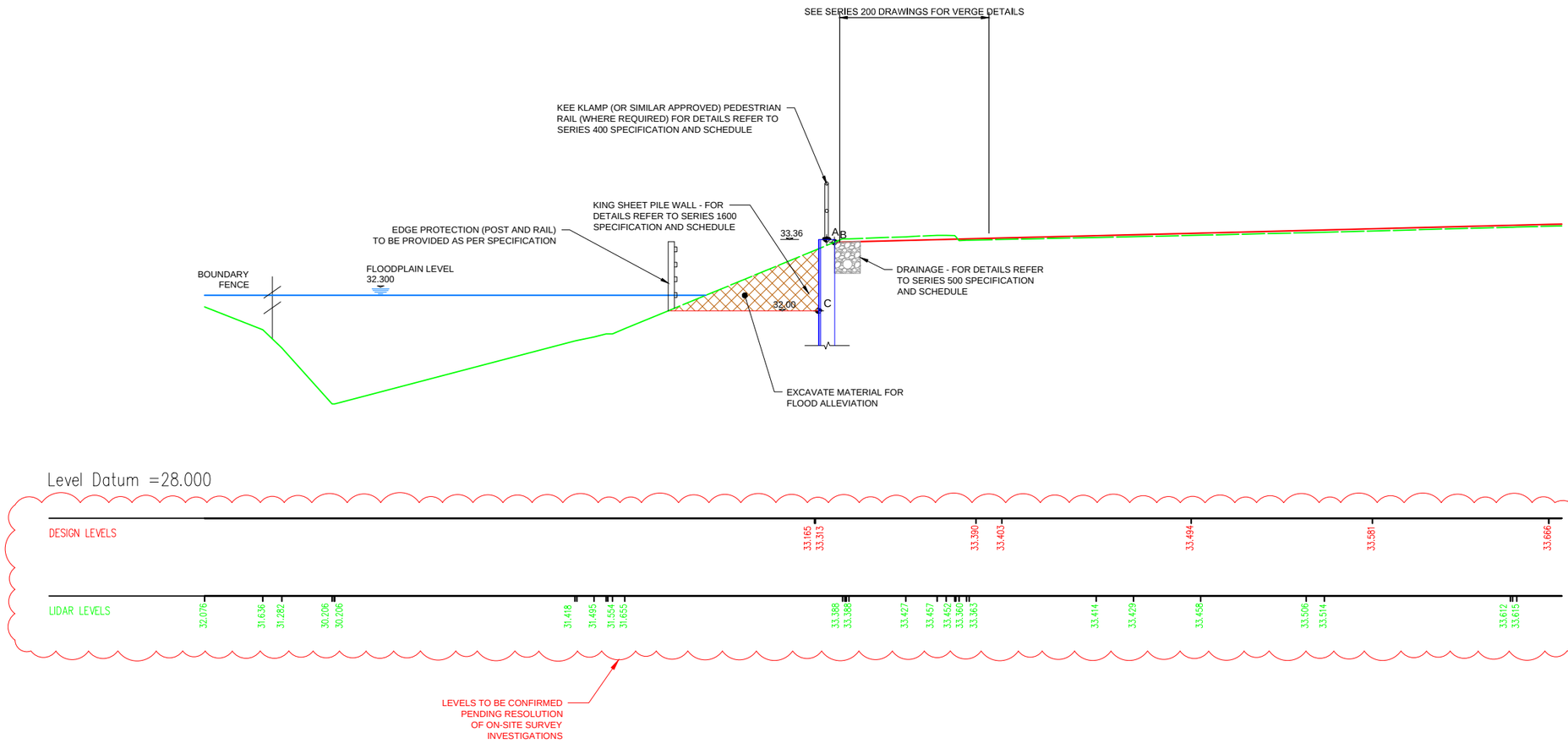
Rev **P06**

Name **HA549342-AMAR-HGT-SWI-DR-CE-001620**

Do not scale

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SECTION A-A
CH. 186430
Scale 1:100 @ A3

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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT
- EXCAVATED MATERIAL (FOR FLOOD PLAIN ELLEVIATION PURPOSES)

Rev	Date	By	Chkd	Appd
P06	02/06/17	LP	---	AB

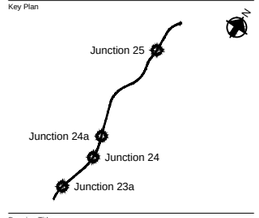
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH.186390 CH.186443 (NB) SHEET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

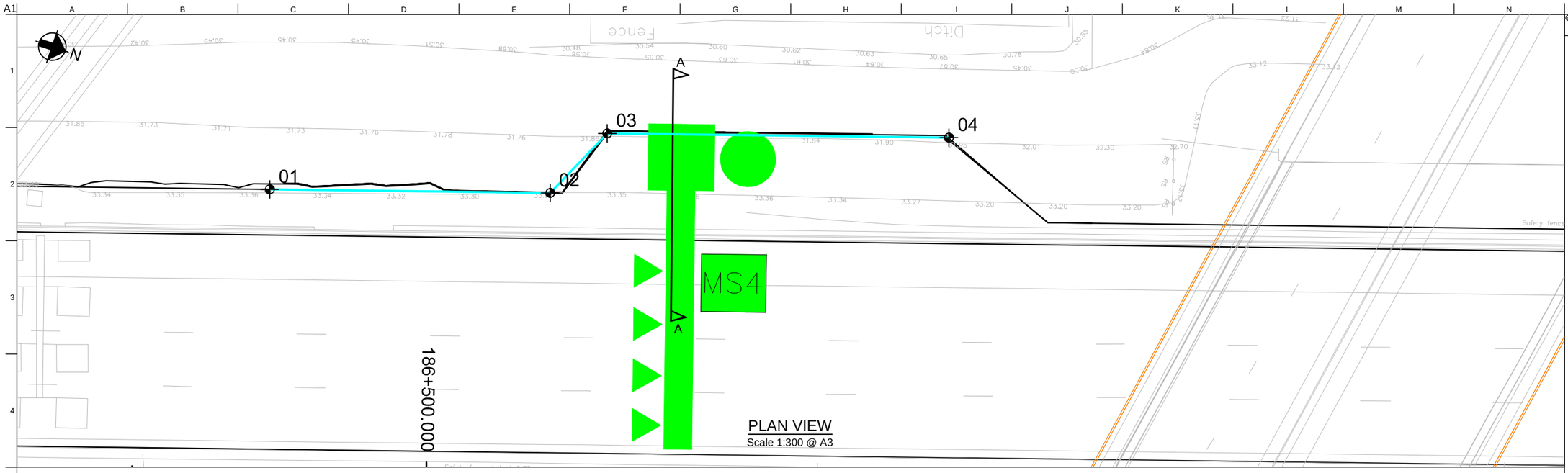
Job No: **244508-00**

Rev: **P06**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001621**

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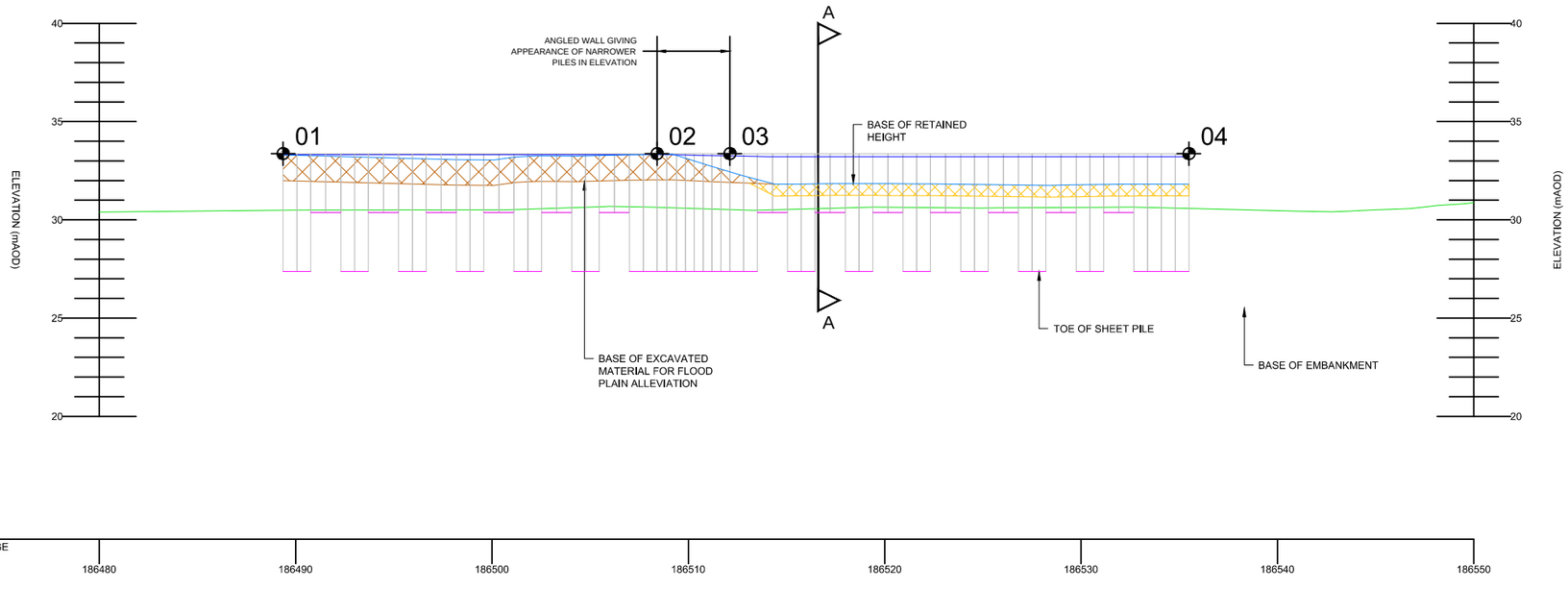


SHEET PILE SETTING OUT POINTS

RET. WALL DETAILS

REFERENCE	EASTING	NORTHING	TOP OF PILE CAP (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BOTTOM OF EXCAVATION (D)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
01	447251.02	328830.69	33.37	33.32	33.31	32.00	1.32	6.00	3.00
02	447245.08	328848.78	33.37	33.32	33.32	32.10	1.22	6.00	3.00
03	447240	328851.15	33.37	33.26	32.45	31.91	0.81	6.00	3.00
04	447232.76	328873.20	33.37	33.22	31.82	31.22	2.00	6.00	3.00

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS



ELEVATION
Scale 1:1300 @ A3

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR FLOOD PLAIN ALLEVIATION PURPOSES)
- EXCAVATED MATERIAL (FOR WALKWAY PURPOSES)

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7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- PLASTIC SHEET PILE LOCATION
- GABION WALL
- SECTION LINE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P06	02/06/17	LP	---	AB

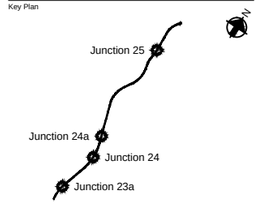
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN CH.186489 TO CH.186535 (NB) SHEET 01 OF 02

Scale at A1: 1:150

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

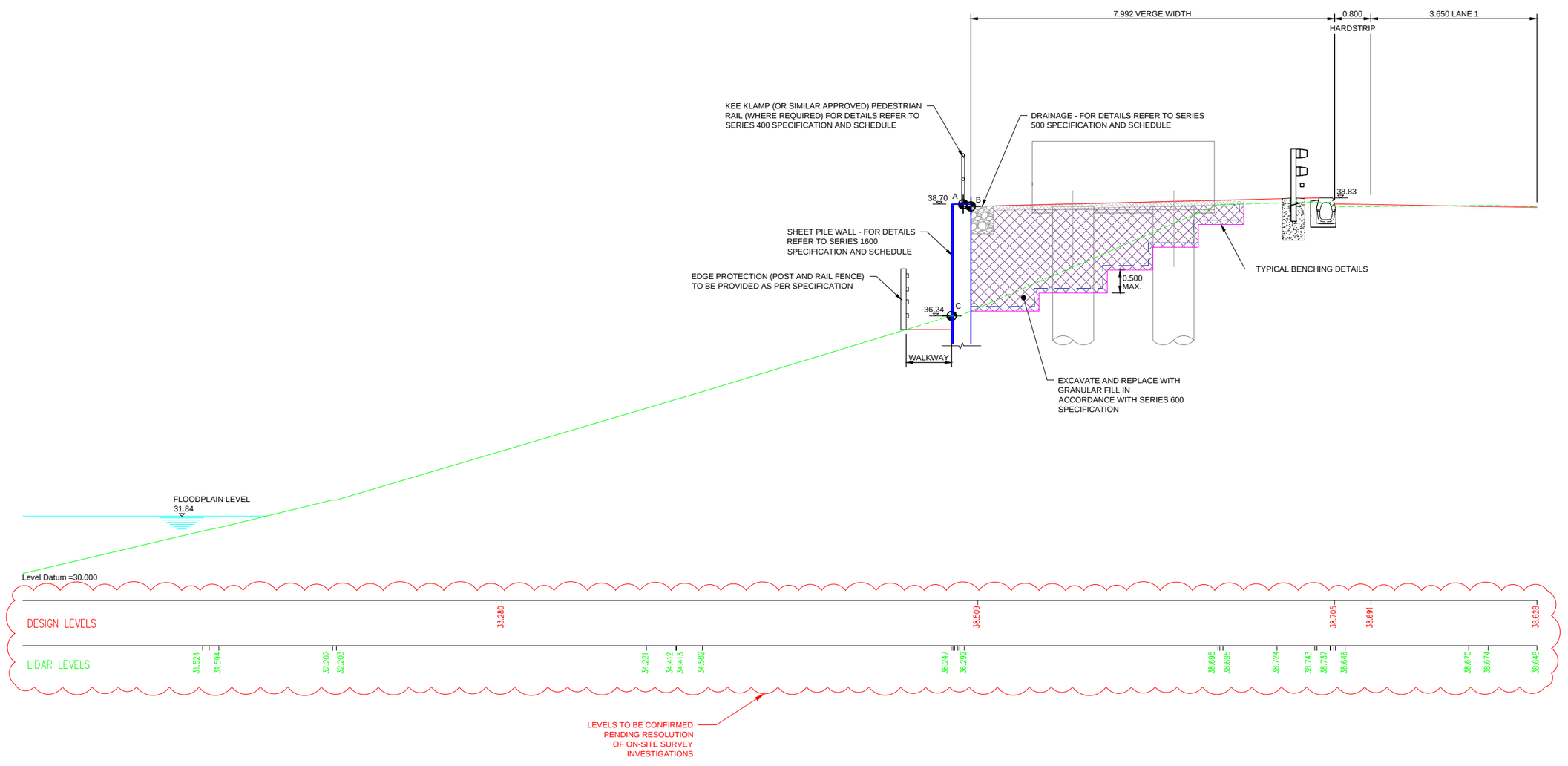
Job No: **244508-00** Rev: **P06**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001622**

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SECTION A-A
CH.188529
Scale 1:100 @ A3

NOTES
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7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P06	02/06/17	LP	---	AB

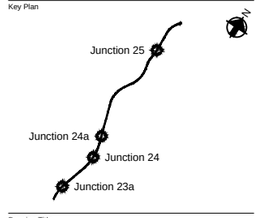
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH.186489 TO CH.186535 (NB) SHEET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

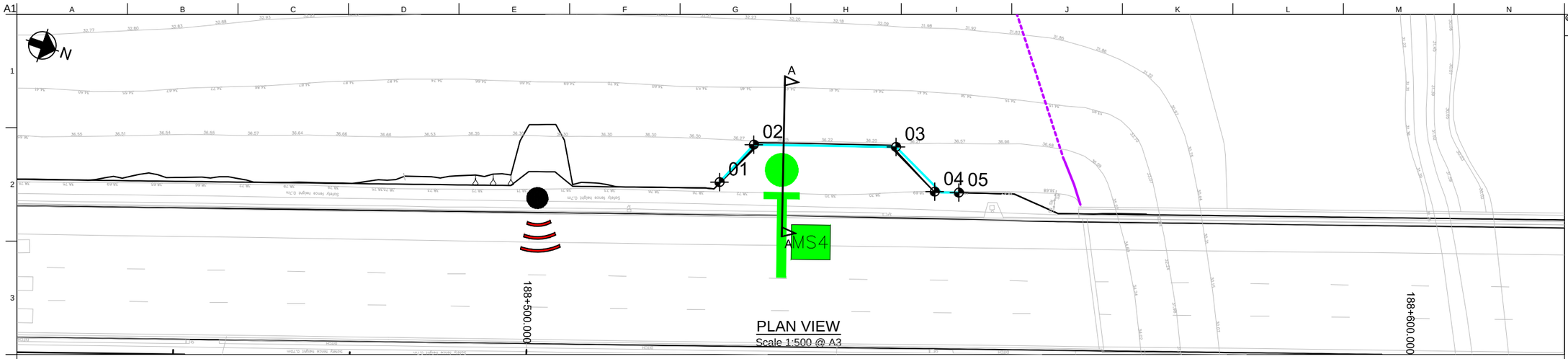
Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P06**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001623**

pw:\WCCNTS914.global.arup.com:FW_ARUP_UKDocumentsSMP M1 J23a - J25\01 Amey Arup JV\CE - Civil - Earthworks and Geotechnics\SHR - Drawing\HA549342-AMAR-HGT-SWI-DR-CE-001623

Do not scale



PLAN VIEW
Scale 1:500 @ A3

SHEET PILE SETTING OUT POINTS

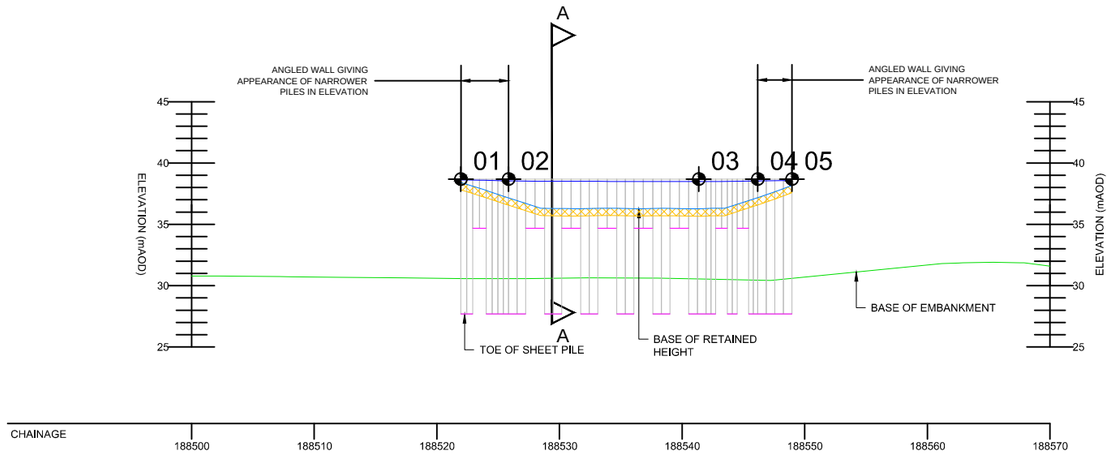
REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)
01	446616.62	330761.63	38.69	38.63	38.42	37.82
02	446611.36	330763.93	38.69	38.55	37.15	36.55
03	446606.39	330779.25	38.69	38.49	36.26	35.66
04	446609.76	330785.04	38.69	38.54	38.18	37.58
05	446608.98	330787.66	38.69	38.59	38.19	37.59

RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
0.81	11.00	4.00
2.00	11.00	4.00
2.83	11.00	4.00
0.96	11.00	4.00
1.00	11.00	4.00

LEVELS TO BE CONFIRMED
PENDING RESOLUTION
OF ON-SITE SURVEY
INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN
ALLEVIATION PURPOSES WAS
NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:500 @ A3

ELEVATION LEGEND
- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR WALKWAY PURPOSES)

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NOTES

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND
- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

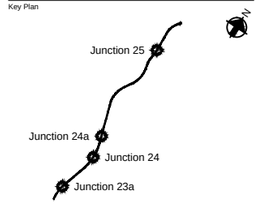
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN
CH.188522 TO CH.188549 (NB)
SHEET 01 OF 02

Scale at A1: 1:250

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

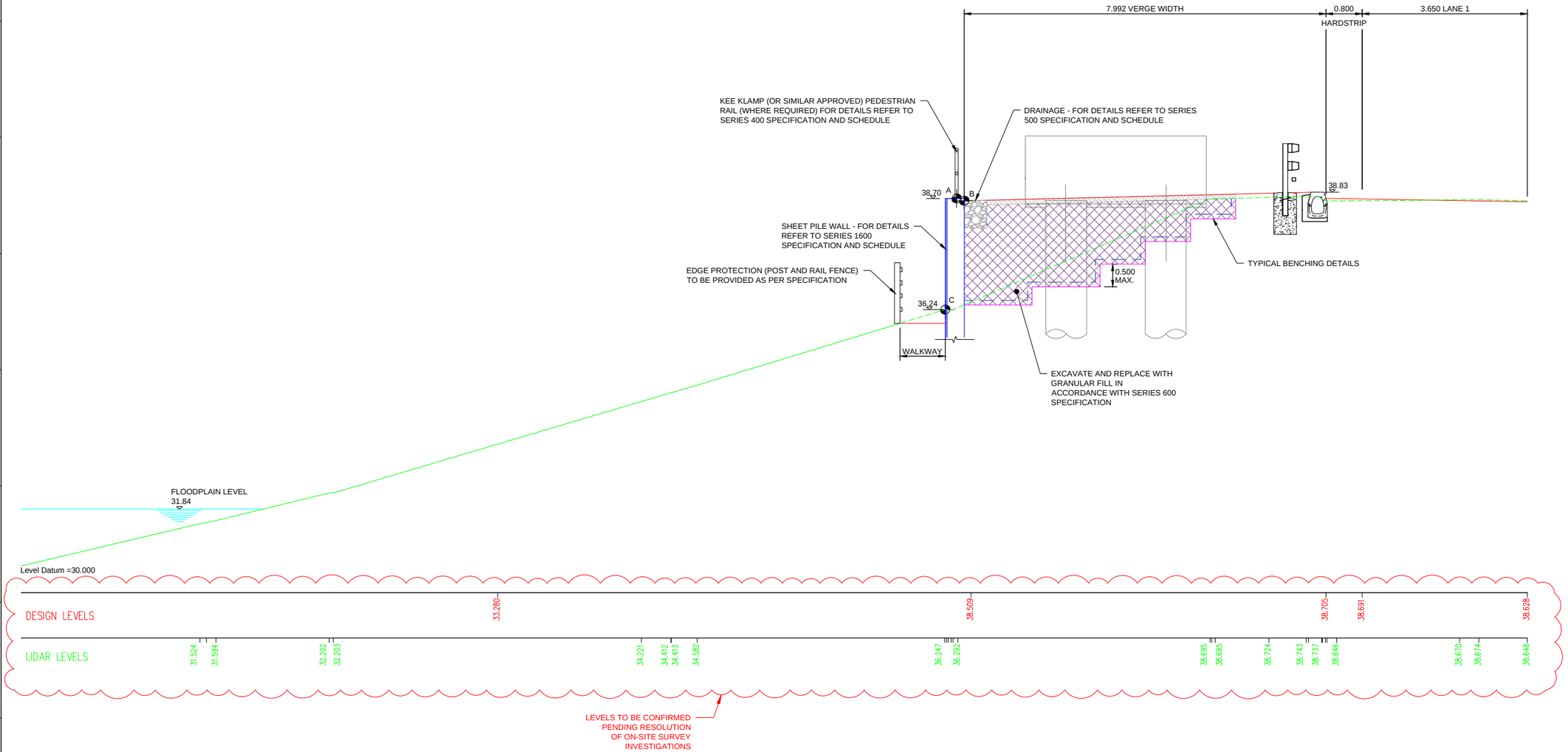
Job No: **244508-00**

Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001624**

Do not scale

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SECTION A-A
CH. 188529
Scale 1:100 @ A3

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NOTES
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3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

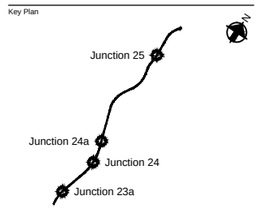
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH.188522 TO CH.188549 (NB) SHEET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

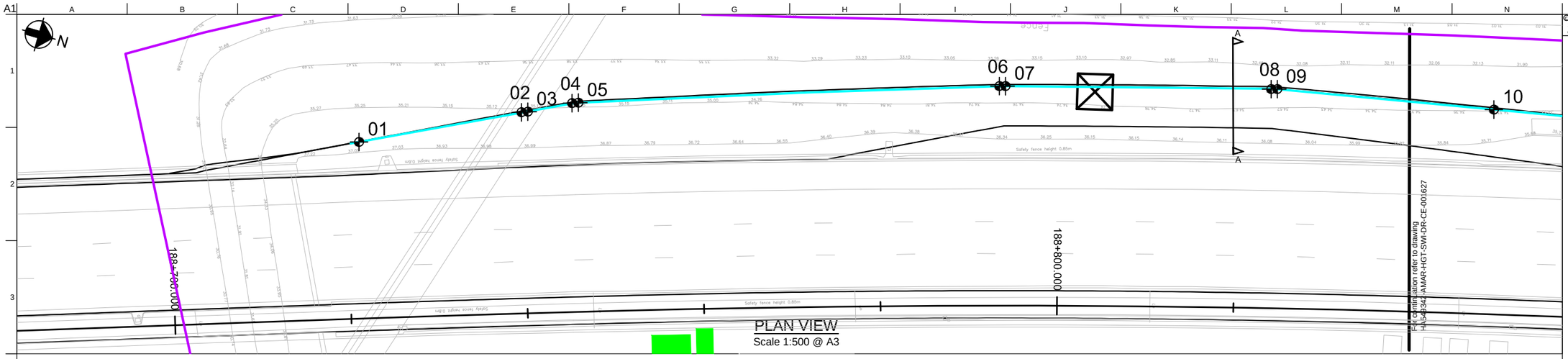
Job No: **244508-00**

Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001625**

Do not scale

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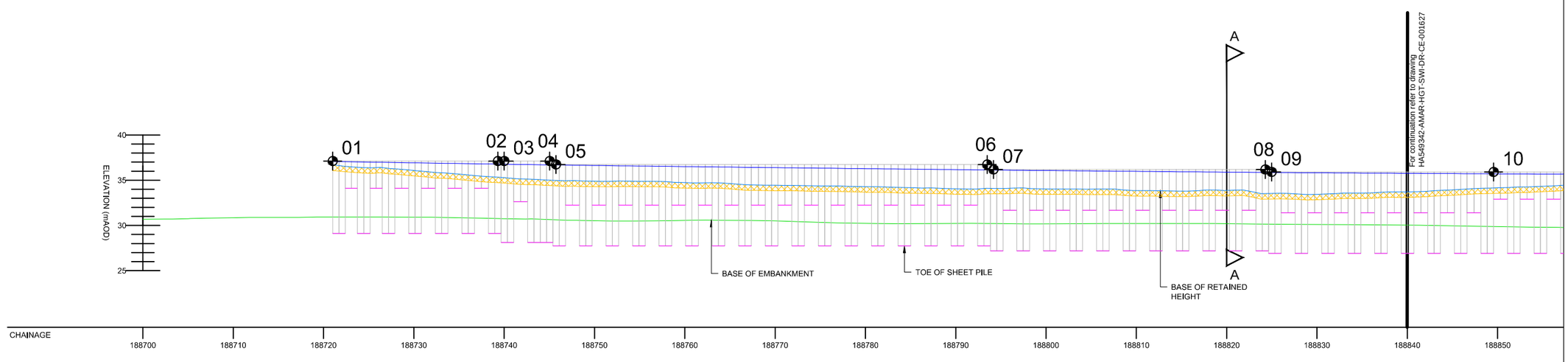
PLAN VIEW
Scale 1:500 @ A3

SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)	RET. WALL DETAILS: TOTAL RETAINED HEIGHT	RET. WALL DETAILS: TOTAL KING SHEET PILE LENGTH	RET. WALL DETAILS: TOTAL INTERMEDIATE SHEET PILE LENGTH
01	446554.53	330951.71	37.13	37.06	36.66	36.06	1.00	8.00	3.00
02	446546.2	330968.47	37.13	36.79	35.34	34.74	2.05	8.00	3.00
03	446545.93	330969.13	37.13	36.78	35.29	34.69	2.09	9.00	4.50
04	446543.62	330973.7	37.13	36.70	35.00	34.40	2.30	9.00	4.50
05	446543.36	330974.36	36.74	36.68	34.97	34.37	2.31	9.00	4.50
06	446528.33	331019.71	36.74	36.14	34.11	33.51	2.63	9.00	4.50
07	446528.14	331020.38	36.18	36.13	34.09	33.49	2.64	9.00	4.50
08	446520.12	331049.4	36.18	35.86	33.52	32.92	2.94	9.00	4.50
09	446519.93	331050.07	35.91	35.86	33.54	32.94	2.92	9.00	4.50

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:500 @ A3

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NOTES

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4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

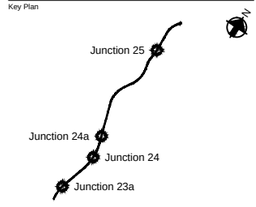
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan

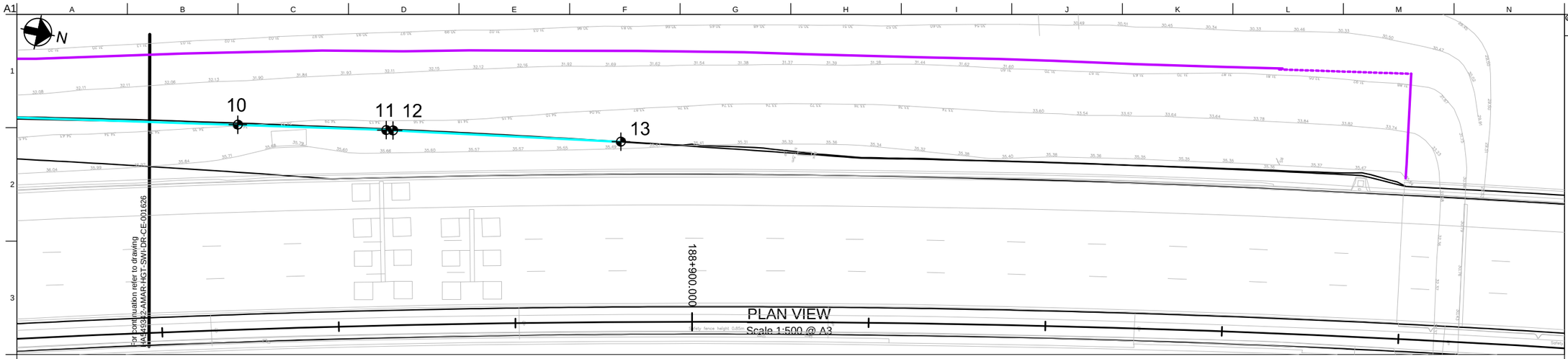


Drawing Title: KING SHEET PILE SOLUTION PLAN
CH.188721 CH.188893 (NB)
SHEET 01 OF 03

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P05
Name: HA549342-AMAR-HGT-SWI-DR-CE-001626

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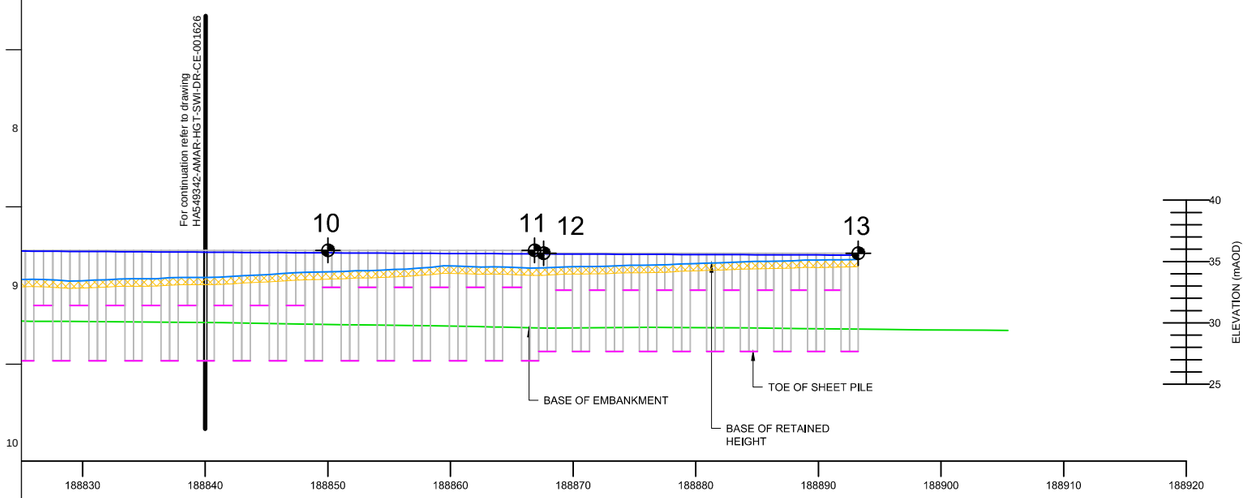


SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)	RET. WALL DETAILS: TOTAL RETAINED HEIGHT	RET. WALL DETAILS: TOTAL KING SHEET PILE LENGTH	RET. WALL DETAILS: TOTAL INTERMEDIATE SHEET PILE LENGTH
10	446515.23	331074.88	35.91	35.71	34.16	33.56	2.15	9.00	3.00
11	446512.26	331091.45	35.62	35.62	34.47	33.87	1.75	9.00	3.00
12	446512.14	331092.2	35.61	35.61	34.48	33.88	1.73	8.00	3.00
13	446507.93	331117.69	35.67	35.52	35.18	34.58	0.94	8.00	3.00

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:500 @ A3

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR WALKWAY PURPOSES)

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NOTES

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4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

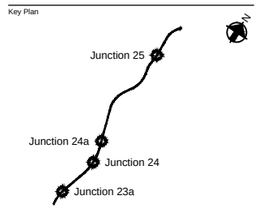
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan

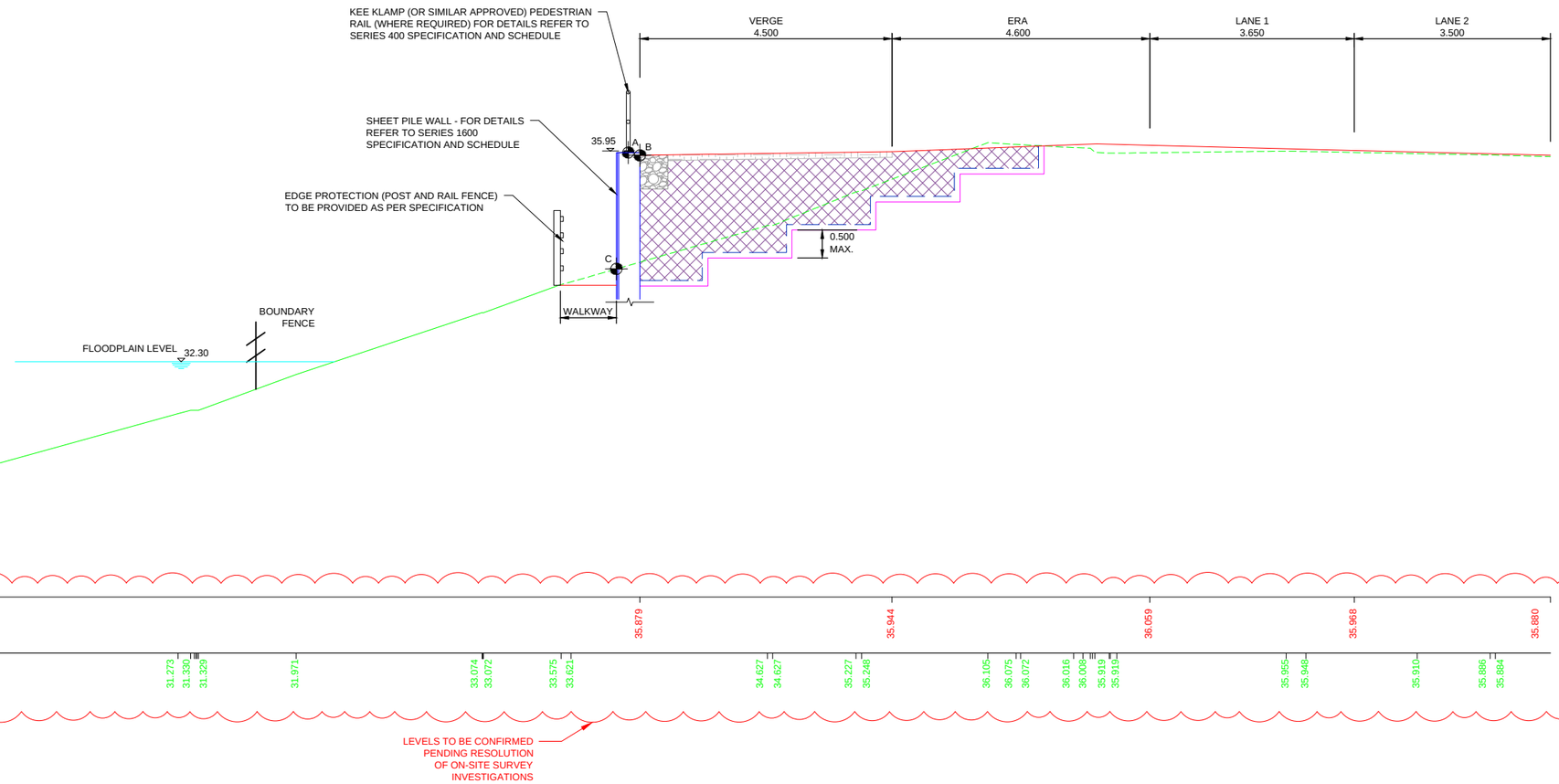


Drawing Title: KING SHEET PILE SOLUTION PLAN
CH.188721 CH.188893 (NB)
SHEET 02 OF 03

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P05**
Name: **HA549342-AMAR-HGT-SWI-DR-CE-001627**

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Do not scale



SECTION A-A
CH. 188820
Scale 1:100 @ A3

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NOTES
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7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- X SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

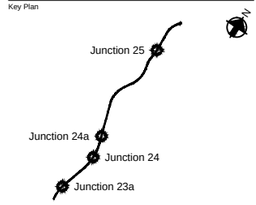
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH.188721 CH.188893 (NB) SHEET 03 OF 03

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

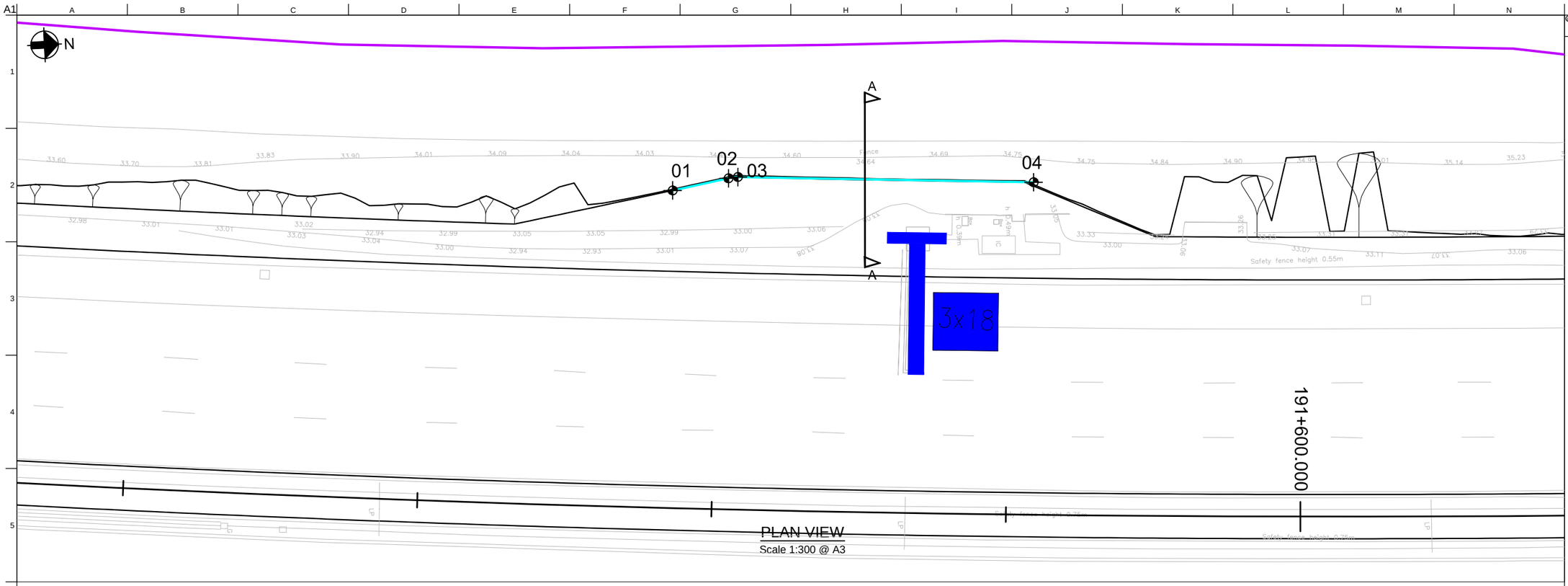
Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001628**

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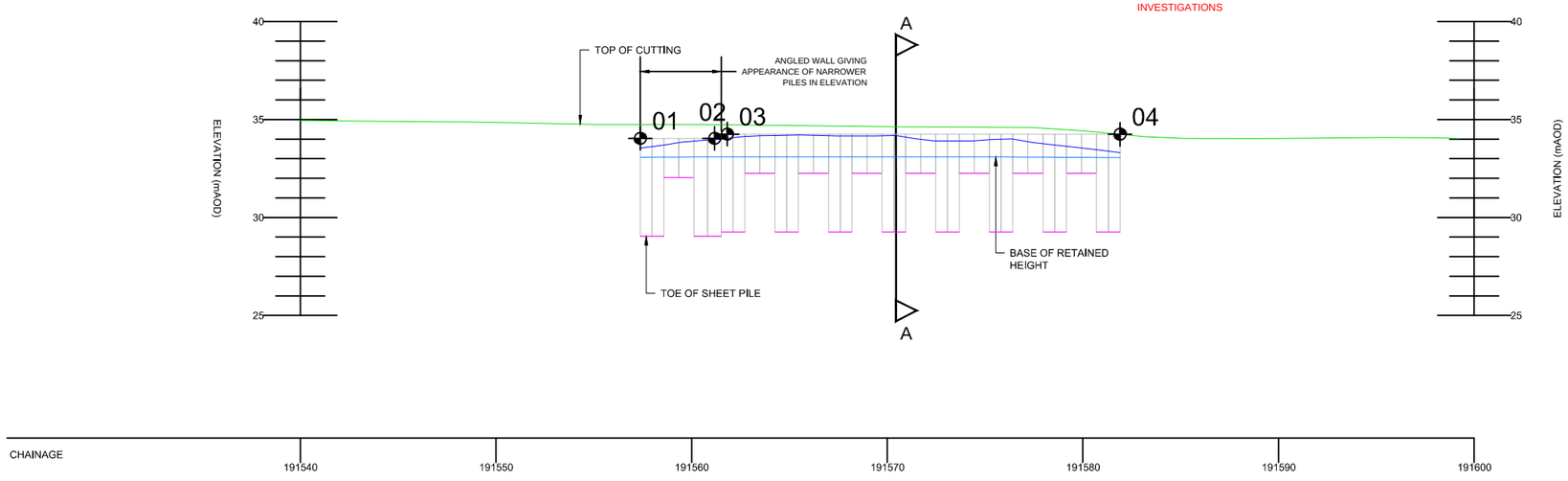
Do not scale



SHEET PILE SETTING OUT POINTS						RET. WALL DETAILS		
REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
01	447262.39	333608.53	34.04	33.54	33.07	0.47	5.00	2.00
02	447261.76	333612.35	34.04	33.97	33.10	0.87	5.00	2.00
03	447261.71	333613	34.25	34.00	33.10	0.90	5.00	2.00
04	447263.04	333633.04	34.25	33.32	33.06	0.26	5.00	2.00

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS



ELEVATION
Scale 1:300 @ A3

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NOTES

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

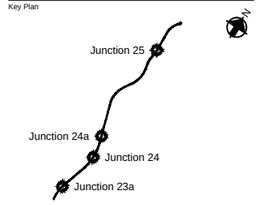
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan

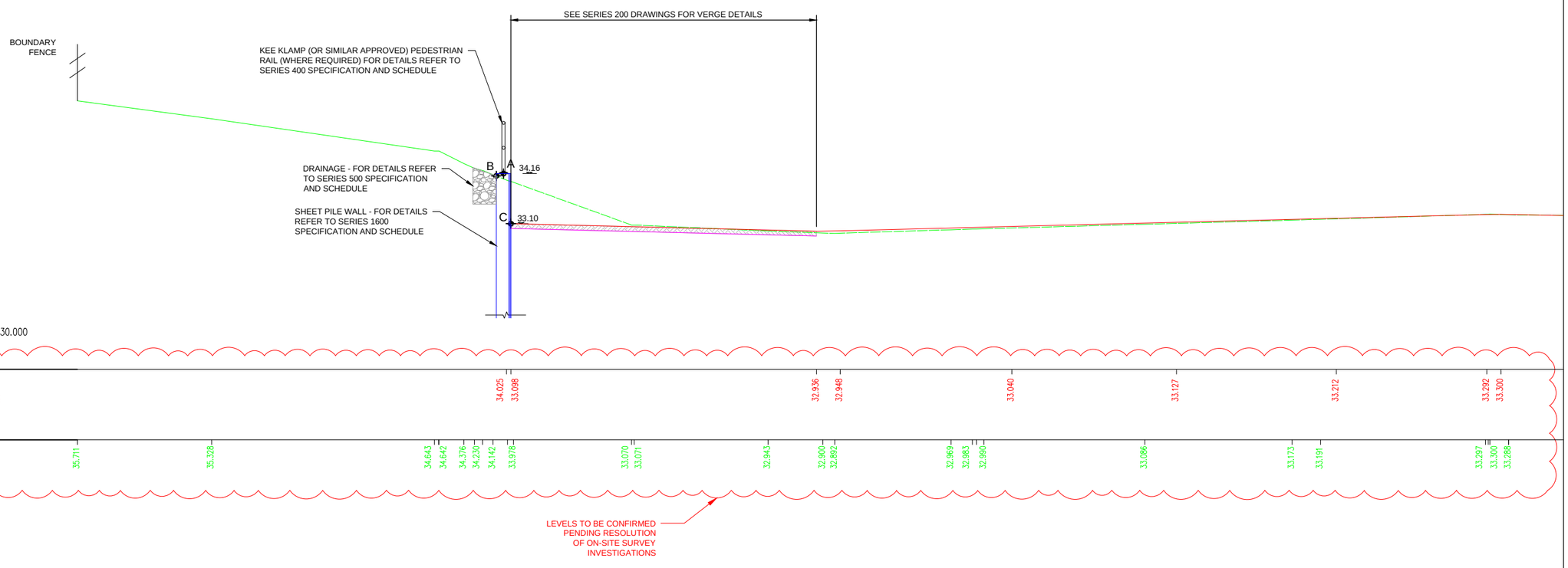


Drawing Title: KING SHEET PILE SOLUTION PLAN
CH.191557 TO CH.191582 (NB)
SHEET 01 OF 02

Scale at A1: 1:150
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P05**
Name: **HA549342-AMAR-HGT-SWI-DR-CE-001629**

pw:\WCONT5914.global.arup.com:FW_ARUP_UKDocumentsSMP M1 J23a - J25\01 Amey Arup JV\CE - Civil - Earthworks and Geotechnics\SHI - Drawing\HA549342-AMAR-HGT-SWI-DR-CE-001629

Do not scale



SECTION A-A
CH. 191570
Scale 1:100 @ A3

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NOTES
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3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

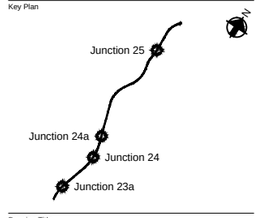
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH.191557 TO CH.191582 (NB) SHEET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

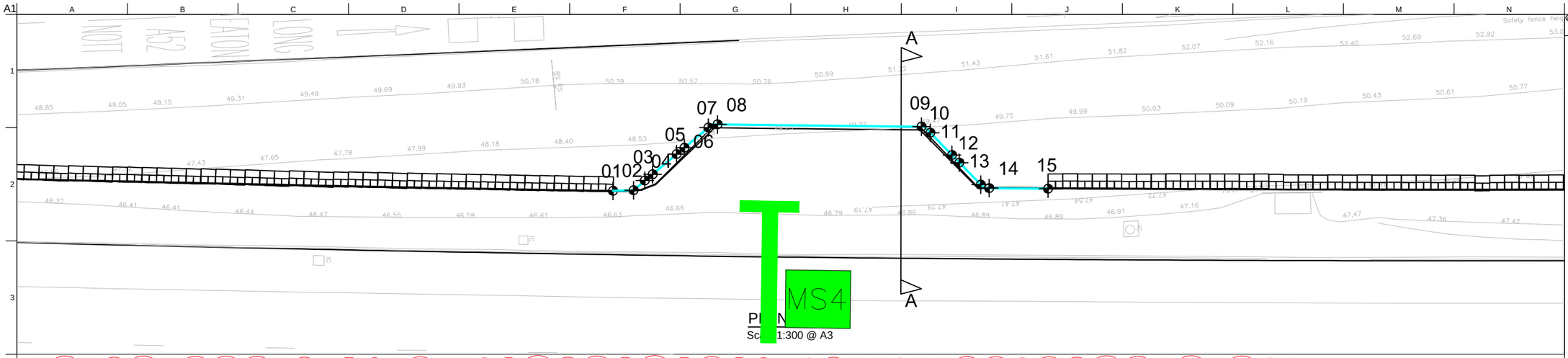
Suitability: S4 - Fit for construction approval

Job No: **244508-00** | Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001630**

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Do not scale



PLAN
Scale 1:300 @ A3

SHEET PILE SETTING OUT POINTS

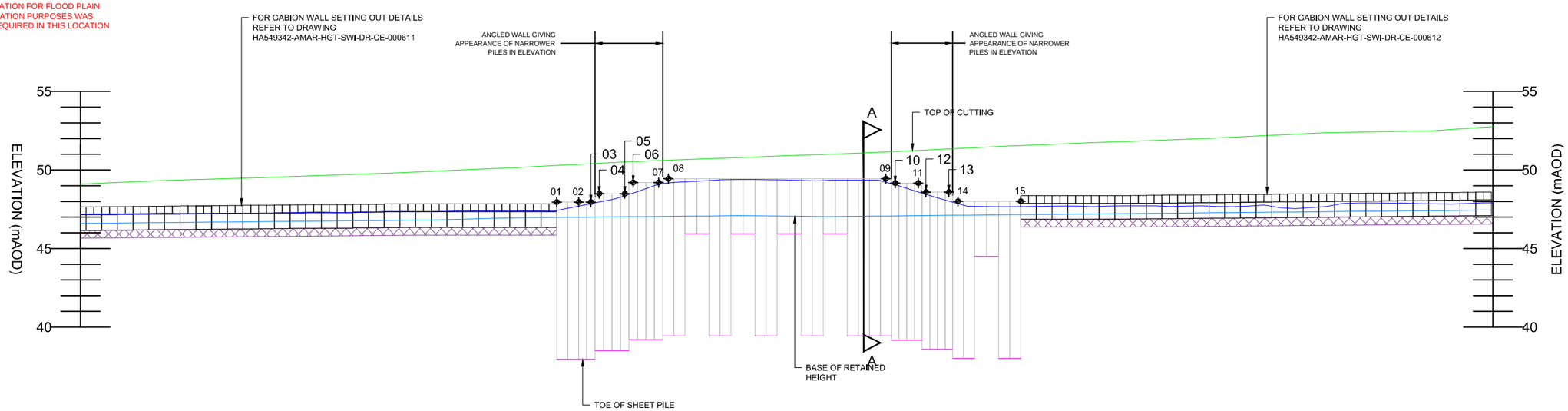
REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	RET. WALL DETAILS: TOTAL RETAINED HEIGHT	RET. WALL DETAILS: TOTAL KING SHEET PILE LENGTH	RET. WALL DETAILS: TOTAL INTERMEDIATE SHEET PILE LENGTH
001	447170.37	335354.89	47.96	47.43	46.99	0.44	10.00	3.50
002	447170.37	335356.29	47.96	47.70	46.99	0.71	10.00	3.50
003	447169.73	335357.07	47.96	47.86	47.01	0.85	10.00	3.50
004	447169.33	335357.62	48.49	47.95	47.00	0.95	10.00	3.50
005	447168	335359.28	48.49	48.35	47.02	1.33	10.00	3.50
006	447167.59	335359.83	49.20	48.53	47.03	1.50	10.00	3.50
007	447166.26	335361.49	49.20	49.11	47.05	2.06	10.00	3.50
008	447166.07	335362.12	49.44	49.17	47.04	2.13	10.00	3.50
009	447166.61	335375.96	49.44	49.21	47.06	2.15	10.00	3.50
0010	447167.04	335376.55	49.20	49.09	47.12	1.97	10.00	3.50
0011	447168.59	335377.98	49.20	48.64	47.13	1.51	10.00	3.50
0012	447169.12	335378.46	48.49	48.34	46.99	1.35	10.00	3.50
0013	447170.65	335379.87	48.49	47.90	47.00	0.90	10.00	3.50
0014	447170.9	335380.45	47.96	47.81	47.07	0.74	10.00	3.50
0015	447171.06	335384.45	47.96	47.63	47.12	0.51	10.00	3.50

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- TOE OF SHEET PILE
- SHEET PILES
- GABION WALL
- GRANULAR FILL [SERIES 600 SPECIFICATION]

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION



CHAINAGE
193290 193300 193310 193320 193330 193340 193350 193360 193370 193380

ELEVATION
Scale 1:300 @ A3

Do not scale

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NOTES

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- GABION WALL
- SECTION LINE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P06	05/06/17	SV	---	AB

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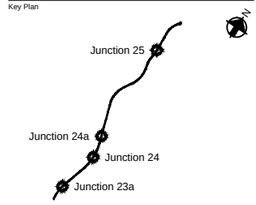
amey ARUP

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN
CH.193320 TO CH.193350 (NB)
SHEET 01 OF 02

Scale at A1: 1:150

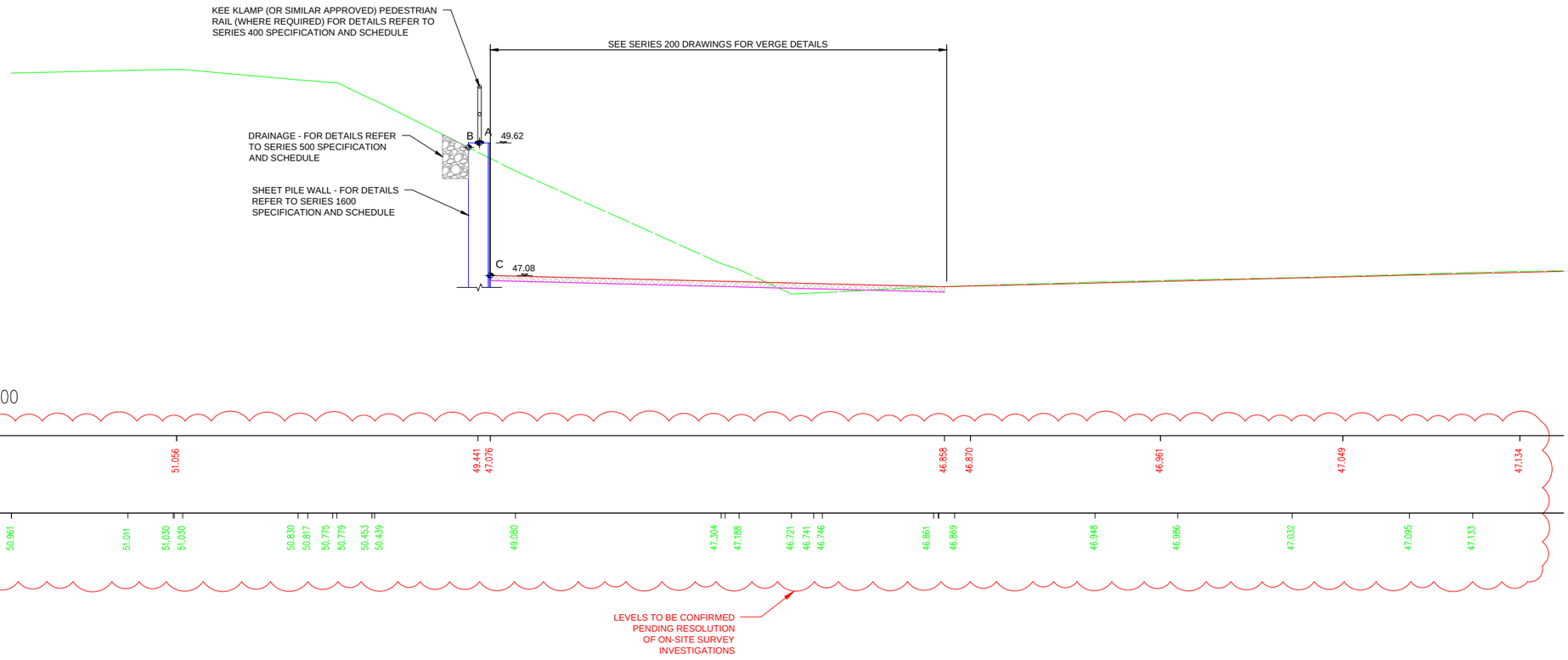
Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00** | Rev: **P06**

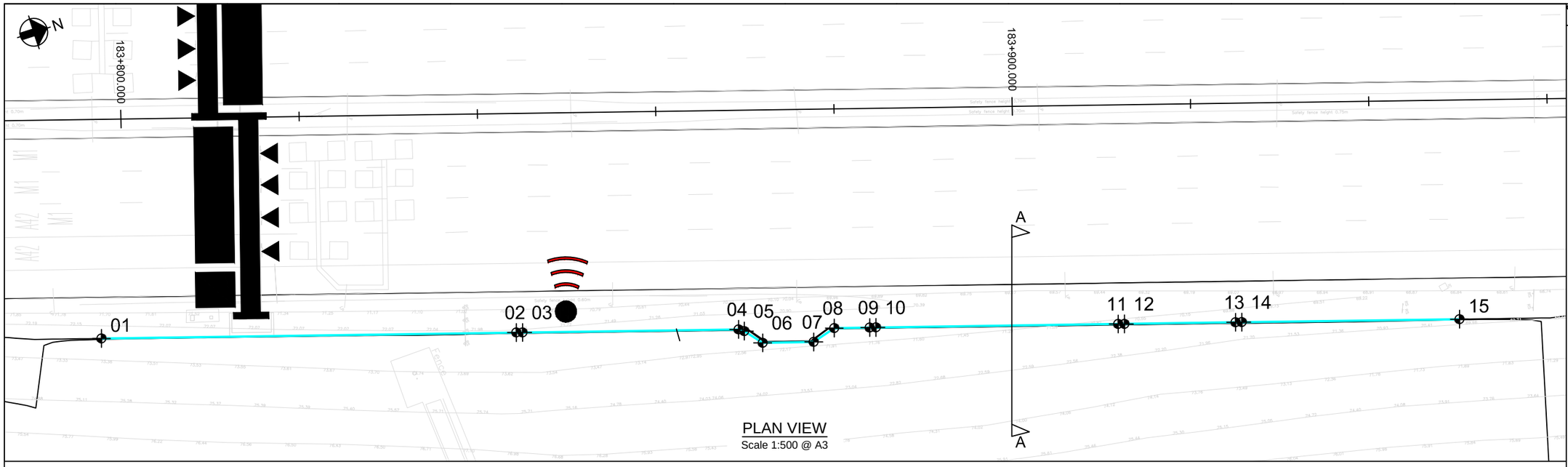
Name: **HA549342-AMAR-HGT-SWI-DR-CE-001634**

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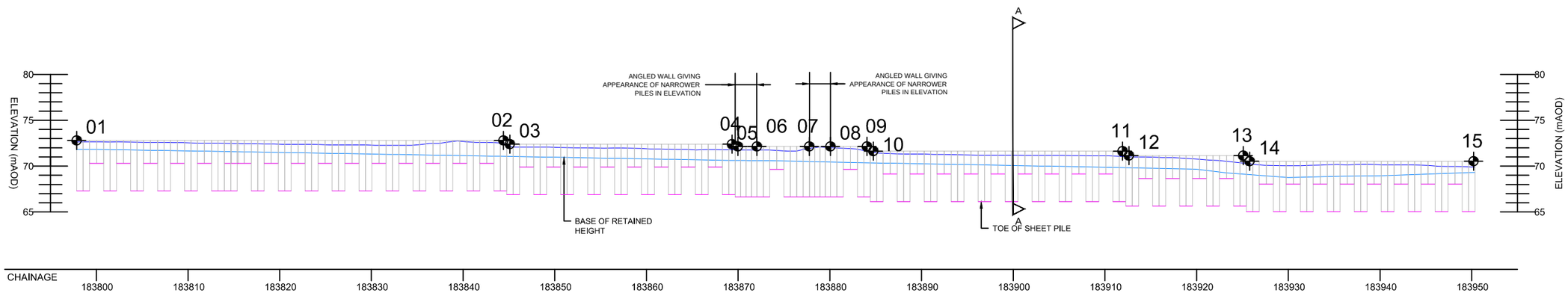
PLAN VIEW
Scale 1:500 @ A3

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION

SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	RET. WALL DETAILS: TOTAL RETAINED HIEGHT	RET. WALL DETAILS: TOTAL KING SHEET PILE LENGTH	RET. WALL DETAILS: TOTAL INTERMEDIATE PILE LENGTH
01	447340.28	326197.53	72.80	72.70	71.80	0.90	5.50	2.50
02	447354.02	326242.02	72.80	72.50	71.10	1.40	5.50	2.50
03	447354.23	326242.68	72.40	72.20	71.10	1.10	5.50	2.50
04	447361.48	326266.16	72.40	71.80	70.62	1.18	5.50	2.50
05	447361.76	326266.38	72.15	71.80	70.60	1.20	5.50	2.50
06	447363.65	326267.93	72.15	71.80	70.60	1.20	5.50	2.50
07	447365.32	326273.41	72.15	71.90	70.50	1.40	5.50	2.50
08	447364.55	326276.09	72.15	72.00	70.51	1.49	5.50	2.50
09	447365.72	326279.89	72.15	71.65	70.40	1.25	5.50	2.50
010	447365.93	326280.56	71.60	71.52	70.35	1.17	5.50	2.50
011	447373.95	326306.52	71.60	71.00	69.85	1.15	5.50	2.50
012	447374.16	326307.19	71.15	71.00	69.80	1.20	5.50	2.50
013	447377.83	326319.1	71.15	70.30	69.40	0.90	5.50	2.50
014	447378.03	326319.77	70.50	70.24	69.10	1.14	5.50	2.50
015	447385.25	326343.1	70.50	69.90	69.30	0.60	5.50	2.50



ELEVATION
Scale 1:500 @ A3

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NOTES

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3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES

Rev	Date	By	Chkd	Appd
P06	22/05/17	LP	---	SV

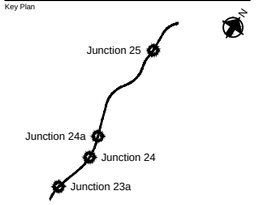
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

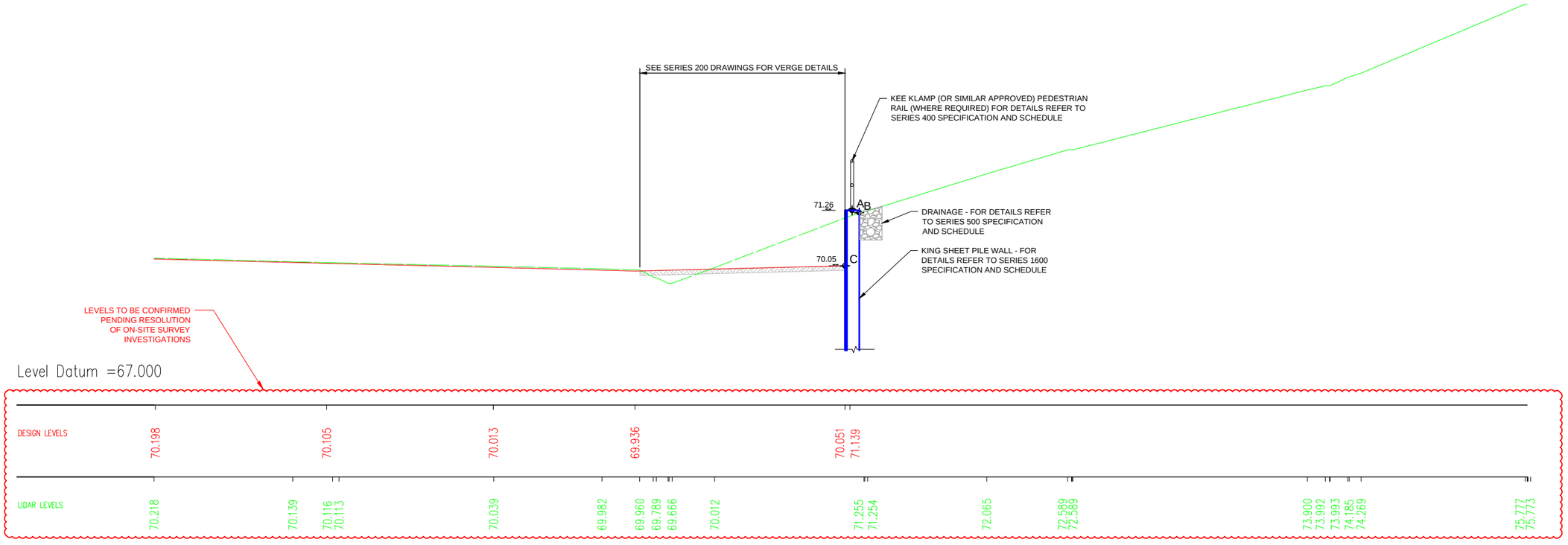
Key Plan



Drawing Title: KING SHEET PILE DESIGN SOLUTION PLAN
CH. 183798 TO CH. 183950 (SB)
SHEET 01 OF 02

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P06**
Name: **HA549342-AMAR-HGT-SWI-DR-CE-001638**

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SECTION A-A
CH. 183900
Scale 1:100 @ A3

NOTES
1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P06	22/05/17	LP	---	SV

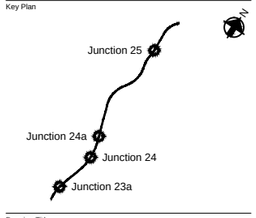
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH. 183798 TO CH. 183950 (SB) SHEET 02 OF 02

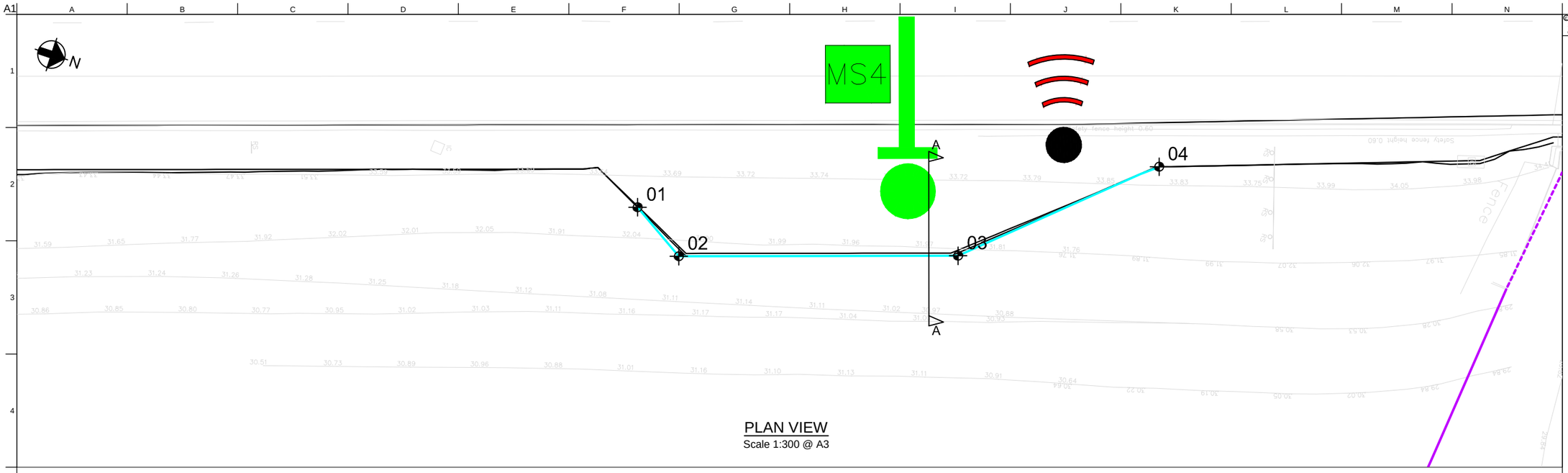
Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P06**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001639**

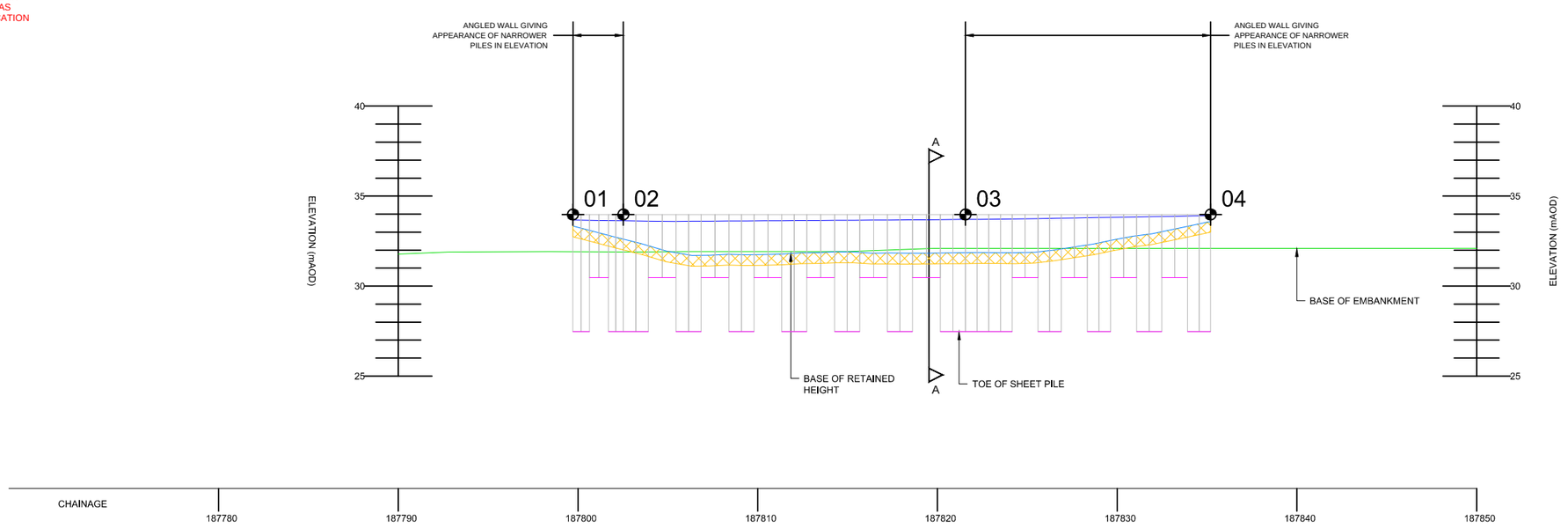


SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)	RET. WALL DETAILS: TOTAL RETAINED HEIGHT	RET. WALL DETAILS: TOTAL KING SHEET PILE LENGTH	RET. WALL DETAILS: TOTAL INTERMEDIATE SHEET PILE LENGTH
01	446881.94	330088.9	33.97	33.66	33.33	32.73	0.93	6.50	3.50
02	446884.23	330092.6	33.97	33.63	32.61	32.01	1.62	6.50	3.50
03	446878.3	330110.65	33.97	33.70	31.85	31.25	2.45	6.50	3.50
04	446868.31	330121.77	33.97	33.91	33.60	33.00	0.91	6.50	3.50

LEVELS TO BE CONFIRMED
PENDING RESOLUTION
OF ON-SITE SURVEY
INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN
ALLEVIATION PURPOSES WAS
NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:300 @ A3

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NOTES

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3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

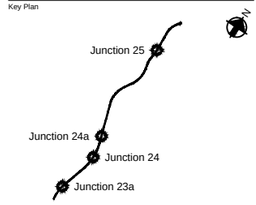
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 187800 TO 187835 (SB)
SHEET 01 OF 02

Scale at A1: 1:150

Role: Civil - Earthworks and Geotech

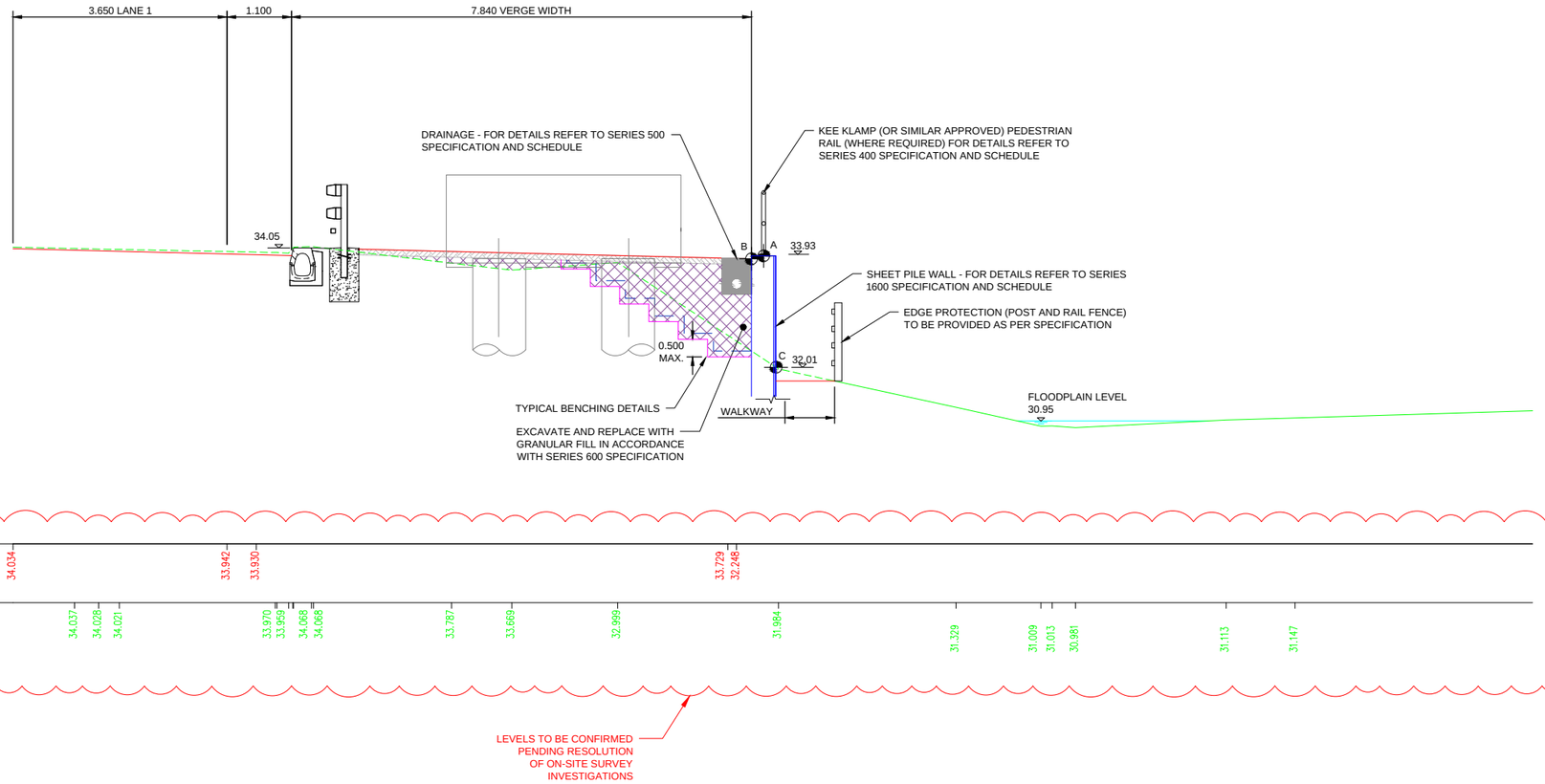
Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001640**

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SECTION A-A
CH. 187818
Scale 1:100 @ A3

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NOTES
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6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

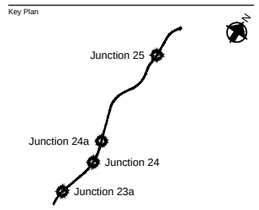
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH. 187800 TO 187835 (SB) SHEET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

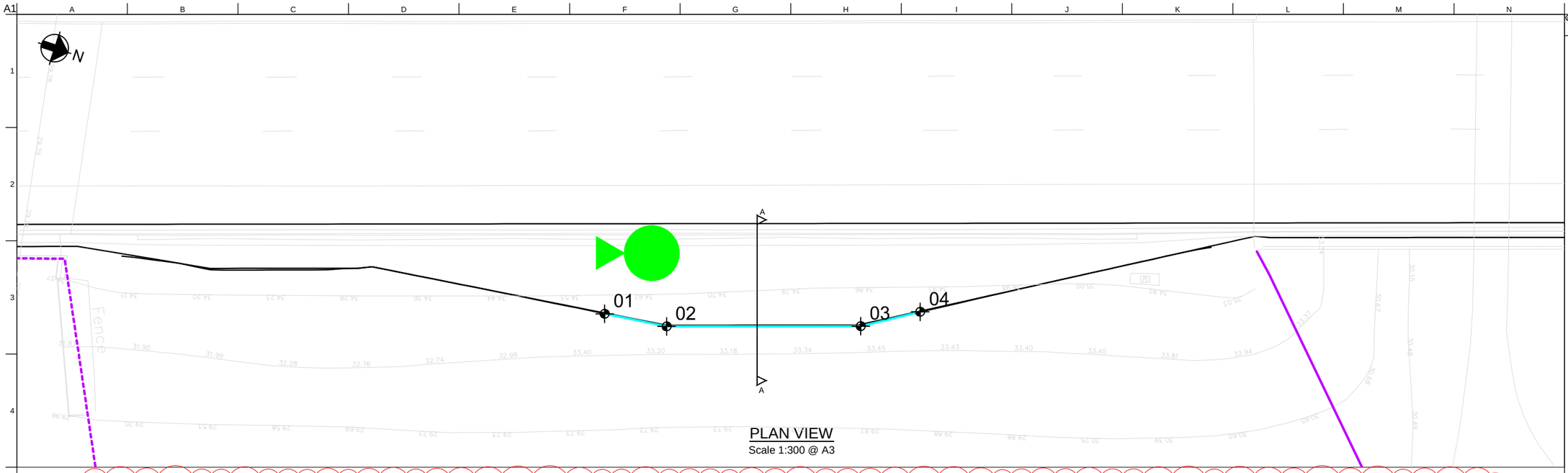
Job No: **244508-00**

Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001641**

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Do not scale



PLAN VIEW
Scale 1:300 @ A3

SHEET PILE SETTING OUT POINTS

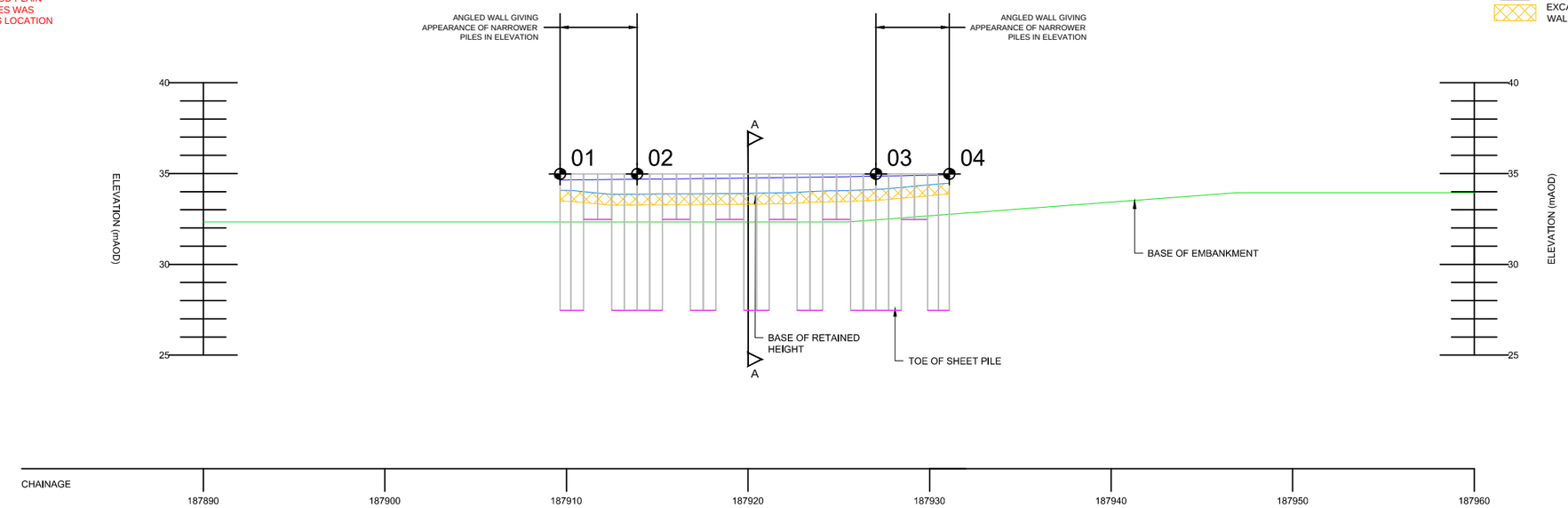
REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)
01	446847.85	330192.53	34.97	34.64	34.06	33.46
02	446847.36	330196.79	34.97	34.67	33.86	33.26
03	446843.25	330209.33	34.97	34.85	34.12	33.52
04	446841.07	330212.87	34.97	34.92	34.46	33.86

RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
1.18	7.50	2.50
1.41	7.50	2.50
1.33	7.50	2.50
1.06	7.50	2.50

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:300 @ A3

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR WALKWAY PURPOSES)

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NOTES

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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

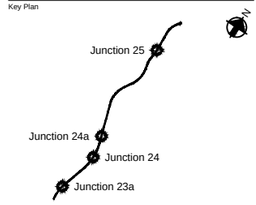
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 187910 TO 187931 (SB)
SHEET 01 OF 02

Scale at A1: 1:150

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

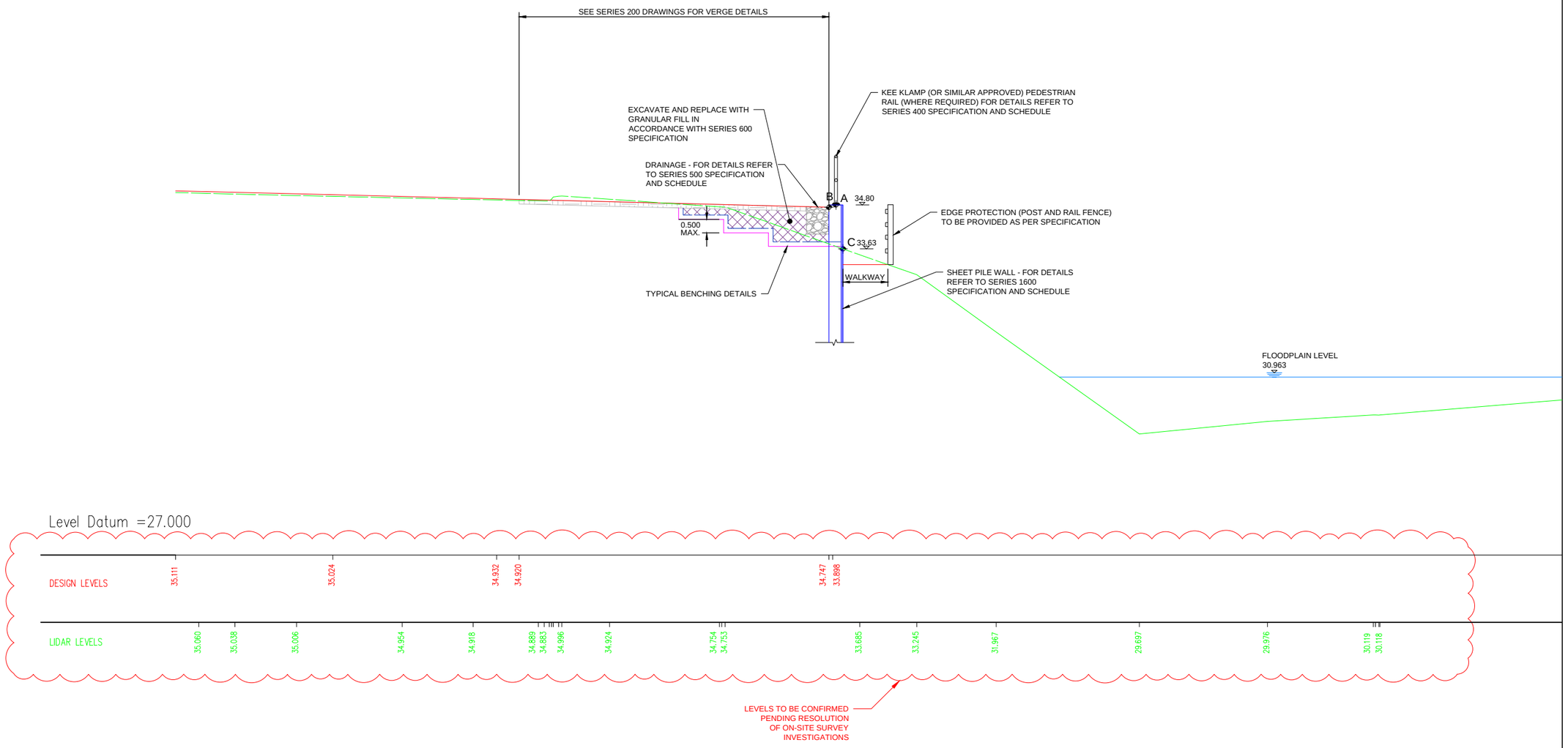
Job No: **244508-00**

Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001642**

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SECTION A-A
CH. 187920
Scale 1:100 @ A3

Do not scale

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NOTES
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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

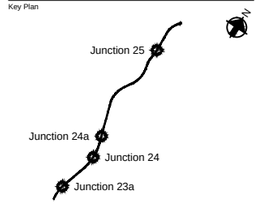
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 187910 TO 187931 (SB)
SHEET 02 TO 02

Scale at A1: 1:50

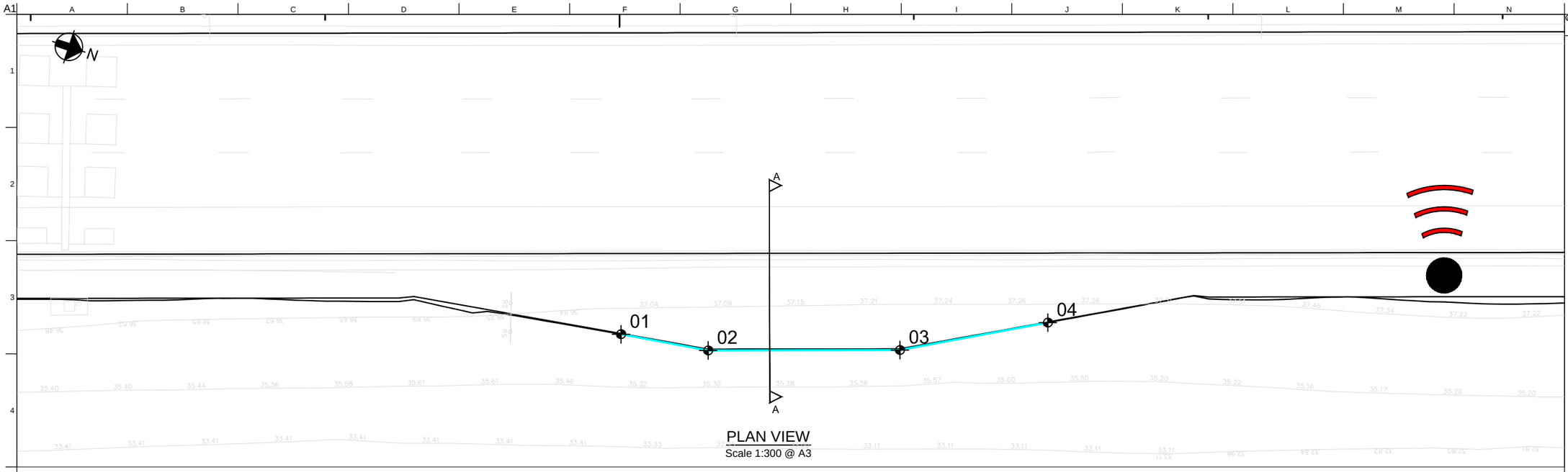
Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001643**

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PLAN VIEW
Scale 1:300 @ A3

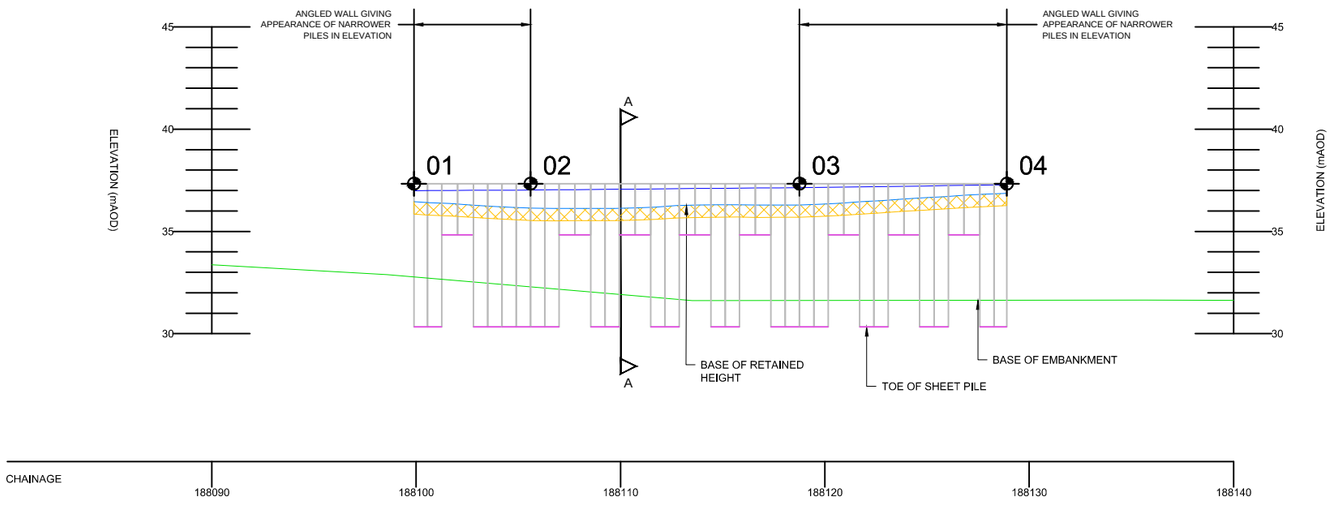
SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)	RET. WALL DETAILS: TOTAL RETAINED HEIGHT	RET. WALL DETAILS: TOTAL KING SHEET PILE LENGTH	RET. WALL DETAILS: TOTAL INTERMEDIATE SHEET PILE LENGTH
01	446788.05	330374.23	37.33	36.99	36.45	35.85	1.14	7.00	2.50
02	446787.25	330380.2	37.33	37.02	36.13	35.53	1.49	7.00	2.50
03	446783.18	330392.57	37.33	37.14	36.29	35.69	1.45	7.00	2.50
04	446778.29	330401.54	37.33	37.27	36.86	36.26	1.01	7.00	2.50

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION

ELEVATION LEGEND
- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR WALKWAY PURPOSES)



ELEVATION
Scale 1:300 @ A3

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NOTES

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7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND
- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

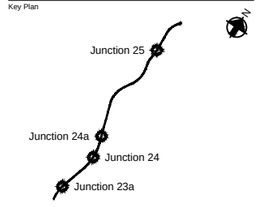
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 188100 TO 188129 (SB)
SHEET 01 OF 02

Scale at A1: 1:150

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00**

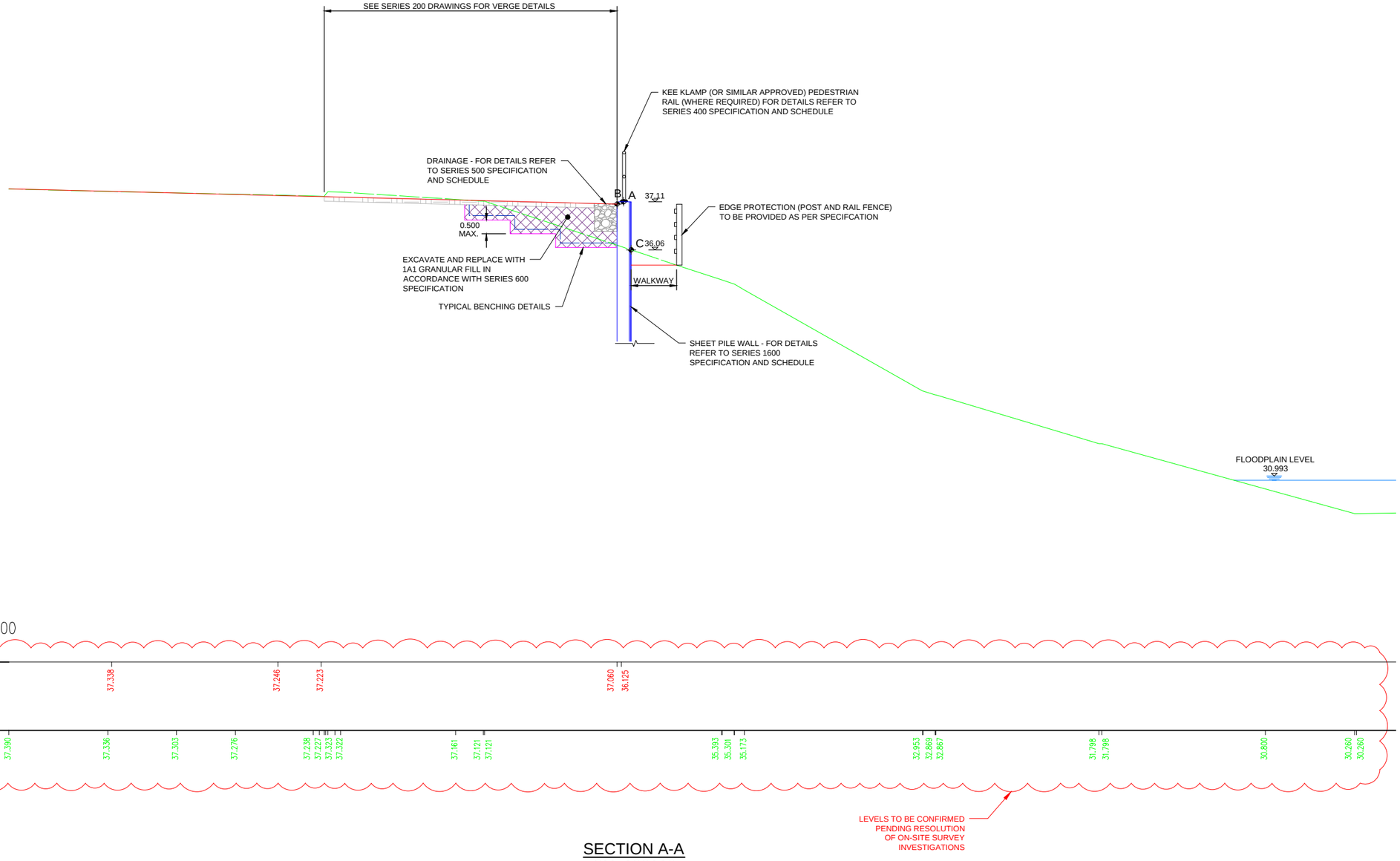
Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001644**

Do not scale

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SECTION A-A
CH. 188110
Scale 1:100 @ A3

NOTES
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2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
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8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

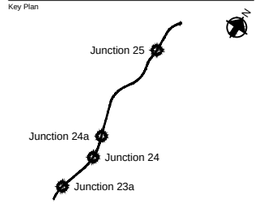
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH. 188100 TO 188129 (SB) SHEET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

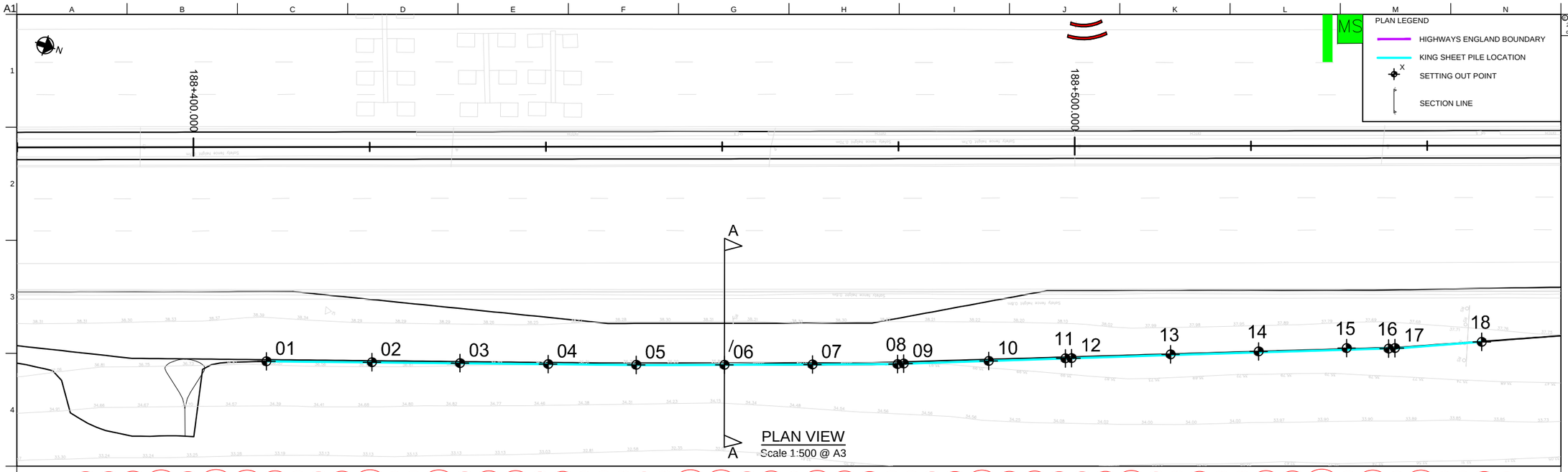
Suitability: S4 - Fit for construction approval

Job No: **244508-00** | Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001645**

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Do not scale



PLAN VIEW
Scale 1:500 @ A3

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

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NOTES

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

ELEVATION LEGEND

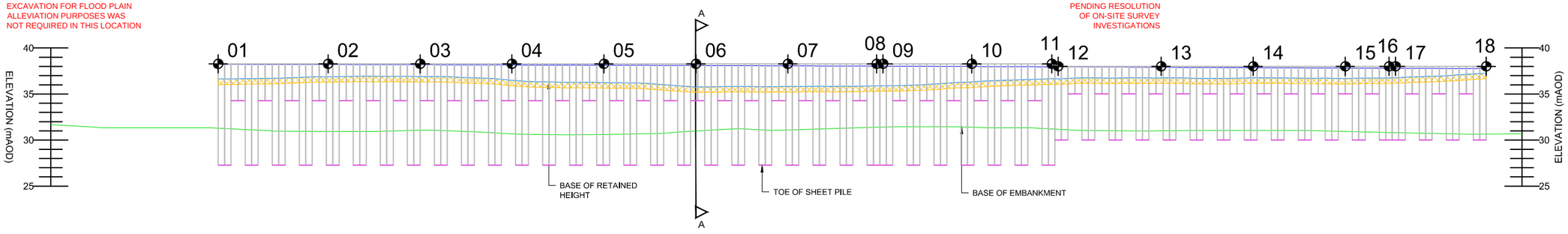
- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR WALKWAY PURPOSES)

SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)	RET. WALL DETAILS: TOTAL RETAINED HEIGHT	TOTAL SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
01	446694.28	330667.8	38.27	38.22	36.64	36.04	2.18	11.00	4.00
02	446690.66	330679.2	38.27	38.20	36.87	36.27	1.93	11.00	4.00
03	446687.65	330688.74	38.27	38.17	36.89	36.29	1.88	11.00	4.00
04	446684.65	330698.28	38.27	38.15	36.49	35.89	2.26	11.00	4.00
05	446681.64	330707.82	38.27	38.13	36.24	35.64	2.49	11.00	4.00
06	446678.52	330717.32	38.27	38.10	35.78	35.18	2.92	11.00	4.00
07	446675.37	330726.81	38.27	38.05	35.80	35.20	2.85	11.00	4.00
08	446672.33	330735.97	38.27	38.03	35.88	35.28	2.75	11.00	4.00
09	446672.07	330736.62	38.27	38.02	35.89	35.29	2.73	11.00	4.00
10	446668.78	330745.69	38.27	37.99	36.30	35.70	2.29	11.00	4.00
11	446665.81	330753.87	38.27	37.96	36.66	36.06	1.90	11.00	4.00
12	446665.56	330754.53	38.01	37.96	36.66	36.06	1.90	8.00	3.00
13	446661.66	330765.08	38.01	37.91	36.75	36.15	1.76	8.00	3.00
14	446658.24	330774.47	38.01	37.87	36.77	36.17	1.70	8.00	3.00
15	446654.78	330783.85	38.01	37.82	36.68	36.08	1.74	8.00	3.00
16	446653.35	330788.4	38.01	37.80	36.75	36.15	1.65	8.00	3.00
17	446653.08	330789.06	38.01	37.79	36.76	36.16	1.63	8.00	3.00
18	446649.34	330798.21	38.01	37.76	37.27	36.67	1.09	8.00	3.00

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS



ELEVATION
Scale 1:500 @ A3

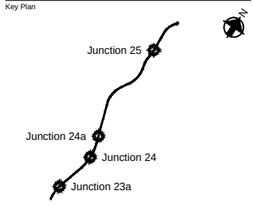
Rev	Date	By	Chkd	Appd
P04	02/06/17	LP	---	AB
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 188408 TO 188546 (SB)
SHEET 01 OF 02

Scale at A1: 1:250

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

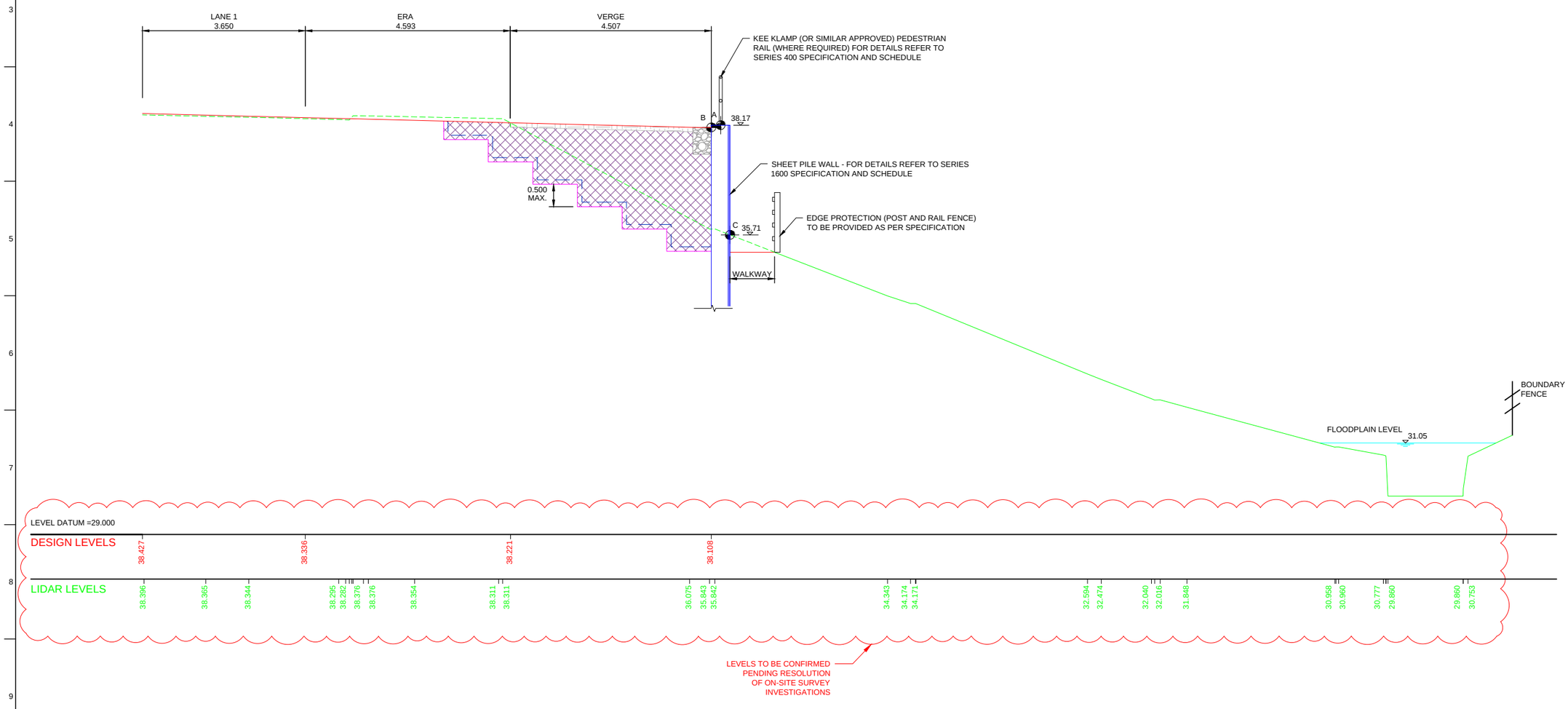
Job No: **244508-00**

Rev: **P04**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001646**

Do not scale

pw:\WCCNTS914.global.arup.com:PW_ARUP_UKDocumentsSMP M1 J23a - J25\01 Amey A+up LYCE - Civil - Earthworks and Geotechnics\SHR - Drawing\HA549342-AMAR-HGT-SWI-DR-CE-001646



SECTION A-A
CH. 188460
Scale 1:100 @ A3

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NOTES
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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

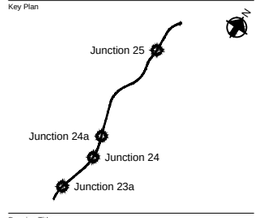
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH. 188408 TO 188546 (SB) SHEET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

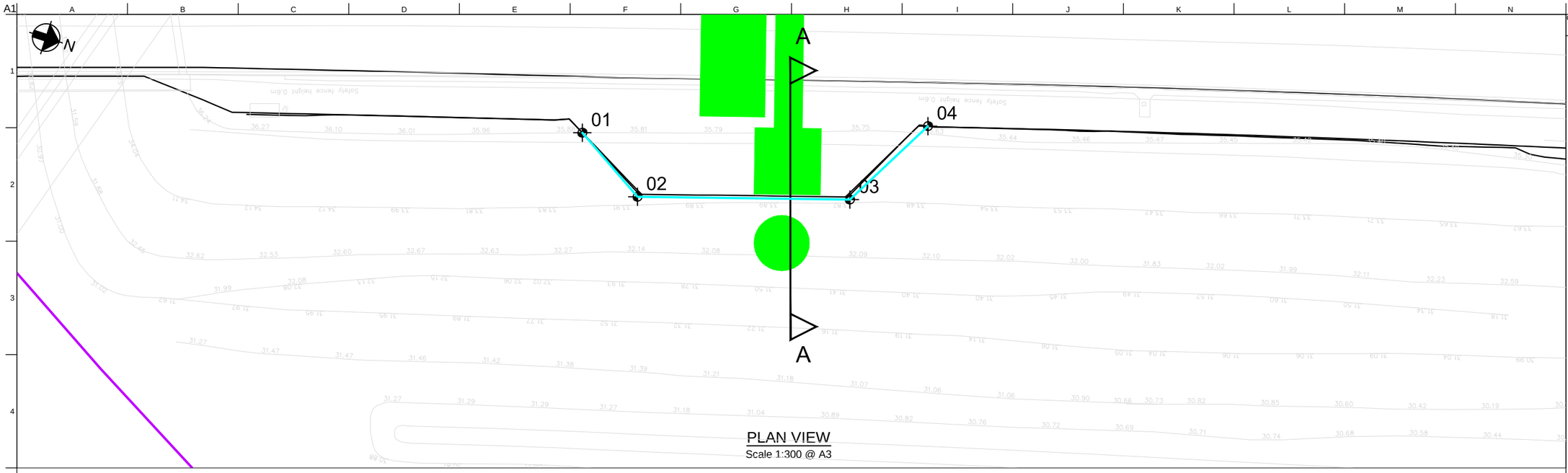
Suitability: S4 - Fit for construction approval

Job No: **244508-00** | Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001648**

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Do not scale



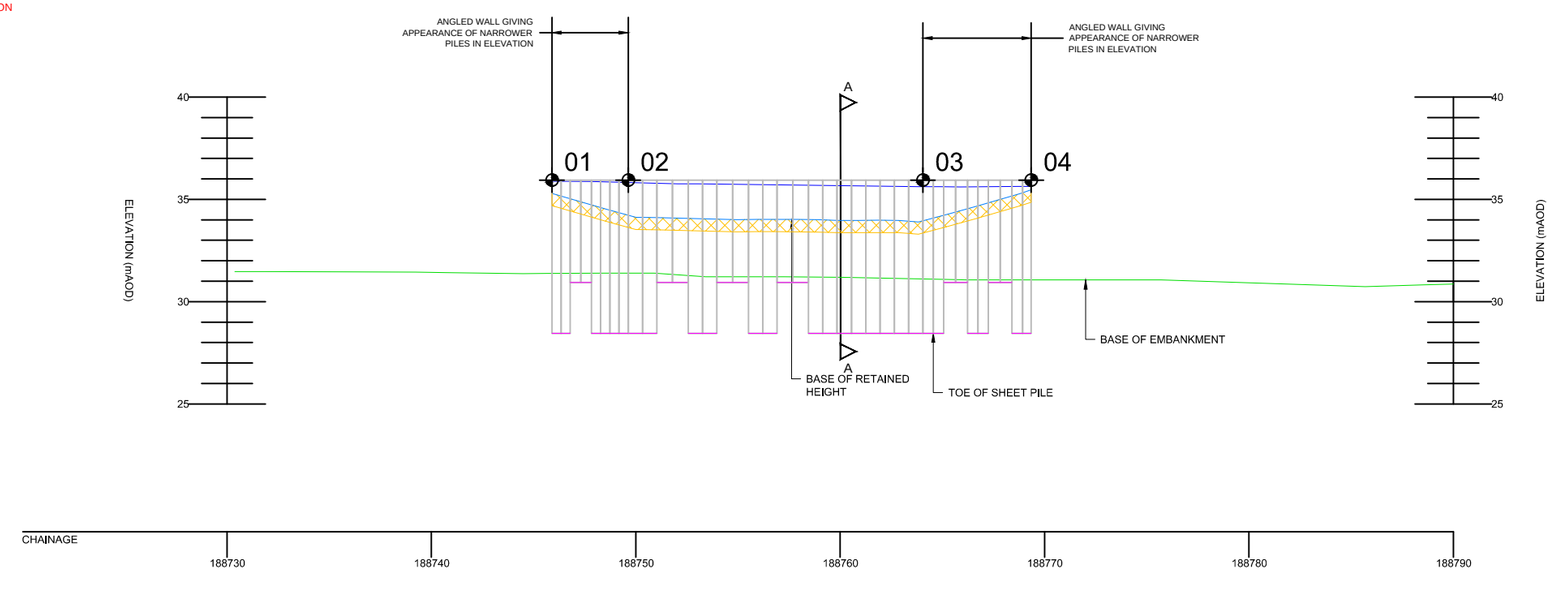
PLAN VIEW
Scale 1:300 @ A3

SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)	RET. WALL DETAILS: TOTAL RETAINED HEIGHT	RET. WALL DETAILS: TOTAL KING SHEET PILE LENGTH	RET. WALL DETAILS: TOTAL INTERMEDIATE SHEET PILE LENGTH
01	446585.39	330987.23	35.94	35.89	35.29	34.69	1.20	7.50	5.00
02	446588.35	330992.14	35.94	35.83	34.23	33.63	2.20	7.50	5.00
03	446584.06	331005.9	35.94	35.62	33.95	33.35	2.27	7.50	5.00
04	446577.68	331009.39	35.94	35.63	35.46	34.86	0.77	7.50	5.00

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:300 @ A3

ELEVATION LEGEND
- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR WALKWAY PURPOSES)

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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND
- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

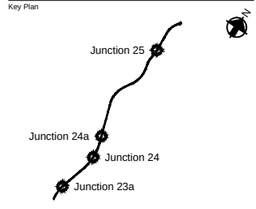
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan

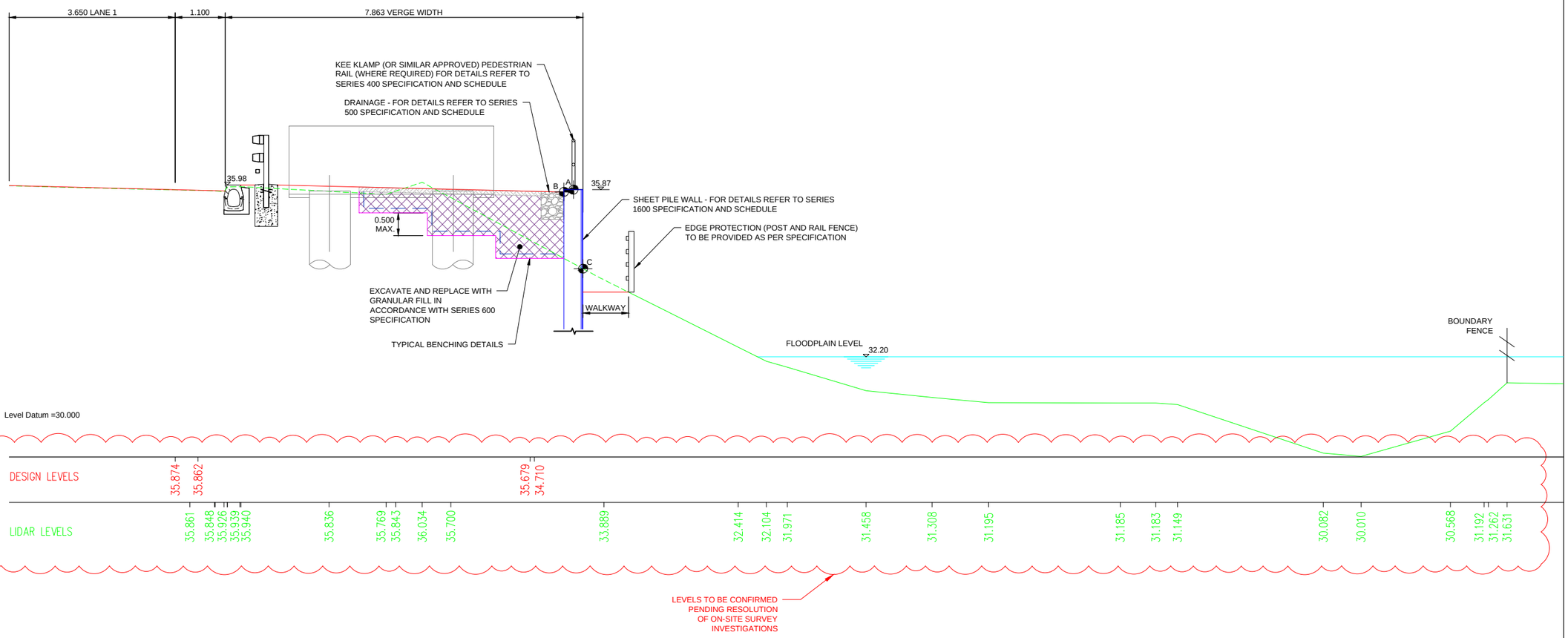


Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 188746 TO 188769 (SB)
SHEET 01 OF 02

Scale at A1: 1:1500
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P05
Name: HA549342-AMAR-HGT-SWI-DR-CE-001649

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Do not scale



SECTION A-A
CH. 188760
Scale 1:100 @ A3

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NOTES
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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

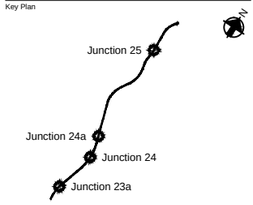
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH. 188746 TO 188769 (SB) SHEET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

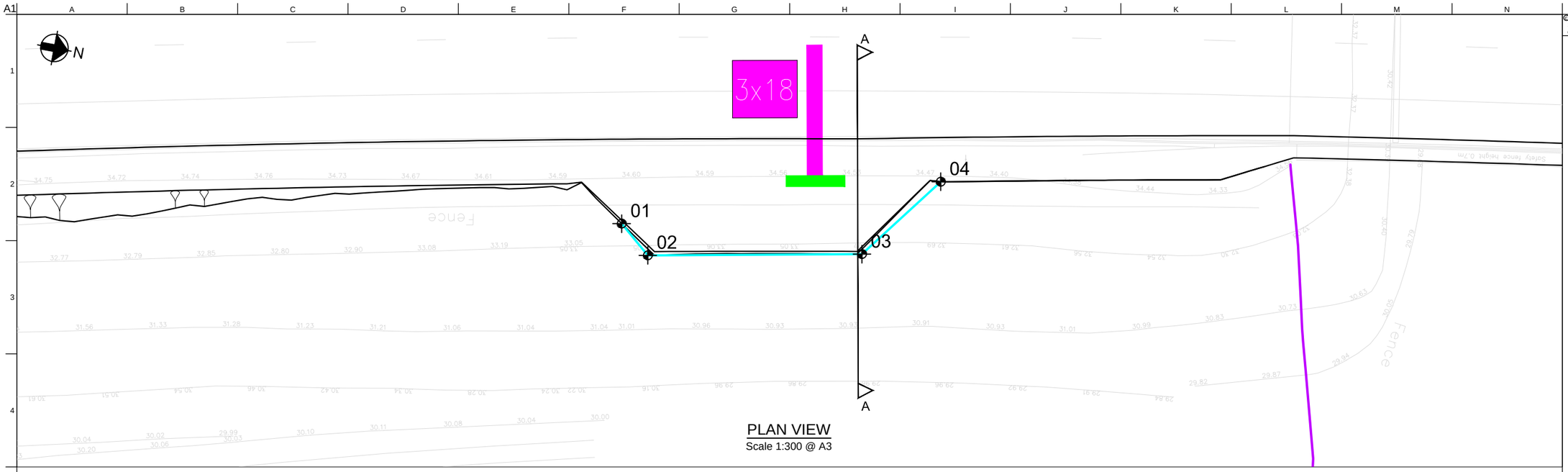
Job No: **244508-00**

Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001650**

Do not scale

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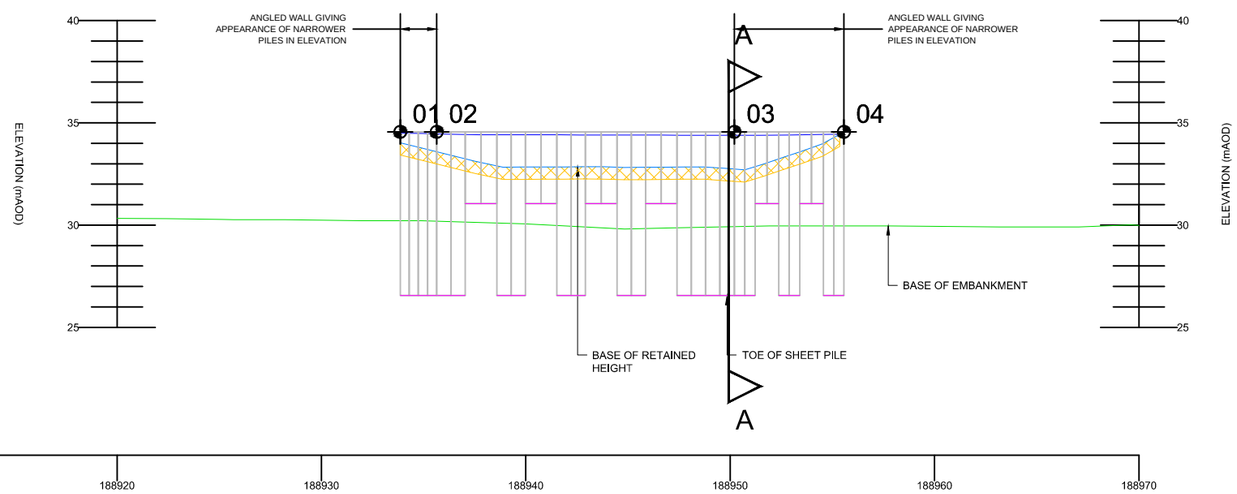
PLAN VIEW
Scale 1:300 @ A3

SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)	RET. WALL DETAILS: TOTAL RETAINED HEIGHT	RET. WALL DETAILS: TOTAL KING SHEET PILE LENGTH	RET. WALL DETAILS: TOTAL INTERMEDIATE SHEET PILE LENGTH
01	446541.19	331167.17	34.56	34.50	34.03	33.43	1.07	8.00	3.50
02	446542.98	331169.32	34.56	34.57	33.70	33.10	1.47	8.00	3.50
03	446540.2	331183.62	34.56	34.39	32.74	32.14	2.25	8.00	3.50
04	446534.37	331187.98	34.56	34.45	34.45	33.85	0.60	8.00	3.50

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:300 @ A3

ELEVATION LEGEND
- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR WALKWAY PURPOSES)

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PLAN LEGEND
- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

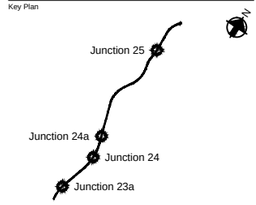
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan

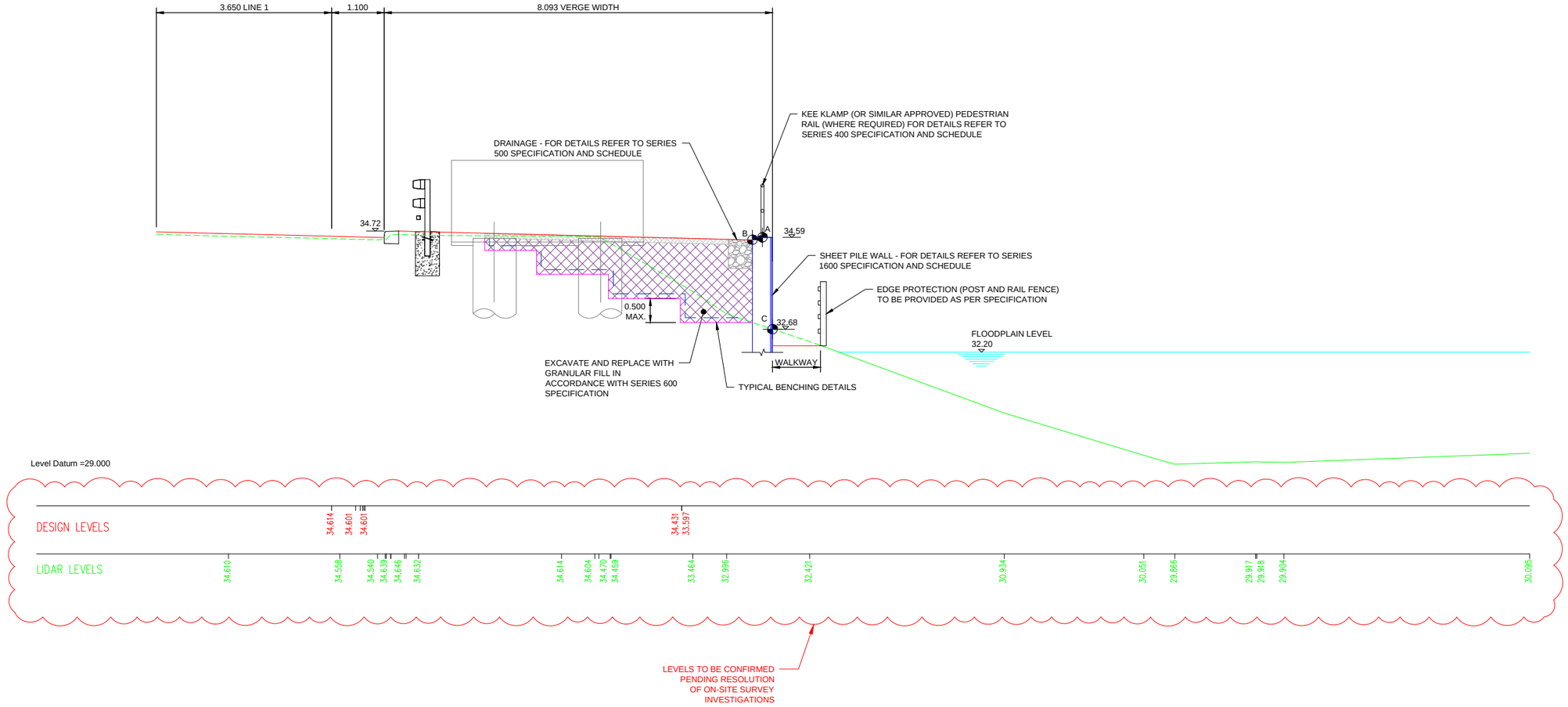


Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 188934 TO 188956 (SB)
SHEEY 01 OF 02

Scale at A1: 1:1500
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P05
Name: HA549342-AMAR-HGT-SWI-DR-CE-001651

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Do not scale



SECTION A-A
CH. 188947
Scale 1:100 @ A3

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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

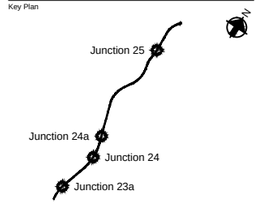
Issued for Client Sharing

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH. 188934 TO 188956 (SB) SHEET 02 TO 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

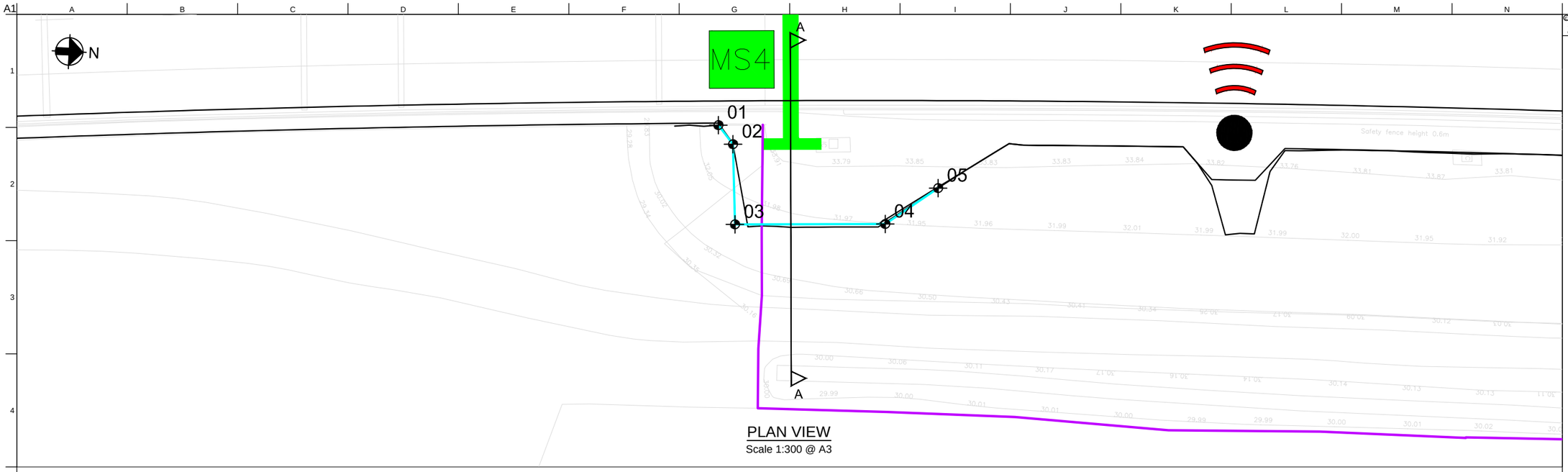
Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001652**

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Do not scale



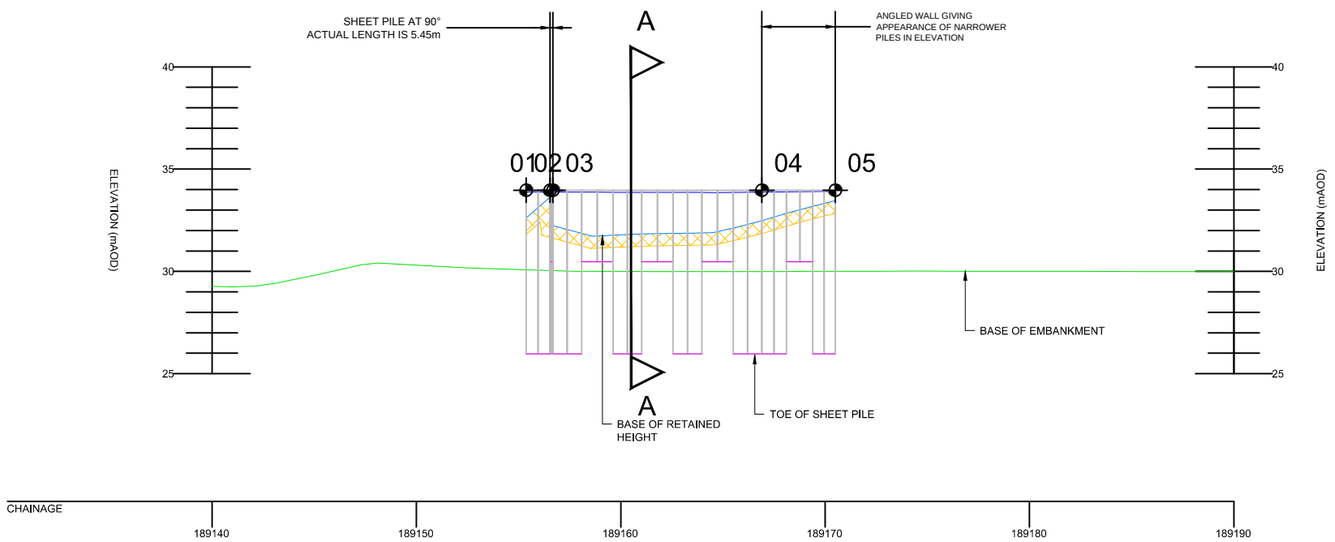
PLAN VIEW
Scale 1:300 @ A3

SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)	RET. WALL DETAILS: TOTAL RETAINED HEIGHT	RET. WALL DETAILS: TOTAL KING SHEET PILE LENGTH	RET. WALL DETAILS: TOTAL INTERMEDIATE SHEET PILE LENGTH
01	446509.79	331383.25	33.97	33.88	32.61	32.01	1.87	8.00	3.50
02	446511.04	331384.31	33.97	33.88	33.63	33.03	0.85	8.00	3.50
03	446516.47	331384.69	33.97	33.87	32.23	31.63	2.24	8.00	3.50
04	446515.97	331394.91	33.97	33.88	32.47	31.87	2.01	8.00	3.50
05	446513.37	331398.38	33.97	33.92	33.46	32.86	1.06	8.00	3.50

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:300 @ A3

ELEVATION LEGEND
- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR WALKWAY PURPOSES)

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NOTES

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND
- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

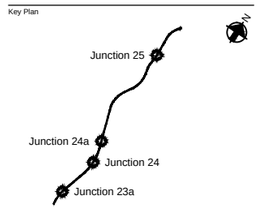
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan

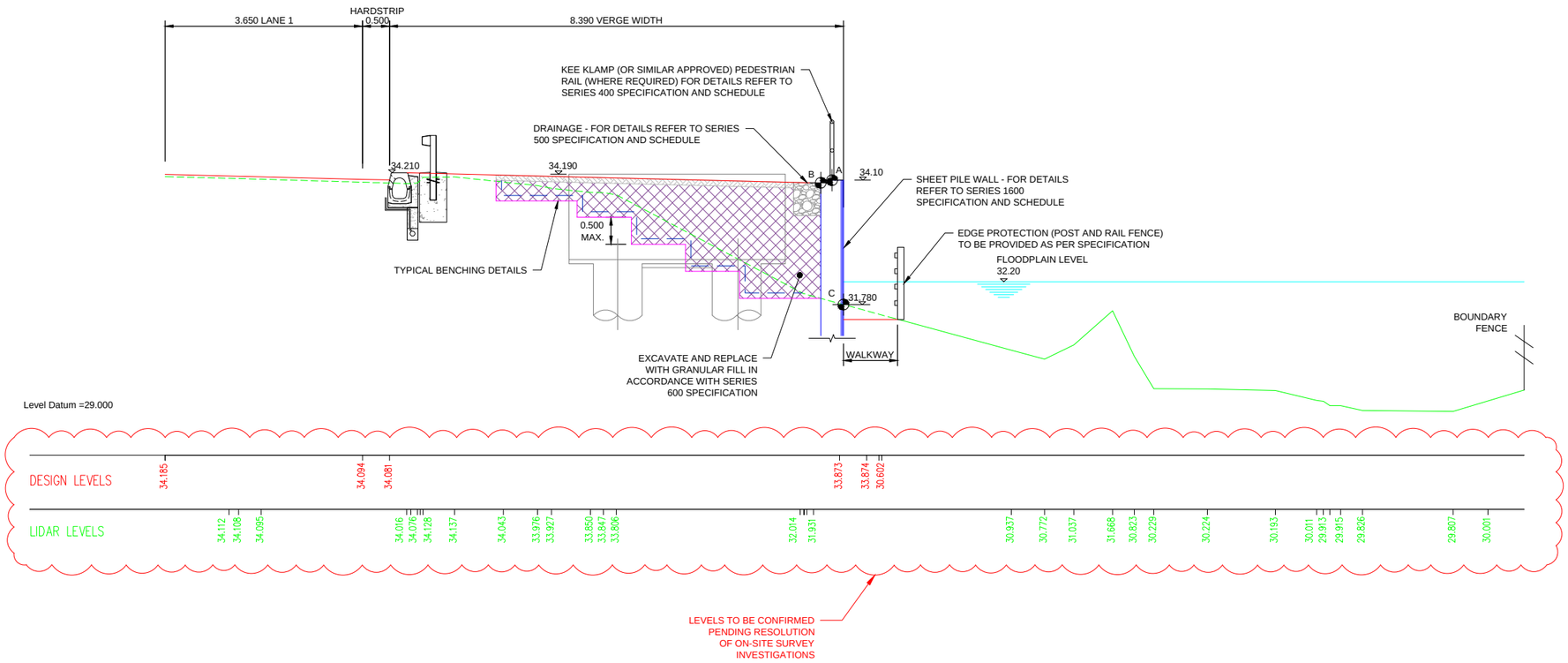


Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 189155 TO 189171 (SB)
SHEET 01 OF 02

Scale at A1: 1:1500
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P05
Name: HA549342-AMAR-HGT-SWI-DR-CE-001653

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Do not scale



SECTION A-A
CH.189160
Scale 1:100 @ A3

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NOTES
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3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

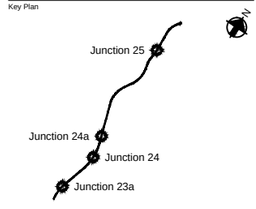
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH. 189155 TO 189171 (SB) SHEET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

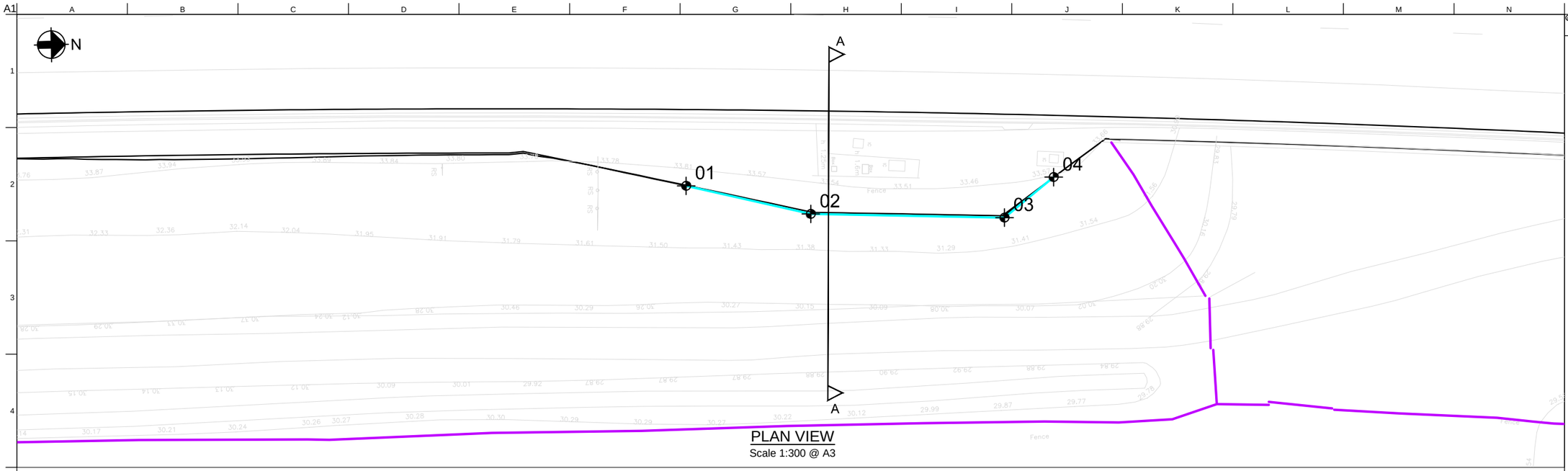
Suitability: S4 - Fit for construction approval

Job No: **244508-00** | Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001654**

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Do not scale



PLAN VIEW
Scale 1:300 @ A3

SHEET PILE SETTING OUT POINTS

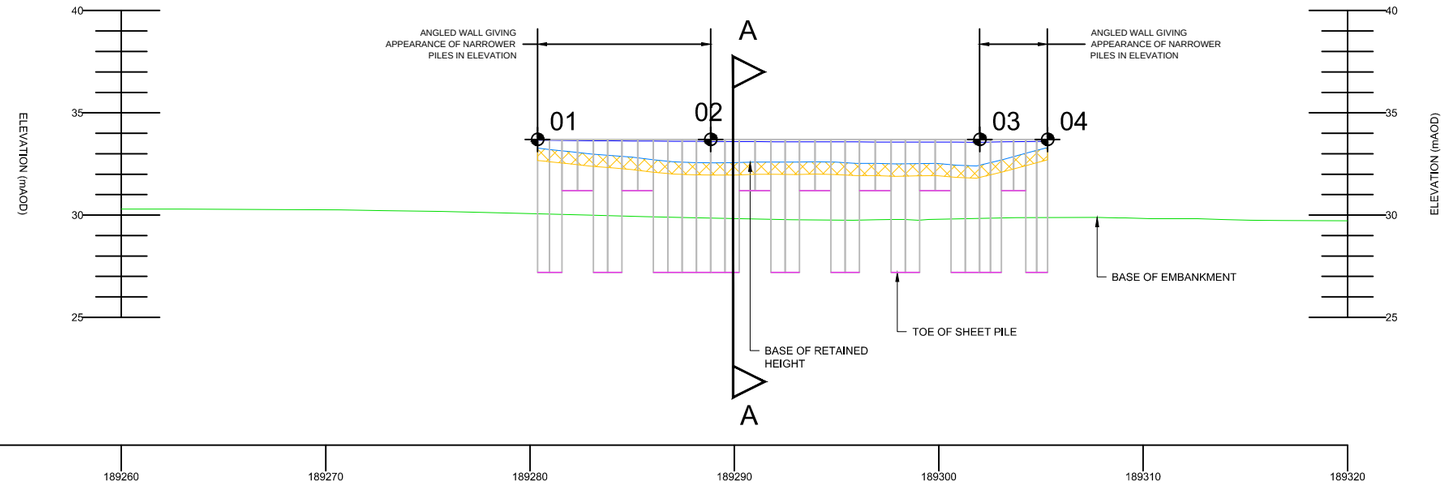
REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)
01	446511.65	331506.94	33.70	33.65	33.37	32.77
02	446513.71	331515.37	33.70	33.60	32.56	31.96
03	446514.2	331528.52	33.70	33.56	32.43	31.83
04	446511.52	331531.91	33.70	33.60	33.30	32.70

RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
0.88	6.50	2.50
1.64	6.50	2.50
1.73	6.50	2.50
0.90	6.50	2.50

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION



ELEVATION
Scale 1:300 @ A3

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR WALKWAY PURPOSES)

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NOTES

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4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

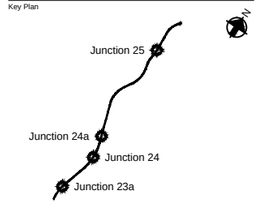
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 189280 TO 189305 (SB)
SHEET 01 OF 02

Scale at A1: 1:150

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00**

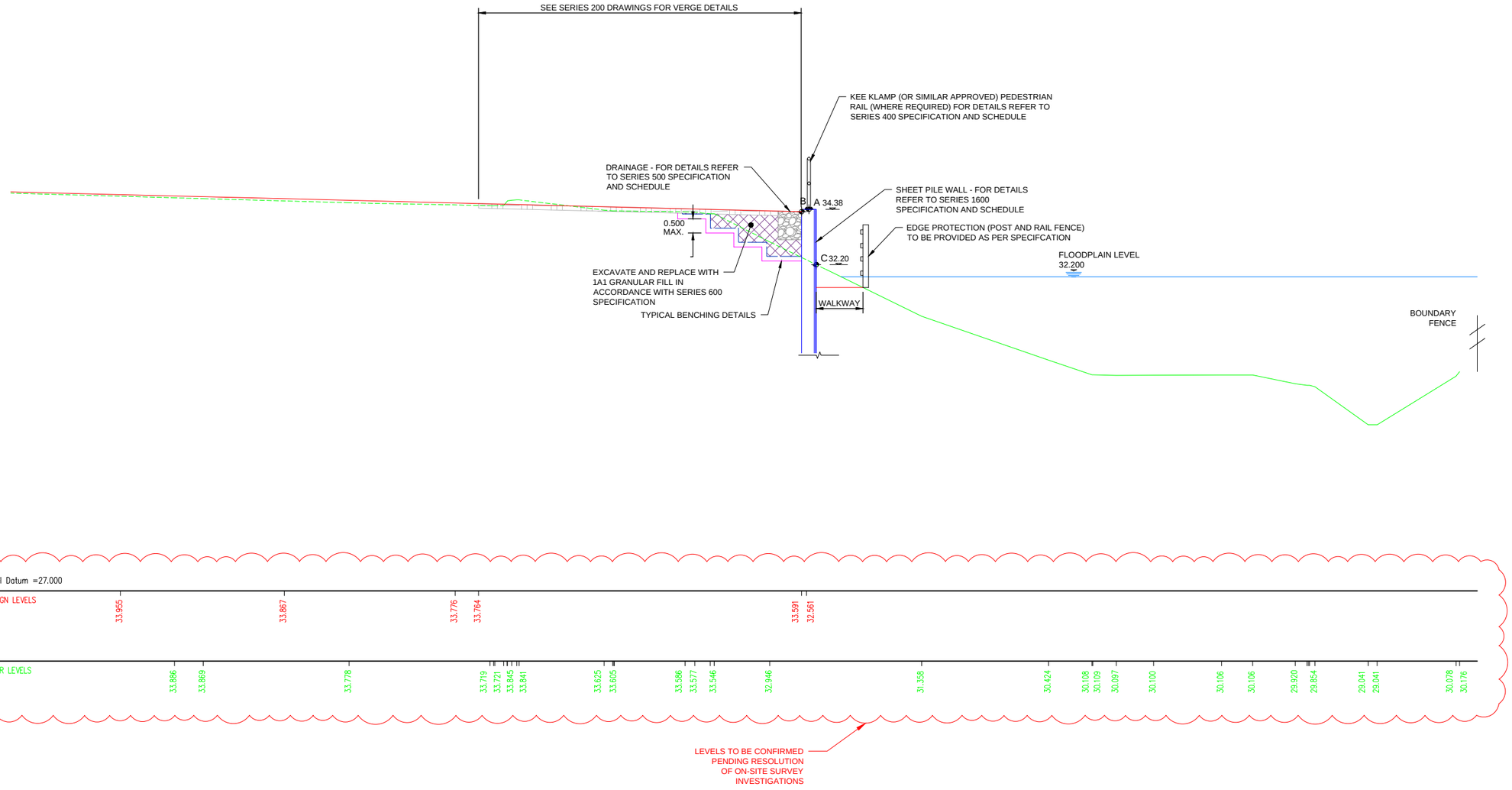
Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001655**

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A1 | A | B | C | D | E | F | G | H | I | J | K | L | M | N

Do not scale



SECTION A-A
CH. 189290
Scale 1:100 @ A3

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7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

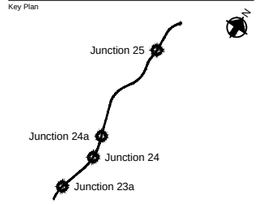
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH. 189280 TO 189305 (SB) SHEET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

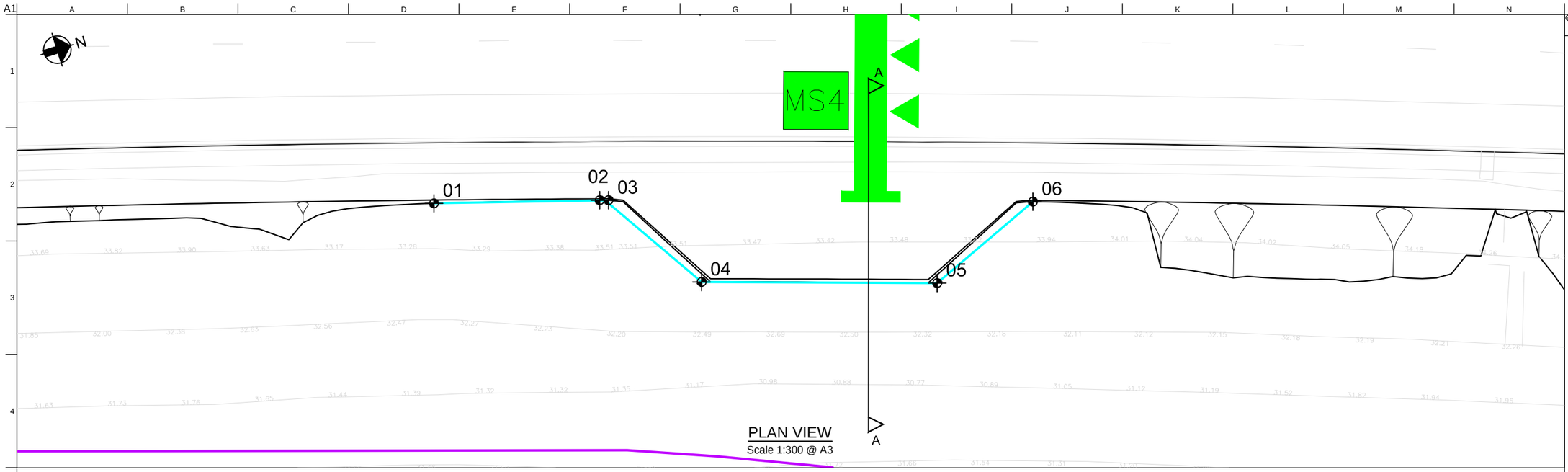
Suitability: S4 - Fit for construction approval

Job No: **244508-00** | Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001656**

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Do not scale



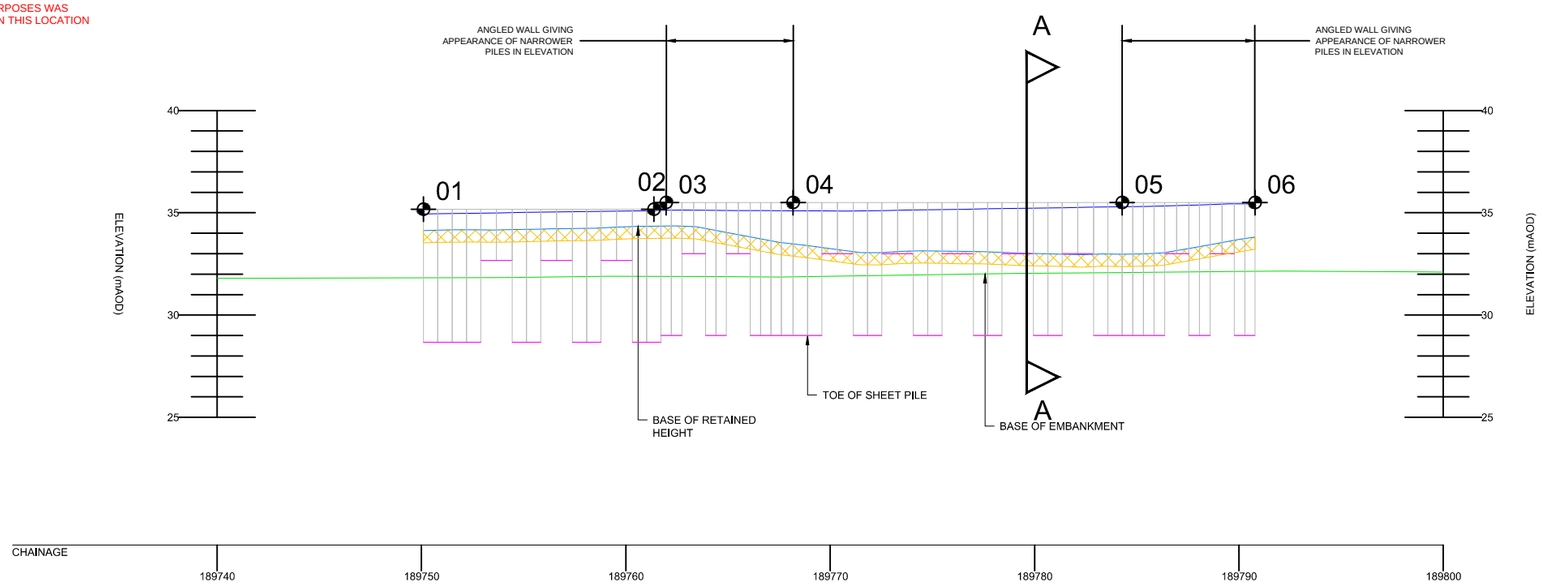
PLAN VIEW
Scale 1:300 @ A3

SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)	RET. WALL DETAILS: TOTAL RETAINED HEIGHT	RET. WALL DETAILS: TOTAL KING SHEET PILE LENGTH	RET. WALL DETAILS: TOTAL INTERMEDIATE SHEET PILE LENGTH
01	446587.17	331963.59	35.18	34.95	34.11	33.51	1.44	9.00	4.00
02	446590.33	331974.4	35.18	35.11	34.34	33.74	1.37	9.00	4.00
03	446590.51	331974.97	35.50	35.12	34.35	33.75	1.37	9.00	4.00
04	446597.69	331979.34	35.50	35.10	33.48	32.88	2.22	9.00	4.00
05	446602.55	331994.6	35.50	35.30	32.97	32.37	2.93	9.00	4.00
06	446599.23	332002.44	35.50	35.44	33.82	33.22	2.22	9.00	4.00

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS



ELEVATION
Scale 1:300 @ A3

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NOTES

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7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

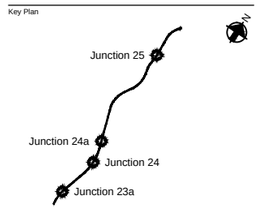
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan

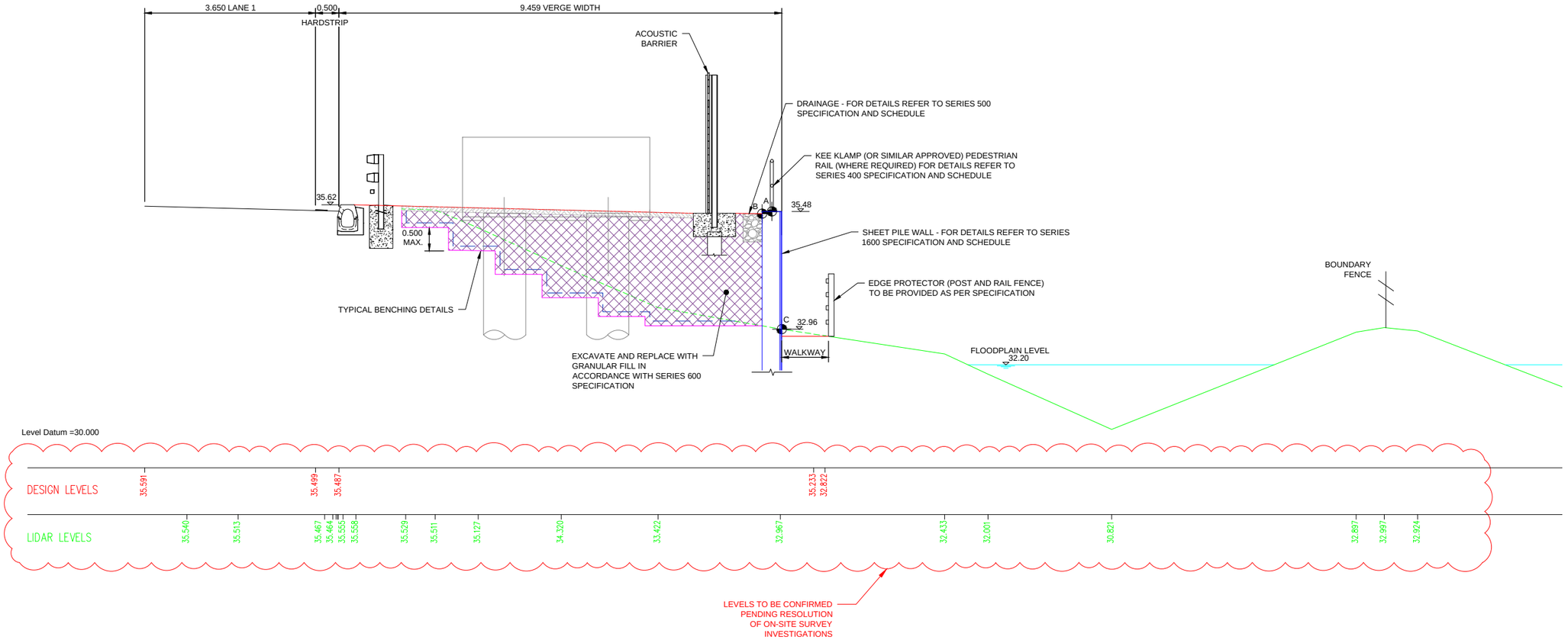


Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 189750 TO CH. 189791 (SB)
SHEET 01 OF 02

Scale at A1: 1:150
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P05**
Name: **HA549342-AMAR-HGT-SWI-DR-CE-001657**

Do not scale

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SECTION A-A
CH. 189780
Scale 1:100 @ A3

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NOTES
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2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P04	02/06/17	LP	---	AB

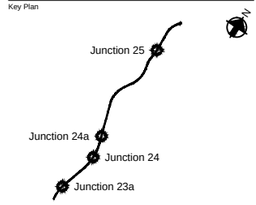
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH. 189750 TO CH. 189791 (SB) SHEET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

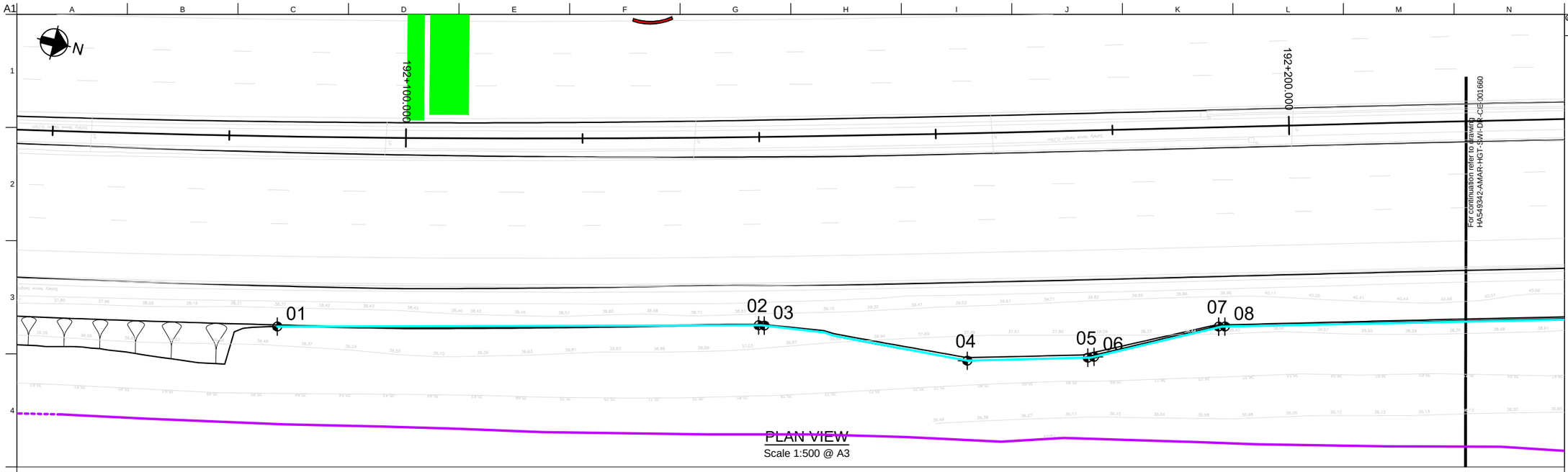
Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P04**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001658**

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Do not scale



PLAN VIEW
Scale 1:500 @ A3

SHEET PILE SETTING OUT POINTS

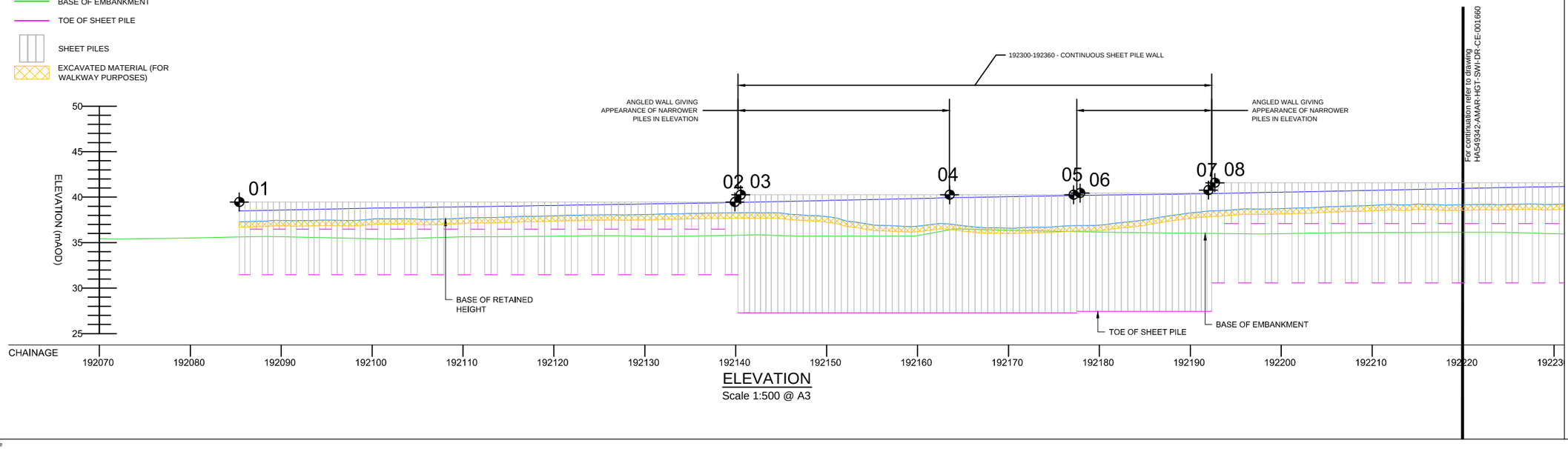
REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)	RET. WALL DETAILS: TOTAL RETAINED HEIGHT	RET. WALL DETAILS: TOTAL KING SHEET PILE LENGTH	RET. WALL DETAILS: TOTAL INTERMEDIATE PILE LENGTH
01	447264.88	334137.22	39.47	38.50	37.30	36.70	1.80	8.00	3.00
02	447251.61	334190.09	39.47	39.41	38.28	37.68	1.73	8.00	3.00
03	447251.48	334190.72	40.27	39.43	38.29	37.69	1.74	13.00	-
04	447249.81	334213.97	40.27	39.93	37.04	36.44	3.49	13.00	-
05	447246.42	334226.33	40.27	40.17	36.83	36.23	3.94	13.00	-
06	447246.12	334226.98	40.77	40.18	36.86	36.26	3.92	13.00	-
07	447239.2	334240.67	40.77	40.39	38.46	37.86	2.53	13.00	-
08	447239.01	334241.36	41.58	40.40	38.49	37.89	2.51	11.00	4.50

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR WALKWAY PURPOSES)



ELEVATION
Scale 1:500 @ A3

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7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

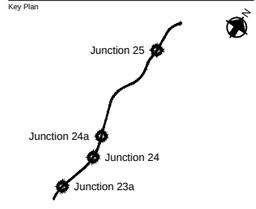
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan

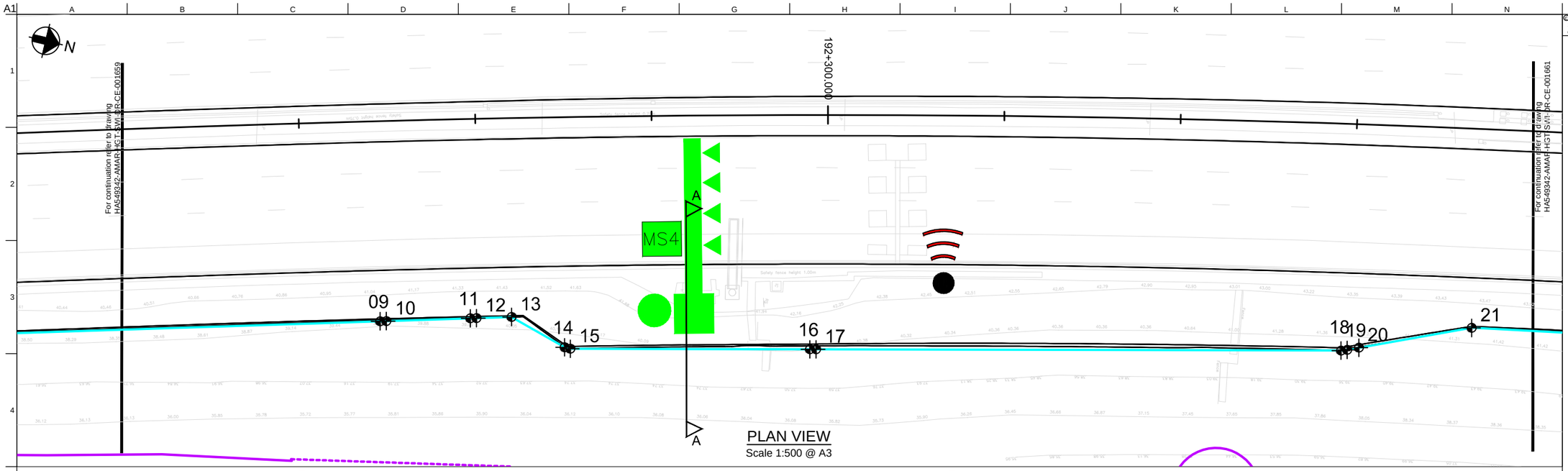


Drawing Title
KING SHEET PILE SOLUTION PLAN
CH. 192085 TO 192523 (SB)
SHEET 01 TO 04

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P05
Name: HA549342-AMAR-HGT-SWI-DR-CE-001659

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Do not scale

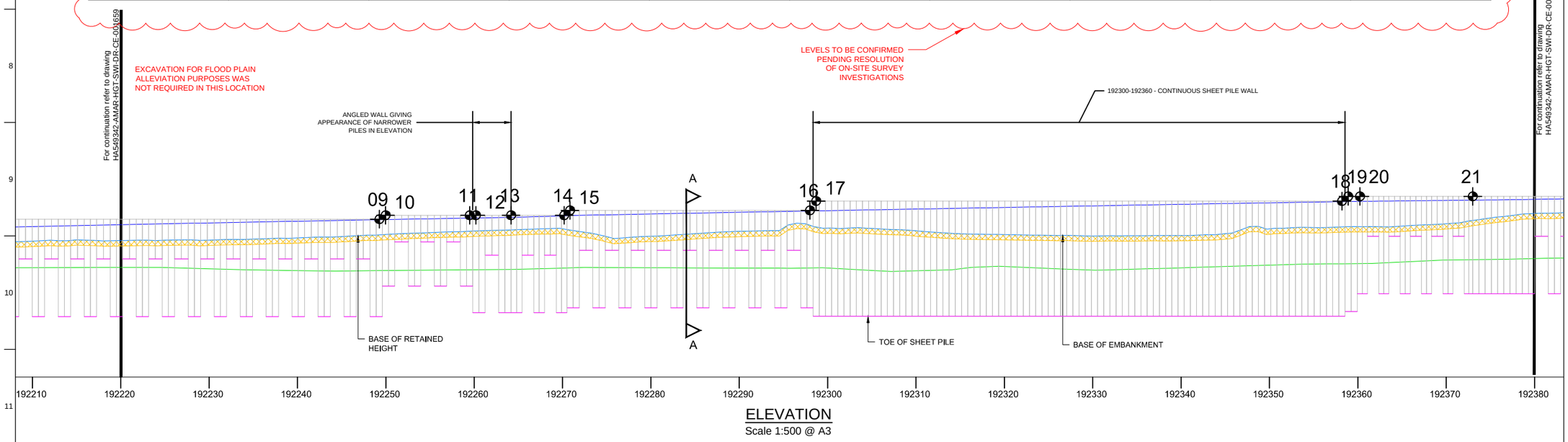


SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)
9	447224.37	334295.6	41.58	41.52	39.80	39.20
10	447224.19	334296.28	42.02	41.52	39.85	39.25
11	448701.77	334403.58	42.02	41.70	40.22	39.62
12	448702.47	334403.58	42.02	41.71	40.23	39.63
13	447220.48	334310	42.02	41.78	40.35	39.75
14	447222.45	334316.64	42.02	41.96	40.44	39.84
15	447222.47	334317.32	42.57	41.98	40.34	39.74
16	447216.31	334343.77	42.57	42.51	40.91	40.31
17	447216.14	334344.45	43.62	42.50	40.67	40.07
18	447202.67	334402.4	43.62	43.56	40.71	40.11
19	447202.43	334403.06	44.15	43.57	40.73	40.13
20	447201.89	334404.31	44.15	43.59	40.74	40.14
21	447196.77	334416.24	44.15	43.73	41.44	40.84

RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
2.32	11.00	4.50
2.27	8.00	3.00
2.08	8.00	3.00
2.08	11.00	4.50
2.03	11.00	4.50
2.12	11.00	4.50
2.24	11.00	4.50
2.20	11.00	4.50
2.43	13.00	-
3.45	13.00	-
3.44	13.00	-
3.45	11.00	4.50
2.89	11.00	4.50



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NOTES

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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

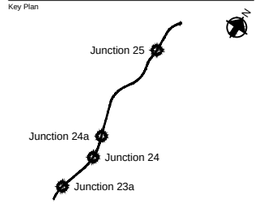
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 192085 TO CH. 192523 (SB)
SHEET 02 TO 04

Scale at A1: 1:250

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

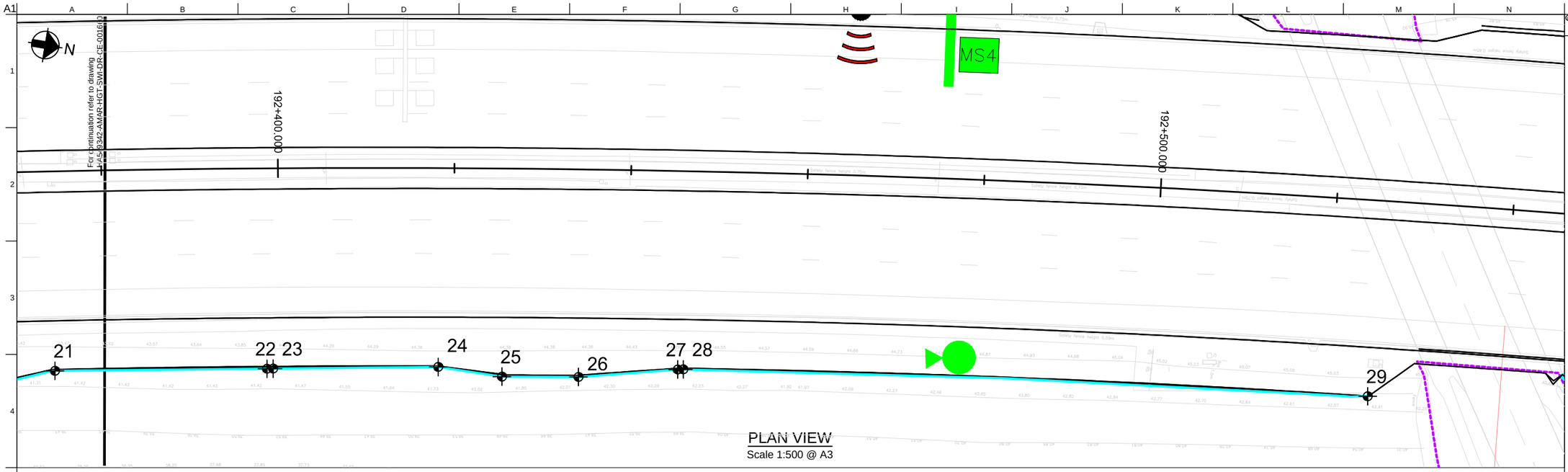
Job No: **244508-00**

Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001660**

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Do not scale



PLAN VIEW
Scale 1:500 @ A3

SHEET PILE SETTING OUT POINTS

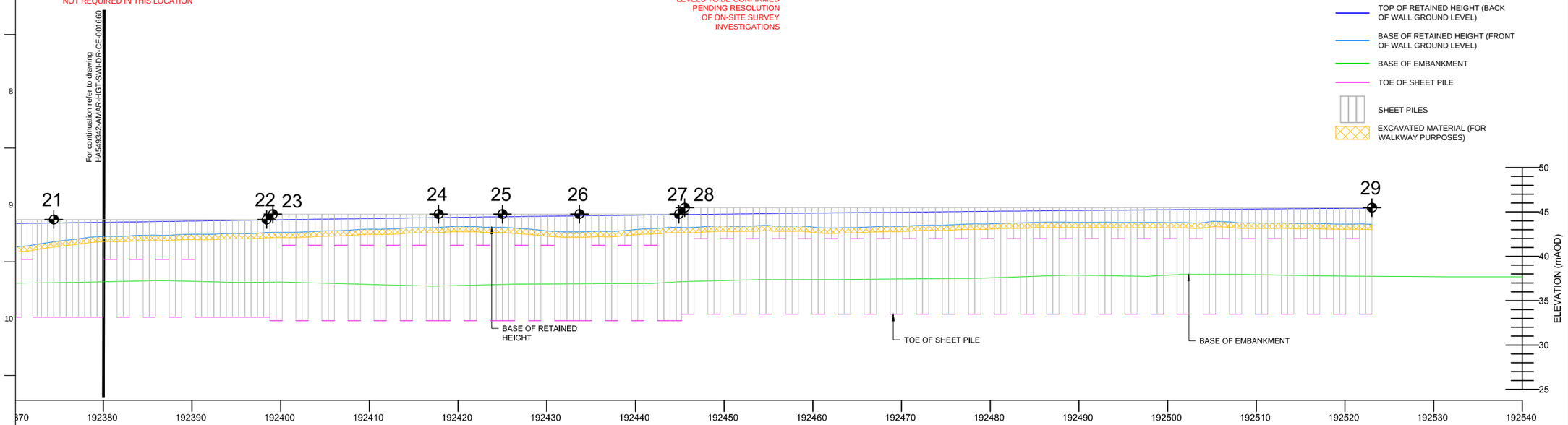
REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)
22	447192.45	334440.2	44.15	44.10	42.69	42.09
23	447192.32	334440.88	44.75	44.10	42.70	42.10
24	447189.02	334459.28	44.75	44.36	43.27	42.67
25	447188.89	334466.56	44.75	44.45	43.27	42.67
26	447187.48	334475.12	44.75	44.66	43.74	43.14
27	447184.78	334486.04	44.75	44.70	43.27	42.67
28	447184.66	334486.68	45.48	44.71	43.25	42.65
29	447174.74	334563.59	45.48	45.43	43.61	43.01

RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
2.01	11.00	4.50
2.00	12.00	3.50
1.69	12.00	3.50
1.78	12.00	3.50
1.52	12.00	3.50
2.03	12.00	3.50
2.06	12.00	3.50
2.42	12.00	3.50

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS



ELEVATION LEGEND
- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR WALKWAY PURPOSES)

ELEVATION
Scale 1:500 @ A3

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NOTES

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7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND
- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

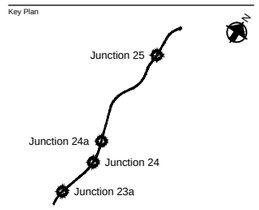
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan

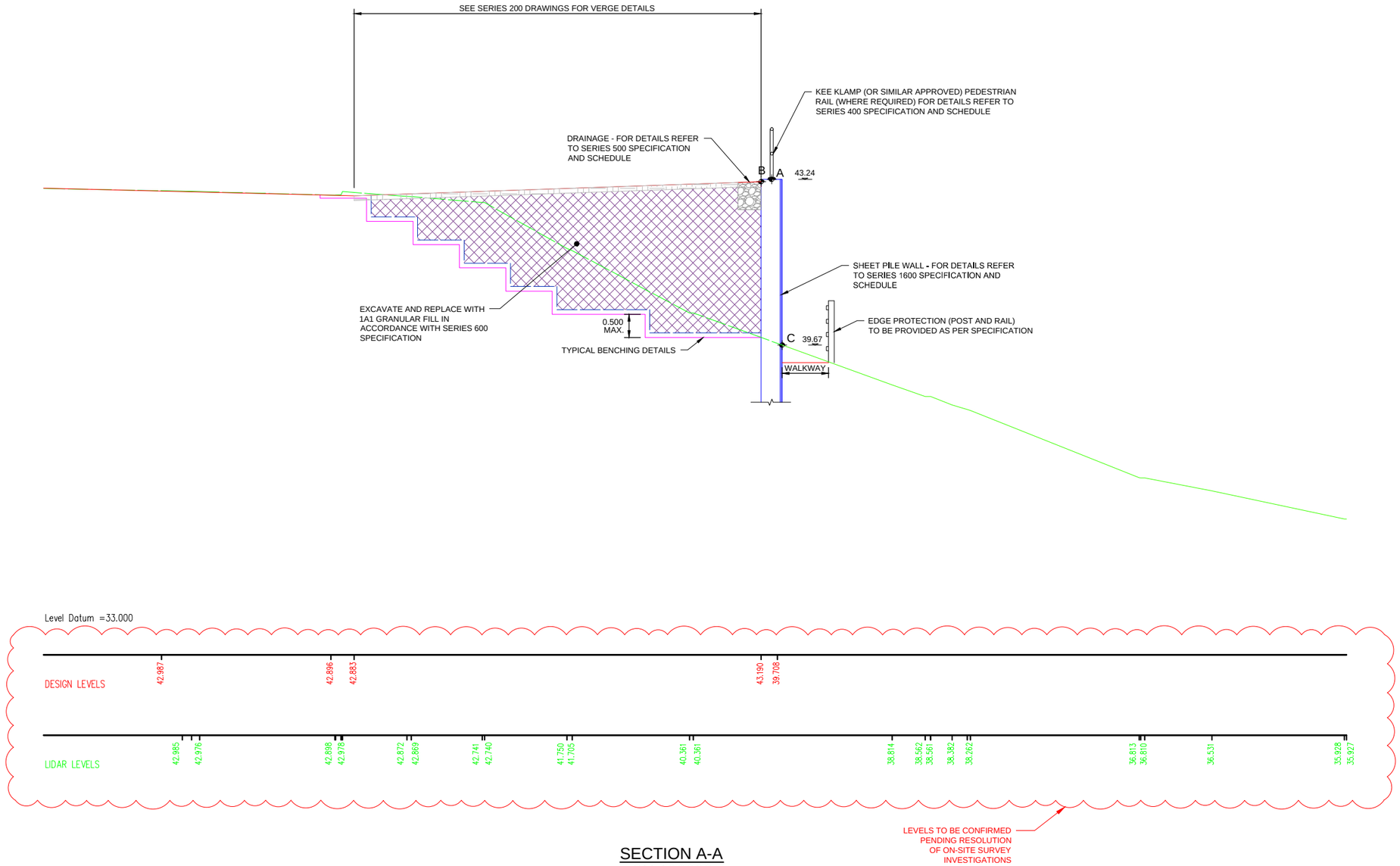


Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 192085 TO 192523 (SB)
SHEET O3 TO 04

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P05
Name: HA549342-AMAR-HGT-SWI-DR-CE-001661

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SECTION A-A
CH.192330
Scale 1:100 @ A3

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SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

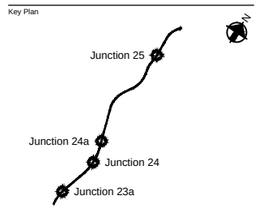
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan

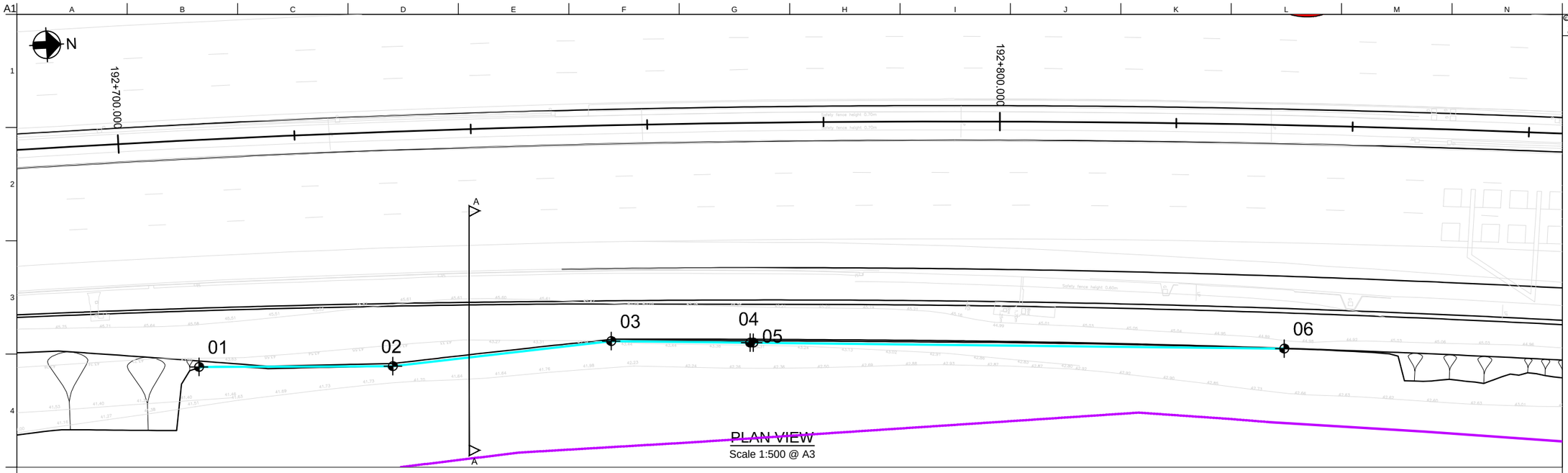


Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH. 192085 TO 192523 (SB) SHEET 04 OF 04

Scale at A1: 1:50
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P05
Name: HA549342-AMAR-HGT-SWI-DR-CE-001662

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Do not scale



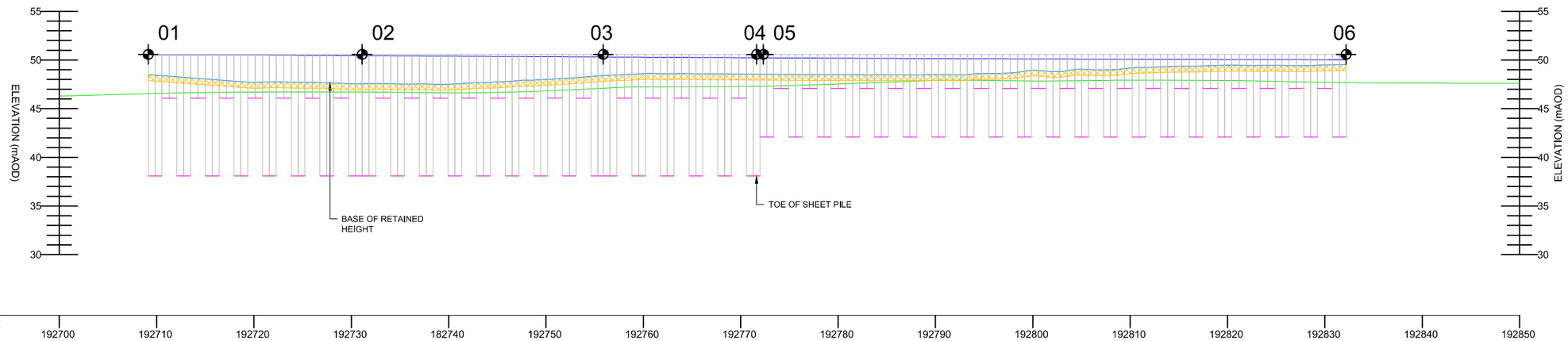
PLAN VIEW
Scale 1:500 @ A3

SHEET PILE SETTING OUT POINTS							RET. WALL DETAILS		
REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	BASE OF EXCAVATION (D)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
01	447169.05	334743.96	50.58	50.53	48.43	47.83	2.70	12.50	4.50
02	447170.07	334765.91	50.58	50.45	47.50	46.90	3.55	12.50	4.50
03	447168.49	334790.78	50.58	50.21	48.31	47.71	2.50	12.50	4.50
04	447169.46	334806.51	50.58	50.23	48.55	47.95	2.28	12.50	4.50
05	447169.48	334806.86	50.58	50.23	48.54	47.94	2.29	8.50	3.50
06	447173.2	334866.94	50.58	50.03	49.53	48.93	1.10	8.50	3.50

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION

ELEVATION LEGEND
- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES
- EXCAVATED MATERIAL (FOR WALKWAY PURPOSES)



ELEVATION
Scale 1:500 @ A3

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NOTES

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND
- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

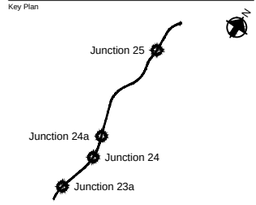
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan

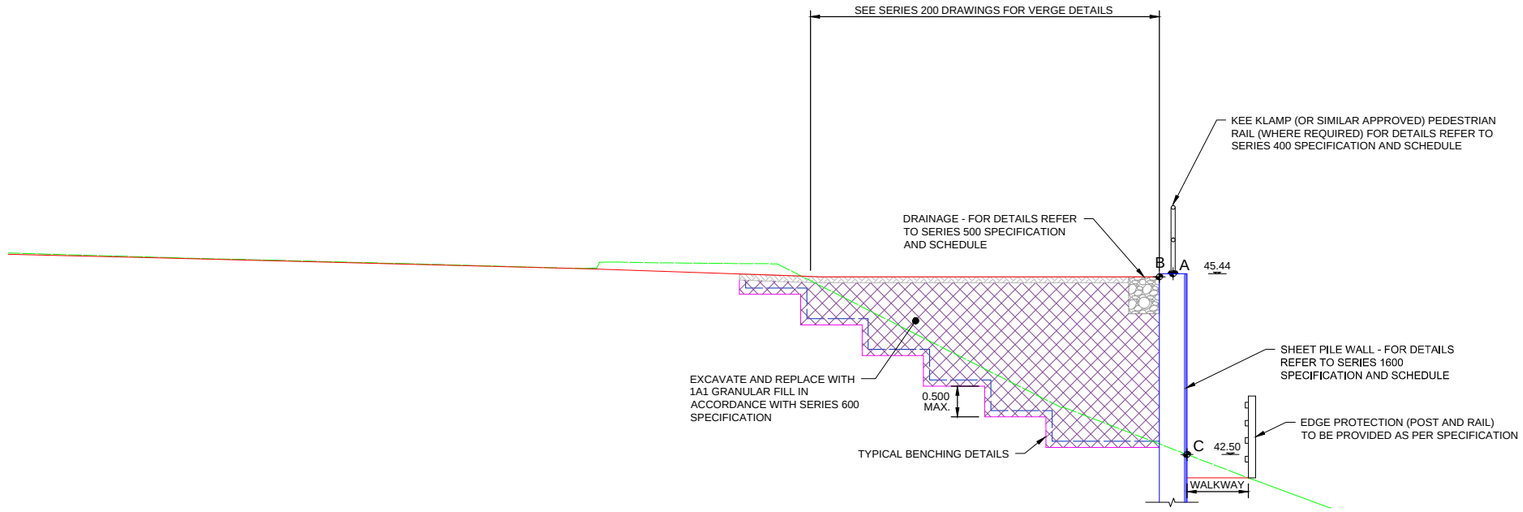


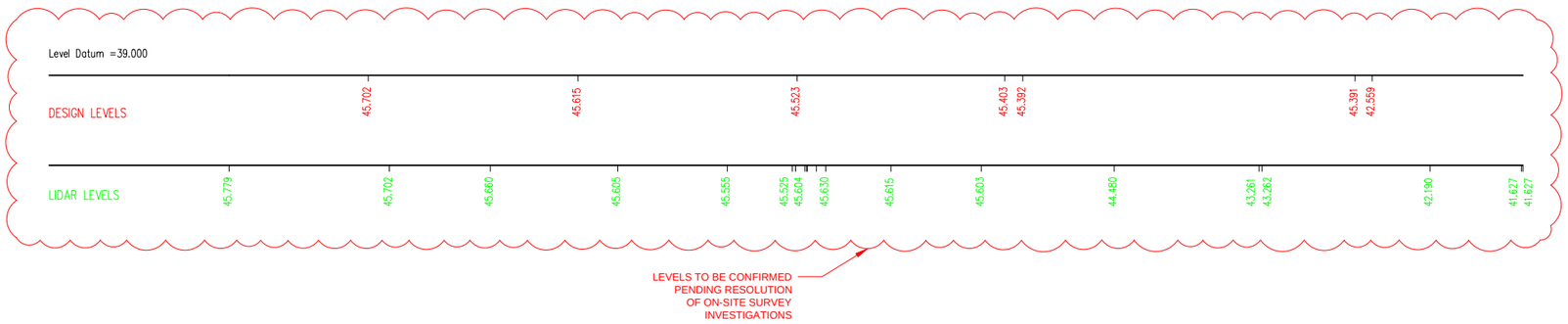
Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 192709 TO 192832 (SB)
SHEET 01 OF 02

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P05
Name: HA549342-AMAR-HGT-SWI-DR-CE-001663

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SECTION A-A
CH. 192740
Scale 1:100 @ A3

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NOTES
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4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P04	02/06/17	LP	---	AB

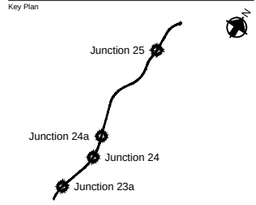
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH. 192709 TO 192832 (SB) SHET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

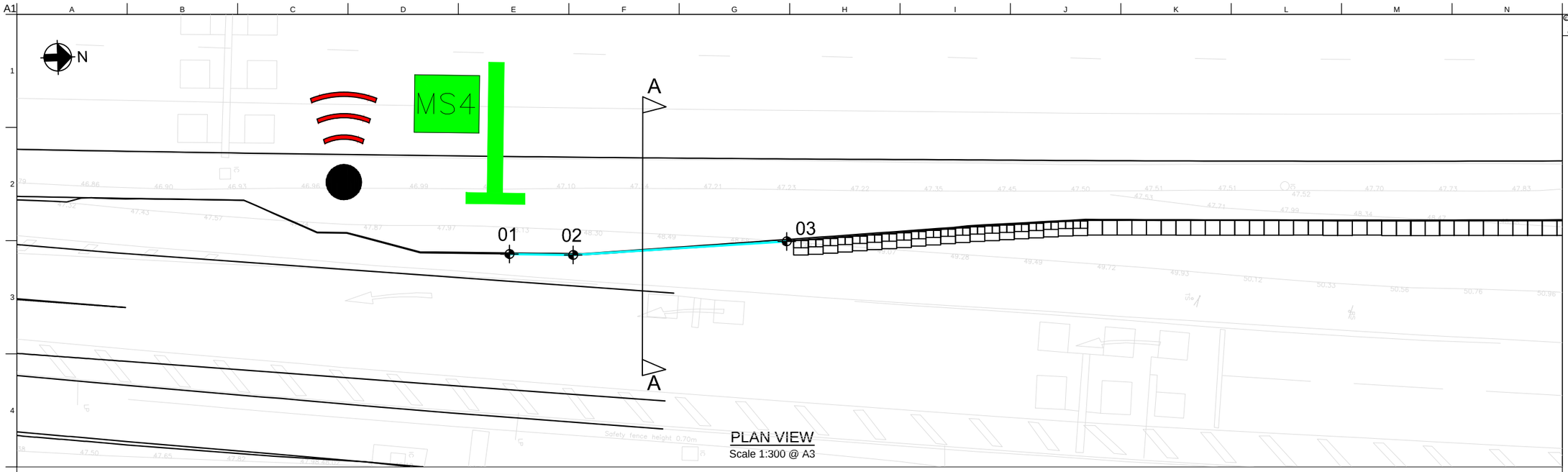
Suitability: S4 - Fit for construction approval

Job No: **244508-00** | Rev: **P04**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001664**

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Do not scale



PLAN VIEW
Scale 1:300 @ A3

SHEET PILE SETTING OUT POINTS

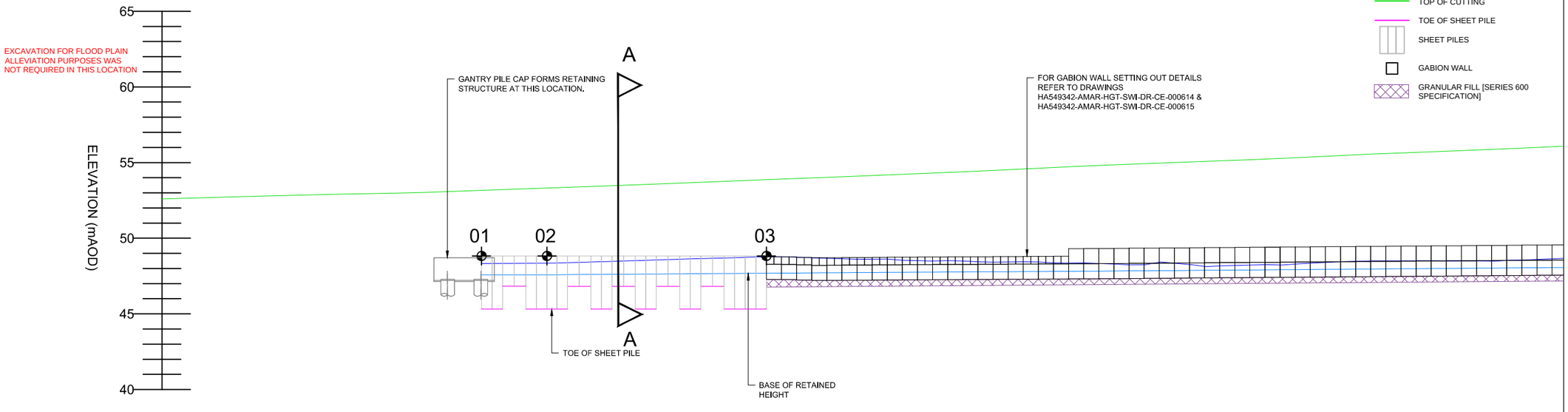
REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)
01	447213.3	335333.93	48.82	48.33	47.58
02	447213.5	335338.26	48.82	48.35	47.58
03	447213.05	335352.81	48.82	48.70	47.90

RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
0.75	3.50	2.00
0.77	3.50	2.00
0.80	3.50	2.00

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

ELEVATION LEGEND
- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- TOE OF SHEET PILE
- SHEET PILES
- GABION WALL
- GRANULAR FILL [SERIES 600 SPECIFICATION]



ELEVATION
Scale 1:300 @ A3

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NOTES

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4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND
- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- GABION WALL
- SECTION LINE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P06	02/06/17	LP	---	AB

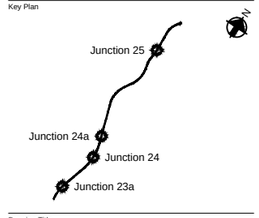
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 193301 TO 193320 (SB)
SHEET 01 OF 02

Scale at A1: 1:150

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00**

Rev: **P06**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001665**

Do not scale

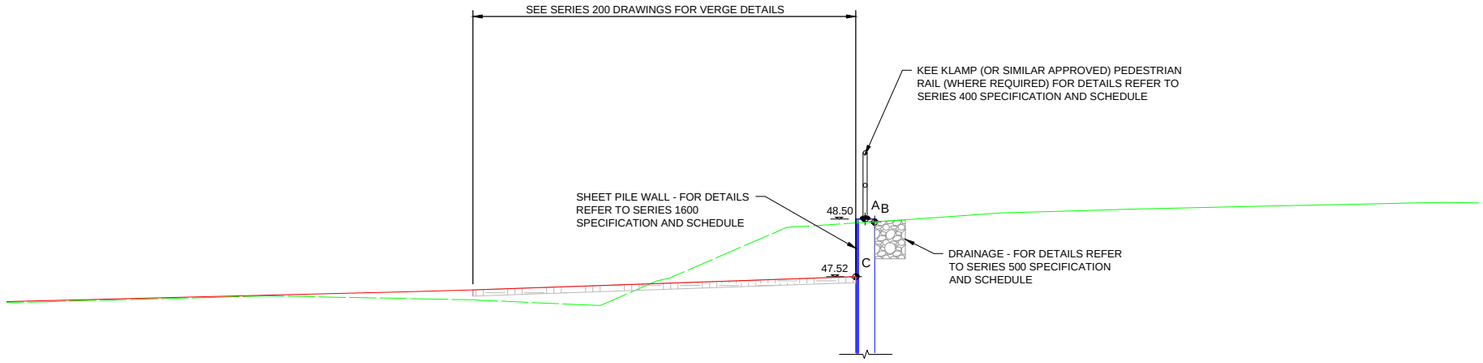
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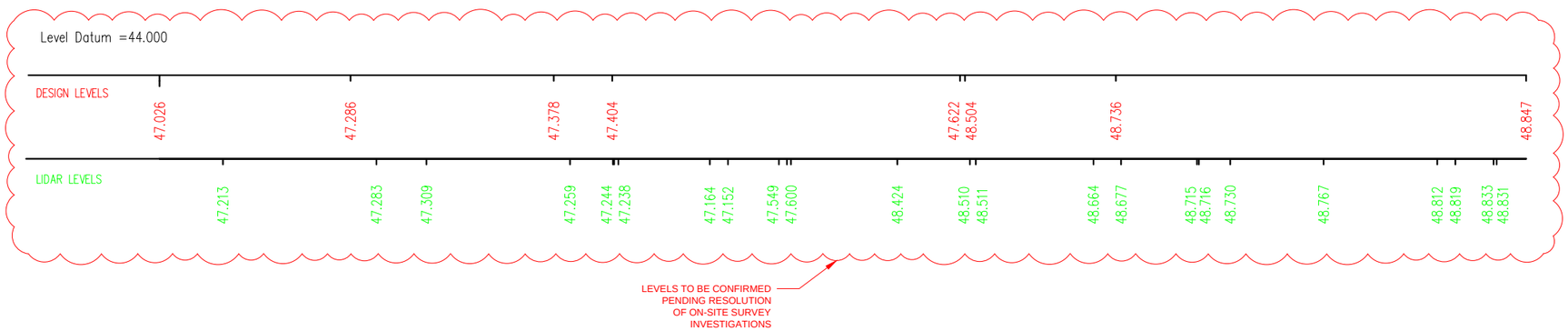
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7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- SHEET PILE
- SETTING OUT POINT





SECTION A-A
CH. 193310
Scale 1:100 @ A3

Rev	Date	By	Chkd	Appd
P06	02/06/17	LP	---	AB

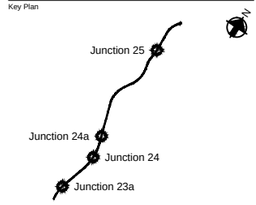
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION
CROSS SECTION
CH. 193301 TO 193320 (SB)
SHEET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

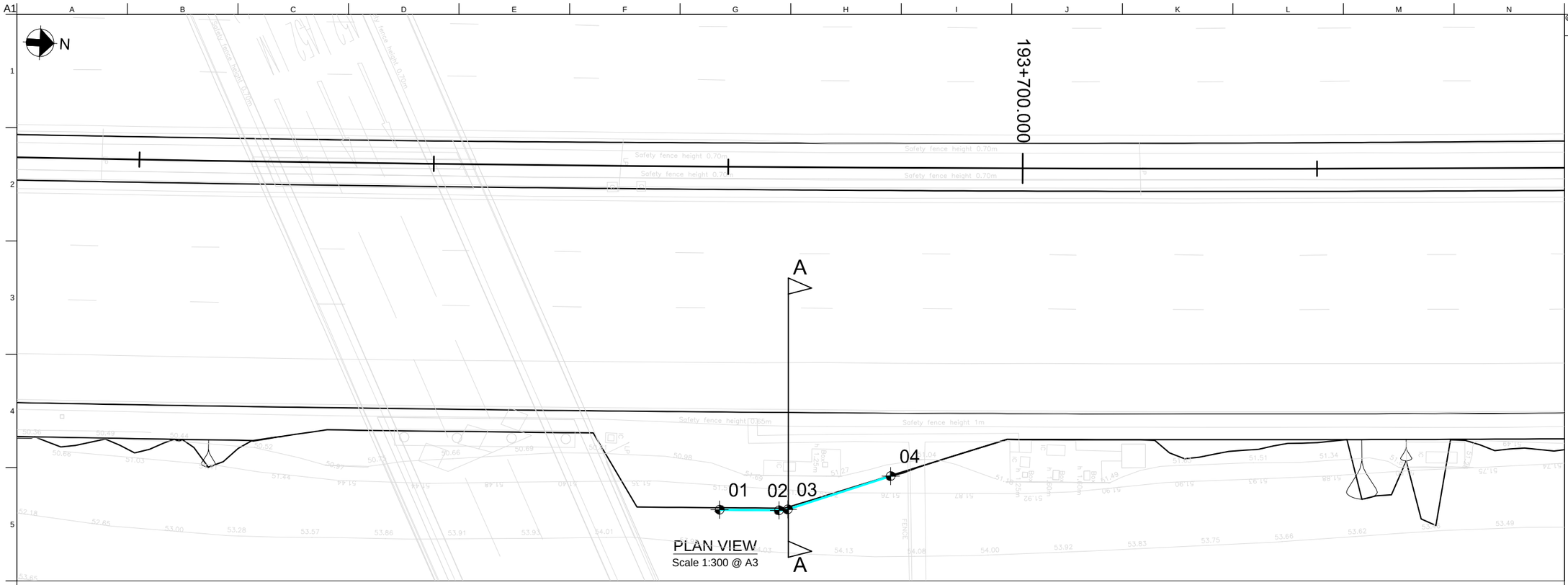
Job No: **244508-00**

Rev: **P06**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001669**

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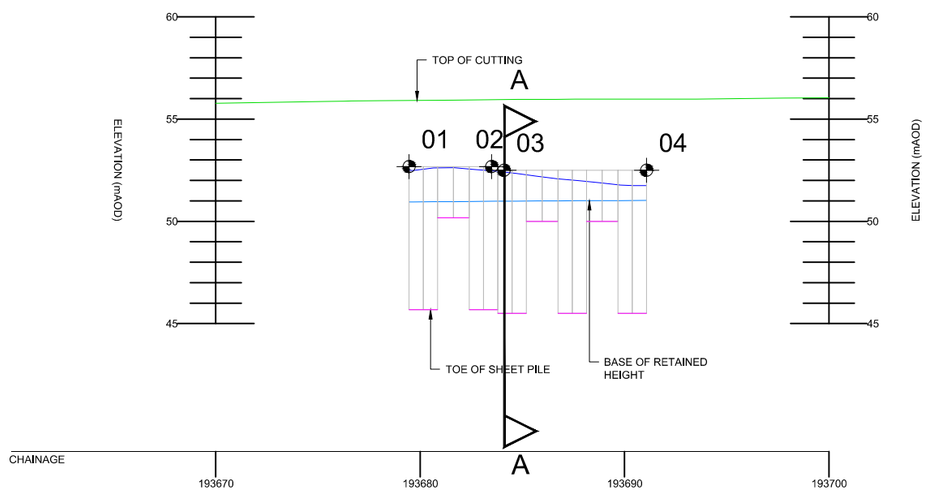


SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	RET. WALL DETAILS: TOTAL RETAINED HEIGHT	RET. WALL DETAILS: TOTAL KING SHEET PILE LENGTH	RET. WALL DETAILS: TOTAL INTERMEDIATE SHEET PILE LENGTH
01	447214.26	335714.38	52.73	52.50	51.00	1.50	7.00	2.50
02	447214.11	335718.42	52.73	52.50	51.00	1.50	7.00	2.50
03	447214.02	335719.01	52.50	52.40	50.90	1.50	7.00	2.50
04	447211.43	335725.88	52.50	51.75	51.00	0.75	7.00	2.50

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS



ELEVATION
Scale 1:300 @ A3

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NOTES

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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- TOE OF SHEET PILE
- SHEET PILES

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

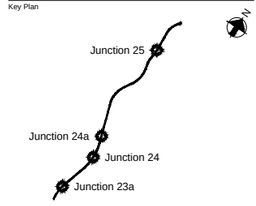
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION PLAN
CH. 193680 TO CH. 193691 (SB)
SHEET 01 OF 02

Scale at A1: 1:150

Role: Civil - Earthworks and Geotech

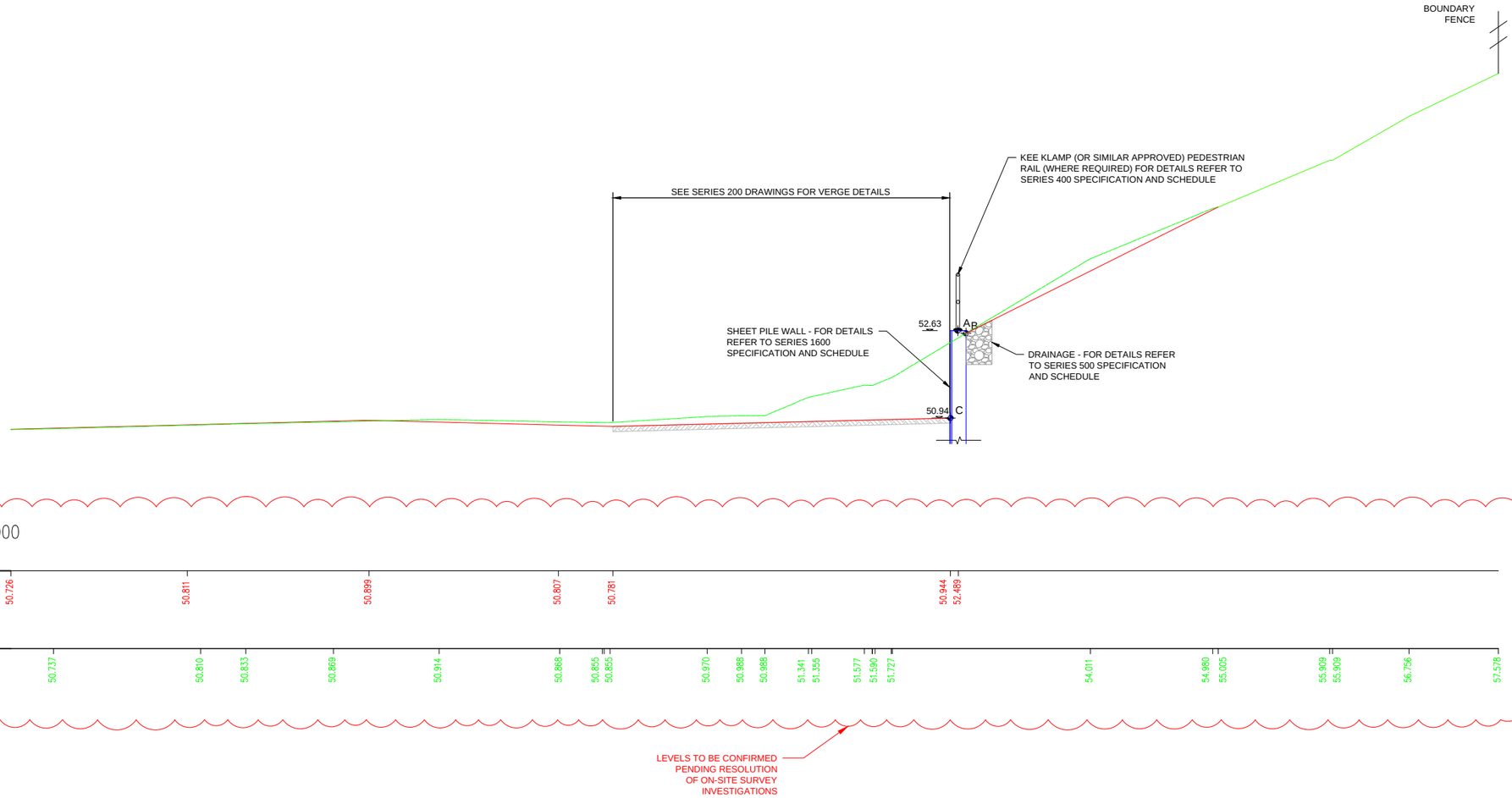
Suitability: S4 - Fit for construction approval

Job No: **244508-00** | Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001670**

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SECTION A-A
CH. 193680
Scale 1:100 @ A3

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NOTES
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7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND
- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P05	02/06/17	LP	---	AB

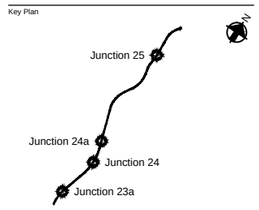
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE SOLUTION CROSS SECTION CH. 193680 TO CH. 193691 (SB) SHET 02 OF 02

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

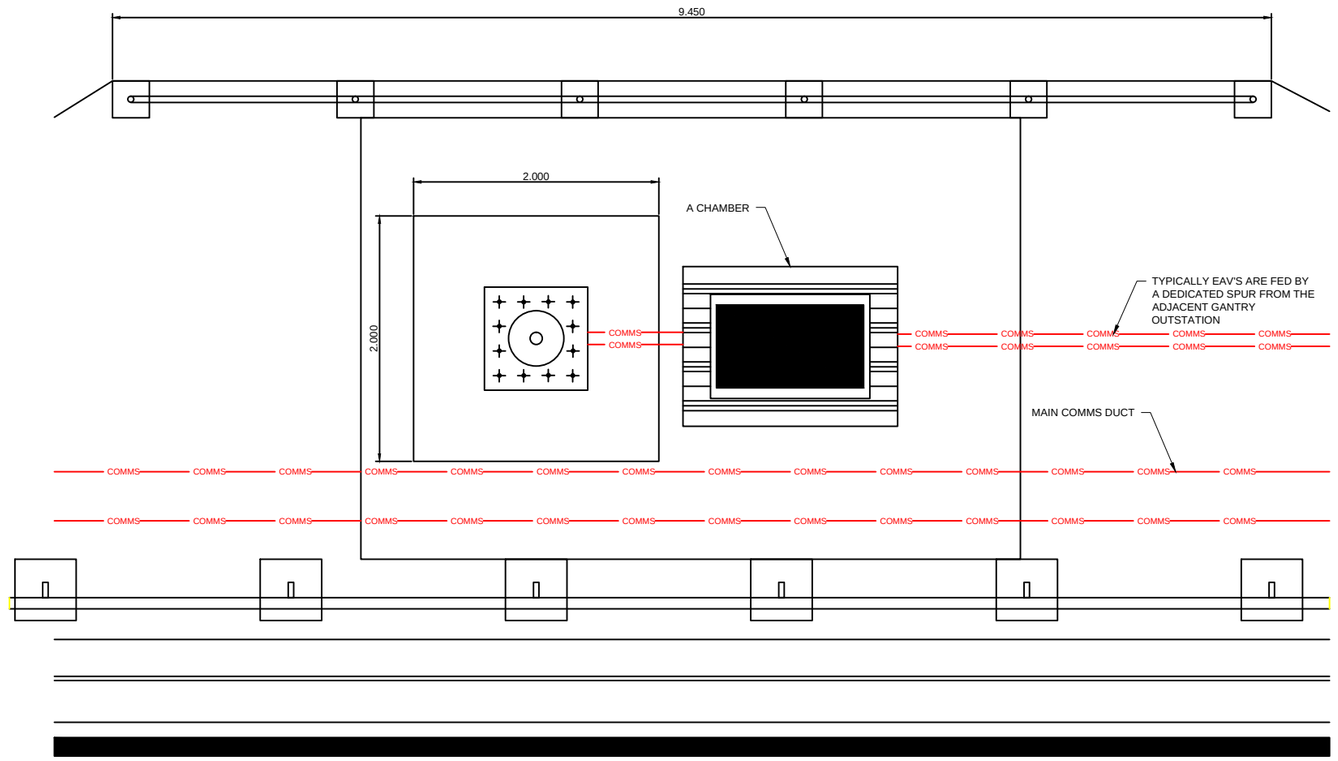
Suitability: S4 - Fit for construction approval

Job No: **244508-00** | Rev: **P05**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001671**

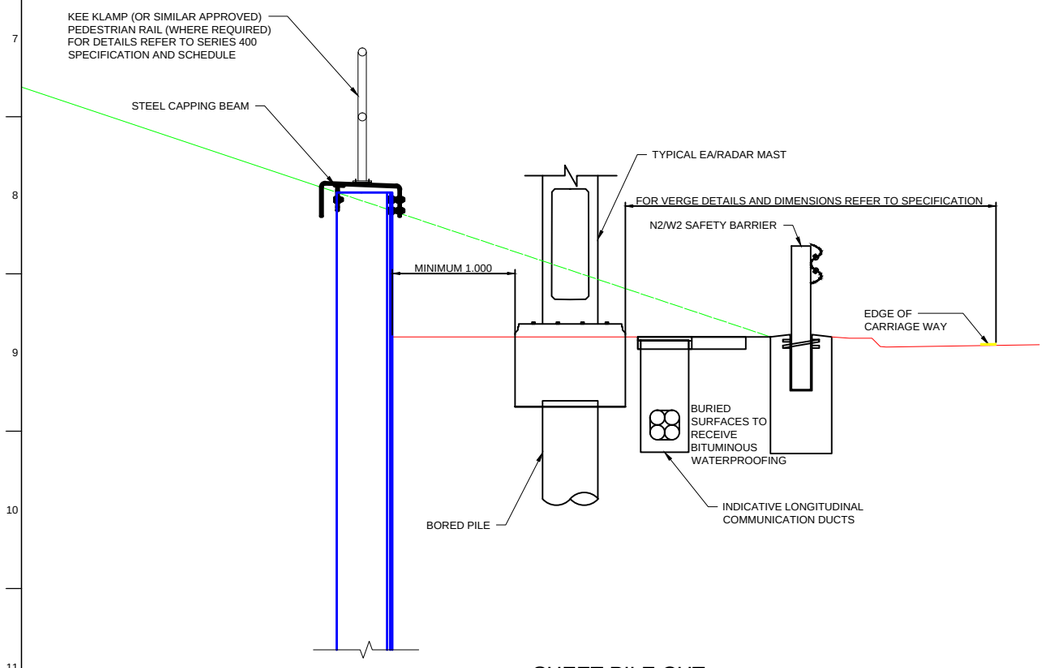
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Do not scale



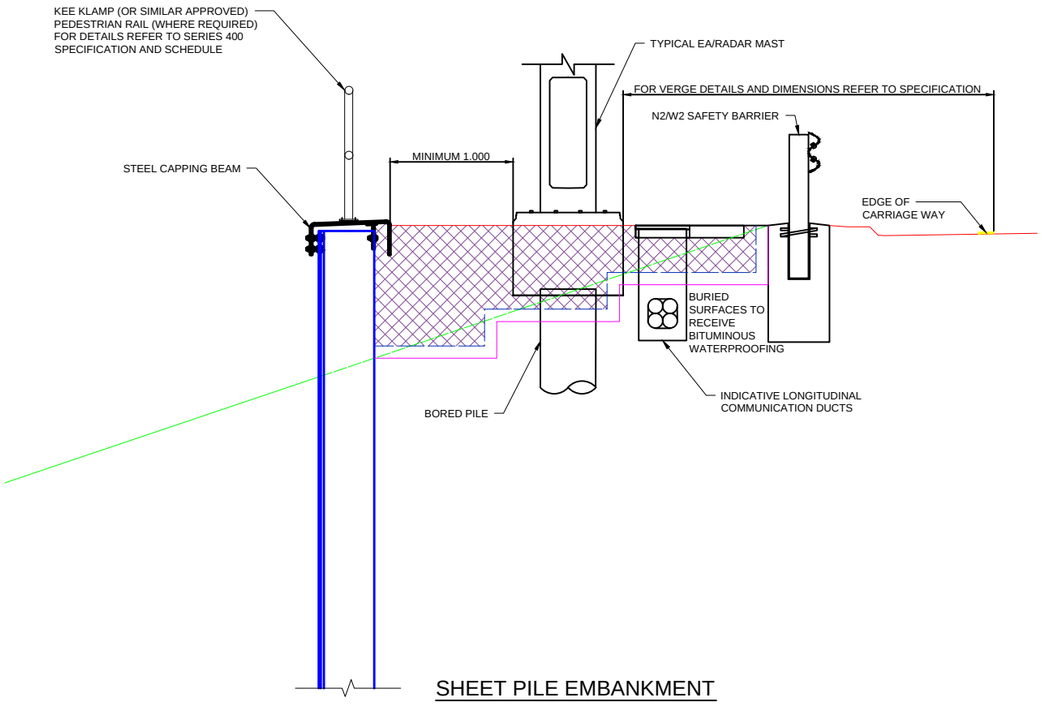
RADAR MAST PLAN VIEW

SCALE 1:50 @ A3



SHEET PILE CUT

SCALE 1:50 @ A3



SHEET PILE EMBANKMENT

SCALE 1:50 @ A3

NOTES

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- CLASS 6N FILL
- SHEET PILE

Rev	Date	By	Chkd	Appd
P02	17/04/17	LP	---	LP

Issued for Client Sharing

Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Drawing Title: Sheet Pile Detail For Radar Mast

Scale at A1: 1:25

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

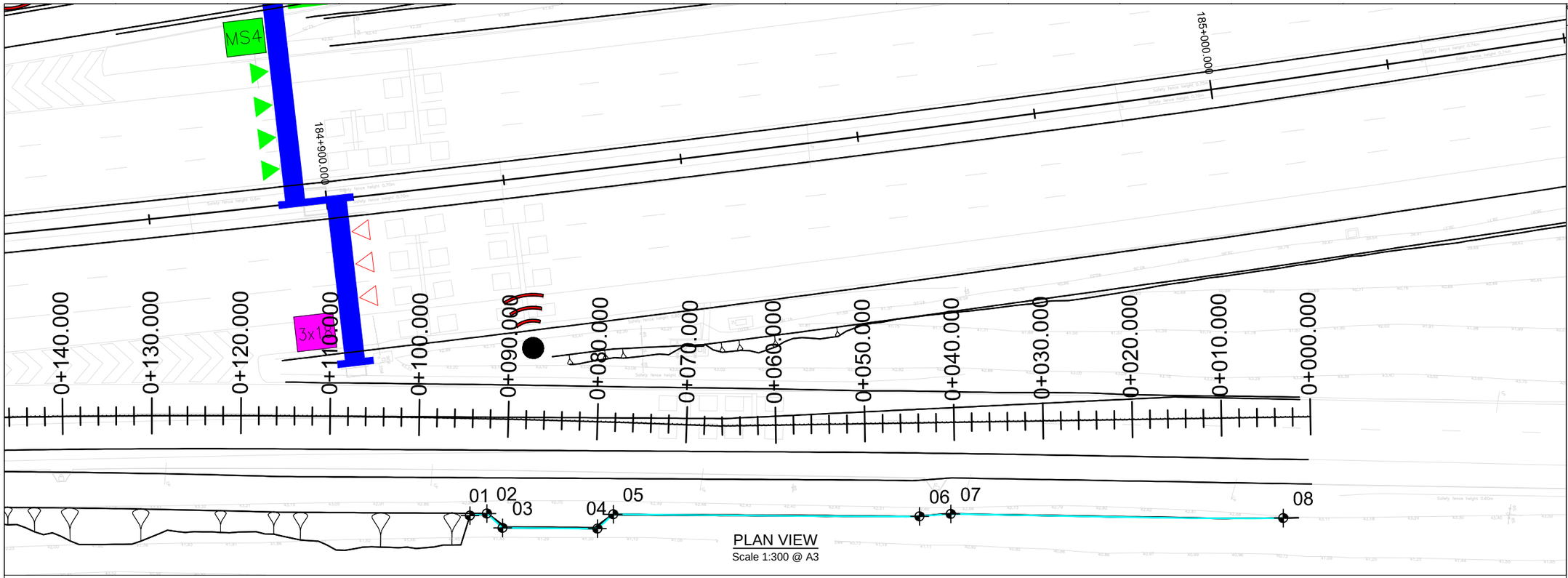
Job No: **244508-00**

Rev: **P02**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001672**

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Do not scale

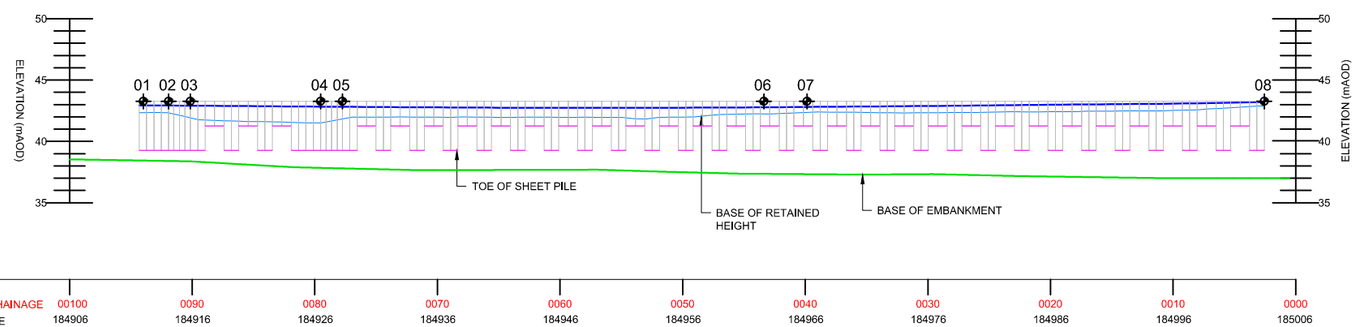


PLAN VIEW
Scale 1:300 @ A3

LEVELS TO BE CONFIRMED PENDING RESOLUTION OF ON-SITE SURVEY INVESTIGATIONS

EXCAVATION FOR FLOOD PLAIN ALLEVIATION PURPOSES WAS NOT REQUIRED IN THIS LOCATION

SHEET PILE SETTING OUT POINTS						RET. WALL DETAILS		
REFERENCE	EASTING	NORTHING	TOP OF PILE CAP (A)	TOP OF RETAINED HEIGHT (B)	BOTTOM OF RETAINED HEIGHT (C)	TOTAL RETAINED HIEGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
001	447573.24	327291.83	43.30	42.90	42.30	0.60	4.00	2.00
002	447573.41	327293.83	43.30	42.90	42.30	0.60	4.00	2.00
003	447575.24	327295.56	43.30	42.90	41.80	1.10	4.00	2.00
004	447576.91	327305.42	43.30	42.80	41.50	1.30	4.00	2.00
005	447575.71	327307.64	43.30	42.80	42.00	0.80	4.00	2.00
006	447581.33	327341.63	43.30	42.70	42.20	0.50	4.00	2.00
007	447581.62	327345.13	43.30	42.80	42.30	0.50	4.00	2.00
008	447588.26	327383.55	43.30	43.20	42.90	0.30	4.00	2.00



ELEVATION
Scale 1:300 @ A3

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NOTES

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2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- BASE OF EMBANKMENT
- TOE OF SHEET PILE
- SHEET PILES

Rev	Date	By	Chkd	Appd
P03	22/05/17	LP	---	SV

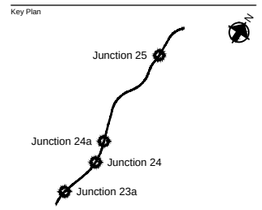
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: KING SHEET PILE DESIGN SOLUTION PLAN
CH.184920 TO CH.185000 SB MERGE
SHEET 01 OF 02

Scale at A1: 1:250

Role: Civil - Earthworks and Geotech

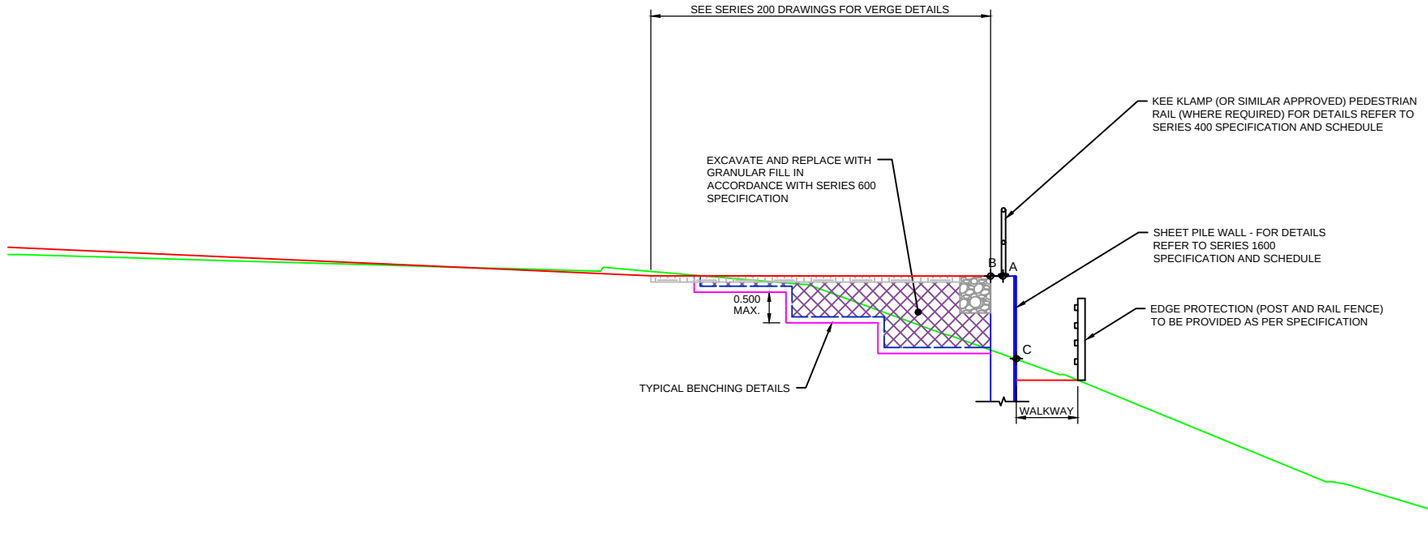
Suitability: S4 - Fit for construction approval

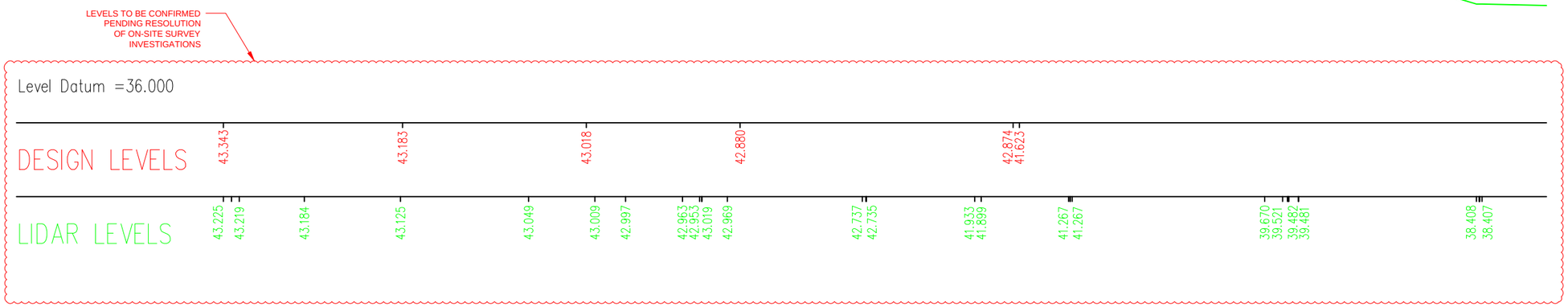
Job No: **244508-00**

Rev: **P03**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-001673**

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SECTION A-A
CH. 187920
Scale 1:100 @ A3

NOTES
1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS. REFER TO SERIES 200.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
9. ALL SECTIONS SHALL BE AZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- VERGE SURFACE
- CLASS 6N FILL
- SHEET PILE
- X SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P03	22/05/17	LP	---	SV

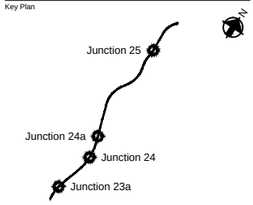
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
KING SHEET PILE SOLUTION
CROSS SECTION
CH.184920 TO CH.185000 SB Merge
SHEET 02 OF 02

Scale at A1: 1:50
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P03**
Name: **HA549342-AMAR-HGT-SWI-DR-CE-001674**

Appendix D. Series 600 Schedule

M1 Junction 23a to 25
Smart Motorways Programme
ALR Works

Volume 2 Works Information

Specification Schedules Series 600 : EARTHWORKS

June 2017

Document History

JOB NUMBER: 244508/COCDFL1SMP01			REFERENCE: HA549342-AMAR-HGT-SWI-SP-CE-000002			
P01	For Target Cost (internal - not issued)	OY	NM	GS/SG	TB	01.07.16
P02	For Target Cost (previously issued as P01)	OY	NM	GS/SG	TB	01.07.16
P03	Addition of minor structures (previously issued as P02 for TQ003)	OY	SA	AB	TB	15.07.16
P04	Internal - not issued	OY	SA	AB	TB	09.09.16
P05	Internal - not issued	OY	SA	AB	TB	18.11.16
P06	DF5 Issue	OY	SA	AB	TB	18.11.16
P07	Internal - not issued	RM	AB	GS	TB	16.12.2016
P08	DF5 Further Design Refineme	SB	AB	GS	TB	22.12.2016
P09	DF5 Further Design Refineme	RM	AB	GS	TB	07.02.2017
P10	Construction issue, internal only	RM	AB	GS	TB	Not issued
P11	Construction issue	RM	AB	GS	TB	07/06/2017
Revision	Purpose Description	Originated	Checked	Reviewed	Authorised	Date

Major Structures - Geotechnical Schedule

N.B.
1) Information provided within this schedule has been provided to the nearest 10m. Exact lengths of retaining structures are provided within the 1600 series schedule and drawings.
2) All 10m gaps between solutions are areas of transition.
3) Minor and major structures have been included in the mainline widening.
4) 0.5m has been added to Max. retained Height for Ret. Wall (Sheet Pile) in embankment.

								Widening Extents (Approx.)		Proposed Solution		
SMIS Structure Name	Asset	SMP Reference	Chainage	Carriageway	Marker Post	New/ Remaining	Asset Type	Longitudinal Length (m)	Proposed Verge Widening (m)	Earthwork Retaining Solution	Max Proposed Retained Earthwork Height (m)	Comments
	Gantry	101	181930	NB	181/9A+30	NEW	MS4 Cantilever	N/A	N/A	**LOCAL REGRADE**	**N/A**	
Vma Gantry No. 51 (M1/23a/1/S)	Gantry	112	185180	SB	185/1B+80	NEW	Super Cantilever	65.0	6.7	**1:3 Full Height Regrade**	**N/A**	
	Gantry	202	186240	NB	186/2A+40	NEW	Superspan Portal	90.0	5.9	**SHEET PILE**	**2.6**	Sheet Pile is required to prevent buildout into the flood plain.
	Gantry	202	186240	SB	186/2B+40	NEW	Superspan Portal	90.0	12.0	**Full Height Embankment Widening 1:2**	**2.9**	Assumes land purchase;
Sign Gantry Number 16	Gantry	203	186400	SB	186/4B+00	NEW	ADS Cantilever	55.0	5.3	**Full Height Embankment Widening 1:2**	**1.6**	
	Gantry	204	186517	NB	186/5A+17	NEW	Super Cantilever	70.0	5.2	**SHEET PILE**	**1.4**	Sheet Pile is required to prevent buildout into the flood plain.
	Gantry	301	186847	NB	186/8b+47	NEW	Superspan Portal	35.0	N/A	**LOCAL REGRADE**	**N/A**	
	Gantry	301	186847	SB	186/8B+47	NEW	Superspan Portal	70.0	7.4	**Full Height Embankment Widening 1:2**	**N/A**	
	Gantry	302	187073	SB	187/0B+73	NEW	ADS Cantilever	65.0	7.9	**Regrade Full Height 1:2**	**N/A**	
	Gantry	326	187300	SB	187/3B+00	NEW	MS4 Cantilever	30.0	5.6	**Full Height Embankment Widening 1:2**	**N/A**	Gantry base can be moved in allowing for a 1:2 regrade
	Gantry	303	187608	SB	187/6B+03	NEW	ADS Cantilever	50.0	6.4	**Full Height Embankment Widening 1:2**	**N/A**	
	Gantry	304	187650	NB	187/6A+50	NEW	Super Cantilever	70.0	3.8	**Granular Wedge at Embankment Crest 1:2**	**N/A**	
	Gantry	305	187818	SB	187/8B+18	NEW	MS4 Cantilever	30.0	3.4	**SHEET PILE**	**2.1**	Sheet Pile is required to prevent buildout into the flood plain.
	Gantry	307	188529	NB	188/5A+29	NEW	MS4 Cantilever	25.0	5.4	**SHEET PILE**	**1.3**	Due to Veg.
	Gantry	308	188760	SB	188/7B+60	NEW	ADS Cantilever	30.0	3.3	**SHEET PILE**	**1.8**	Sheet Pile is required to prevent buildout into the flood plain.
	Gantry	309	188947	SB	188/9B+47	NEW	MS3 Cantilever	40.0	3.1	**SHEET PILE**	**1.7**	Sheet Pile is required to maintain existing vegetation.
Cantilever VMS 188.0 South	Gantry	310	189160	SB	189/1B+60	NEW	MS4 Cantilever	30.0	5.7	**SHEET PILE**	**2.3**	Sheet Pile is required to prevent buildout into the flood plain.
	Gantry	311	189780	NB	189/7AB+80	NEW	Superspan Portal	30.5	6.5	**Granular Wedge at Embankment Crest 1:2**	**N/A**	
	Gantry	311	189780	SB	189/7AB+80	NEW	Superspan Portal	80.0	8.1	**SHEET PILE**	**2.4**	Sheet Pile is required to prevent buildout into the flood plain.
	Gantry	313	190771	NB	190/7A+71	NEW	MS3 Cantilever	30.0	4.9	**Granular Wedge at Embankment Crest 1:2**	**N/A**	
	Gantry	314	191096	NB	191/0A+96	NEW	MS4 Cantilever	30.0	6.7	**Granular Wedge at Embankment Crest 1:2**	**N/A**	
	Gantry	315	191296	NB	191/2A+96	NEW	ADS Cantilever	28.0	8.6	**Full Height Embankment Widening 1:2**	**N/A**	Amended from local regrade following increase in buildout 13/10/2016
	Gantry	316	191430	SB	191/4B+30	NEW	MS4 Cantilever	50.0	7.3	**Granular Wedge At Embankment Crest 1:2**	**N/A**	
	Gantry	318	191801	NB	191/8A+01	NEW	MS4 Cantilever	40.0	6.0	**Regrade Full Height 1:3**	**N/A**	
	Gantry	319	192101	NB	192/1A+01	NEW	ADS Cantilever	40.0	7.2	**Full Height Embankment Widening 1:2**	**N/A**	
	Gantry	320	192285	SB	192/2B+90	NEW	Super Cantilever	60.0	3.5	**SHEET PILE**	**2.1**	Sheet Pile is required to maintain existing vegetation.
	Gantry	321	192476	NB	192/4A+76	NEW	MS4 Cantilever	50.0	4.1	**Full Height Embankment Widening 1:2**	**N/A**	
	Gantry	322	192906	NB	192/9A+06	NEW	ADS Cantilever	40.0	10.0	**LOCAL REGRADE**	**N/A**	
	Gantry	323	193300	SB	193/3B+00	NEW	MS4 Cantilever	45.0	4.0	**NO SOLUTION REQUIRED***	**1.1**	*Gantry base to be used as retaining structure.
Cantilever VMS 191.5 North	Gantry	324	193331	NB	193/3A+31	NEW	MS4 Cantilever	30.0	4.9	**SHEET PILE**	**2.1**	Sheet Pile is required to prevent buildout into the flood plain.
	ERA	E1-A1	185195-185305	NB	185/2A+50	NEW	ERA	100.0	5.8	**SHEET PILE**	**2.6**	Sheet Pile is required to maintain existing vegetation.
	ERA	E2-A1	186645-186755	NB	186/7A+00	NEW	ERA	100.0	5.7	**Full Height Embankment Widening 1:2**	**N/A**	
	ERA	E3-B1	188425-188525	SB	188/5B+50	NEW	ERA	100.0	4.5	**SHEET PILE**	**2.3**	
	ERA	E3-A1	188765-188865	NB	188/8A+10	NEW	ERA	100.0	6.0	**SHEET PILE**	**2.4**	Sheet Pile is required to maintain existing vegetation.
	ERA	E3-B2	190465-190565	SB	190/3B+00	NEW	ERA	100.0	5.0	**Granular Wedge At Embankment Crest 1:2**	**N/A**	
	ERA	E3-A2	190800-190900	NB	190/8A+60	NEW	ERA	100.0	2.5	**Granular Wedge at Embankment Crest 1:2**	**N/A**	
	ERA	E3-B3	191845-191955	SB	191/9B+00	NEW	ERA	100.0	N/A	**SHEET PILE**	**1**	ERA Width may be reduced - TO'R to confirm

Mainline Widening Solutions Schedule Northbound

N.B.
1) Information provided within this schedule has been provided to the nearest 10m. Exact lengths of retaining structures are provided within the 1600 series schedule and drawings.

2) All 10m gaps between solutions are areas of transition.
3) Minor and major structures have been included in the mainline widening.
4) 0.5m has been added to Max. retained Height for Ret. Wall (Sheet Pile) in embankment.

Chainage Start	Chainage End	Length (m)	Earthwork Type	Worst Case Existing Vegetation (RAG)	Max. Flood Risk (mAOD)	Earthworks Widening solution	Max. Retained Height (m)	Max Buildout Width (m)*	Max Cut / Fill Height (m)	Comments
182000	182050	50	Embankment	G	None	No Solution Used	--	N/A	N/A	--
182060	182160	100	At Grade	G	None	<500mm Cut	--	N/A	N/A	--
182170	182220	50	At Grade	G	None	<500mm Cut	--	2.3	0.68	--
182230	182450	220	Cutting	G	None	<500mm Cut	--	N/A	N/A	--
182460	182470	10	Cutting	G	None	<500mm Cut	--	0.2	5.6	--
182480	182640	160	Cutting	G	None	<500mm Cut		0.3	1	--
182650	182710	60	Cutting	G	None	<500mm Cut	--	0.2	3.5	--
182720	182740	20	Cutting	G	None	No Solution Used		N/A	N/A	--
182750	182790	40	-	-	-	Overbridge	--	N/A	N/A	--
182800	182880	80	Cutting	G	None	Gabion Wall	1	N/A	N/A	--
182880	182890	10	Cutting	G	None	Ret. Wall (Plastic Sheet Pile)	0.4	N/A	N/A	--
182890	182910	20	Cutting	G	None	<500mm Cut	--	N/A	N/A	--
182910	183000	90	Cutting	G	None	<500mm Fill	--	N/A	N/A	--
183000	183070	70	At Grade	G	None	<500mm Cut	--	N/A	N/A	--
183080	183150	70	Embankment	G	None	Granular Wedge at Embankment Crest 1:2	--	2.4	5	--
183160	183400	240	Embankment	G	None	Full Height Embankment Widening 1:2	--	4.1	6.5	
183410	183430	20	At Grade	G	None	<500mm Fill	--	N/A	N/A	--
183440	183570	130	Cutting	G	None	<500mm Fill	--	N/A	N/A	--
183580	183610	30	Cutting	G	None	<500mm Cut	--	2.5	1.9	--
183620	183700	80	Cutting	G	None	Regrade Full Height 1:3	--	2	7.6	--
183710	183780	70	Cutting	G	None	Gabion Wall	0.9	N/A	N/A	--
183790	183990	200	Cutting	G	None	<500mm Cut	--	N/A	N/A	--
184000	184020	20	Cutting	G	None	Gabion Wall	0.9	N/A	N/A	--
184030	184070	40	-	-	-	Overbridge	--	N/A	N/A	--
184080	184140	60	Cutting	G	None	Ret. Wall (Sheet Pile)	1.0	N/A	N/A	--
184140	184430	290	Cutting	G	None	Ret. Wall (Sheet Pile)	1.8	N/A	N/A	--
184430	184450	20	Cutting	G	None	Ret. Wall (Sheet Pile)	1.0	N/A	N/A	--
184460	184480	20	At Grade	G	None	No Solution Used	--	N/A	N/A	--
184490	184550	60	At Grade	G	None	<500mm Cut	--	N/A	N/A	--
184560	184700	140	At Grade	G	None	Regrade Full Height 1:2.5	--	2	0.7	--
184710	184740	30	Embankment	G	None	<500mm Fill	--	N/A	N/A	--
184750	184900	150	Embankment	G	None	Full Height Embankment Widening 1:2	--	3.1	3.5	--
184910	185100	190	At Grade	G	None	<500mm Fill	--	N/A	N/A	--
184910	185010	100	At Grade	G	None	<500mm Cut	--			
185020	185020	0	Cutting			<500mm Cut	--			
185030	185060	30	Cutting			<500mm Cut	--			
185070	185100	10	Cutting	G	None	<500mm Cut	--			
185110	185120	10	-	-	-	Overbridge	--	N/A	N/A	--
185130	185140	10	Cutting	G	None	<500mm Cut	--	N/A	N/A	--
185150	185220	70	Cutting	G	None	Ret. Wall (Sheet Pile)	2.0	N/A	N/A	--
185220	185270	50	Cutting	G	None	Ret. Wall (Sheet Pile)	2.3	N/A	N/A	--
185270	185320	50	Cutting	G	None	Ret. Wall (Sheet Pile)	2.0	N/A	N/A	--
185330	185340	10	Cutting	G	None	No Solution Used	--	N/A	N/A	--
185350	185360	10	-	-	-	Overbridge	--	N/A	N/A	--
185370	185640	270	Cutting	A	None	<500mm Cut	--	N/A	N/A	--
185640	185820	180	At Grade	A	None	<500mm Cut	--	N/A	N/A	--
185830	185850	20	At Grade	A	None	No Solution Used	--	N/A	N/A	--
185860	185880	20	Embankment	A	32.30	Granular Wedge at Embankment Crest 1:2	--	1.2	1.6	--
185890	185950	60	Embankment	A	32.30	Ret. Wall (Sheet Pile)	2.0	N/A	N/A	--
185950	185990	40	Embankment	A	32.30	Ret. Wall (Sheet Pile)	2.1	N/A	N/A	--
185990	186040	50	Embankment	A	32.30	Ret. Wall (Sheet Pile)	2.0	N/A	N/A	--
186040	186090	50	Embankment	A	32.30	Ret. Wall (Sheet Pile)	2.3	N/A	N/A	--
186090	186230	140	Embankment	A	32.30	Ret. Wall (Sheet Pile)	2.0	N/A	N/A	--
186230	186270	40	Embankment	A	32.30	Ret. Wall (Sheet Pile)	2.5	N/A	N/A	--
186270	186360	90	Embankment	A	32.30	Ret. Wall (Sheet Pile)	2.0	N/A	N/A	--
186370	186390	20	Embankment	A	32.30	<500mm Cut	--	N/A	N/A	--
186390	186440	50	Embankment	A	32.30	<500mm Fill	1.4	N/A	N/A	--
186440	186450	10	Embankment	A	32.30	<500mm Fill	--	N/A	N/A	--
186460	186500	40	Embankment	A	32.30	No Solution Used	--	N/A	N/A	--
186500	186530	30	Embankment		32.30	Ret. Wall (Sheet Pile)	1.9	N/A	N/A	--
186540	186580	40	-	-	-	Overbridge	--	N/A	N/A	--
186590	186670	80	Embankment	R	None	No Solution Used / <500mm Cut	--	N/A	N/A	--
186680	186760	80	Embankment	A	None	Full Height Embankment Widening 1:2	--	6.7	3	--
186770	186840	70	Embankment	A	None	No Solution Used	--	N/A	N/A	--
186850	186900	50	Embankment	A	None	No Solution Used	--	N/A	N/A	--
186900	186960	60	Embankment	A	None	No Solution Used		1.3	6.4	--
186970	187070	100	Embankment	A	None	No Solution Used	--	1	6.5	--
187080	187090	10	-	-	-	Overbridge	--	N/A	N/A	--
187100	187180	80	Embankment	A	30.90	<500mm Fill	--	N/A	N/A	--
187180	187250	70	Embankment	A	30.90	Granular Wedge at Embankment Crest 1:2	--	4	5.9	--
187260	187270	10	-	-	-	Underbridge	--	N/A	N/A	--
187280	187320	40	Embankment	A	30.90	<500mm Fill	--	N/A	N/A	--
187330	187340	10	-	-	-	Culvert	--	N/A	N/A	--
187350	187380	30	Embankment	A	30.90	Granular Wedge at Embankment Crest 1:2	--	4.6	2.6	--
187390	187540	150	Embankment	A	30.90	No Solution Used / <500mm Fill	--	N/A	N/A	--
187550	187790	240	Embankment	A	31.30	Granular Wedge at Embankment Crest 1:2	--	4.3	2.6	--
187790	187860	70	Embankment	A	31.3	<500mm Fill	--			
187870	187880	10	-	-	-	Culvert	--	N/A	N/A	--
187890	187920	30	Embankment	A	31.40	<500mm Fill	--	N/A	N/A	--
187930	187940	10	Embankment	A	32.40	Granular Wedge at Embankment Crest 1:2	--	2	1.3	--
187950	188000	50	-	-	-	River Trent Bridge	--	N/A	N/A	--
188010	188120	110	Embankment	R	31.70	<500mm Fill	--	N/A	N/A	--
188130	188190	60	Embankment	R	31.70	Granular Wedge at Embankment Crest 1:2		3.9	5.2	
188190	188230	40	Embankment	R	31.70	<500mm fill / No Solution		N/A	N/A	
188240	188290	50	-	-	-	Culvert	--	N/A	N/A	--
188290	188490	200	Embankment	R	31.90	No Solution Used	--	N/A	N/A	--
188500	188500	0	Embankment	R	31.90	Granular Wedge at Embankment Crest 1:2	--	1.9	2.6	--
188510	188520	10	Embankment	R	31.90	No Solution	--	N/A	N/A	--
188520	188550	30	Embankment	R	31.90	Ret. Wall (Sheet Pile)	2.7	N/A	N/A	--
188550	188560	10	Embankment	R	31.90	No Solution Used	--	N/A	N/A	
188570	188710	140	-	-	-	River Trent Bridge	--	N/A	N/A	--
188720	188740	20	Embankment	R	32.20	Ret. Wall (Sheet Pile)	2.0	N/A	N/A	--
188740	188850	110	Embankment	R	32.20	Ret. Wall (Sheet Pile)	2.8	N/A	N/A	--
188850	188890	40	Embankment	R	32.20	Ret. Wall (Sheet Pile)	2.0	N/A	N/A	--
188900	188980	80	Embankment	R	32.20	No Solution Used	--	N/A	N/A	--
188990	189160	170	-	-	-	River Trent Bridge	--	N/A	N/A	--
189170	189310	140	Embankment	A	32.20	No Solution Used / <500mm Fill	--	N/A	N/A	--
189310	189480	170	-	-	-	River Trent Bridge	--	N/A	N/A	--
189490	189510	20	Cutting	A	32.20	<500mm Cut / <500mm Fill	--	N/A	N/A	--
189520	189530	10	-	-	-	Overbridge	--	N/A	N/A	--
189540	189630	90	Embankment	A	32.20	<500mm Fill	--	N/A	N/A	--
189640	189660	20	Embankment	G	32.20	<500mm Cut	--	N/A	N/A	--
189670	189770	100	Embankment	G	32.20	<500mm Fill	--	N/A	N/A	--
189780	189800	20	Embankment	G	32.20	Granular Wedge at Embankment Crest 1:2	--	6.3	3.28	--
189810	189930	120	Embankment	G	32.20	<500mm Fill	--	N/A	N/A	--
189940	189950	10	-	-	-	Culvert	--	N/A	N/A	--
189960	190150	190	Embankment	G	None	<500mm Fill	--	N/A	N/A	--
190160	190360	200	Embankment	G	None	No Solution Used	--	N/A	N/A	--
190370	190390	20	-	-	-	Overbridge	--	N/A	N/A	--
190400	190520	120	Embankment	G	31.20	No Solution Used	--	N/A	N/A	--
190530	190560	30	Embankment	G	32.20	Granular Wedge at Embankment Crest 1:2	--	4.4	4.1	--
190570	190650	80	Embankment	G	31.20	<500mm Fill	--	N/A	N/A	--
190660	190670	10	-	-		Culvert	--	N/A	N/A	--
190680	190730	50	Embankment	G	31.20	<500mm Fill	--	N/A	N/A	--
190740	190930	190	Embankment	G	31.20	Granular Wedge at Embankment Crest 1:2	--	4.9	2.9	--
190940	190970	30	Embankment	G	31.20	<500mm Fill	--	N/A	N/A	--
190980	191050	70	Embankment	A	31.20	No Solution Used	--	N/A	N/A	--
191060	191080	20	Embankment	A	31.20	<500mm Fill	--	N/A	N/A	--
191090	191190	100	Embankment	A	31.20	Full Height Embankment Widening 1:2	--	5	2.1	--
191200	191220	20	Embankment	A	31.20	No Solution Used	--	N/A	N/A	--
191230	191280	50	Embankment	A	31.20	<500mm Fill	--	N/A	N/A	--
191290	191310	20	Embankment	A	31.20	Full Height Embankment Widening 1:2	--	N/A	N/A	--
191320	191350	30	Embankment	A	31.20	<500mm Fill	--	N/A	N/A	--
191360	191370	10	-	-	-	Culvert	--	N/A	N/A	--
191380	191450	70	Cutting	A	31.20	<500mm Cut	--	N/A	N/A	--
191460	191480	20	Cutting	A	32.20	Regrade Full Height 1:3	--	3.7	1.6	--
191480	191550	70	Cutting	A	33.20	<500mm Cut	--	N/A	N/A	--
191560	191580	20	Cutting	R	None	Ret. wall (Sheet Pile)	0.9	N/A	N/A	--
191590	191640	50	Cutting	R	None	<500mm Cut	--	N/A	N/A	--
191650	191660	10	-	-	-	Overbridge	--	N/A	N/A	--
191670	191760	90	Cutting	G	None	No Solution Used	--	N/A	N/A	--
191770	191820	50	Bund	G	None	Regrade Full Height 1:3	--	5.8	1.7	--
191830	192060	230	At Grade	G	None	No Solution Used	--	N/A	N/A	--
192070	192090	20	Embankment	G	None	<500mm Cut	--	N/A	N/A	--
192100	192110	10	Embankment	G	None	Full Height Embankment Widening 1:2	--	--	1.1	--
192120	192130	10	Embankment	A	None	<500mm Cut	--	N/A	N/A	--
192130	192140	10	Embankment	A	None	Granular Wedge at Embankment Crest 1:2	--	N/A	N/A	--
192140	192200	60	Embankment	A	None	<500mm Fill	--	N/A	N/A	--
192210	192400	190	Embankment	A	None	Granular Wedge at Embankment Crest 1:2	--	4	4.62	--
192410	192460	50	Embankment	A	None	<500mm Fill	--	N/A	N/A	--
192470	192500	30	Embankment	A	None	Full Height Embankment Widening 1:2	--	4	6.2	--
192500	192510	10	Embankment	A	None	<500mm Fill	--	--	--	--
192510	192530	20	-	-	-	Culvert	--	N/A	N/A	--
192540	192970	430	Embankment	A	None	<500mm Fill	--	N/A	N/A	--
192980	193020	40	Cutting	A	None	Gabion Wall	1.6	N/A	N/A	--
193030	193060	30	-	-	-	Overbridge	--	N/A	N/A	--
193070	193190	120	At Grade	A	None	<500mm Cut	--	N/A	N/A	--
193200	193250	50	Cutting	A	None	<500mm Fill	--	N/A	N/A	--
193250	193320	70	Cutting	A	None	Gabion Wall	0.5	N/A	N/A	--
193320	193350	30	Cutting	A	None	Ret. Wall (Sheet Pile)	2.3	N/A	N/A	--
193350	193420	70	Cutting	A	None	Gabion Wall	1.0	N/A	N/A	--
193430	193470	40	Cutting	A	None	Gabion Wall	0.5	N/A	N/A	--
193470	193480	10	Cutting	A	None	<500mm Cut	--	N/A	N/A	--
193490	193500	10	-	-	-	Overbridge	--	N/A	N/A	--
193510	193570	60	Cutting	A	None	No Solution Used	--	N/A	N/A	--
193580	193600	20	-	-	-	Overbridge	--	N/A	N/A	--
193610	193630	20	Cutting	G	None	No Solution Used	--	N/A	N/A	--
193640	193660	20	-	-	-	Overbridge	--	N/A	N/A	--
193670	193730	60	Cutting	G	None	No Solution Used	--	N/A	N/A	--
193740	193790	50	Cutting	G	None	No Solution Used	0.8	N/A	N/A	--
193790	193810	20	Cutting	G	None	<500mm Cut & Fill	--	N/A	N/A	--
193820	193840	20	Cutting	A	None	<500mm Cut	--	N/A	N/A	--
193840	194900	1060	Cutting	A	None	No Solution Used	--	N/A	N/A	--
194910	194920	10	-	-	-	Overbridge	--	N/A	N/A	--
194930	195000	70	Cutting	N/A	-	None	No Solution Used	--	N/A	N/A	--

* The maximum buildout widths have been calculated using the exsiting verge widths and the proposed verge widths.

Mainline Widening Solutions Schedule Southbound

N.B.
1) Information provided within this schedule has been provided to the nearest 10m. Exact lengths of retaining structures are provided within the 1600 series schedule and drawings.
2) All 10m gaps between solutions are areas of transition.
3) Minor and major structures have been included in the mainline widening.
4) 0.5m has been added to Max. retained Height for Ret. Wall (Sheet Pile) in embankment.

Chainage Start	Chainage End	Length (m)	Earthwork Type	Worst Case Existing Vegetation (RAG)	Max. Flood Risk (mAOD)	Earthworks Widening solution	Max. Retained Height (m)	Max Buildout Width (m)*	Max Cut / Fill Height (m)	Comments
182000	182020	20	Cutting	G	None	No Solution Used	--	N/A	N/A	--
182030	182090	60	-	-	-	Overbridge	--	N/A	N/A	--
182100	182150	50	Cutting	A	None	Regrade Full Height 1:2.5	--	2.8	5.5	--
182150	182230	80				Regrade Full Height 1:3.0		2.9	7.3	
182240	182620	380	Cutting	A	None	Regrade Full Height 1:3	--	2.8	7.2	--
182630	182700	70	Cutting	A	None	<500mm Cut	--	N/A	N/A	Areas of cut and fill present
182710	182730	20	-	-	-	Overbridge	--	N/A	N/A	--
182740	182780	40	At Grade	A	None	<500mm Cut	--	N/A	N/A	--
182790	182890	100	At Grade	A	None	No Solution Used	--	N/A	N/A	--
182900	182930	30	Embankment	A	None	<500mm Fill	--	N/A	N/A	--
182940	183310	370	Embankment	A	None	Granular Wedge At Embankment Crest 1:2	--	2.9	8	--
183320	183430	110	Embankment	A	None	Full Height Embankment Widening 1:2	--	3.9	5.2	--
183440	183470	30	At Grade	A	None	<500mm Cut	--	N/A	N/A	--
183480	183510	30	At Grade	G	None	Regrade Full Height 1:3	--	2.4	1	--
183520	183780	260	Cutting	G	None	<500mm Cut	--	N/A	N/A	--
183790	183790	10	Cutting	G	None	Regrade Full Height 1:2.5	--	2.8	3.1	--
183800	183950	150	Cutting	G	None	Ret. Wall (Sheet Pile)	1.1	N/A	N/A	--
183960	184020	60	Cutting	G	None	Regrade Full Height 1:3	--	4.0	9.6	--
184030	184060	30	Cutting	G	None	<500mm Cut	--	N/A	N/A	--
184070	184100	30	-	-	-	Overbridge	--	N/A	N/A	--
184110	184130	20	Cutting	G	None	Regrade Full Height 1:2.5	--	2.6	6.5	--
184130	184170	40	Cutting	G	None	Regrade Partial Height 1:2.5	--	2.0	3.4	--
184170	184200	30	Cutting	G	None	<500mm Cut	--	N/A	N/A	--
184210	184220	10	Cutting	G	None	Regrade Partial Height 1:2.5	--	1.9	2.6	--
184230	184270	40	Cutting	G	None	<500mm Cut	--	N/A	N/A	--
184280	184330	50	Cutting	G	None	Regrade Partial Height 1:2.5	--	5.2	4.5	--
184340	184380	40	Cutting	G	None	<500mm Cut	--	N/A	N/A	--
184390	184470	80	Cutting	G	None	Regrade Full Height 1:2.5	--	4.8	2.9	--
184480	184620	140	At Grade	A	None	<500mm Cut / No Solution	--	N/A	N/A	--
184630	184740	110	Embankment	A	None	Full Height Embankment Widening 1:2	--	5.2	2.6	--
184750	184870	120	Embankment	R	None	No Solution Used	--	N/A	N/A	--
184880	185100	220	Cutting	R	None	<500mm Fill	--	N/A	N/A	--
185110	185120	10	-	-	-	Overbridge	--	N/A	N/A	--
185130	185160	30	Cutting	R	None	No Solution Used	--	N/A	N/A	--
185170	185210	40	Cutting	R	None	Regrade Full Height 1:3	--	5.6	3.1	--
185220	185330	110	Cutting	R	None	<500mm Fill	--	N/A	N/A	--
185340	185360	20	-	-	-	Overbridge	--	N/A	N/A	--
185370	185470	100	Cutting	R	None	<500mm Fill	--	N/A	N/A	--
185480	185500	20	Cutting	R	None	<500mm Cut	--	N/A	N/A	
185510	185600	90	Cutting	G	None	Regrade Full Height 1:3	--	1.7	2.8	--
185610	185620	10	At Grade	G	None	<500mm Cut	--	N/A	N/A	--
185630	185860	230	At Grade	G	None	<500mm Fill	--	N/A	N/A	--
185870	185900	30	Embankment	A	30.6	Granular Wedge At Embankment Crest 1:2	--	1.9	2.3	--
185900	0	0	-	-	-	Culvert	--	N/A	N/A	--
185900	186200	300	Embankment	A	30.6	Granular Wedge At Embankment Crest 1:2	--	1.9	3	--
186210	186400	190	Embankment	A	31.6	Full Height Embankment Widening 1:2	--	4.7	2.9	--
186410	186440	30	Embankment	A	None	<500mm Fill	--	N/A	N/A	--
186450	186520	70	At Grade	A	None	No Solution Used	--	N/A	N/A	--
186530	186560	30	-	-	-	Overbridge	--	N/A	N/A	--
186570	186790	220	Embankment	G	30.5	<500mm Cut	--	N/A	N/A	--
186800	186830	30	Embankment	G	30.5	Granular Wedge At Embankment Crest 1:2	--	3.6	5.7	--
186830	186860	30	Embankment	G	30.5	Full Height Embankment Widening 1:2	--	3.6	5.7	--
186860	186880	20	Embankment	G	32.5	Granular Wedge At Embankment Crest 1:2	--	3.6	5.7	--
186890	187080	190	Embankment	G	30.5	Full Height Embankment Widening 1:2	--	--	6.5	
187090	187110	20	-	-	-	Underbridge	--	N/A	N/A	--
187120	187250	130	Embankment	A	None	Granular Wedge At Embankment Crest 1:2	--	1	5.5	--
187260	187270	10	-	-	-	Culvert	--	N/A	N/A	--
187280	187320	40	Embankment	A	30.9	Full Height Embankment Widening 1:2	--	4.3	2	--
187330	187340	10	-	-	-	Culvert	--	N/A	N/A	--
187350	187490	140	Embankment	A	30.9	Granular Wedge At Embankment Crest 1:2	--	1.0	4.5	--
187500	187590	90	Embankment	A	30.9	<500mm Fill	--	N/A	N/A	--
187600	187620	20	Embankment	A	30.9	Full Height Embankment Widening 1:2	--	5.1	2	--
187620	187790	170	Embankment	A	30.9	<500mm Cut	--	N/A	N/A	--
187800	187830	30	Embankment	A	31.0	Ret. Wall (Sheet Pile)	2.3	N/A	N/A	--
187840	187850	10	Embankment	A	31.0	<500mm Cut	--	N/A	N/A	--
187860	187870	10	-	-	-	Culvert	--	N/A	N/A	--
187880	187900	20	Embankment	A	31.0	No Solution Used	--	N/A	N/A	--
187910	187930	20	Embankment	A	31.0	Ret. Wall (Sheet Pile)	1.2	N/A	N/A	--
187940	187960	20	Embankment	A	31.0	No Solution Used	--	N/A	N/A	--
187960	188010	50	-	-	-	Underbridge	--	N/A	N/A	--
188020	188090	70	Embankment	A	31.0	<500mm Fill	--	N/A	N/A	--
188100	188130	30	Embankment	A	31.0	Ret. Wall (Sheet Pile)	1.4	N/A	N/A	--
188140	188220	80	Embankment	A	31.0	No Solution Used	--	N/A	N/A	--
188230	188250	20	Embankment	A	31.0	Full Height Embankment Widening 1:2	--	3.3	7.3	--
188250	188300	50	-	-	-	Underbridge	--	N/A	N/A	--
188310	188370	60	Embankment	A	31.1	No Solution Used	--	N/A	N/A	--
188380	188400	20	Embankment	A	31.1	Granular Wedge At Embankment Crest 1:2	--	4.3	4.8	--
188410	188500	90	Embankment	R	31.1	Ret. Wall (Sheet Pile)	2.7	N/A	N/A	--
188500	188550	50	Embankment	R	31.1	Ret. Wall (Sheet Pile)	2.0	N/A	N/A	--
188560	188720	160	-	-	-	Underbridge	--	N/A	N/A	--
188720	188740	20	Embankment	R	32.2	No Solution Used	--	N/A	N/A	--
188750	188770	20	Embankment	R	32.2	Ret. Wall (Sheet Pile)	2.3	N/A	N/A	--
188780	188860	80	Embankment	R	32.2	<500mm Cut	--	N/A	N/A	--
188870	188930	60	Embankment	R	32.2	<500mm Fill	--	N/A	N/A	Areas of cut and fill present
188940	188960	20	Embankment	R	32.2	Ret. Wall (Sheet Pile)	2.1	N/A	N/A	--
188970	188980	10	Embankment	R	32.2	<500mm Fill	--	N/A	N/A	--
188990	189150	160	-	-	-	Underbridge	--	N/A	N/A	--
189150	189170	20	Embankment	A	32.2	Ret. Wall (Sheet Pile)	2.5	N/A	N/A	--
189180	189180	0	Embankment	A	33.2	No Solution Used	--	N/A	N/A	--
189190	189190	0	Embankment	A	34.2	<500mm fill	--	N/A	N/A	--
189200	189270	70	Embankment	A	32.2	No Solution Used	0	N/A	N/A	--
189280	189310	30	Embankment	A	33.2	Ret. Wall (Sheet Pile)	1.5	N/A	N/A	--
189320	189480	160	-	-	-	Underbridge	--	N/A	N/A	--
189490	189510	20	Cutting	A	32.2	<500mm Cut	--	N/A	N/A	--
189520	189530	10	-	-	-	Overbridge	--	N/A	N/A	--
189540	189550	10	Cutting	A	32.2	<500mm Cut	--	N/A	N/A	--
189560	189740	180	Embankment	A	32.2	Granular Wedge At Embankment Crest 1:2	--	N/A	1.3	--
189750	189790	40	Embankment	A	32.2	Ret. Wall (Sheet Pile)	2.8	N/A	N/A	--
189800	189930	130	Embankment	A	32.2	Granular Wedge At Embankment Crest 1:2	--	3.9	2.7	--
189940	189950	10	-	-	-	Underbridge	--	N/A	N/A	--
189960	190280	320	Embankment	A	32.2	Granular Wedge At Embankment Crest 1:2	--	N/A	4.5	--
190290	190320	30	Embankment	A	32.2	<500mm Fill	--	N/A	N/A	--
190330	190370	40	Embankment	A	32.2	Granular Wedge At Embankment Crest 1:2	--	N/A	5.8	--
190380	190390	10	-	-	-	Underbridge	--	N/A	N/A	--
190400	190440	40	Embankment	A	31.2	<500mm Fill	--	4.1	6.3	--
190440	190650	210	Embankment	A	31.2	Granular Wedge At Embankment Crest 1:2	--	4.1	6.3	
190660	190670	10	-	-	-	Culvert	--	N/A	N/A	--
190680	191040	360	Embankment	A	31.2	Granular Wedge At Embankment Crest 1:2	--	1	2.6	--
191050	191410	360	Embankment	A	31.2	<500mm Fill	--	N/A	N/A	--
191420	191450	30	Embankment	A	32.2	Granular Wedge At Embankment Crest 1:2	--	--	2.8	--
191450	191500	50	Embankment	A	None	<500mm Fill	--	N/A	N/A	--
191500	191530	30	At Grade	A	None	<500mm Fill	--	N/A	N/A	--
191530	191560	20	Cutting	A	None	<500mm Fill	--	N/A	N/A	--
191560	191570	10	Cutting	A	None	Regrade Partial Height 1:3	--	1.5	1	--
191580	191650	70	Cutting	A	None	<500mm Fill	--	N/A	N/A	--
191660	191680	20	-	-	-	Overbridge	--	N/A	N/A	--
191690	191830	140	At Grade	R	None	<500mm Fill	--	N/A	N/A	--
191840	191930	90	Cutting	R	None	<500mm Cut	--	N/A	--	--
191940	191960	20	Cutting	R	None	<500mm Cut	--	N/A		--
191960	191970	10	Cutting	R	None	No Solution Used	--	N/A	N/A	--
191970	191990	20	Cutting	R	None	<500mm Cut	--	N/A	--	--
192000	192020	20	Embankment	R	None	<500mm Fill	--	N/A	N/A	--
192030	192080	50	Embankment	R	None	Granular Wedge At Embankment Crest 1:2	--	4.4	1.9	--
192090	192140	50	Embankment	R	None	Ret. Wall (Sheet Pile)	2.0	N/A	N/A	--
192140	192190	50	Embankment	R	None	Ret. Wall (Sheet Pile)	3.8	N/A	N/A	--
192190	192250	60	Embankment	R	None	Ret. Wall (Sheet Pile)	3.1	N/A	N/A	--
192250	192260	10	Embankment	R	None	Ret. Wall (Sheet Pile)	2.0	N/A	N/A	--
192260	192300	40	Embankment	R	None	Ret. Wall (Sheet Pile)	3.1	N/A	N/A	--
192300	192360	60	Embankment	R	None	Ret. Wall (Sheet Pile)	3.8	N/A	N/A	--
192360	192400	40	Embankment	R	None	Ret. Wall (Sheet Pile)	3.1	N/A	N/A	--
192400	192480	80	Embankment	R	None	Ret. Wall (Sheet Pile)	2.1	N/A	N/A	--
192480	192520	40	Embankment	R	None	Ret. Wall (Sheet Pile)	2.3	N/A	N/A	--
192530	192550	20	-	-	-	Underbridge	--	N/A	N/A	--
192560	192700	140	Embankment	A	None	Full Height Embankment Widening 1:2	--	2.5	6.3	--
192710	192770	60	Embankment	A	None	Ret. Wall (Sheet Pile)	2.9	N/A	N/A	--
192770	192840	70	Embankment	A	None	Ret. Wall (Sheet Pile)	2.0	N/A	N/A	--
192850	192890	40	Embankment	A	None	<500mm Fill	--	N/A	N/A	--
192900	192980	80	Cutting	A	None	<500mm Cut	--	N/A	N/A	--
192990	193220	230	Cutting	A	None	No Solution Used	--	N/A	N/A	--
193230	193290	60	At Grade	A	None	<500mm Fill	--	N/A	N/A	--
193300	193320	20	Cutting	A	None	Ret. Wall (Sheet Pile)		N/A	N/A	--
193320	193490	170	Cutting	A	None	Gabion Wall	0.8	N/A	N/A	--
193500	193510	10	-	-	-	Overbridge	--	N/A	N/A	--
193520	193570	50	Cutting	A	None	No Solution Used	--	N/A	N/A	--
193580	193590	10	-	-	-	Overbridge	--	N/A	N/A	--
193600	193640	40	Cutting	A	None	<500mm Cut	--	N/A	N/A	--
193650	193670	20	-	-	-	Overbridge	--	N/A	N/A	--
193680	193690	10	Cutting	A	None	Ret. Wall (Sheet Pile)	1.5	N/A	N/A	--
193700	193730	30	Cutting	A	None	No Solution Used	--	N/A	N/A	--
193740	193840	100	Cutting	A	None	No Solution Used	--	N/A	N/A	--
193850	193860	10	At Grade	A	None	No Solution Used	--	N/A	N/A	--
193860	193880	20	At Grade	A	None	No Solution Used	--	N/A	N/A	--
193880	194080	200	Cutting	A	None	No Solution Used	--	N/A	N/A	--
194080	194100	20	-	-	-	Overbridge	--	N/A	N/A	--
194100	194320	220	Cutting	A	None	No Solution Used	--	N/A	N/A	--
194330	194500	170	Cutting	A	None	<500mm Fill	--	N/A	N/A	--
194510	194930	420	Cutting	A	None	No Solution Used	--	N/A	N/A	--
194930	194940	10	-	-	-	Overbridge	--	N/A	N/A	--
194940	195000	60	Cutting	N/A	None	No Solution Used	--	N/A	N/A	--

* The maximum buildout widths have been calculated using the exsiting verge widths and the proposed verge widths.
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Mainline Widening Solutions Schedule Merges & Diverges

N.B.

1) Information provided within this schedule has been provided to the nearest 10m. Exact lengths of retaining structures are provided within the 1600 series schedule and drawings.

2) All 10m gaps between solutions are areas of transition.

3) Minor and major structures have been included in the mainline widening.

4) 0.5m has been added to Max. retained Height for Ret. Wall (Sheet Pile) in embankment.

Chainage Start	Chainage End	Length (m)	Junction	NB/SB	Carriageway	Earthwork Type	Worst Case Existing Vegetation (RAG)	Max. Flood Risk (mAOD)	Earthworks Widening solution	Max. Retaind Height (m)	Max Buildout Width (m)*	Max Cut / Fill Height (m)	Comments
182480	182630	150	23a	SB	M1-A42 (east)	Cutting	Green	None	<500mm Fill	--	1.5	N/A	
182630	182650	20	23a	SB	M1-A42 (east)	Cutting	Green	None	<500mm Cut	--	1.5	N/A	
182650	182720	70	23a	SB	M1-A42 (east)	Cutting	Green	None	Overbridge	--	N/A	N/A	
182720	182760	40	23a	SB	M1-A42 (east)	Cutting	Green	None	Regrade Full Height 1:3	--	4.0	1.6	
182760	182770	10	23a	SB	M1-A42 (east)	Cutting	Green	None	??	--	4.0	??	Insufficient topo data for full earthwork height
182770	182780	10	23a	SB	M1-A42 (east)	Cutting	Green	None	<500mm Cut	--	4.0	--	
182780	182790	10	23a	SB	M1-A42 (east)	Cutting	Green	None	Regrade Full Height 1:3	--	5.0	1.1	
182790	182830	40	23a	SB	M1-A42 (east)	Cutting	Green	None	??	--	5.0	??	Insufficient topo data for full earthwork height
182830	182900	70	23a	SB	M1-A42 (east)	Cutting	Green	None	Regrade Full Height 1:3	--	4.0	1.3	
181960	182070	110	23a	NB	A42-M1 (west)	Cutting	Green	None	No Solution Used	--	0.0	N/A	
182080	182110	30	23a	NB	A42-M1 (west)	Cutting	Green	None	Overbridge	--	N/A	N/A	
182120	182140	20	23a	NB	A42-M1 (west)	Cutting	Green	None	Granular Wedge At Embankment Crest 1:2	--	3.8	3.3	
182150	182240	90	23a	NB	A42-M1 (west)	Cutting	Green	None	<500mm Fill	--	3.0	N/A	
182250	182280	30	23a	NB	A42-M1 (west)	Cutting	Green	None	No Solution Used	--	1.6	N/A	
184900	185100	200	24	NB	M1-A453/A50/A6 Offslip (west)	??	Green	None	??	--	??	??	Insufficient tooo data
184860	185000	140	24	SB	A453/A50/A6-M1 Onslip (east)	Embankment	Red	None	Ret Wall (Sheet Pile)	6.2	5.5	N/A	
185010	185100	90	24	SB	A453/A50/A6-M1 Onslip (east)	Embankment	Red	None	??	--	??	??	Insufficient topo data
185380	185400	20	24	NB	A453/A50/A6-M1 Onslip (west)	Embankment	Amber	None	No Solution Required	--	0.0	N/A	No topo data
185400	185510	110	24	NB	A453/A50/A6-M1 Onslip (west)	Embankment	Amber	None	Full Height Embankment Widening 1:2	--	4.0	1.8	
185510	185540	30	24	NB	A453/A50/A6-M1 Onslip (west)	Embankment	Amber	None	<500mm Fill	--	4.0	N/A	
185540	185550	10	24	NB	A453/A50/A6-M1 Onslip (west)	Embankment	Amber	None	<500mm Cut	--	4.0	N/A	
185550	185590	40	24	NB	A453/A50/A6-M1 Onslip (west)	At Grade	Amber	None	Regrade Partial Height 1:3	--	4.0	0.8	
185590	185610	20	24	NB	A453/A50/A6-M1 Onslip (west)	At Grade / Cutting	Amber	None	??	--	4.0	??	Insufficient topo data
185610	185640	30	24	NB	A453/A50/A6-M1 Onslip (west)	Cutting	Amber	None	Regrade Partial Height 1:3	--	4.0	1.3	
186200	186450	250	24	SB	M1-A453/A50/A6 Offslip (east)	--	--	--	See mainiline widening schedule	--	--	--	
186700	186760	60	24a	NB	A50-M1 Onslip (west)	Embankment	Amber	None	No Solution Used	--	0.0	N/A	
186760	186970	210	24a	NB	A50-M1 Onslip (west)	Embankment	Green	None	Full Height Embankment Widening 1:2	--	3.0	6.2	
186970	187070	100	24a	NB	A50-M1 Onslip (west)	Embankment	Green	None	Granular Wedge At Embankment Crest 1:2	--	3.0	5.9	
186550	186640	90	24a	SB	M1-A50 Offslip (east)	--	--	--	See mainiline widening schedule	--	--	--	
193110	193260	150	25	NB	M1-A52 Offslip (west)	Cutting	Amber	None	<500mm Cut	--	3.0	N/A	
193260	193500	240	25	NB	M1-A52 Offslip (west)	Cutting	Amber	None	No Solution Used	--	3.0	N/A	Topo data does not cover full slope
193120	193260	140	25	SB	A52-M1 Onslip (east)	Cutting	Amber	None	<500mm Cut	--	3.8	N/A	Topo data does not cover full slope
193260	193400	140	25	SB	A52-M1 Onslip (east)	Cutting	Amber	None	No Solution Used	--	3.8	N/A	Topo data does not cover full slope
193400	193420	20	25	SB	A52-M1 Onslip (east)	Cutting	Amber	None	<500mm Fill	--	3.8	N/A	Topo data does not cover full slope
193420	193500	80	25	SB	A52-M1 Onslip (east)	Cutting	Amber	None	No Solution Used	--	3.8	N/A	Topo data does not cover full slope
193680	193950	270	25	NB	A52-M1 Onslip (west)	Embankment	Green	None	No Solution Used	--	0.0	N/A	
193700	194100	400	25	SB	M1-A52 Offslip (east)	Embankment	Amber	None	No Solution Used	--	0.0	N/A	

* The maximum buildout widths have been calculated using the exsiting verge widths and the proposed verge widths.

Appendix E. Series 1600 Schedule

M1 Junction 23a to 25
Smart Motorways Programme
ALR Works

Volume 2 Works Information

Specification Schedules Series 1600 : PILING AND EMBEDDED RETAINING WALLS

June 2017

Document History

JOB NUMBER: 244508/COCDFL1SMP01			REFERENCE: HA549342-AMAR-HGT-SWI-SP-CE-000004			
P01	For Target Cost	RM	SB	GS/SG	TB	01.07.16
P02	TQ18 - Foundation Information	SB	SA	AB	TB	21.07.16
P03	Updated Foundation Information (internal / not issued)	SB	SA	AB	TB	Not issued
P04	DF5 Submission	SA	SB	AB	TB	18.11.16
P05	Internal - not issued	RM	AB	GS/SG	TB	16.12.16
P06	DF5: Further Design Refinement	SA	AB	GS	TB	23.12.16
P07	DF5: Further Design Refinement (internal / not issued)	WP	AB	GS	TB	Not issued
P08	DF5: Further Design Refinement (internal / not issued)	WP	AB	GS	TB	17.01.17
P09	DF5: Further Design (ROTTMS)	LP	LP	LP	SV	19.01.17
P10	DF5: Further Design (Retaining walls)	AB	AB	AB	TB	20.01.17
P11	Post DF5: further design refinement (Internal - Not Issued)	AB	AB	AB	TB	Not issued
P12	Post DF5: further design refinement	AB	AB	AB	TB	22.01.17
P13	Post DF5: Single Option Selected for piled foundations (driven pile option removed) Changes highlighted are for versions P12 & P13	AB	AB	AB	TB	24.01.17
P14	Post DF5: Inclusion of King Sheet Pile Wall (KSP) details and Z section details as alternative to Standard Sheet Pile Wall with U sections	RM	AB	AB	TB	10.03.17
P15	Construction issue, internal only	WP	RM	AB	TB	Not issued
P16	Construction issue	WP	RM	AB	TB	18.04.17
P17	Revised Construction Issue - Internal Only	OY	AB	LP	SV	Not issued
P18	Revised Construction Issue	OY	AB	LP	SV	06.06.17
Revision	Purpose Description	Originated	Checked	Reviewed	Authorised	Date

Sheet Piling Schedule Northbound

						Sheet Pile Wall				King Sheet Pile Wall						
										KSP (700mm Sections)				Intermediate KSP Sections (770mm)		
Chainage Start	Chainage End	Earthwork Type	Sheet Pile Type	Total Structure Length (m)	Max. Retained Height (m)	Max. Embedment Depth (m)	Total Pile Length (m)	Section	Steel Grade	Max. Embedment Depth (m)	Total Pile Length (m)	Section	Steel Grade	Section	Steel Grade	Min. Embedment Depth
182880	182890	Cutting	Plastic	10	0.40	1.1	1.5	-	-							
184071	184140	Cutting	Steel	69	1.0	-	-	-	-	3.5	4.5	AZ12	S 390 GP	AZ12	S 270 GP	1.0
184140	184430	Cutting	Steel	290	1.8	-	-	-	-	4.2	6.0	AZ12	S 390 GP	AZ12	S 270 GP	1.0
184430	184453	Cutting	Steel	23	1.0	-	-	-	-	3.5	4.5	AZ12	S 390 GP	AZ12	S 270 GP	1.0
185139	185220	Cutting	Steel	81	2.0	-	-	-	-	6.0	8.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0
185220	185270	Cutting	Steel	50	2.3	-	-	-	-	7.7	10.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0
185270	185321	Cutting	Steel	51	2.0	-	-	-	-	6.0	8.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0
185893	185950	Embankment	Steel	57	2.0	-	-	-	-	4.5	6.5	AZ24	S 390 GP	AZ12	S 270 GP	1.0
185950	185990	Embankment	Steel	40	2.1	-	-	-	-	4.4	6.5	AZ24	S 390 GP	AZ12	S 270 GP	1.0
185990	186040	Embankment	Steel	50	2.0	-	-	-	-	4.5	6.5	AZ24	S 390 GP	AZ12	S 270 GP	1.0
186040	186090	Embankment	Steel	50	2.3	-	-	-	-	5.2	7.5	AZ24	S 390 GP	AZ12	S 270 GP	1.0
186090	186230	Embankment	Steel	140	2.0	-	-	-	-	4.5	6.5	AZ24	S 390 GP	AZ12	S 270 GP	1.0
186230	186270	Embankment	Steel	40	2.5	-	-	-	-	5.0	7.5	AZ24	S 390 GP	AZ12	S 270 GP	1.0
186270	186360	Embankment	Steel	90	2.0	-	-	-	-	4.5	6.5	AZ24	S 390 GP	AZ12	S 270 GP	1.0
186390	186443	Embankment	Steel	53	1.4	-	-	-	-	5.1	6.5	AZ12	S 390 GP	AZ12	S 270 GP	1.0
186489	186530	Embankment	Steel	41	1.9	-	-	-	-	4.1	6.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0
188522	188549	Embankment	Steel	27	2.7	-	-	-	-	8.3	11.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0
188721	188740	Embankment	Steel	19	2.0	-	-	-	-	6.0	8.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0
188740	188850	Embankment	Steel	110	2.8	-	-	-	-	6.2	9.0	AZ24	S 390 GP	AZ12	S 270 GP	1.5
188850	188865	Embankment	Steel	15	2.0	-	-	-	-	7.0	9.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0
188865	188893	Embankment	Steel	28	2.0	-	-	-	-	6.0	8.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0
191557	191582	Cutting	Steel	25	0.9	-	-	-	-	3.8	4.7	AZ12	S 390 GP	AZ12	S 270 GP	1.0
193320	193350	Cutting	Steel	30	2.3	-	-	-	-	7.7	10.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0

Sheet Piling Schedule Southbound

						King Sheet Pile Wall										
						Sheet Pile Wall				KSP (700mm sections)				Intermediate KSP Sections (770mm)		
Chainage Start	Chainage End	Earthwork Type	Sheet Pile Type	Total Structure Length (m)	Max. Retained Height (m)	Max. Embedment Depth (m)	Total Pile Length (m)	Section	Steel Grade	Max. Embedment Depth (m)	Total Pile Length (m)	Section	Steel Grade	Section	Steel Grade	Min. Embedment Depth (mbgl)
183798	183950	Cutting	Steel	152	1.4	-	-	-	-	4.1	5.5	AZ12	S 390 GP	AZ12	S 270 GP	1.0
187800	187835	Embankment	Steel	35	2.3	-	-	-	-	4.2	6.5	AZ 24	S 390 GP	AZ12	S 270 GP	1.0
187910	187931	Embankment	Steel	21	1.2	-	-	-	-	6.9	7.5	AZ12	S 390 GP	AZ12	S 270 GP	1.0
188100	188129	Embankment	Steel	29	1.4	-	-	-	-	5.6	7.0	AZ12	S 390 GP	AZ12	S 270 GP	1.0
188408	188500	Embankment	Steel	92	2.7	-	-	-	-	8.3	11.0	AZ46	S 390 GP	AZ12	S 270 GP	1.0
188500	188546	Embankment	Steel	46	2.0	-	-	-	-	6.0	8.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0
188746	188769	Embankment	Steel	23	2.3	-	-	-	-	5.2	7.5	AZ24	S 390 GP	AZ12	S 270 GP	2.5
188934	188956	Embankment	Steel	22	2.1	-	-	-	-	5.7	8.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0
189155	189171	Embankment	Steel	16	2.5	-	-	-	-	5.3	8.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0
189280	189305	Embankment	Steel	25	1.5	-	-	-	-	5.0	6.5	AZ12	S 390 GP	AZ12	S 270 GP	1.0
189750	189791	Embankment	Steel	41	2.9	-	-	-	-	6.1	9.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0
192085	192140	Embankment	Steel	55	2.0	-	-	-	-	6.0	8.0	AZ36	S 390 GP	AZ12	S 270 GP	1.0
192140	192190	Embankment	Steel	50	3.9	9.1	13.0	AZ50	S 390 GP	-	-	-	-	-	-	-
192190	192240	Embankment	Steel	50	3.1	-	-	-	-	7.9	11.0	AZ36	S 390 GP	AZ12	S 270 GP	1.0
192240	192260	Embankment	Steel	20	2.0	-	-	-	-	6.0	8.0	AZ36	S 390 GP	AZ12	S 270 GP	1.0
192260	192300	Embankment	Steel	40	3.1	-	-	-	-	7.9	11.0	AZ36	S 390 GP	AZ12	S 270 GP	1.0
192300	192370	Embankment	Steel	70	3.9	9.1	13.0	AZ50	S 390 GP	-	-	-	-	-	-	-
192370	192400	Embankment	Steel	30	3.1	-	-	-	-	7.9	11.0	AZ36	S 390 GP	AZ12	S 270 GP	1.0
192400	192480	Embankment	Steel	80	2.4	-	-	-	-	9.6	12.0	AZ36	S 390 GP	AZ12	S 270 GP	1.0
192480	192523	Embankment	Steel	43	2.3	-	-	-	-	9.7	12.0	AZ36	S 390 GP	AZ12	S 270 GP	1.0
192709	192770	Embankment	Steel	61	3.4	-	-	-	-	9.1	12.5	AZ50	S 390 GP	AZ12	S 270 GP	1.0
192770	192832	Embankment	Steel	62	2.5	-	-	-	-	6.0	8.5	AZ36	S 390 GP	AZ12	S 270 GP	1.0
193301	193320	Cutting	Steel	19	1.1	-	-	-	-	4.2	5.0	AZ12	S 390 GP	AZ12	S 270 GP	1.0
193680	193691	Cutting	Steel	11	1.5	-	-	-	-	5.5	7.0	AZ24	S 390 GP	AZ12	S 270 GP	1.0

Sheet Piling Schedule Merges & Diverges

										King Sheet Pile Wall						
						Sheet Pile Wall				KSP (700mm sections)				Intermediate KSP Sections (770mm)		
Chainage Start	Chainage End	Earthwork Type	Sheet Pile Type	Total Structure Length (m)	Max. Retained Height (m)	Max. Embedment Depth (m)	Total Pile Length (m)	Section	Steel Grade	Max. Embedment Depth (m)	Total Pile Length (m)	Section	Steel Grade	Section	Steel Grade	Min. Embedment Depth (mbgl)
184920	185000	Embankment	Steel	80	1.0	-	-	-	-	6.5	7.5	AZ12	S 390 GP	AZ12	S 270 GP	1.0

Asset	SMP Reference	Chainage (m)	Carriageway	Foundation type	Pile Type	Number of Piles	Pile Diameter (mm)	Pile Spacing (m)	Pile Length (m)
Gantry (MS4)	101	181950	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	11
Gantry (Super Cantilever)	112	185180	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	28
Gantry (Superspan Portal)	202	186240	NB	Pile Group	Bored	3 (1 x 3)	0.9	2.7	15.5
Gantry (Superspan Portal)	202	186240	SB	Pile Group	Bored	3 (1 x 3)	0.9	2.7	15.5
Gantry (ADS)	203	186400	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	25
Gantry (Super Cantilever)	204	186526	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	19
Gantry (Superspan Portal)	301	186847	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	13
Gantry (Superspan Portal)	301	186847	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	13
Gantry (ADS)	302	187073	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	21
Gantry (MS4)	326	187300	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	17
Gantry (ADS)	303	187608	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	20
Gantry (Super Cantilever)	304	187650	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	12.5
Gantry (MS4)	305	187818	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	9
Gantry (MS4)	307	188529	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	15
Gantry (ADS)	308	188760	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	26
Gantry (MS3)	309	188947	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	12
Gantry (MS4)	310	189160	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	6
Gantry (Superspan Portal)	311	189780	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	15.5
Gantry (Superspan Portal)	311	189780	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	15.5
Gantry (MS4)	312	190605	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	16
Gantry (MS3)	313	190771	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	8
Gantry (MS4)	314	191096	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	11
Gantry (ADS)	315	191296	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	25
Gantry (MS4)	316	191430	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	10.5
Gantry (MS4)	318	191801	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	13
Gantry (ADS)	319	192101	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	25
Gantry (Super Cantilever)	320	192290	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	12.5
Gantry (MS4)	321	192476	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	15
Gantry (ADS)	322	192906	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	15
Gantry (MS4)	323	193300	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	6
Gantry (MS4)	324	193331	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	7

Notes

This schedule should be read in conjuntion with the Series 1600 and 1700 Specifications and drawings

Asset	SMP Reference	Chainage (m)	Carriageway	Foundation type	Pad Size (W x L x D) (m)	Pile Type	Number of Piles	Pile Diameter (mm)	Pile Spacing (m)	Pile Length (m)
ROTTM	FTP_NB2	Removed from schedule								
ROTTM	FTP_NB2_200y	187767	NB	Pile Group	N/A	Bored	2	450	1.35	3.0
ROTTM	FTP_NB2_400y	187551	NB	Pile Group	N/A	Bored	2	450	1.35	3.0
ROTTM	FTP_NB2_600y	187368	NB	Pile Group	N/A	Bored	2	450	1.35	4.0
ROTTM	FTP_NB2_800y	187215	NB	Pile Group	N/A	Bored	2	450	1.35	6.0
ROTTM	FTP_NB2_1m	186340	NB	Pile Group	N/A	Bored	2	450	1.35	3.0
ROTTM	FTP_NB2_1m_2	186950	NB	Pile Group	N/A	Bored	2	450	1.35	5.0
ROTTM	FTP_NB4	Removed from schedule								
ROTTM	FTP_NB4_200y	191967	NB	Pad	2.3m x 2.0m x 1.5m	N/A	N/A	N/A	N/A	N/A
ROTTM	FTP_NB4_400y	191785	NB	Pile Group	2.3m x 2.0m x 1.5m	N/A	N/A	N/A	N/A	N/A
ROTTM	FTP_NB4_600y	191560	NB	Pad	2.3m x 2.0m x 1.5m	N/A	N/A	N/A	N/A	N/A
ROTTM	FTP_NB4_800y	191485	NB	Pad	2.3m x 2.0m x 1.5m	N/A	N/A	N/A	N/A	N/A
ROTTM	FTP_NB4_1m	190541	NB	Pile Group	N/A	Bored	2	450	1.35	5.0
ROTTM	FTP_SB2	Removed from schedule								
ROTTM	FTP_SB2_200y	192176	SB	Pile Group	N/A	Bored	2	450	1.35	3.5
ROTTM	FTP_SB2_400y	192357	SB	Pile Group	N/A	Bored	2	450	1.35	6.0
ROTTM	FTP_SB2_600y	192564	SB	Pile Group	N/A	Bored	2	450	1.35	5.5
ROTTM	FTP_SB2_800y	192731	SB	Pile Group	N/A	Bored	2	450	1.35	4.5
ROTTM	FTP_SB2_1m_1	193683	SB	Pad	2.3m x 2.0m x 2.0m	N/A	N/A	N/A	N/A	N/A
ROTTM	FTP_SB2_1m_2	193439	M	Pad	2.3m x 2.0m x 2.0m	N/A	N/A	N/A	N/A	N/A
ROTTM	FTP_SB3	Removed from schedule								
ROTTM	FTP_SB3_200y	190368	SB	Pile Group	N/A	Bored	2	450	1.35	6.5
ROTTM	FTP_SB3_400y	190640	SB	Pile Group	N/A	Bored	2	450	1.35	5.0
ROTTM	FTP_SB3_600y	190749	SB	Pile Group	N/A	Bored	2	450	1.35	4.0
ROTTM	FTP_SB3_800y	190932	SB	Pile Group	N/A	Bored	2	450	1.35	3.0
ROTTM	FTP_SB3_1m	191809	SB	Pad	2.3m x 2.0m x 1.5m	N/A	N/A	N/A	N/A	N/A
ROTTM	FTP_SB4	Removed from schedule								
ROTTM	FTP_SB4_200y	187923	SB	Pile Group	N/A	Bored	2	450	1.35	4.5
ROTTM	FTP_SB4_400y	188116	SB	Pile Group	N/A	Bored	2	450	1.35	6.0
ROTTM	FTP_SB4_600y	188240	SB	Pile Group	N/A	Bored	2	450	1.35	6.5
ROTTM	FTP_SB4_800y	188395	SB	Pile Group	N/A	Bored	2	450	1.35	6.0
ROTTM	FTP_SB4_1m	189299	SB	Pile Group	N/A	Bored	2	450	1.35	3.5
ROTTM	FTP_SB5	Removed from schedule								
ROTTM	FTP_SB5_200y	184105	SB	Pad	2.3m x 2.0m x 2.0m	N/A	N/A	N/A	N/A	N/A
ROTTM	FTP_SB5_400y	184306	SB	Pad	2.3m x 2.0m x 2.0m	N/A	N/A	N/A	N/A	N/A
ROTTM	FTP_SB5_600y	184474	SB	Pad	2.3m x 2.0m x 2.0m	N/A	N/A	N/A	N/A	N/A
ROTTM	FTP_SB5_800y	184672	SB	Pile Group	N/A	Bored	2	450	1.35	3.5
ROTTM	FTP_SB5_1m(b)	184925	M	Pad	2.3m x 2.0m x 2.0m	N/A	N/A	N/A	N/A	N/A
ROTTM	FTP_SB5_1m_2	185389	SB	Pad	2.3m x 2.0m x 1.5m	N/A	N/A	N/A	N/A	N/A
ROTTM	FTP_SB5_1m_1	Removed from schedule								

Asset	SMP Reference	Chainage Start	Chainage End	Length	Carriageway	Marker Post Start	Marker Post End	Noise Barrier Height (m)	Pile Type	Pile Diameter (mm)	Pile Length (m)
Noise Barrier	NB7_1	187865	187870	5	NB	187/8A+65	187/8A+70	3	Fixed to existing parapet plinth		
Noise Barrier	NB7_2	187870	187945	75	NB	187/8A+70	187/9A+45	3	Bored	450	9.0
Noise Barrier	NB7_3	187945	188000	55	NB	187/9A+45	188/0A+00	3	Fixed to existing parapet plinth		
Noise Barrier	NB7_4	188000	188195	195	NB	188/0A+00	188/1A+95	3	Bored	450	9.0
Noise Barrier	ENS2_1	189535	189560	25	SB	189/5B+35	189/5B+60	3	Existing to be retained		
Noise Barrier	ENS2_2	189560	189690	130	SB	189/5B+60	189/6B+90	4	Bored	750	8.0
Noise Barrier	ENS2_3	189690	189935	245	SB	189/6B+90	189/9B+35	3	Bored	450	7.0
Noise Barrier	ENS2_4	189935	189950	15	SB	189/9B+35	189/9B+50	2	Existing to be retained		
Noise Barrier	ENS2_5	189950	190115	165	SB	189/9B+50	190/1B+15	3	Bored	450	9.0
		190115	190125	10		190/1B+15	190/1B+25			750	7.0
		190125	190245	120		190/1B+25	190/2B+45			450	9.0
		190245	190265	20		190/2B+45	190/2B+65			750	7.0
		190265	190375	110		190/2B+65	190/3B+75			450	9.0
Noise Barrier	ENS3_1	190395	190655	260	SB	190/3B+95	190/6B+55	3	Bored	450	9.0
Noise Barrier	ENS3_2	190655	190660	5	SB	190/6B+55	190/6B+60	3	Fixed to new parapet plinth		
Noise Barrier	ENS3_3	190660	191030	370	SB	190/6B+60	191/0B+30	3	Bored	450	6.0
Noise Barrier	ENS3_4	191030	191080	50	SB	191/0B+30	191/0B+80	3	Existing to be retained		
Noise Barrier	ENS3_5	191080	191400	320	SB	191/0B+80	191/4B+00	4	Existing to be retained		
Noise Barrier	ENS3_6	191400	191455	55	SB	191/4B+00	191/4B+55	4	Bored	750	6.0
Noise Barrier	ENS3_7	191455	191535	80	SB	191/4B+55	191/5B+35	4	Existing to be retained		
Noise Barrier	ENS3_8	191535	191665	130	SB	191/5B+35	191/6B+65	4	Existing to be retained		
Noise Barrier	ENS4_1	190835	191025	190	NB	190/8A+35	191/0A+25	2	Bored	450	4.0
Noise Barrier	ENS4_2	191025	191060	35	NB	191/0A+25	191/0A+60	2	Bored	450	4.0
		191060	191080	20		191/0A+60	191/0A+80				5.0
		191080	191310	230		191/0A+80	191/3A+10				4.0
		191310	191360	50		191/3A+10	191/3A+60				4.0
Noise Barrier	ENS4_3	191360	191365	5	NB	191/3A+60	191/3A+65	2	Existing to be retained		
Noise Barrier	ENS4_4	191365	191480	115	NB	191/3A+65	191/4A+80	2	Bored	450	6.0
Noise Barrier	ENS4_5	191480	191640	160	NB	191/4A+80	191/6A+40	2	Existing to be retained		
Noise Barrier	ENS5_1	191680	192000	320	SB	191/6B+80	192/0B+00	4	Existing to be retained		
Noise Barrier	ENS5_2	192000	192020	20	SB	192/0B+00	192/0B+20	4	Bored	750	4.0
		192020	192140	120		192/0B+20	192/1B+40				6.0
		192140	192165	25		192/1B+40	192/1B+65				6.0
Noise Barrier	ENS5_3	192165	192265	100	SB	192/1B+65	192/2B+65	3	Bored	450	8.0
		192265	192530	265		192/2B+65	192/5B+30				7.0

Notes

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Asset	SMP Reference	New or Modified Existing	Chainage (m)	Carriageway	Foundation type	Pile Type	Pile Diameter (mm)	Pile Length (m)
CCTV	CCTV_01	Modified	182040	SB	Existing	Existing foundation to be reused		
CCTV	CCTV_02	New	182245	SB	Single Pile	Bored	450	3.0
CCTV	CCTV_03	Modified	182779	SB	Existing	Existing foundation to be reused		
CCTV	CCTV_04	New	182695	NB	Single Pile	Bored	750	7.0
CCTV	CCTV_05	New	183270	NB	Single Pile	Bored	450	5.0
CCTV	CCTV_06	New	183813	NB	Single Pile	Bored	450	3.0
CCTV	CCTV_07	New	184180	SB	Single Pile	Bored	450	3.0
CCTV	CCTV_08	New	184900	NB	Single Pile	Bored	450	5.0
CCTV	CCTV_09	Modified	185102	M	Existing	Existing foundation to be reused		
CCTV	CCTV_10	New	185379	K	Single Pile	Bored	750	7.0
CCTV	CCTV_11	New	186031	SB	Single Pile	Bored	750	7.0
CCTV	CCTV_12	New	186517	NB	Single Pile	Bored	450	5.0
CCTV	CCTV_13	Modified	186552	SB	Existing	Existing foundation to be reused		
CCTV	CCTV_14	New	186847	SB	Single Pile	Bored	450	5.0
CCTV	CCTV_15	New	187072	SB	Single Pile	Bored	750	5.0
CCTV	CCTV_16	New	187650	NB	Single Pile	Bored	750	5.0
CCTV	CCTV_17	New	187818	SB	Single Pile	Bored	750	5.0
CCTV	CCTV_18	New	188529	NB	Single Pile	Bored	750	7.0
CCTV	CCTV_19	New	188760	SB	Single Pile	Bored	750	5.0
CCTV	CCTV_20	Modified	189256	NB	Existing	Existing foundation to be reused		
CCTV	CCTV_21	New	189780	NB	Single Pile	Bored	750	5.0
CCTV	CCTV_22	New	190225	NB	Single Pile	Bored	750	5.0
CCTV	CCTV_23	New	190985	SB	Single Pile	Bored	750	7.0
CCTV	CCTV_24	New	191700	SB	Single Pile	Bored	750	5.0
CCTV	CCTV_25	New	192285	SB	Single Pile	Bored	450	5.0
CCTV	CCTV_26	New	192905	NB	Single Pile	Bored	750	5.0
CCTV	CCTV_27	New	193385	M	Single Pile	Bored	750	5.0
CCTV	CCTV_28	Modified	193502	NB	Existing	Existing foundation to be reused		
CCTV	CCTV_29	Modified	193597	NB	Existing	Existing foundation to be reused		
PTZ Camera	CCTV_30	New	182786	L	Single Pile	Bored	450	3.0
PTZ Camera	CCTV_31	New	192476	NB	Single Pile	Bored	750	5.0
CCTV	CCTV_32	Modified	193949	L	Existing	Existing foundation to be reused		

Notes

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CCTV 04 and 30 are located adjacent to overbridges, due to lack of topographical data it has been assumed that the cameras are to be located within the earthwork

Asset	SMP Reference	Chainage (m)	Carriageway	Foundation type	Planted Depth (m)	Pile Type	Pile Diameter (mm)	Pile Length (m)
Radar	RAD_01	181920	NB	Single Pile	N/A	Bored	450	3.0
Radar	RAD_02	182220	NB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_03	182275	SB	Single Pile	N/A	Bored	450	3.0
Radar	RAD_04	182812	NB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_05	183240	NB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_06	183284	SB	Single Pile	N/A	Bored	450	5.0
Radar	RAD_07	183781	NB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_08	183850	SB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_09	184350	NB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_10	184420	SB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_11	184890	NB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_12	184921	SB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_13	185210	SB	Single Pile	N/A	Bored	450	3.0
Radar	RAD_14	185595	NB	Single Pile	N/A	Bored	450	3.0
Radar	RAD_15	186265	NB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_16	186505	NB	Single Pile	N/A	Bored	450	3.0
Radar	RAD_17	186872	NB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_18	187290	SB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_19	187620	NB	Single Pile	N/A	Bored	450	3.0
Radar	RAD_20	187828	SB	Single Pile	N/A	Bored	450	3.0
Radar	RAD_21	188172	SB	Single Pile	N/A	Bored	450	5.0
Radar	RAD_22	188501	NB	Single Pile	N/A	Bored	450	7.0
Radar	RAD_23	188854	SB	Single Pile	N/A	Bored	450	5.0
Radar	RAD_24	189190	SB	Single Pile	N/A	Bored	450	3.0
Radar	RAD_25	189788	NB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_26	190205	NB	Single Pile	N/A	Bored	450	7.0
Radar	RAD_27	190630	SB	Single Pile	N/A	Bored	450	5.0
Radar	RAD_28	191085	SB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_29	191440	SB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_30	191775	NB	Single Pile	N/A	Bored	450	3.0
Radar	RAD_31	192128	NB	Single Pile	N/A	Bored	450	3.0
Radar	RAD_32	192313	SB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_33	192466	NB	Single Pile	N/A	Bored	450	5.0
Radar	RAD_34	192834	NB	Single Pile	N/A	Bored	450	3.0
Radar	RAD_35	193290	SB	Planted	1.2	N/A	N/A	N/A
Radar	RAD_36	193696	SB	Single Pile	N/A	Bored	450	3.0
Radar	RAD_37	193960	SB	Single Pile	N/A	Bored	450	3.0

Notes

This schedule should be read in conjuntion with the Series 1600 Specifications and drawings

Options have been given for both a bored pile and driven pile solution due to the potential risk of driveability issues.

Asset	SMP Reference	Chainage (m)	Carriageway	Foundation type	Pile Type	Pile Diameter (mm)	Pile Length (m)
EAV Pole	EAV_01-3	183613	NB	Single Pile	Bored	450	3.0
EAV Pole	EAV_06-3	184590	SB	Single Pile	Bored	450	3.0
EAV Pole	EAV_05-3M	187912	SB	Single Pile	Bored	450	3.0
EAV Pole	EAV_02-3	189630	NB	Single Pile	Bored	450	3.0
EAV Pole	EAV_03	191701	NB	Single Pile	Bored	450	5.0
EAV Pole	EAV_04-3	192478	SB	Single Pile	Bored	450	3.0

Notes

This schedule should be read in conjuntion with the Series 1600 and 1700 Specifications and drawings

Options have been given for both a bored pile and driven pile solution due to the potential risk of driveability issues.

Asset	SMP Reference	Chainage	Carriageway	Pad or Pile	Pad Size (w x l x d) (m)	No of Piles Required per Sign Post Leg	Pile Group Layout (Width x Length)	Total No of Piles Required	Pile Type	Pile Diameter (mm)	Pile Length (m)
Large Traffic Sign	NB03	182109	NB	Pad	2.6 x 3.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	NB04	182413	NB	Pad	2.6 x 3.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	NB07	183411	NB	Jerol Pad Foundation		N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	NB11	183700	NB	Pad	2.6 x 2.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	NB13	184135	NB	Pad	2.6 x 4.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	NB19	184905	NB	Pile	N/A	1	N/A	1	Bored	450	5.0
Large Traffic Sign	NB21	185180	NB	Pad	2.6 x 3.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	NB30	186480	NB	Pile	N/A	1	N/A	2	Bored	450	5.0
Large Traffic Sign	NB31	186790	NB	Pile	N/A	2	1 x 2	4	Bored	450	5.0
Large Traffic Sign	NB32	186630	NB	Pad	2.6 x 3.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	NB41	187450	NB	Pile	N/A	1	N/A	2	Bored	450	5.0
Large Traffic Sign	NB42	187630	NB	Pile	N/A	2	1 x 2	4	Bored	450	5.0
Large Traffic Sign	NB46	188748	NB	Pile	N/A	1	N/A	2	Bored	450	10.0
Large Traffic Sign	NB50	188561	NB	Pile	N/A	1	N/A	2	Bored	450	10.0
Large Traffic Sign	NB58	190800	NB	Pile	N/A	1	N/A	2	Bored	450	5.0
Large Traffic Sign	NB70	192660	NB	Pile	N/A	1	N/A	2	Bored	450	5.0
Large Traffic Sign	NB75	193173	NB	Pad	2.6 x 2.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	NB76	193171	NB	Pad	2.6 x 2.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	SB03	194700	SB	Pad	2.6 x 2.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	SB11	192302	SB	Pile	N/A	2	1 x 2	4	Bored	450	9.0
Large Traffic Sign	SB12	192430	SB	Pile	N/A	1	N/A	2	Bored	450	10.0
Large Traffic Sign	SB14	191970	SB	Pad	2.6 x 3.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	SB28	190578	SB	Pile	N/A	1	N/A	2	Bored	450	10.0
Large Traffic Sign	SB37	189200	SB	Pile	N/A	2	1 x 2	4	Bored	450	5.0
Large Traffic Sign	SB40	188880	SB	Pile	N/A	1	N/A	2	Bored	450	5.0
Large Traffic Sign	SB43	188522	SB	Pile	N/A	1	N/A	2	Bored	450	10.0
Large Traffic Sign	SB48	188321	SB	Pile	N/A	2	1 x 2	6	Bored	450	9.0
Large Traffic Sign	SB50	188180	SB	Pile	N/A	2	1 x 2	4	Bored	450	9.0
Large Traffic Sign	SB54	187712	SB	Pile	N/A	2	1 x 2	4	Bored	450	5.0
Large Traffic Sign	SB55	187518	SB	Pile	N/A	1	N/A	2	Bored	450	5.0
Large Traffic Sign	SB56	187418	SB	Pile	N/A	1	N/A	2	Bored	450	5.0
Large Traffic Sign	SB62	187230	SB	Pile	N/A	1	N/A	2	Bored	450	5.0
Large Traffic Sign	SB69	186605	SB	Pile	N/A	2	1 x 2	4	Bored	450	5.0
Large Traffic Sign	SB72	186183	SB	Pile	N/A	1	N/A	2	Bored	450	5.0
Large Traffic Sign	SB76	185597	SB	Pile	N/A	1	N/A	2	Bored	450	3.0
Large Traffic Sign	SB84	184220	SB	Pad	2.6 x 2.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	SB86	183963	SB	Jerol Pad Foundation		N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	SB89	183565	SB	Pad	2.6 x 3.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	SB92	183436	SB	Pile	N/A	1	N/A	2	Bored	450	5.0
Large Traffic Sign	SB96	182544	SB	Pad	2.6 x 3.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Large Traffic Sign	SB98	196220	SB	Pile	N/A	N/A	N/A	2	Bored	450	7.0
Slip Road Sign	NBS04	0 + 245	23a Entry Slip	Pad	2.6 x 3.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	NBS05	0 + 245	23a Entry Slip	Pile	N/A	1	N/A	2	Bored	450	5.0
Slip Road Sign	NBS07	0 +160	24 Entry Slip	Pad	2.6 x 2.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	NBS12	0 + 220	24a Entry Slip	Pile	N/A	1	N/A	2	Bored	450	7.0
Slip Road Sign	SBS04	0 + 60	25 Entry Slip	Pile	N/A	1	N/A	2	Bored	450	5.0
Slip Road Sign	SBS07	0 + 310	24a Exit Slip	Pad	2.6 x 3.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	SBS08	0 + 308	24a Exit Slip	Pad	2.6 x 3.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	SBS11	0 + 103	24 Exit Slip	Pad	2.6 x 2.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	SBS12	0 + 30	24a Entry Slip	Pad	2.6 x 2.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	SBS18	0 + 360	23a Exit Slip	Pad	2.6 x 3.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A
Ghost Island Sign	TS1	183485	NB	Pile	N/A	2	1 x 2	8	Bored	450	5.0
Ghost Island Sign	TS2	183890	NB	Pile	N/A	2	1 x 2	8	Bored	450	5.0
Ghost Island Sign	TS3	184146	SB	Pile	N/A	2	1 x 2	6	Bored	450	3.0
Ghost Island Sign	TS4	183748	SB	Pile	N/A	2	1 x 2	6	Bored	450	3.0

Notes

This schedule should be read in conjuntion with the Series 1700 Specifications and drawings

Asset	SMP Reference	Chainage	Carriageway	Planted Option Possible	Minimum Planted Depth (m)	Alternative Pad or Pile	Pad Size (w x l x d) (m)	No of Piles Required per Sign Post Leg	Pile Group Layout (Width x Length)	Total No of Piles Required	Pile Type	Pile Diameter (mm)	Pile Length (m)
Single Post Sign	NB01	181808	NB	No	N/A	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB02	181970	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB05	182460	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB06	182948	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB08	183445	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB09	183654	NB	NAL socket foundation to be used				N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB10	183750	NB	No	N/A	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB12	183945	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB14	183995	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB15	184335	NB	No	N/A	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB16	184095	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB17	184455	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB18	184195	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB20	184970	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB22	185227	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB23	185243	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB23A	185243	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB24	185255	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB25	185500	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB27	185595	NB	No	N/A	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB28	186112	NB	No	N/A	Pile	N/A	1	N/A	1	Bored	450	7.0
Single Post Sign	NB29	186154	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB33	186675	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB34	186693	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB35	186693	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB36	186703	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB39	187120	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB40	187500	NB	No	N/A	Pile	N/A	1	N/A	1	Bored	450	7.0
Single Post Sign	NB43	187598	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB44	188167	NB	No	N/A	Pile	N/A	1	N/A	1	Bored	450	7.0
Single Post Sign	NB45	188089	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB47	188793	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB48	189013	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB48A	189013	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB49	189024	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB51	188977	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB52	189250	NB	No	N/A	Pile	N/A	1	N/A	1	Bored	450	7.0
Single Post Sign	NB53	189492	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB55	189976	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB56	190063	NB	No	N/A	Pile	N/A	1	N/A	1	Bored	450	7.0
Single Post Sign	NB57	190449	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB59	190845	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB60	190866	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB61	190866	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB62	190872	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB63	190947	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB65	191476	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB66	191850	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB68	192240	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB69	192635	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB71	192725	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB72	192731	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB73	192811	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB77	193171	NB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB78	193300	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	NB80	193547	NB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB07	193535	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB08	193450	SB	No	N/A	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB09	192798	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB10	192684	SB	No	N/A	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB13	192250	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB15	191944	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB17	191902	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB18	191902	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB19	191887	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB22	191550	SB	No	N/A	Pile	N/A	1	N/A	1	Bored	450	7.0
Single Post Sign	SB24	191347	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB25	191140	SB	No	N/A	Pile	N/A	1	N/A	1	Bored	450	7.0
Single Post Sign	SB26	191040	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB29	190550	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB30	190532	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB31	190532	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB32	190514	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB34	189873	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB35	189570	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB36	189540	SB	No	N/A	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB38	189275	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB39	188971	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB41	188728	SB	No	N/A	Pile	N/A	1	N/A	1	Bored	450	7.0
Single Post Sign	SB44	188474	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB45	188454	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB46	188454	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB47	188434	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB49	188192	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB53	187783	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB57	187383	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB58	187280	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB59	187310	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB60	187188	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB63	186746	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB64	186730	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB65	186650	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB66	186570	SB	Yes	0.6	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB68	186463	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB73	186095	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB75	186450	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB79	184974	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB83	184450	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB85	184202	SB	NAL socket foundation to be used				N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB87	183945	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB91	183456	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB95	182945	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Single Post Sign	SB97	185820	SB	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	NBS01	0 + 62.5	23a Entry Slip	No	N/A	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	NBS06	0 + 120	24 Entry Slip	No	N/A	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	NBS09	0 + 192	24a Entry Slip	No	N/A	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	SBS03	0 - 8	25 Entry Slip	No	N/A	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	SBS09	0 + 180	24a Exit Slip	Yes	1.0	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	SBS10	0	24a Entry Slip	No	N/A	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	SBS17	0 - 23	24 Entry Slip	No	N/A	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A
Slip Road Sign	SBS20	0 + 230	24a Exit Slip	Yes	0.8	Pad	1.2 x 2.0 x 1.2	N/A	N/A	N/A	N/A	N/A	N/A

Notes

This schedule should be read in conjuntion with the Series 1700 Specifications and drawings

Appendix F. Strengthened Earthwork Appraisal Form

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06 Product Development & Production

Preconstruction and Construction services

Smart Motorways Programme

M1 Junction 23a to 25

Strengthened Earthwork Appraisal Form: Gabion Retaining Walls

June 2017

Notice

This document and its contents have been prepared and are intended solely for Highways England's information and use in relation to the Smart Motorways Programme.

Document history

Amey Arup assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

This document has 38 pages including the cover.

Revision history

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Revision	Purpose description	Originated	Checked	Reviewed	Approved	Date
P01	Design Fix 5	SB	AMTB	GS	TB	05/06/2017

Document control

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Project	SMP M1 Junction 23a to 25 PIN No 549342
Document title	Strengthened Earthwork Appraisal Form: Gabion Retaining Walls
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1. Introduction

This report relates to the Smart Motorway scheme on the M1 motorway between Junctions 23a (East Midlands Airport) and 25 (A52 Nottingham).

The M1 in the East Midlands is a key strategic route that carries high volumes of heavy goods and other vehicles between the conurbations in Leicestershire, Nottinghamshire, Derbyshire and beyond to South and West Yorkshire, with key links to the West Midlands and the South.

The proposed SMP scheme for M1 Junctions 23a to 25 includes the following elements:

- Smart Motorway infrastructure to enable hard shoulder running;
- Emergency Refuge Areas (ERAs);
- Lane specific signals and gateway gantries;
- Rigid concrete barrier in central reserve;
- Lighting;
- Pavement and drainage renewals;
- Environmental barrier;
- Cross Carriageway Ducts (CCDs);
- Tie-in to development of the proposed strategic rail freight terminal between Junctions 24 and 24a.

Where verge widening is located on an embankment or in a cutting, earthworks and/or retaining structures will be needed.

The Amey Arup Joint Venture (AMAR) Geotechnical Design Report (GDR) [Ref 1] describes the philosophy behind the geotechnical design solutions for structure foundations, earthworks and retaining structures for the Smart Motorway works. Stand-alone Geotechnical Summary Sheets were produced that outline the ground model, material parameters and geotechnical design at the specific location of major geotechnical solutions; these are appended to the GDR [Ref 1].

This Strengthened Earthwork Appraisal Form (SEAF) looks at the design philosophy for gabion retaining walls and has been produced by AMAR in accordance with the requirements of HD22/08 [Ref 2] as a Design Fix 5 deliverable. A revised SEAF will be issued to incorporate any major design changes during the construction phases. Minor changes shall be incorporated in a Geotechnical Feedback Report (GFR).

The following geotechnical reports have been produced for this scheme:

- AMAR, ‘M1 J23a - J25, Statement of Intent (SoI), Report Ref. HA549342-AAJV-HGT-SWI-RP-CE-000001, HAGDMS Ref. 28704’, October 2015 [Ref 3];
- AMAR, ‘M1 Junction 23a to 25, Ground Investigation Report (GIR), Report Ref. HA549342-AAJV-HGT-SWI-RP-CE-000002, HAGDMS Ref. 28929, February 2016’ [Ref 4];
- AMAR, ‘M1 Junction 23a to 25, Geotechnical Design Report, Report Ref. HA549342-AAJV-HGT-SWI-RP-CE-000003, HAGDMS Ref. 29152’, June 2017 [Ref 1].

2. Scheme Details

2.1. Name of Scheme

Smart Motorways Programme M1 J23a to 25.

2.2. Type of highway

The M1 from Junction 23a to Junction 25 is a 16km stretch of three lane motorway.

2.3. Permitted Traffic Speed

70mph (48kph).

2.4. Nature of Scheme / Scheme Element

Earthworks modification to incorporate road widening and installation of new Smart Motorways elements summarised in Section 1 of this report.

3. Strengthened Earthwork Type, Purpose and Location

3.1. Generic Type of Strengthened Earthwork

The gabion retaining wall will be designed as a gravity wall.

The height will vary between approximately 1.05m and 1.50m.

The front face of the wall will slope backwards at an angle of 6°.

The wall will have a stepped rear face construction.

Further details of the formation of the gabion retaining wall are shown in the Standard Detail Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000602, which is appended to this SEAF.

3.2. Purpose of Strengthened Earthwork

The purpose of using strengthened earthworks is to accommodate verge widening required to incorporate the installation of Smart Motorways elements.

3.3. Intended Location(s) for Use

The scheme comprises a section of the M1 Motorway between Junctions 23a and 25. The Ordnance Survey Grid Co-ordinates for the Site are approximately:

- Junction 23a: E: 446900, N: 324770;
- Junction 24: E: 447530, N: 327620;
- Junction 24a: E: 447250, N: 328900;
- Junction 25: E: 447190, N: 335610.

Cutting slopes at the proposed gabion locations, as shown in the LiDAR survey information, have a range of approximate slope gradients of 22° to 27° and approximate maximum heights of 3.6m to 7.5m, comprising weathered bedrock (Mercia Mudstone – III/IV) or Embankment Fill (reworked Mercia Mudstone).

The lengths of retaining wall range from 28m to 177m.

Table 3-1 provides a summary of the approximate locations of all currently proposed gabion walls.

Table 3-1 – Gabion Wall Locations

Chainage	NB/SB	Start	Finish	Length of Wall (m)
182800-182880	NB	E 446999, N 325259	E 447024, N 325335	80
183701-183789	NB	E 447265, N 326121	E 447290, N 326200	77
183996-184024	NB	E 447355, N 326401	E 447363, N 326426	28
192971-193020	NB	E 447140, N 335014	E 447145, N 335059	49
193251-193321	NB	E 447167, N 335286	E 447170, N 335355	70
193350-193475	NB	E 447171, N 335384	E 447171, N 335392	125
193320-193497	SB	E 447212, N 335358	E 447214, N 335531	177

Table 3-2 provides a schedule of all currently proposed gabion retaining walls.

Table 3-2 – Schedule of Gabion Walls

Chainage	NB/SB	Earthwork Type	Maximum Earthwork Height (m)	Maximum Retained Height (m)	Length of Wall (m)
182800-182880	NB	Cutting	5.0	1.05	80
183701-183788	NB	Cutting	5.0	1.10	77
183996-184024	NB	Cutting	3.6	1.10	28
192971-193020	NB	Cutting	7.5	1.49	49
193251-193321	NB	Cutting	6.4	1.05	70
193350-193475	NB	Cutting	7.0	1.50	125
193320-193497	SB	Cutting	5.8	1.10	177

4. Outline of Existing Ground and Groundwater Conditions

4.1. Ground Investigation Data

Historical Ground Investigations (GIs) relevant to the scheme extents were outlined in Section 3.1 and Appendix B of the AMAR SoI [Ref 3] and in Section 2.7 of the AMAR GIR [Ref 4]. The findings from these GIs were reviewed as part of Section 4 and 5 of the AMAR GIR [Ref 4].

4.2. Existing Ground Conditions

Details of the existing ground conditions for the scheme extents are presented in Sections 4 and 5 of the AMAR GIR [Ref 4].

Location-specific GI data from historical GI data for each gabion wall location was assessed and presented in the form of Geotechnical Summary Sheets, which are included as Appendix A of the AMAR GDR [Ref 1]:

4.3. Existing Groundwater Conditions

Details of the existing groundwater conditions for the scheme extents are presented in Section 5.5 of the AMAR GIR [Ref 4].

Ground water level is assumed at 1.0m below toe of cutting.

For global stability analyses, each stratum was modelled with a Ru value of 0.2.Soil and Groundwater Chemistry

Details of the soil and groundwater chemistry for each stratum within the scheme extents are presented in Section 5 of the AMAR GIR [Ref 4].

4.4. Existing Geotechnical Problems and Risks

Geotechnical and geo-environmental risk assessments of the proposed scheme were undertaken in accordance with HD22/08 [Ref 2] and HD41/15 [Ref 5]. The Geotechnical Risk Register is included as Section 11 of the AMAR GDR [Ref 1].

5. Proposed Strengthened Earthwork

5.1. Description of Strengthened Earthwork

It is proposed to construct gabion walls at the 7 No. locations shown in Tables 3-1 and 3-2 of this SEAF.

The proposed gabion walls comprise inclined gabion baskets tilted at 6°, to be constructed parallel to the motorway.

In accordance with Table A.1 of the Interim Advice Note 124/11 – Annex A [Ref 6], the design working life of the retaining structure (Design Working Life Category 5) will be ≥120 years.

The standard details for the gabion walls are recorded on the Standard Detail Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000602 which is appended to this SEAF.

The locations of the gabion baskets are included in the Earthwork General Arrangement Drawing Sequence HA549342-AMAR-HGT-SWI-DR-CE-000603 to HA549342-AMAR-HGT-SWI-DR-CE-000616, which is appended to this SEAF.

The maximum retained heights and lengths of gabion walls are included in Table 3-2 of this SEAF.

Details of the construction methodology are included in the AMAR Series 600 Specification [Ref 7] for this scheme.

5.2. Foundation Preparation, including any Measures to deal with Geotechnical Problems

The gabion walls will be founded within the weathered bedrock (Mercia Mudstone – III/IV).

A minimum embedment depth of 0.5m below carriageway level will be used to incorporate the gabion basket foundation.

Standard benching detail, as shown in Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000602, which is appended to this SEAF, is to be applied in accordance with the AMAR Series 600 Specification [Ref 7] for this scheme. Where a deviation from the standard benching details is necessary to ensure global stability, this has been highlighted in the relevant Geotechnical Summary Sheet, included as Appendix A to the AMAR GDR [Ref 1].

5.3. Materials to be used in Construction

The proposed layouts of the materials to be used in construction are recorded on the Standard Detail Drawing No. HA549342-AMAR-HGT-SWI-DR-CE-000602 which is appended to this SEAF.

Existing materials behind the gabion wall are to be excavated and replaced with 6N granular fill in accordance with the AMAR Series 600 Specification [Ref 7] for this scheme.

Details of the gabion wire mesh, fill, etc. are provided in the AMAR Series 600 Specification [Ref 7] for this scheme.

5.4. Drainage Measures

Retaining walls have been designed to allow the incorporation of drainage assets within the scheme.

5.5. Arrangements for Highway Furniture and Buried Services and Landscaping

Any existing underground services, including drainage, will need to be diverted.

5.6. Inspection and Maintenance

Future maintenance inspections, in accordance with BD 63/07 [Ref 8] and HD 41/15 [Ref 5] will be required.

Hard shoulder closure may be necessary for such inspections.

Routine inspection of the finished structures can be made on foot from the crest and the 'toe' of the structure.

5.7. Interface with Structures

The interface of the gabion walls with earthworks, retaining walls and any other structures are to be finalised as part of an assessment of interface between all earthwork widening solutions to be undertaken during site mobilisation; during which time verification surveys are scheduled to be undertaken.

6. Design Methods

6.1. Internal Stability

The methods used for design checks included the limit equilibrium approach in accordance with the NA to BS EN 1997-1:2004+A1:2013 [Ref 9].

Internal check analyses for sliding and overturning, for each gabion layer, were completed using GawacWin software [Ref 10].

Any potential passive resistance at the front of the wall was not taken into consideration during the analyses for a conservative approach.

6.2. External / Global Stability

Global stability analysis of the gabion retaining wall was undertaken using SLOPE/W software [Ref 11] in accordance with the NA to BS EN 1997-1:2004+A1:2013 [Ref 9].

7. Design/Assessment Criteria

7.1. List of Relevant Documents

List of Relevant Documents:

- BRE Construction Division, 'BRE Special Digest 1:2005, Concrete in aggressive ground', 2005 [Ref 12];
- British Standards Institute, 'BS 6031:2009, Code of Practice for Earthworks', 2009 [Ref 13];
- British Standards Institute, 'BS 8002:2015, Code of Practice for Earth Retaining Structures', 2015 [Ref 14];
- British Standards Institute, 'BS EN 1990:2002+A1:2005, Eurocode – Basis of Structural Design', 2010 [Ref 15];
- British Standards Institution, 'BS EN 1997-1:2004+A1:2013, Eurocode 7, Geotechnical design, General rules', 2013 [Ref 16];
- British Standards Institution, 'NA to BS EN 1990:2002+A1:2005, Eurocode – Basis of structural design', 2004 [Ref 17];
- British Standards Institution, 'NA+A1:2014 to BS EN 1997-1:2004+A1:2013, UK National Annex to Eurocode 7: Geotechnical Design, Part 1 – General Rules', 2007 [Ref 9];
- CIRIA, 'CIRIA C143, The standard penetration test (SPT): methods and use', 1995 [Ref 18];
- CIRIA, 'CIRIA C570, Engineering in Mercia Mudstone', 2001 [Ref 19];
- CIRIA, 'CIRIA C580, Embedded retaining walls – guidance for economic design', 2003 [Ref 20];
- CIRIA & DETR Environment Transport Regions, 'CIRIA C516, Modular gravity retaining walls – design guidance', 2000 [Ref 21];
- The Highways Agency, 'Design Manual for Roads and Bridges, Volume 1 (Highways Structures: Approval Procedures and General Design) Section 3 (General Design) Part 14, BD 37/01, (Loads For Highway Bridges)', 2001 [Ref 22];
- The Highways Agency, 'Design Manual for Roads and Bridges, Volume 3 Highways Structures: Inspection and Maintenance, Section 1 Inspection, Part 4, BD 63/07, Inspection of Highway Structures', 2007 [Ref 8];
- The Highways Agency, 'Design Manual for Roads and Bridges, Volume 4 Geotechnics and Drainage, Section 1 Earthworks, Part 2, HD 22/08, Managing Geotechnical Risk', 2008 [Ref 2];
- The Highways Agency, 'Interim Advice Note 124/11, Use of Eurocodes for the design of highway structures', 2011 [Ref 6];
- Highways England, 'IAN 161/15 – Smart Motorways', 2015 [Ref 23].

7.2. Limit State Design Criteria

Analysis of the gabion wall was undertaken using Gawacwin [Ref 10] and SLOPE/W [Ref 11] software with active and passive earth pressures in accordance with NA+A1:2014 to BS EN 1997-1:2004+A1:2013 [Ref 9]. The analyses used Design Approach 1, which looked at failure in the soil and in the structure using two sets of partial factors.

7.3. Serviceability Design Criteria

No serviceability limits have been applied during the design; compliance with limit state design requirements should ensure adequate serviceability.

No allowance for total/differential settlement of the gabion retaining walls along their length has been made, as this form of construction is considered sufficiently flexible to cater for differential settlement that may occur.

7.4. Design Parameters for Soils and Materials

Geotechnical design parameters for soils and materials are outlined for each gabion wall location in the Geotechnical Summary Sheets appended to the AMAR GDR [Ref 1].

The following assumptions have been made for the gabion basket:

- Unit weight of gabion basket = 24kN/m^3 (for rock fill);
- Porosity = 33% (therefore modelled with a unit weight of 18kN/m^3).

The following assumptions have been made for the granular material (Class 6N) to be used as backfill behind the gabions and as a founding layer:

- Unit weight = 20kN/m^3;
- Angle of shearing resistance ϕ' = 36°.

7.5. Design Groundwater Conditions

For internal stability analyses, groundwater level was assumed to be 1.0m below cutting toe.

For global stability analyses, each stratum was modelled with a Ru value of 0.2.

7.6. Live Loadings

Loads were modelled as shown in with Section 2.2.4 and 3.4 of the AMAR GDR [Ref 1].

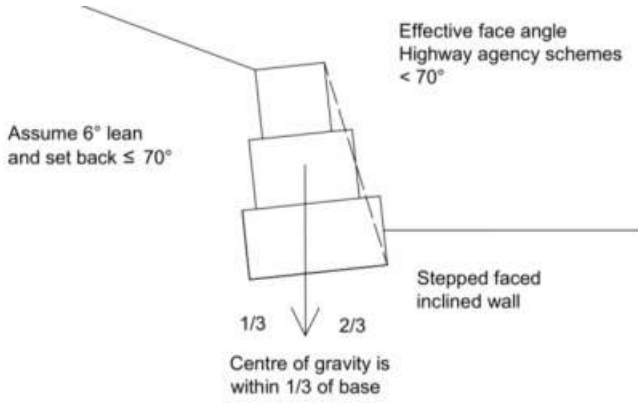
7.7. Description / Diagram of Idealised Soil Structure Model to be used in Analysis

A gabion retaining wall is reliant on the gravitational resistance developed by the gabion fill to support the retained material.

For equilibrium the disturbing moment must be balanced with the restoring moment caused by the gabion wall.

An idealised diagram of the gabion wall to illustrate the design method and associated main design assumptions shown in Figure 7-1 below:

Figure 7-1 Gabion Wall Detail



7.8. Precautions against Chemical Attack to Materials

None.

7.9. Proposed Departures from Design Standards

None.

8. Checking

8.1. General

In accordance with HD 22/08 (Appendix E) [Ref 2] the design should be checked by a Geotechnical Engineer who is independent of the design team.

9. Drawings and Documents

9.1. List of Drawings and Documents Accompanying Submission

Appendix A **Soils Information**

Refer to the below Geotechnical Summary Sheets for the relevant gabion wall locations, of which are appended to the AMAR GDR:

- HA549342-AMAR-HGT-182800-182890NB-GSS-CE-000001;
- HA549342-AMAR-HGT-183620-183780NB-GSS-CE-000001;
- HA549342-AMAR-HGT-184000-184450NB-GSS-CE-000001;
- HA549342-AMAR-HGT-193200-193420NB-GSS-CE-000001;
- HA549342-AMAR-HGT-193430-193480NB-GSS-CE-000001;
- HA549342-AMAR-HGT-193300-193490SB-GSS-CE-000001.

Appendix B **Relevant Correspondence, Documents and Certificates from Consultation with Relevant Authorities**

None.

Appendix C **Drawings and Documents**

The below drawings are appended to this SEAF:

- Drawing No. HA549342-AMAR-HGT-MLC-DR-CE-000602, Rev P02, Typical Retaining Solutions – Gabion Wall;
- Drawing Sequence HA549342-AMAR-HGT-MLC-DR-CE000603 to HA549342-AMAR-HGT-MLC-DR-CE000616, Rev P03, Gabion Wall Earthworks Design Solutions

10. References

1. AMAR, 'M1 Junction 23a to 25, Geotechnical Design Report, Report Ref. HA549342-AAJV-HGT-SWI-RP-CE-000003, HAGDMS Ref. 29152', Rev P02, June 2017;
2. The Highways Agency, 'Design Manual for Roads and Bridges, Volume 4 Geotechnics and Drainage, Section 1 Earthworks, Part 2, HD 22/08, Managing Geotechnical Risk', 2008;
3. AMAR, 'M1 J23a - J25, Statement of Intent, Report Ref. HA549342-AAJV-HGT-SWI-RP-CE-000001, HAGDMS Ref. 28704', Rev P01, October 2015;
4. AMAR, 'M1 Junction 23a to 25, Ground Investigation Report, Report Ref. HA549342-AAJV-HGT-SWI-RP-CE-000002, HAGDMS Ref. 28929', Rev P01, February 2016;
5. The Highways Agency, 'Design Manual for Roads and Bridges, Volume 4 (Geotechnics and Drainage) Section 1 (Earthworks) Part 3, HD 41/15, (Maintenance of Highway Geotechnical Assets)', 2015;
6. The Highways Agency, 'Interim Advice Note 124/11, Use of Eurocodes for the design of highway structures', 2011;
7. AMAR, 'M1 Junction 23a to 25, 'Volume 2 Works Information, Specification Appendices Series 600 Earthworks', December 2016, Rev P09, February 2017;
8. The Highways Agency, 'Design Manual for Roads and Bridges, Volume 3 Highways Structures: Inspection and Maintenance, Section 1 Inspection, Part 4, BD 63/07, Inspection of Highway Structures', 2007;
9. British Standards Institution, 'NA+A1:2014 to BS EN 1997-1:2004+A1:2013, UK National Annex to Eurocode 7: Geotechnical Design, Part 1 – General Rules', 2007;
10. Maccaferri Ltd, GawacWin 2003;
11. Geo-Slope International, Geo Studio 2012 (August 2015 Release), SLOPE/W Slope Stability Analysis;
12. BRE Construction Division, 'BRE Special Digest 1:2005, Concrete in aggressive ground', 2005;
13. British Standards Institute, 'BS 6031:2009, Code of Practice for Earthworks', 2009;
14. British Standards Institute, 'BS 8002:2015, Code of Practice for Earth Retaining Structures', 2015;
15. British Standards Institute, 'BS EN 1990:2002+A1:2005, Eurocode – Basis of Structural Design', 2010;
16. British Standards Institution, 'BS EN 1997-1:2004+A1:2013, Eurocode 7, Geotechnical design, General rules', 2013;
17. British Standards Institution, 'NA to BS EN 1990:2002+A1:2005, Eurocode – Basis of structural design', 2004;
18. CIRIA, 'CIRIA C143, The standard penetration test (SPT): methods and use', 1995;
19. CIRIA, 'CIRIA C570, Engineering in Mercia Mudstone', 2001;
20. CIRIA, 'CIRIA C580, Embedded retaining walls – guidance for economic design', 2003;
21. CIRIA & DETR Environment Transport Regions, 'CIRIA C516, Modular gravity retaining walls – design guidance', 2000;
22. The Highways Agency, 'Design Manual for Roads and Bridges, Volume 1 (Highways Structures: Approval Procedures and General Design) Section 3 (General Design) Part 14, BD 37/01, (Loads For Highway Bridges)', 2001;
23. Highways England, 'IAN 161/15 – Smart Motorways', 2015.

11. THE ABOVE DESIGN AND CONSTRUCTION PROPOSALS ARE SUBMITTED FOR REVIEW.

Signed: .....

Geotechnical Team Leader, Design Team

Name: .....

Engineering Qualifications: .....

Date: .....

On Behalf of .....

Geotechnical Certificate Ref No. .....

*Signed: .....

*Contractor (Agent or Contracts Director)

*Name: .....

*Date: .....

*on behalf of .....

* delete as appropriate

12. The Above SEAF Is

i: received*

ii: received with comments as follows*

iii: return marked “comments” as follows*

* delete as appropriate.

Signed: .....

Overseeing Organisation’s Geotechnical Advisor

Name: .....

Date:

Appendix A. Soils Information

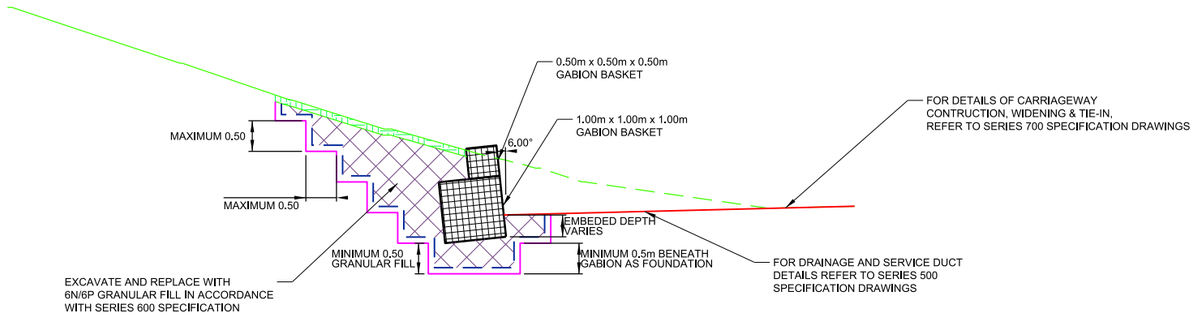
Refer to the below Geotechnical Summary Sheets for the relevant gabion wall locations, of which are appended to the AMAR GDR:

- HA549342-AMAR-HGT-182800-182890NB-GSS-CE-000001;
- HA549342-AMAR-HGT-183620-183780NB-GSS-CE-000001;
- HA549342-AMAR-HGT-184000-184450NB-GSS-CE-000001;
- HA549342-AMAR-HGT-193200-193420NB-GSS-CE-000001;
- HA549342-AMAR-HGT-193430-193480NB-GSS-CE-000001;
- HA549342-AMAR-HGT-193300-193490SB-GSS-CE-000001.

Appendix B. Relevant Correspondence, Documents and Certificates from Consultation with Relevant Authorities

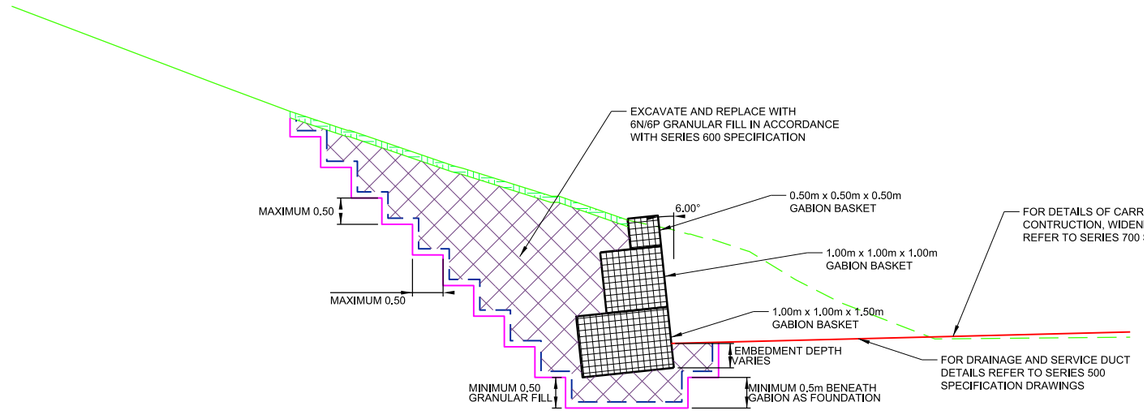
None.

Appendix C. Drawings and Documents



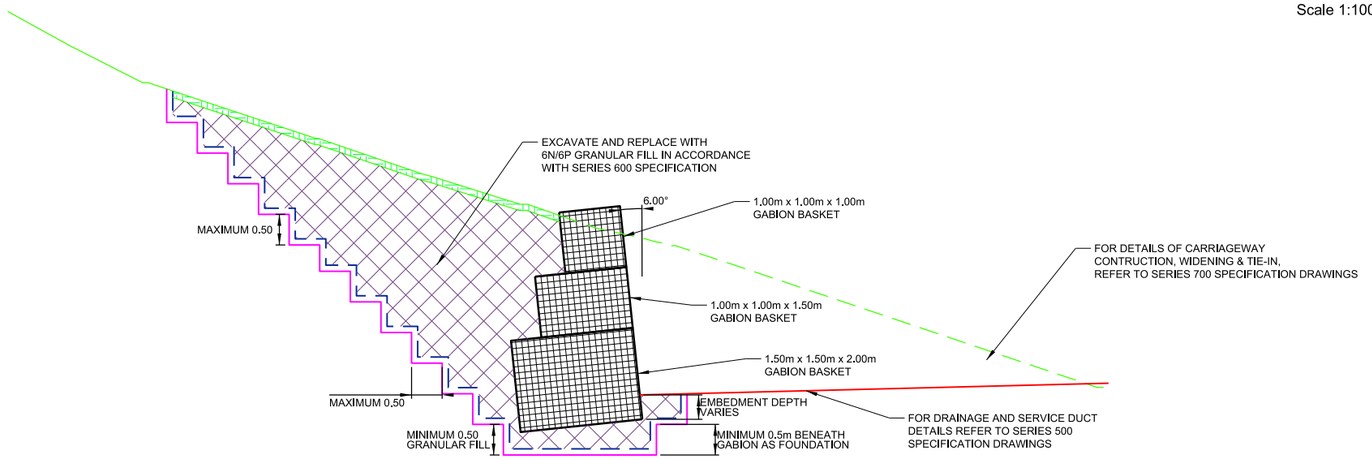
GABION WALL DETAIL (1.00m RETAINED HEIGHT)

Scale 1:100 @ A3



GABION WALL DETAIL (2.00m RETAINED HEIGHT)

Scale 1:100 @ A3



GABION WALL DETAIL (3.00m RETAINED HEIGHT)

Scale 1:100 @ A3

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NOTES

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2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRAWING SERIES HA549342-AMAR-HGT-MLC-DR-CE-000001 TO HA549342-AMAR-HGT-MLC-DR-CE-000013.
3. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR HGT-SWI-SP-CE-000002.)
4. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
5. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
6. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
7. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150mm FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300mm FOR SHALLOWER GRADIENTS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
9. EXCAVATION PROFILES WILL VARY DEPENDING ON TOPOGRAPHY.
10. FOR TYPICAL DETAILS OF GABION WALL SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000602.
11. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001601.
11. FOR TYPICAL DETAILS OF LOW HEIGHT RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001602.

LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]
- GABION WALL

Rev	Date	By	Chkd	Appd
P02	24/04/17	TB	---	SV

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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Drawing Title: RETAINING SOLUTIONS GABION WALL

Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

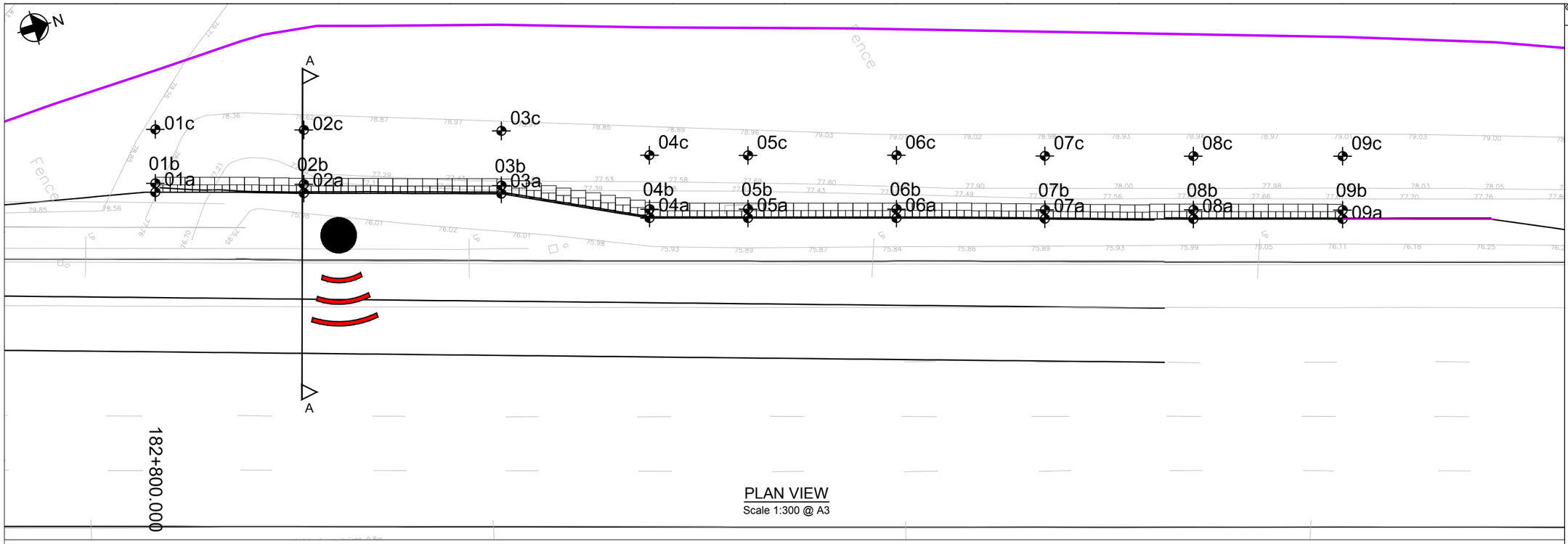
Job No: 244508-00

Rev: P02

Name: HA549342-AMAR-HGT-SWI-DR-CE-000602

pw:\MCONTS04.global.arup.com:PW_ARUP_UKDocuments\SMP M1 J23a - J25\01 Amey Arup JV\CE - Civil - Earthworks and Geotechnics\DR - Drawing\HA549342-AMAR-HGT-SWI-DR-CE-000602

Do not scale



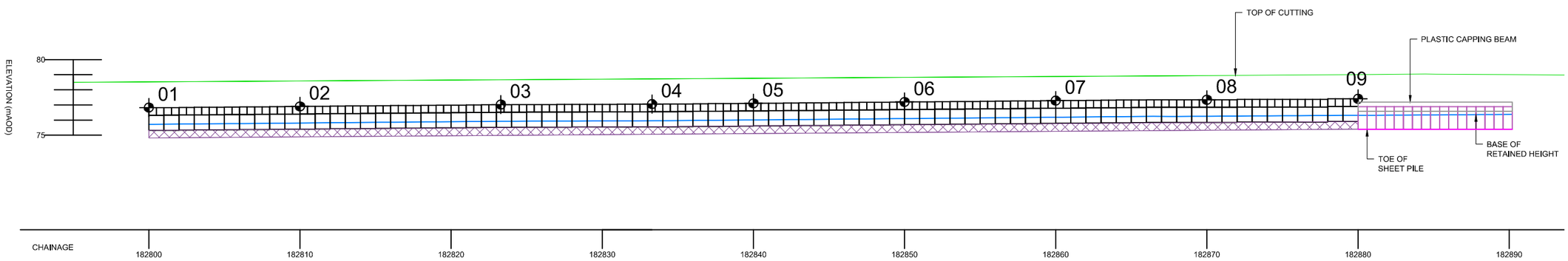
PLAN VIEW
Scale 1:300 @ A3

GABION WALL SETTING OUT POINTS

	BASE OF RETAINED HEIGHT [a]			BACK OF GABION [b]			BACK OF BATTER [c]			GABION WALL DETAILS	
REFERENCE	EASTING	NORTHING	LEVELS (mAOD)	EASTING	NORTHING	LEVELS (mAOD)	EASTING	NORTHING	LEVELS (mAOD)	TOTAL RETAINED HEIGHT (m)	EMBEDMENT DEPTH (m)
001	446998.90	325259.02	75.72	446998.33	325259.20	76.77	446994.86	325260.26	78.50	1.05	0.45
002	447001.91	325268.56	75.80	447001.34	325268.74	76.85	446997.84	325269.81	78.20	1.05	0.45
003	447004.88	325278.11	75.88	447004.36	325278.27	76.93	447000.84	325279.35	78.70	1.05	0.45
004	447008.87	325287.29	75.96	447008.29	325287.47	77.01	447004.82	325288.52	78.10	1.05	0.45
005	447012.33	325296.66	76.04	447011.76	325296.84	77.09	447008.30	325297.91	78.10	1.05	0.45
006	447015.28	325306.22	76.12	447014.7	325306.40	77.17	447011.23	325307.46	78.10	1.05	0.45
007	447018.27	325315.76	76.20	447017.69	325315.94	77.25	447014.23	325317.01	78.50	1.05	0.45
008	447021.22	325325.31	76.25	447020.65	325315.94	77.30	447017.18	325326.56	78.50	1.05	0.45
009	447024.19	325334.92	76.31	447023.62	325335.10	77.36	447020.15	325336.17	78.50	1.05	0.45

ELEVATION LEGEND

- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- TOE OF SHEET PILE
- PLASTIC CAPPING BEAM
- PLASTIC SHEET PILES
- GABION WALL
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]



ELEVATION
Scale 1:300 @ A3

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NOTES

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2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- PLASTIC SHEET PILE LOCATION
- GABION WALL
- SECTION LINE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

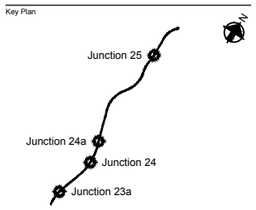
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

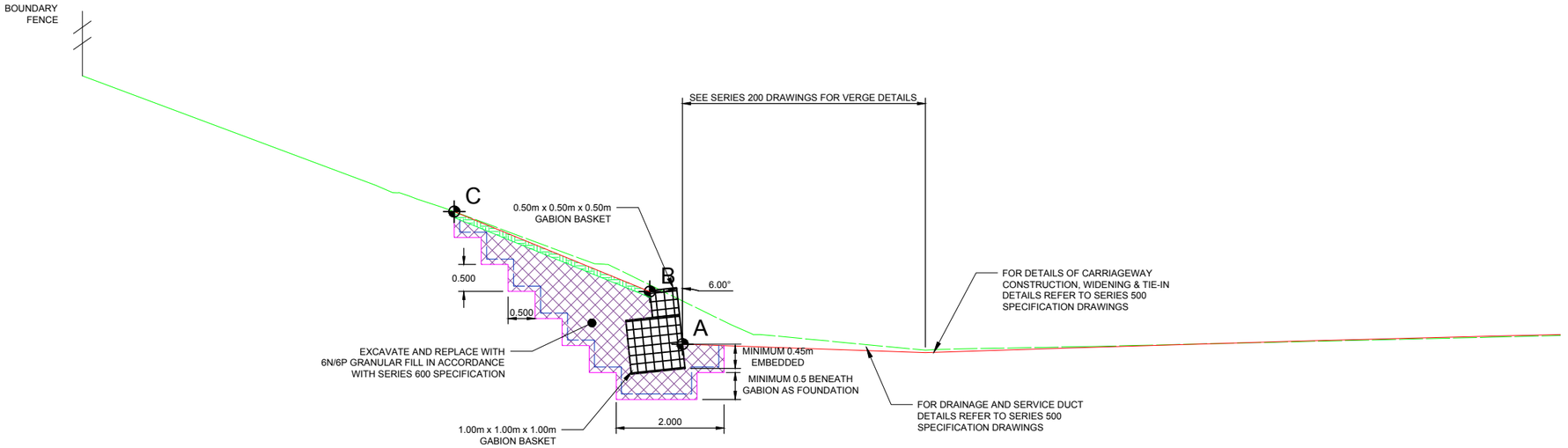
Key Plan



Drawing Title
EARTHWORKS DESIGN SOLUTION PLAN
CH.182800 TO CH.182880 (NB)
SHEET 01 OF 02

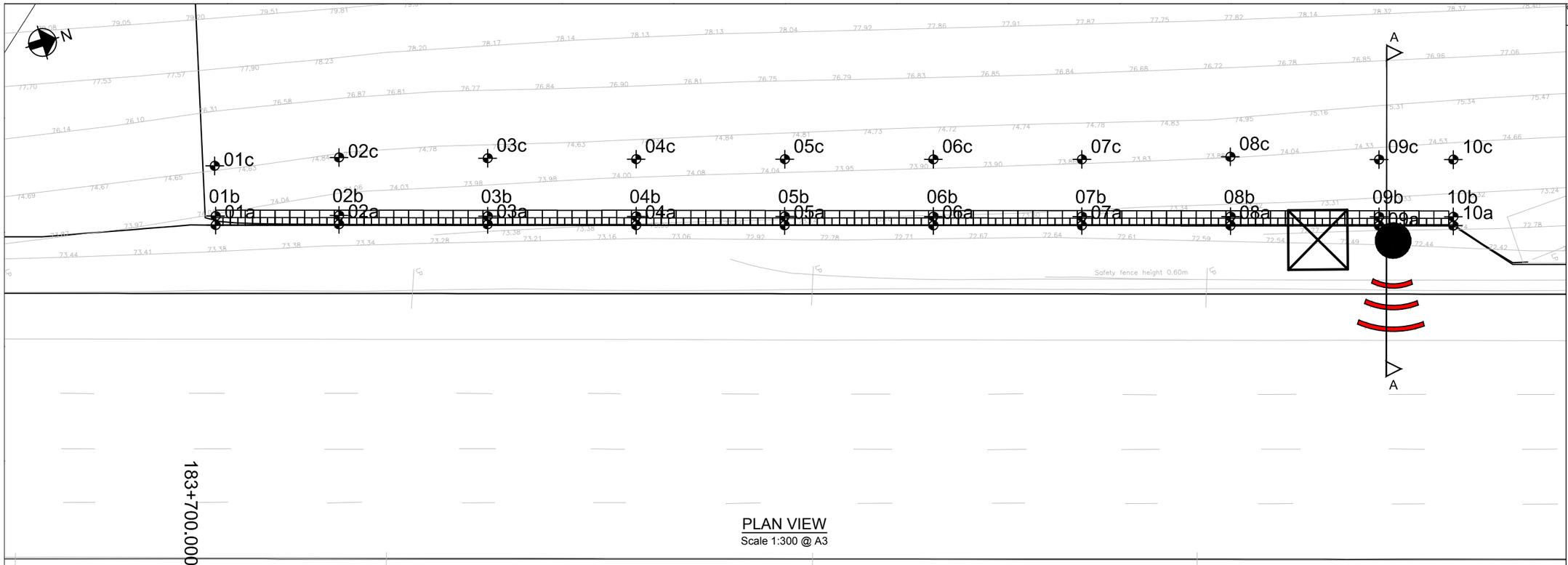
Scale at A1: 1:150
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: 244508-00
Rev: P03
Name: HA549342-AMAR-HGT-SWI-DR-CE-000603

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Level Datum =73.000

| | | |



PLAN VIEW
Scale 1:300 @ A3

GABION WALL SETTING OUT POINTS

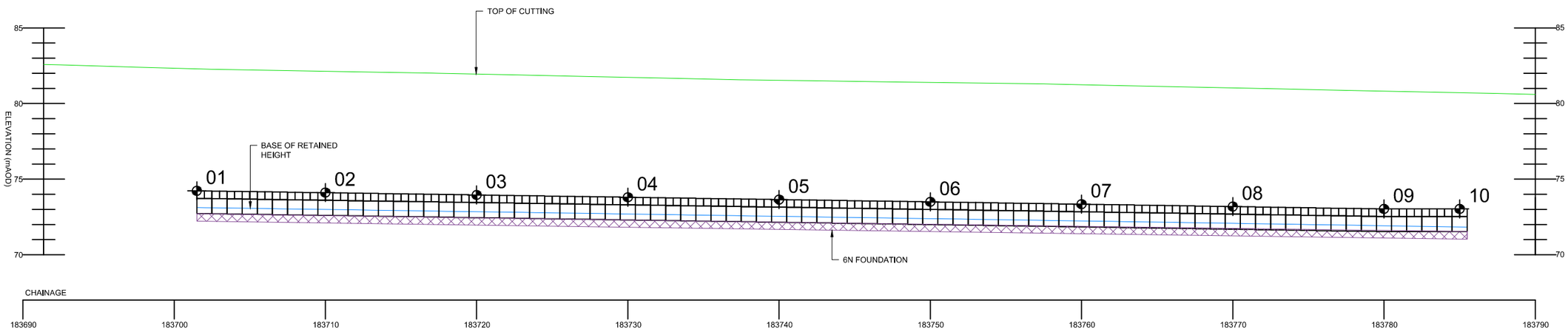
	BASE OF RETAINED HEIGHT [a]			BACK OF GABION [b]			BACK OF BATTER [c]		
REFERENCE	EASTING	NORTHING	LEVEL (mAOD)	EASTING	NORTHING	LEVEL (mAOD)	EASTING	NORTHING	LEVEL (mAOD)
001	447265.00	326121.00	73.13	447264.00	326121.00	74.23	447261.00	326122.00	74.90
002	447267.00	326128.00	73.00	447267.00	326129.00	74.10	447263.00	326130.00	74.60
003	447270.00	326138.00	72.80	447270.00	326138.00	73.90	447266.00	326139.00	74.40
004	447273.00	326148.00	72.70	447273.00	326148.00	73.80	447269.00	326149.00	74.30
005	447276.00	326157.00	72.50	447276.00	326157.00	73.60	447272.00	326158.00	74.00
006	447279.00	326167.00	72.40	447279.00	326167.00	73.50	447275.00	326168.00	74.00
007	447282.00	326176.00	72.20	447282.00	326176.00	73.30	447278.00	326178.00	73.90
008	447285.00	326186.00	72.10	447285.00	326186.00	73.20	447281.00	326187.00	73.90
009	447288.00	326195.00	71.90	447288.00	326196.00	73.00	447284.00	326197.00	73.90
0010	447290.00	326200.00	71.80	447289.00	326200.00	72.90	447285.00	326201.00	73.90

GABION WALL DETAILS

TOTAL RETAINED HEIGHT (m)	EMBEDMENT DEPTH (m)
1.10	0.40
1.10	0.40
1.10	0.40
1.10	0.40
1.10	0.40
1.10	0.40
1.10	0.40
1.10	0.40
1.10	0.40
1.10	0.40

ELEVATION LEGEND

- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- GABION BASKET
- GRANULAR FILL [REFER SERIES 600 SPECIFICATION]



ELEVATION
Scale 1:300 @ A3

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NOTES

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3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- GABION LOCATION
- SETTING OUT POINTS
- SECTION LINE

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

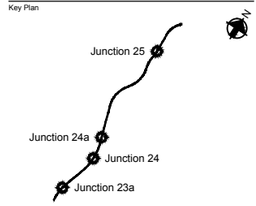
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
EARTHWORKS DESIGN SOLUTION PLAN
CH.183701 TO CH.183788 (NB)
SHEET 01 OF 02

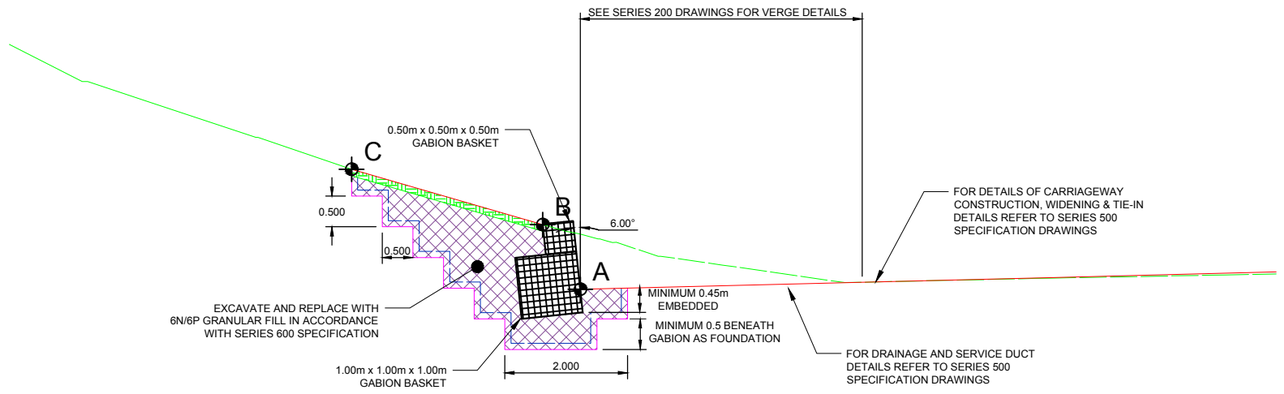
Scale at A1: 1:150
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P03**
Name: **HA549342-AMAR-HGT-SWI-DR-CE-000605**

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NOTES
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3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.

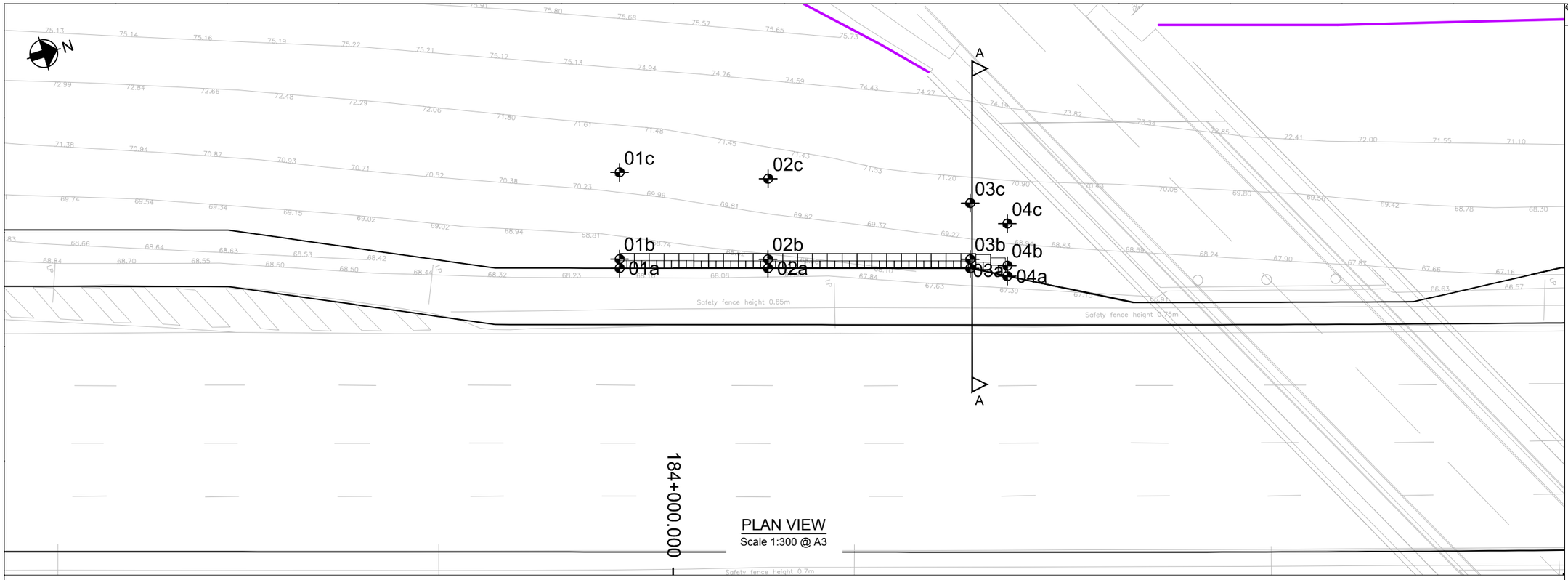
SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL [MINIMUM 0.1m]
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]
- GABION BASKET
- X SETTING OUT POINT



Level Datum =69.000

| | | |



PLAN VIEW
Scale 1:300 @ A3

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NOTES

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5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- GABION LOCATION
- SETTING OUT POINTS
- SECTION LINE

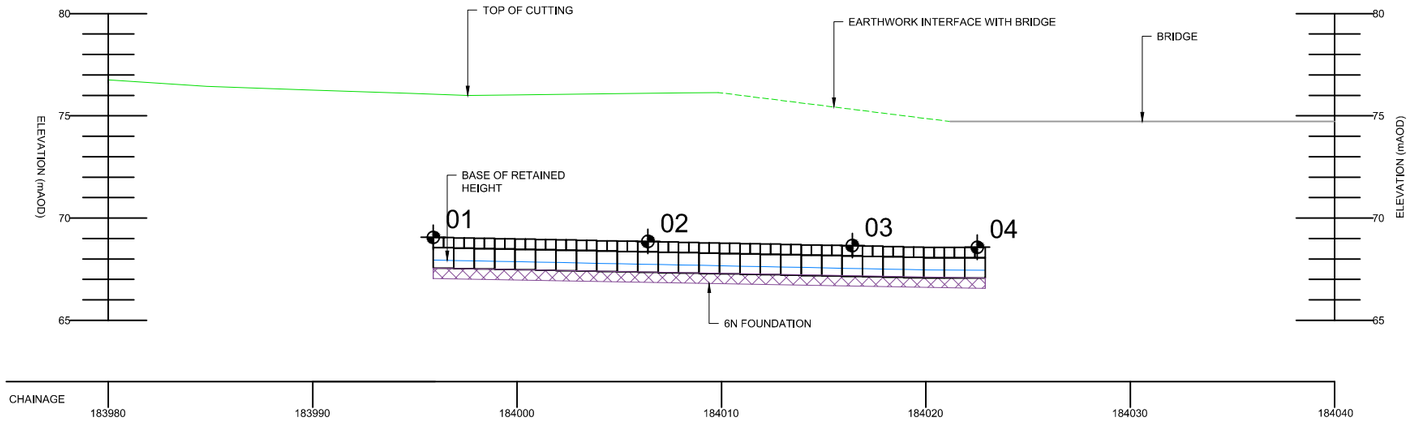
GABION WALL SETTING OUT POINTS

GABION WALL DETAILS

	BASE OF RETAINED HEIGHT [a]			BACK OF GABION [b]			BACK OF BATTER [c]				
REFERENCE	EASTING	NORTHING	LEVEL (mAOD)	EASTING	NORTHING	LEVEL (mAOD)	EASTING	NORTHING	LEVEL (mAOD)	TOTAL RETAINED HEIGHT (m)	EMBEDMENT DEPTH (m)
001	447355.28	326401.08	67.95	447354.70	326401.26	69.05	447349.12	326402.98	70.90	1.10	0.40
002	447358.23	326410.63	67.70	447357.65	326410.81	68.80	447352.48	326412.42	70.70	1.10	0.40
003	447361.18	326420.19	67.55	447360.61	326420.36	68.65	447356.99	326421.48	70.50	1.10	0.40
004	447363.49	326425.88	67.45	447362.82	326426.09	68.55	447360.11	326426.93	70.40	1.10	0.40

ELEVATION LEGEND

- BASE OF RETAINED HEIGHT (FROM OF WALL GROUND LEVEL)
- TOP OF CUTTING
- GABION BASKET
- GRANULAR FILL [REFER SERIES 600 SPECIFICATION]



SECTION
Scale 1:300 @ A3

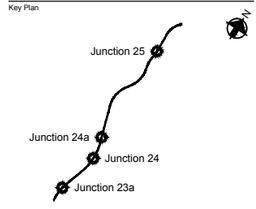
Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV
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Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

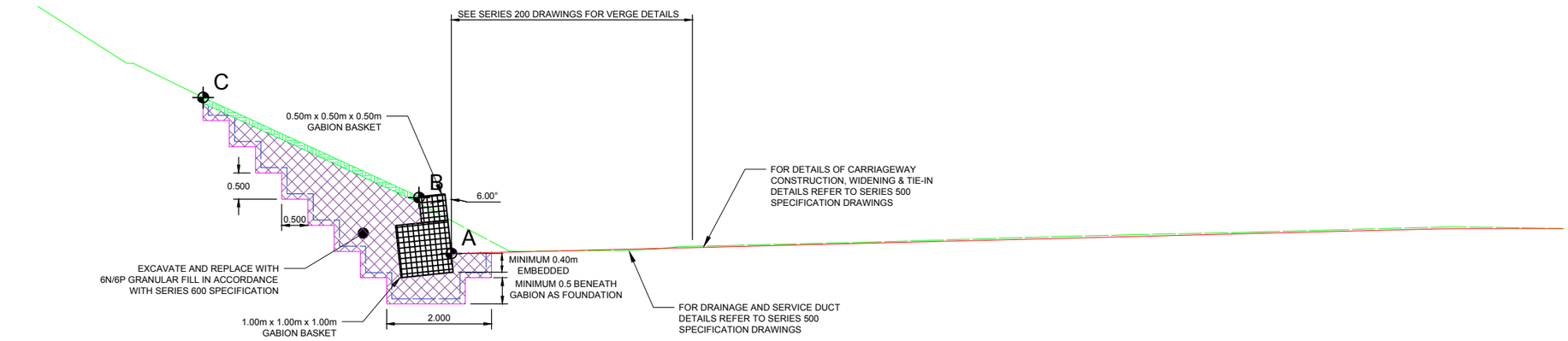
Key Plan



Drawing Title
EARTHWORKS DESIGN SOLUTION PLAN
CH.183996 TO CH.184024 (NB)
SHEET 01 OF 02

Scale at A1: 1:150
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P03**
Name: **HA549342-AMAR-HGT-SWI-DR-CE-000607**

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Level Datum =65.000

DESIGN LEVELS

68.129 67.463 67.558 67.571 67.663 67.756 67.848 67.933 67.940 67.940

LIDAR LEVELS

71.098 71.094 69.865 69.141 69.137 68.430 67.509 67.506 67.525 67.527 67.549 67.553 67.598 67.619 67.679 67.714 67.795 67.820 67.874 67.915 67.974 67.976

SECTION A-A
CH. 184020
Scale 1:100 @ A3

NOTES
1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
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3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL [MINIMUM 0.1m]
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]
- GABION BASKET
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

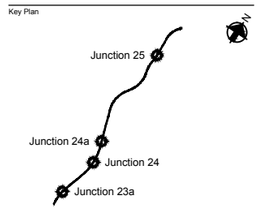
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: EARTHWORKS DESIGN SOLUTION CROSS SECTION CH.183996 TO CH.184024 (NB) SHEET 02 OF 02

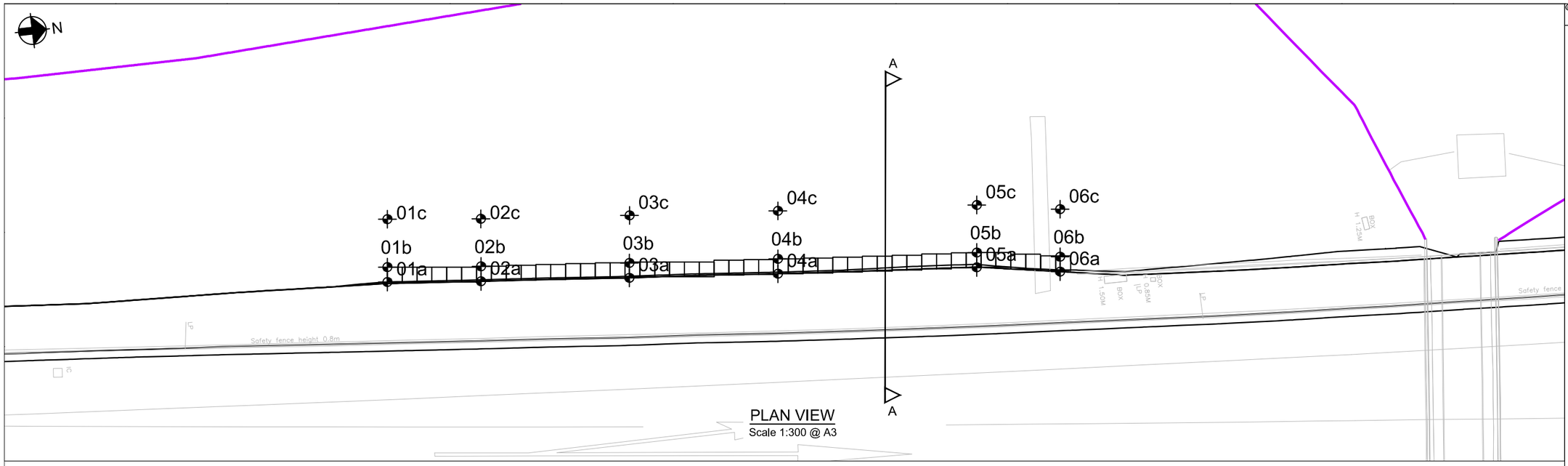
Scale at A1: 1:50

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P03**

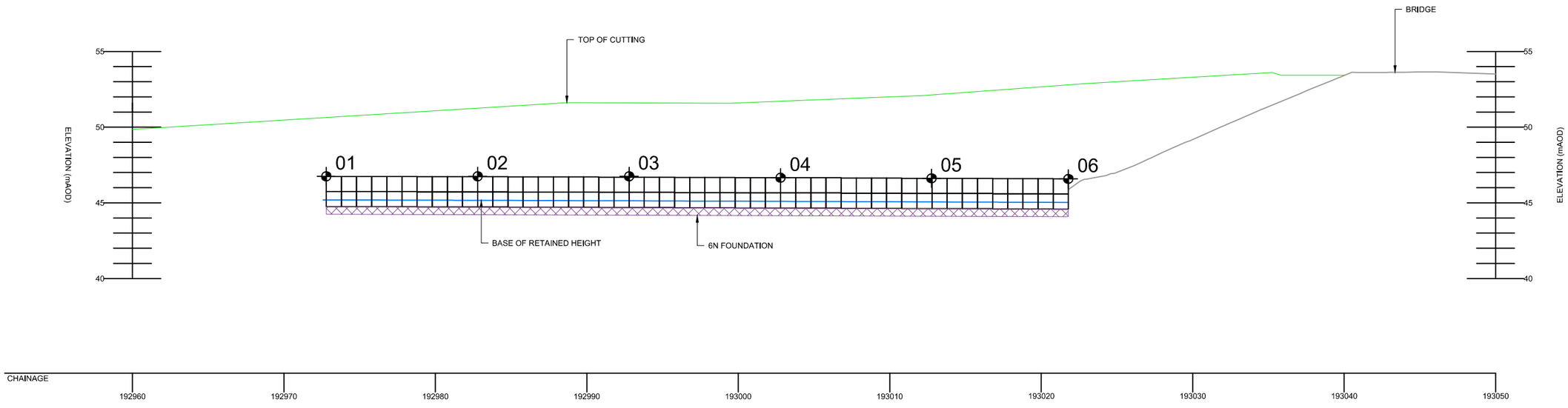
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PLAN VIEW
Scale 1:300 @ A3

GABION WALL SETTING OUT POINTS

	BASE OF RETAINED HEIGHT [a]			BACK OF GABION [b]			BACK OF BATTER [c]			GABION WALL DETAILS	
REFERENCE	EASTING	NORTHING	LEVEL (mAOD)	EASTING	NORTHING	LEVEL (mAOD)	EASTING	NORTHING	LEVEL (mAOD)	TOTAL RETAINED HEIGHT (m)	EMBEDMENT DEPTH (m)
001	447140.31	335014.34	45.20	447139.31	335014.45	46.69	447136.11	335014.83	47.70	1.49	0.45
002	447141	335020.61	45.20	447140.01	335020.73	46.69	447136.83	335021.09	47.70	1.49	0.45
003	447141.94	335030.56	45.10	447140.95	447140.95	46.59	447137.77	335031.06	47.60	1.49	0.45
004	447142.84	335040.53	45.10	447141.84	335040.64	46.59	447138.64	335041.02	47.60	1.49	0.45
005	447143.68	335050.49	45.10	447142.69	335050.61	46.59	447139.51	335050.98	47.50	1.49	0.45
006	447144.92	335059.43	45	447143.93	335059.54	46.49	447140.75	335059.92	47.50	1.49	0.45



SECTION
Scale 1:300 @ A3

ELEVATION LEGEND

- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- GABION BASKET
- GRANULAR FILL [REFER SERIES 600 SPECIFICATION]

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NOTES

1. ALL DIMENSIONS AND MEASUREMENTS ARE IN METRES (m) UNLESS OTHERWISE STATED.
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3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- GABION LOCATION
- SETTING OUT POINTS
- SECTION LINE

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

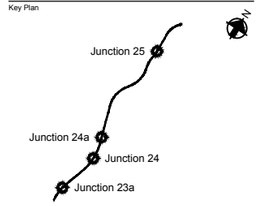
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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: EARTHWORKS DESIGN SOLUTION PLAN
CH.192971 TO CH.193020 (NB)
SHEET 01 OF 02

Scale at A1: 1:150

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P03**

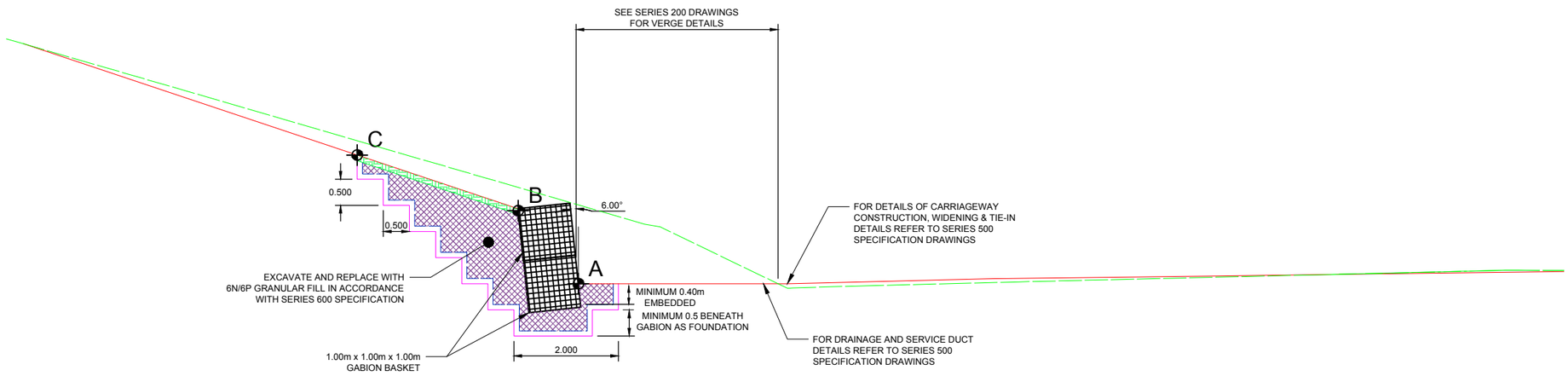
Name: **HA549342-AMAR-HGT-SWI-DR-CE-000609**

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8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL [MINIMUM 0.1m]
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]
- GABION BASKET
- X SETTING OUT POINT



Level Datum =42.000

DESIGN LEVELS	46.624	45.072	45.072	45.085	45.168	45.213	45.257	45.300
LIDAR LEVELS	46.211	46.160	44.986	44.991	45.034	45.074	45.107	45.238	45.242	45.321	45.330	45.329

SECTION A-A
CH. 193010
Scale 1:100 @ A3

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

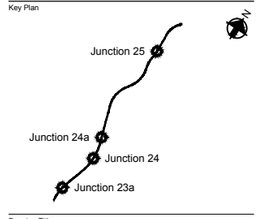
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Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: EARTHWORKS DESIGN SOLUTION CROSS SECTION CH.192971 TO CH.193020 (NB) SHEET 02 OF 02

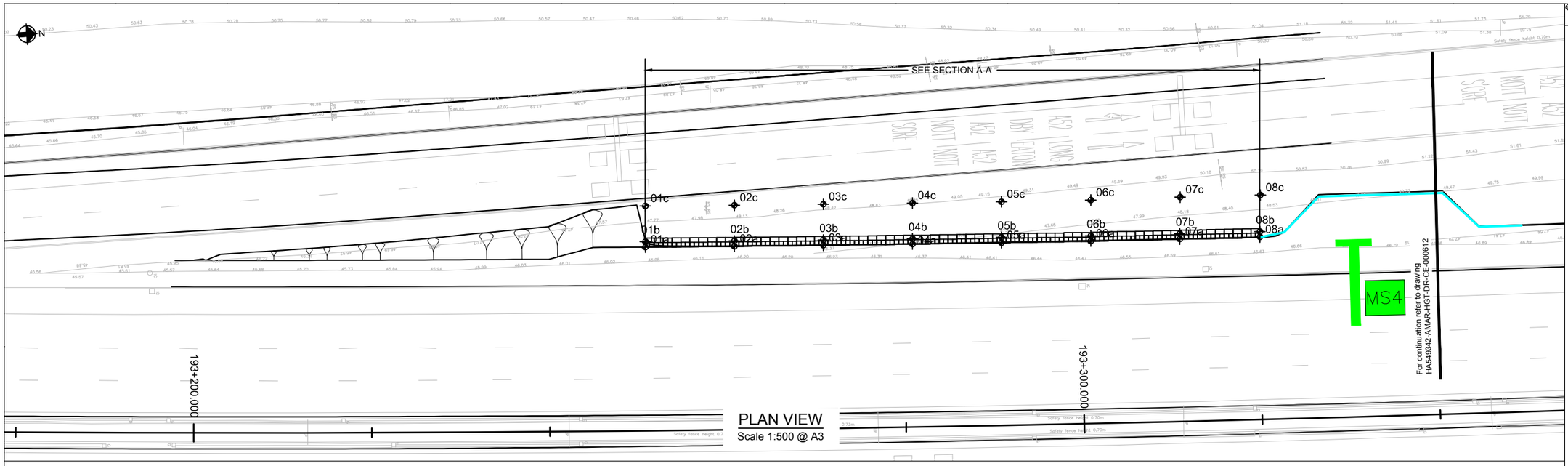
Scale at A1: 1:25

Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

Job No: **244508-00** Rev: **P03**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000610**



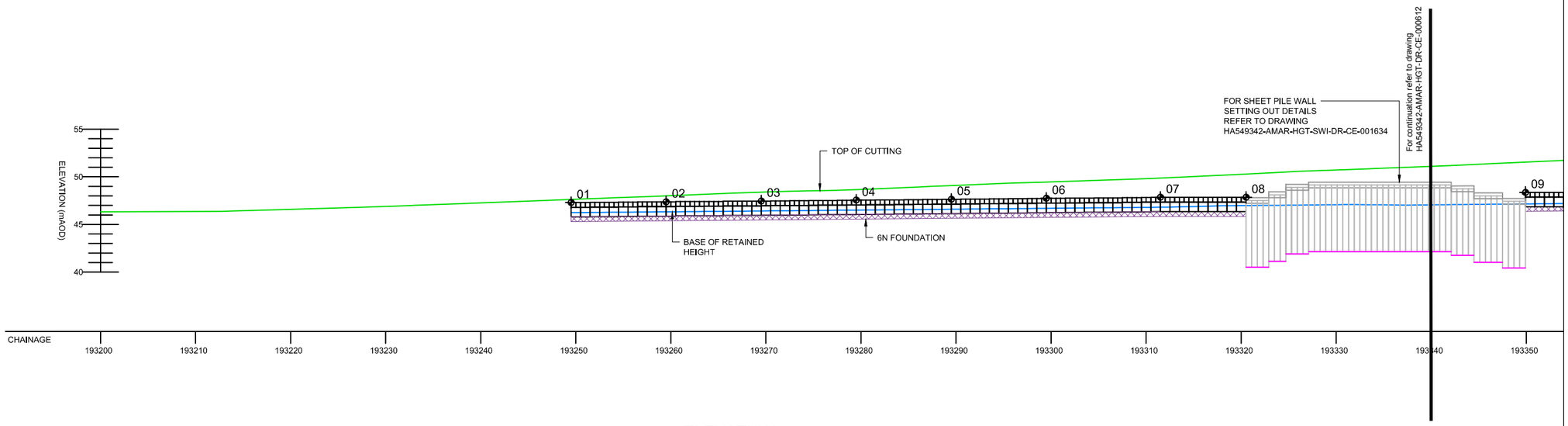
PLAN VIEW
Scale 1:500 @ A3

GABION WALL SETTING OUT POINTS

	BASE OF RETAINED HEIGHT [a]			BACK OF GABION [b]			BACK OF BATTER [c]			GABION WALL DETAILS	
REFERENCE	EASTING	NORTHING	LEVEL (mAOD)	EASTING	NORTHING	LEVEL (mAOD)	EASTING	NORTHING	LEVEL (mAOD)	TOTAL RETAINED HEIGHT (m)	EMBEDMENT DEPTH (m)
01	447166.84	335286.12	46.40	447166.24	335286.16	47.45	447162.25	335286.43	47.90	1.05	0.45
02	447167.43	335296.11	46.50	447166.83	335296.15	47.55	447162.84	335296.42	47.80	1.05	0.45
03	447167.99	335306.09	46.60	447167.39	335306.13	47.65	447163.4	335306.4	48.20	1.05	0.45
04	447168.53	335316.08	46.60	447167.93	335316.12	47.65	447163.94	335316.39	48.50	1.05	0.45
05	447169.05	335326.06	46.70	447168.45	335326.1	47.75	447164.47	335326.37	48.90	1.05	0.45
06	447169.55	335336.07	46.70	447168.95	335336.11	47.75	447164.96	335336.38	49.15	1.05	0.45
07	447169.99	335346.05	46.80	447169.4	335346.09	47.85	447165.31	335346.42	49.20	1.05	0.45
08	447170.37	335355.05	47.00	447169.77	335355.09	48.05	447165.69	335355.41	49.30	1.05	0.45

ELEVATION LEGEND

- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- TOE OF SHEET PILE
- STEEL CAPPING BEAM
- SHEET PILES
- GABION WALL
- GRANULAR FILL [SERIES 600 SPECIFICATION]



ELEVATION
Scale 1:500 @ A3

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8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE LOCATION
- GABION WALL
- SECTION LINE
- SETTING OUT POINT

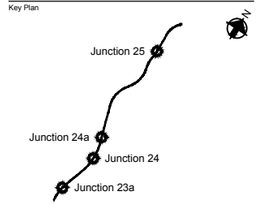
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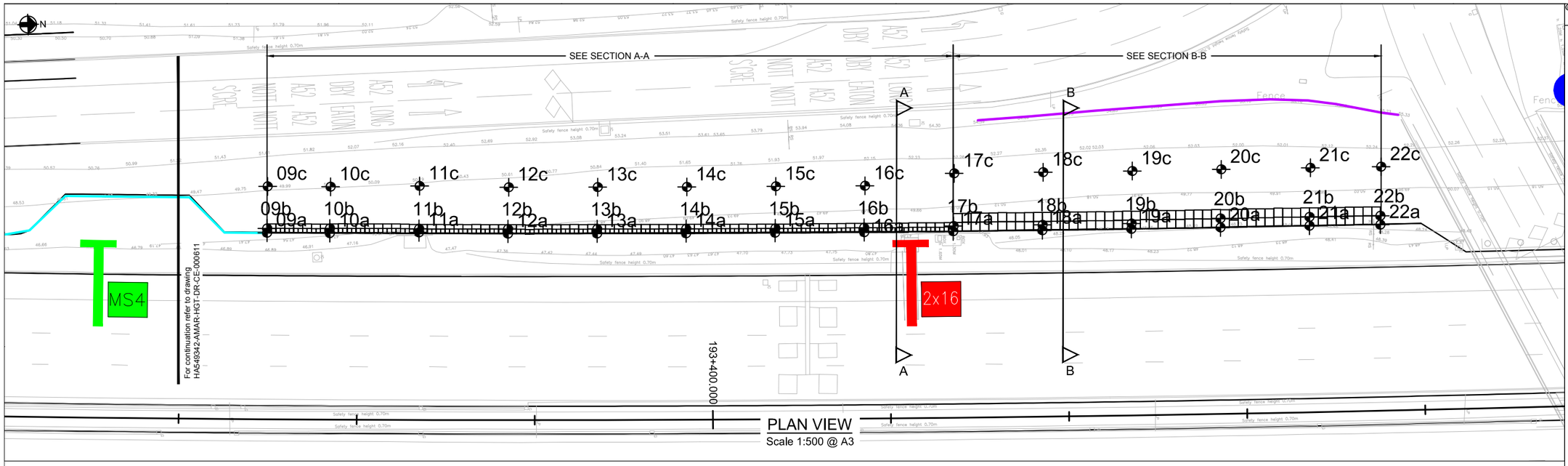
Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
EARTHWORKS DESIGN SOLUTION PLAN - CH.193251 TO CH.193321 & CH.193350 TO CH.193475 (NB) SHEET 01 OF 03

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P03**
Name: **HA549342-AMAR-HGT-SWI-DR-CE-000611**



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7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.

PLAN LEGEND

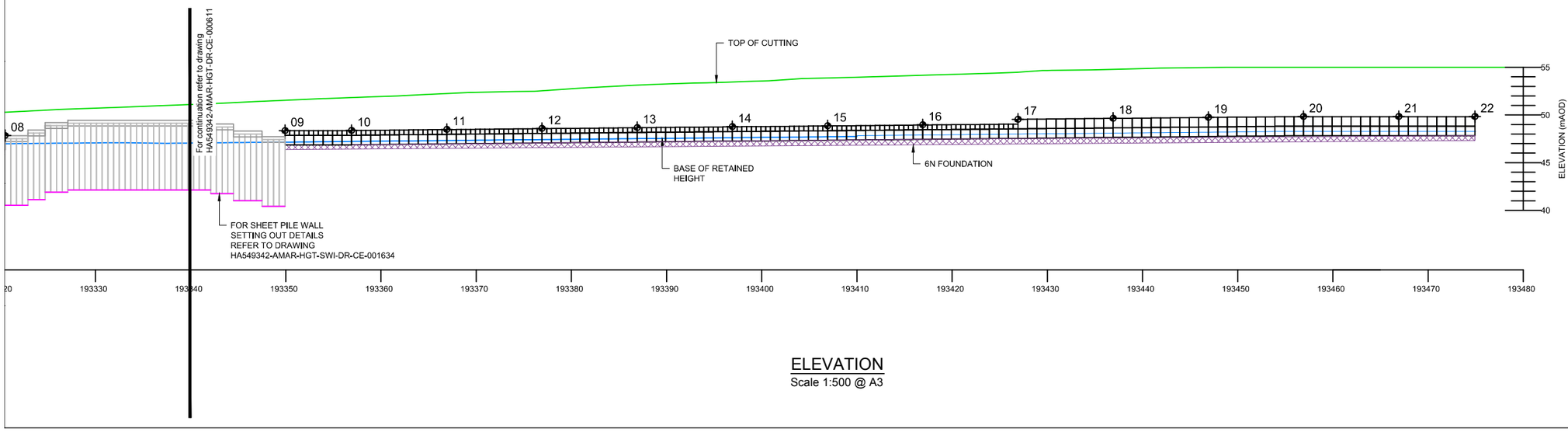
- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE LOCATION
- GABION WALL
- SECTION LINE
- SETTING OUT POINT

GABION WALL SETTING OUT POINTS

	BASE OF RETAINED HEIGHT [a]			BACK OF GABION [b]			BACK OF BATTER [c]			GABION WALL DETAILS	
REFERENCE	EASTING	NORTHING	LEVEL (mAOD)	EASTING	NORTHING	LEVEL (mAOD)	EASTING	NORTHING	LEVEL (mAOD)	TOTAL RETAINED HEIGHT (m)	EMBEDMENT DEPTH (m)
9	447171.05	335384.45	47.20	447170.55	335384.46	48.25	447165.85	335384.67	49.90	1.05	0.45
10	447171.29	335391.50	47.20	447170.75	335391.52	48.25	447166.09	335391.72	49.90	1.05	0.45
11	447171.49	335401.53	47.20	447171.09	335401.52	48.25	447166.29	335401.72	49.90	1.05	0.45
12	447171.90	335411.51	47.30	447171.39	335411.50	48.35	447166.71	335411.71	50.00	1.05	0.45
13	447172.17	335421.49	47.30	447171.67	335421.50	48.35	447166.98	335421.71	50.10	1.05	0.45
14	447172.43	335431.48	47.40	447171.92	335431.49	48.45	447167.23	335431.71	50.20	1.05	0.45
15	447172.66	335441.48	47.50	447172.15	335441.50	48.55	447167.45	335441.70	50.30	1.05	0.45
16	447172.86	335451.48	47.60	447172.36	335451.48	48.65	447167.66	335451.70	50.40	1.05	0.45
17	447173.04	335461.48	47.70	447172.44	335461.52	49.20	447166.55	335461.75	50.90	1.50	0.45
18	447173.20	335471.48	47.80	447172.60	335471.52	49.30	447166.71	335471.75	51.00	1.50	0.45
19	447173.34	335481.47	48.00	447172.74	335481.51	49.50	447166.84	335481.75	51.20	1.50	0.45
20	447173.45	335491.47	48.10	447172.45	335491.50	49.60	447166.95	335491.75	51.30	1.50	0.45
21	447173.54	335501.47	48.20	447172.54	335501.05	49.70	447167.04	335501.75	51.40	1.50	0.45
22	447171.32	335392.4	48.30	447172.64	335509.45	49.80	447167.1	335509.81	51.50	1.50	0.45

ELEVATION LEGEND

- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- TOE OF SHEET PILE
- STEEL CAPPING BEAM
- SHEET PILES
- GABION WALL
- GRANULAR FILL [SERIES 600 SPECIFICATION]



ELEVATION
Scale 1:500 @ A3

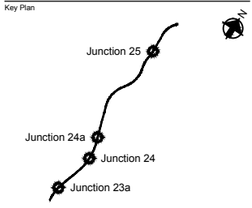
Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV
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Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

Project Title: SMP M1 J23a - J25

Key Plan



Drawing Title: EARTHWORKS DESIGN SOLUTION PLAN - CH.193251 TO CH.193321 & CH.193350 TO CH.193475 (NB) SHEET 02 OF 03

Scale at A1: 1:250

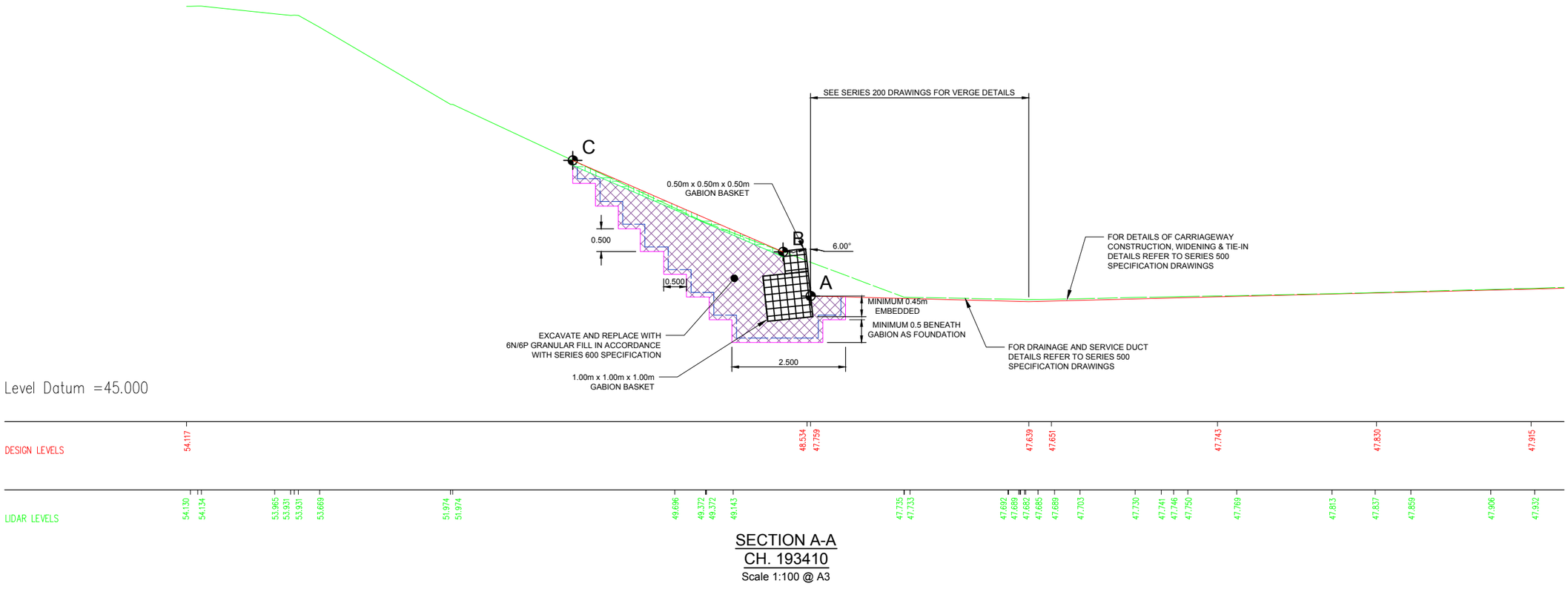
Role: Civil - Earthworks and Geotech

Suitability: S4 - Fit for construction approval

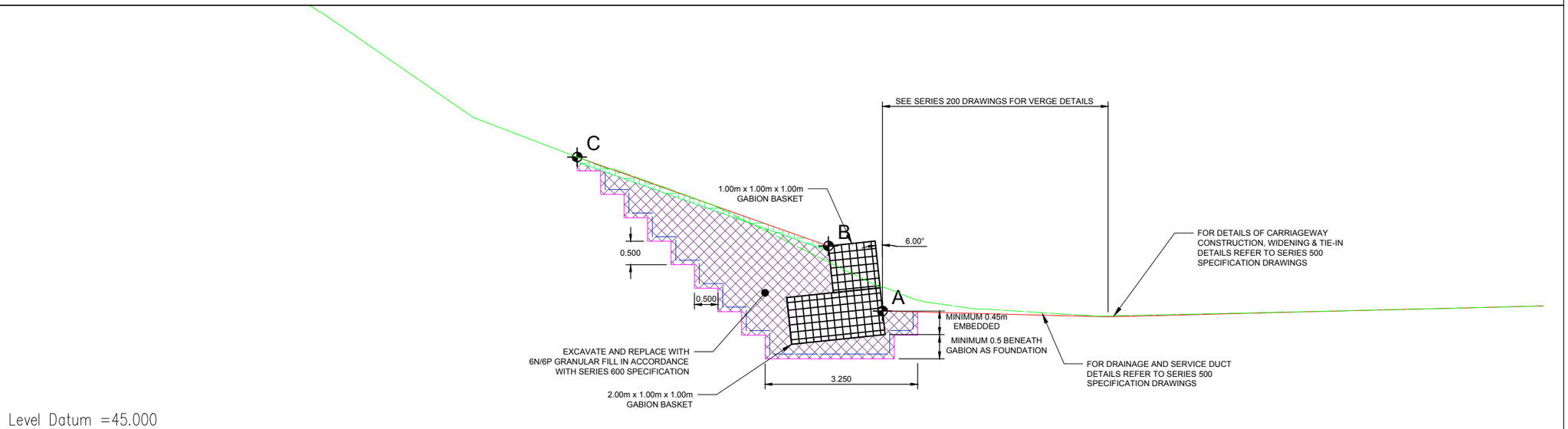
Job No: **244508-00** | Rev: **P03**

Name: **HA549342-AMAR-HGT-SWI-DR-CE-000612**

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SECTION A-A
CH. 193410
Scale 1:100 @ A3



SECTION B-B
CH. 193440
Scale 1:100 @ A3

NOTES
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6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERGE SURFACE TO BE IN ACCORDANCE WITH PROJECT VERGE DETAILS.
8. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL [MINIMUM 0.1m]
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]
- GABION BASKET
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

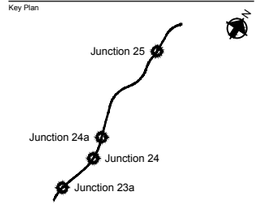
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amey ARUP
Colmore Plaza
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 214 2000

Client: highways england driving forward

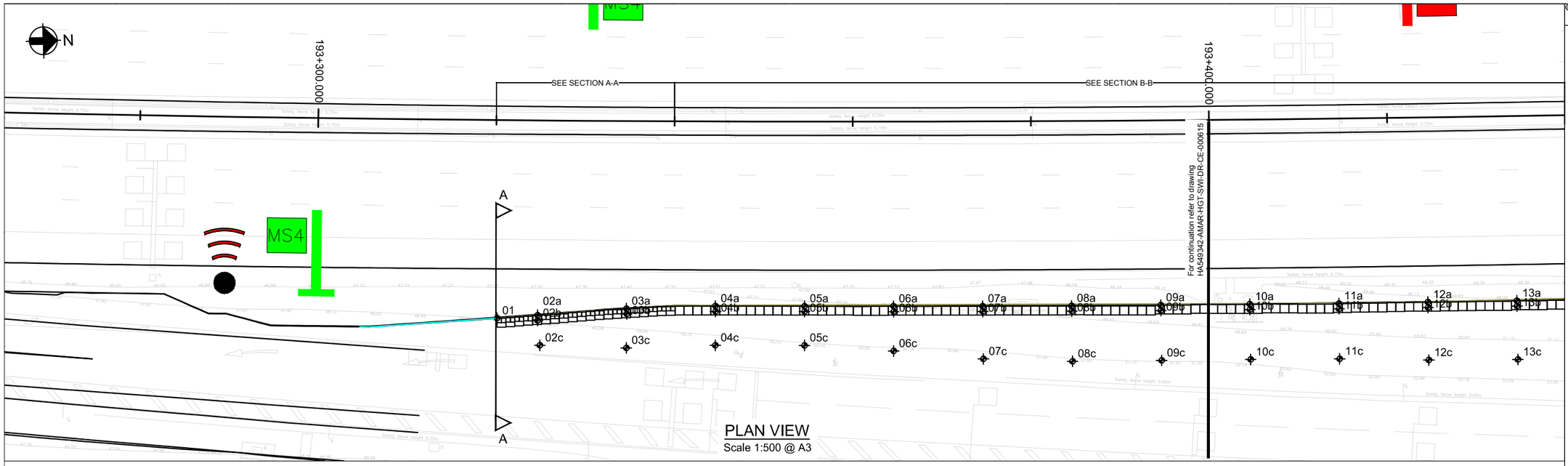
Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
EARTHWORK DESIGN SOLUTION CROSS SECTION - 193251 TO 193321 & CH. 193350 TO CH. 193475 (NB) SHEET 03 OF 03

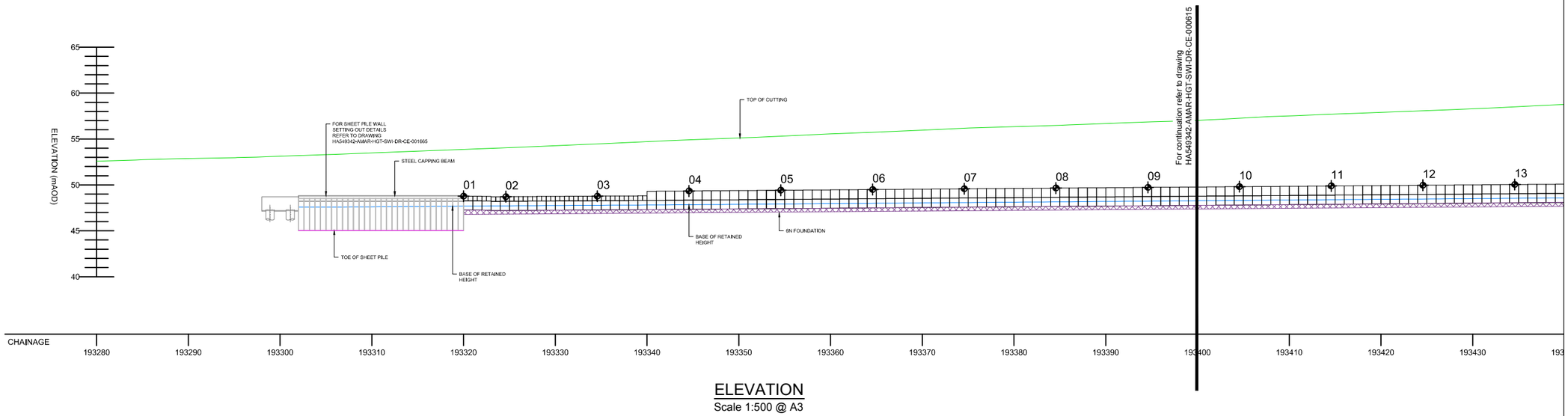
Scale at A1: 1:50
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P03**
Name: **HA549342-AMAR-HGT-SWI-DR-CE-000613**



PLAN VIEW
Scale 1:500 @ A3

GABION WALL SETTING OUT POINTS

	BASE OF RETAINED HEIGHT [a]			BACK OF GABION [b]			BACK OF BATTER [c]			GABION WALL DETAILS	
REFERENCE	EASTING	NORTHING	LEVEL (mAOD)	EASTING	NORTHING	LEVEL (mAOD)	EASTING	NORTHING	LEVEL (mAOD)	TOTAL RETAINED HEIGHT (m)	EMBEDMENT DEPTH (m)
002	447212.81	335357.86	47.80	447213.41	335357.84	48.90	447216.2	335358	50.00	1.10	0.40
003	447212.4	335367.85	47.80	447213	335367.87	48.90	447216.79	335367.7	50.00	1.10	0.40
004	447212.44	335377.85	47.80	447213.04	335377.85	48.90	447216.83	335377.7	50.10	1.10	0.40
005	447212.77	335387.84	47.90	447213.37	335387.82	49.00	447217.17	335387.7	50.40	1.10	0.40
006	447213.1	335397.84	47.90	447213.7	335397.84	49.00	447218.12	335397.69	50.80	1.10	0.40
007	447213.42	335407.83	48.00	447214.02	335407.83	49.10	447219.34	335407.74	51.20	1.10	0.40
008	447213.7	335417.83	48.10	447214.3	335417.83	49.20	447219.92	335417.73	51.60	1.10	0.40
009	447213.95	335427.82	48.20	447214.55	335427.82	49.30	447220.15	335427.73	51.80	1.10	0.40
0010	447214.17	335437.82	48.30	447214.77	335437.82	49.40	447220.37	335437.72	51.80	1.10	0.40
0011	447214.42	335447.82	48.40	447215.02	335447.82	49.50	447220.61	335447.72	52.10	1.10	0.40
0012	447214.58	335457.82	48.50	447215.18	335457.82	49.60	447221.08	335457.72	52.20	1.10	0.40
0013	447214.75	335467.82	48.60	447215.35	335467.82	49.70	447221.33	335467.71	52.30	1.10	0.40



ELEVATION
Scale 1:500 @ A3

ELEVATION LEGEND

- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- TOE OF SHEET PILE
- STEEL CAPPING BEAM
- SHEET PILES
- GABION WALL
- GRANULAR FILL [SERIES 600 SPECIFICATION]

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NOTES

1. ALL DIMENSIONS AND MEASUREMENTS IN METRES (m) UNLESS OTHERWISE STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. DOCUMENT NO. HA549342-AMAR-HGT-SWI-SH-CE-000001) AND SERIES 1600 SCHEDULE (REF. DOCUMENT NO.HA549342-AMAR-HGT-SWI-SH-CE-000002).
3. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS REFER TO SERIES 500 SPECIFICATION DRAWINGS.
5. FOR DETAILS OF CARRIAGEWAY CONSTRUCTION, WIDENING & TIE-IN, REFER TO SERIES 700 SPECIFICATION DRAWINGS.
6. ALL NEW SLOPE SURFACES TO BE TOPSOILED IN ACCORDANCE WITH THE PROJECT LANDSCAPING SPECIFICATION, BUT NO THICKER THAN 150MM FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300MM FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5 IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.

PLAN LEGEND

- HIGHWAYS ENGLAND BOUNDARY
- SHEET PILE LOCATION
- GABION WALL
- SECTION LINE
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
P03	17/04/17	LP	---	SV

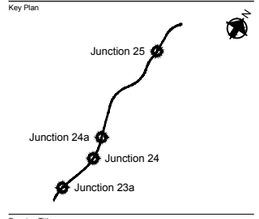
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Tel 0121 214 2000

Client: highways england driving forward

Project Title
SMP M1 J23a - J25

Key Plan



Drawing Title
EARTHWORKS DESIGN SOLUTION PLAN
CH. 193320 TO CH.193497 (SB)
SHEET 01 OF 03

Scale at A1: 1:250
Role: Civil - Earthworks and Geotech
Suitability: S4 - Fit for construction approval
Job No: **244508-00**
Rev: **P03**
Name: **HA549342-AMAR-HGT-SWI-DR-CE-000614**