East Midlands Gateway
Phase 2 (EMG2)

Document DCO 6.14F/MCO 6.14F (Part 2)

ENVIRONMENTAL STATEMENT

Technical Appendices

Appendix 14F

Preliminary Sources Study Affecting National Highways

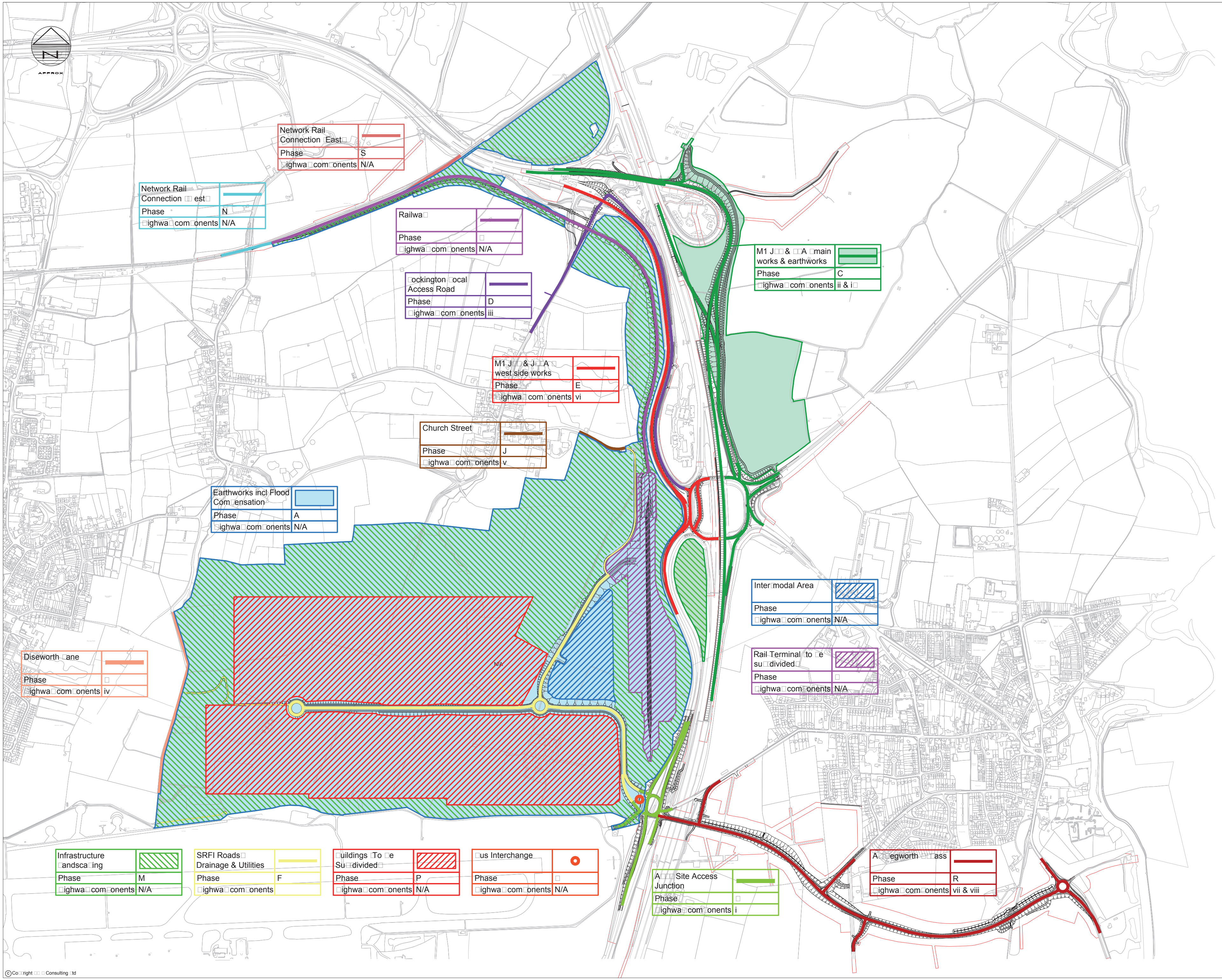
August 2025

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



NOTES

1. DO NOT SCA E T IS DRA IN . A DIMENSIONS MUST E C EC ED/ VERIFIED ON SITE. IF IN DOU T AS .

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Rev	Date	Details of issue / revision	Drw	Rev
P		RAI ANDSCAPIN INC UDED IN P ASE M	SR	SR
P		UPDATED FO O IN REVIE	SR	SR
P1		PRE IMINAR ISSUE	SR	SR

ISSUES & REVISIONS

BWB
CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

irmingham
eeds
ondon
Manchester
Nottingham
[redacted]

Client

ROXHILL

Pro ect Title

EAST MIDLANDS GATEWAY STRATEGIC RAIL FREIGHT INTERCHANGE

Drawing Title

DCO PHASING

Scale	1	Drawn	S. ilditch
Size	A1	Reviewed	S. ilditch

Drawing Status

PRELIMINARY

Drawing No. **NTH/209/SK212**

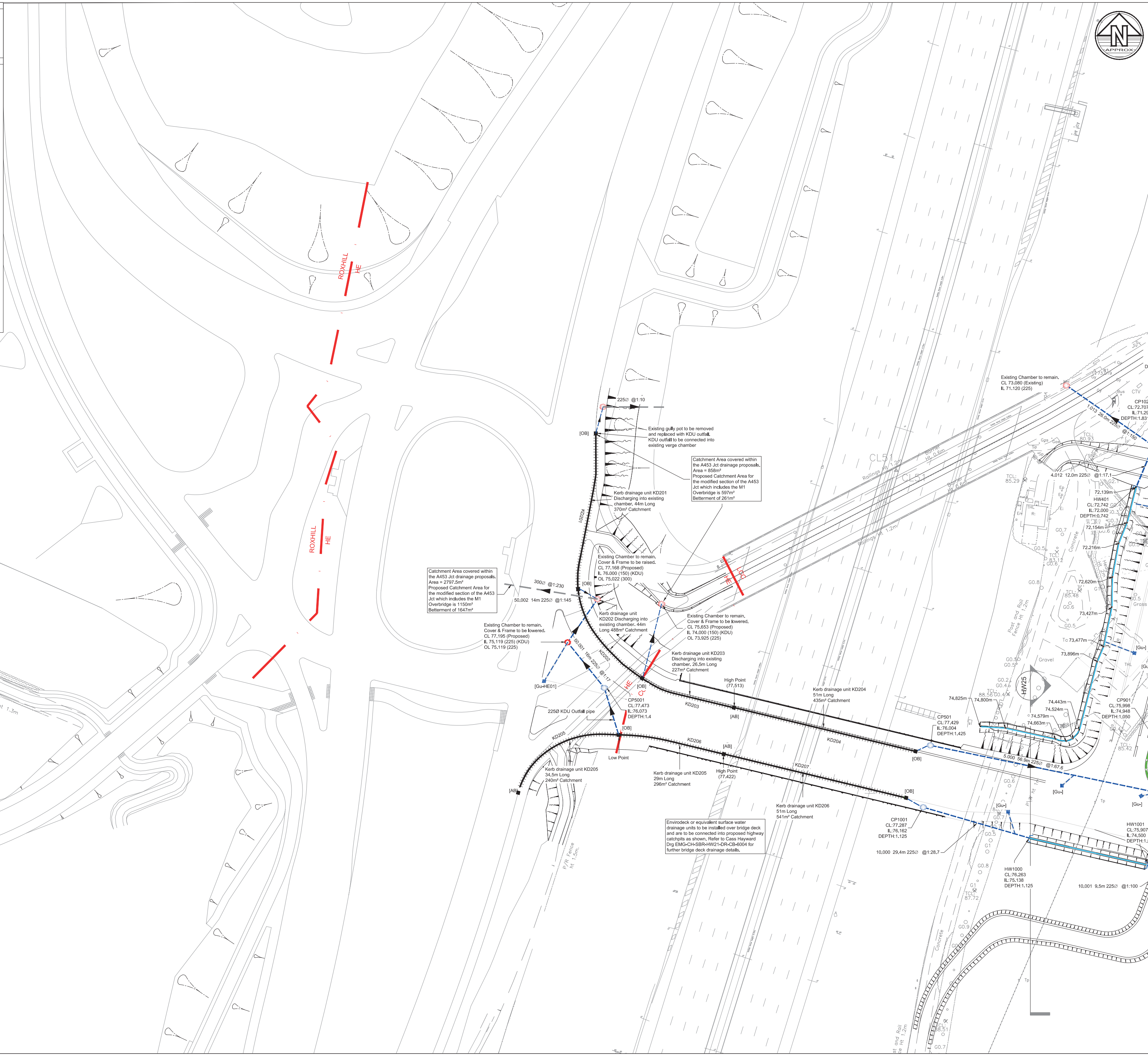
Revision **P3**

Pipework Schematic

Pipework Length to chamber centroid (m)
Pipe Microdrainage Reference
Pipework Internal Diameter (mm)
Pipework Longfall gradient
8.002 80.1m 225Dia. @ 1:230

Legend

- Proposed Combined Filter / Carrier Drain System
- Proposed Filter Drain System
- Proposed Surface Water Gravity Sewer System
- Proposed narrow fin drain Type 8 as to HCD Drg F18
- Proposed ditch. 1 in 2 Side Slopes Base width 0.5m
- Existing Highway Drainage System to remain unaltered
- Proposed Linear Combined Kerb Drainage System - ACO Kerbdrain or equivalent approved
- Indicative position of Kerb/Channel drain access box - details to be confirmed by manufacturer [AB]
- Indicative position of Kerb/Channel drain outlet point - details to be confirmed by manufacturer [OB]
- Proposed Gully Pot and Lateral Connection to Sewer. See Note 10
- Proposed precast concrete headwalls. See Note 14
- Proposed LCC Catchpits to be Type CP1 As To 6Cs design SD/5/19, See Note 7
- Proposed HE Catchpits to be Type Type 7, See Note 9
- Existing Catchpit



Notes

1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
3. All dimensions in metres unless noted otherwise. All levels in metres unless noted otherwise.
4. Any discrepancies noted on site are to be reported to the engineer immediately.
5. Drawings should be printed in colour.
7. LCC Highway Chambers to be Type CP1 as to 6Cs Design Drg SD/5/19 unless shown otherwise.
8. For LCC Network, trench and pipe bedding shall be in accordance with 6Cs Design Drg SD/5/2 & SD/5/4. For Highways England Network refer to HCD Drg F1 & F2 unless shown otherwise.
9. For pipes up to 450mmØ, Highway Chambers shall be Type 7 as to HCD Drg F11. For pipe diameters greater than 450mm then chamber dia size shall increase as to the manufactures guidelines unless shown otherwise.
10. Type 8 Narrow Filter drains as to HCD Drg F18 shall outfall into the next downstream Chamber along that particular drainage run.
11. All gully gratings, manhole frames and covers to have hinged openings. For details of gully and manhole frames refer to Appendix 5/1.
10. All LCC road gullies shall be trapped and shall be in accordance with 6Cs Design Drg SD/5/13 unless shown otherwise.
11. Where new gullies discharge directly into the proposed highway ditches then ACO SuDS Swale Inlets (or equivalent approved.) shall be be used. Refer to ACO Standard Details.
12. Pipe Strengths and material type shall be in accordance with Appendix 5/1 of the Contract Specification and DMRB Volume 4 HA 40/01 Section 2, Part 5, Appendix C.
13. Precast concrete rings to be constructed to BS EN 1917 and BS EN 5911-3.
14. All Headwalls shall be Althon precast concrete headwalls or equivalent approved unless shown otherwise.
    For pipe diameters up to 300mm and backwall height less than 1m = Althon H3C Headwall Range
    For pipe diameters up to 525mm and backwall height between 1.1m to 2m = Althon H6C Headwall Range
    For pipe diameters up to 900mm = Althon H10C Headwall Range
15. Mortar to be designation (I) to SHW Series 2400.
16. Pipes to be built into chamber with designation (I) mortar.
17. See SHW, sub-clause 507.7, regarding backfill arrangements/surrounds to chamber.
18. All ST concrete shall be to SHW Clause 2602.
19. Sump dimensions are indicative and are subject to manufacturers requirements upon final selection of flow control device.
20. The Contractor is to refer to Drg No. EMG-BWB-VTO-HW-DR-D-092 for site specific/extraordinary hazards which have been identified during the detailed design stage.

Rev	Date	Details of issue / revision	Drw	Rev
P1	10.07.17	FOR LCC & HE APPROVAL	GJ	NL
T1	29.03.17	FOR TENDER	RJT	NL

Issues & Revisions

BWB
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- Birmingham | 0121 233 3322
- Leeds | 0113 233 8000
- London | 020 7407 3879
- Manchester | 0161 233 4260
- Nottingham | 0115 924 1100

www.bwbconsulting.com

Client

ROXHILL

Project Title

THE EAST MIDLANDS GATEWAY RAIL FREIGHT INTERCHANGE

Drawing Title

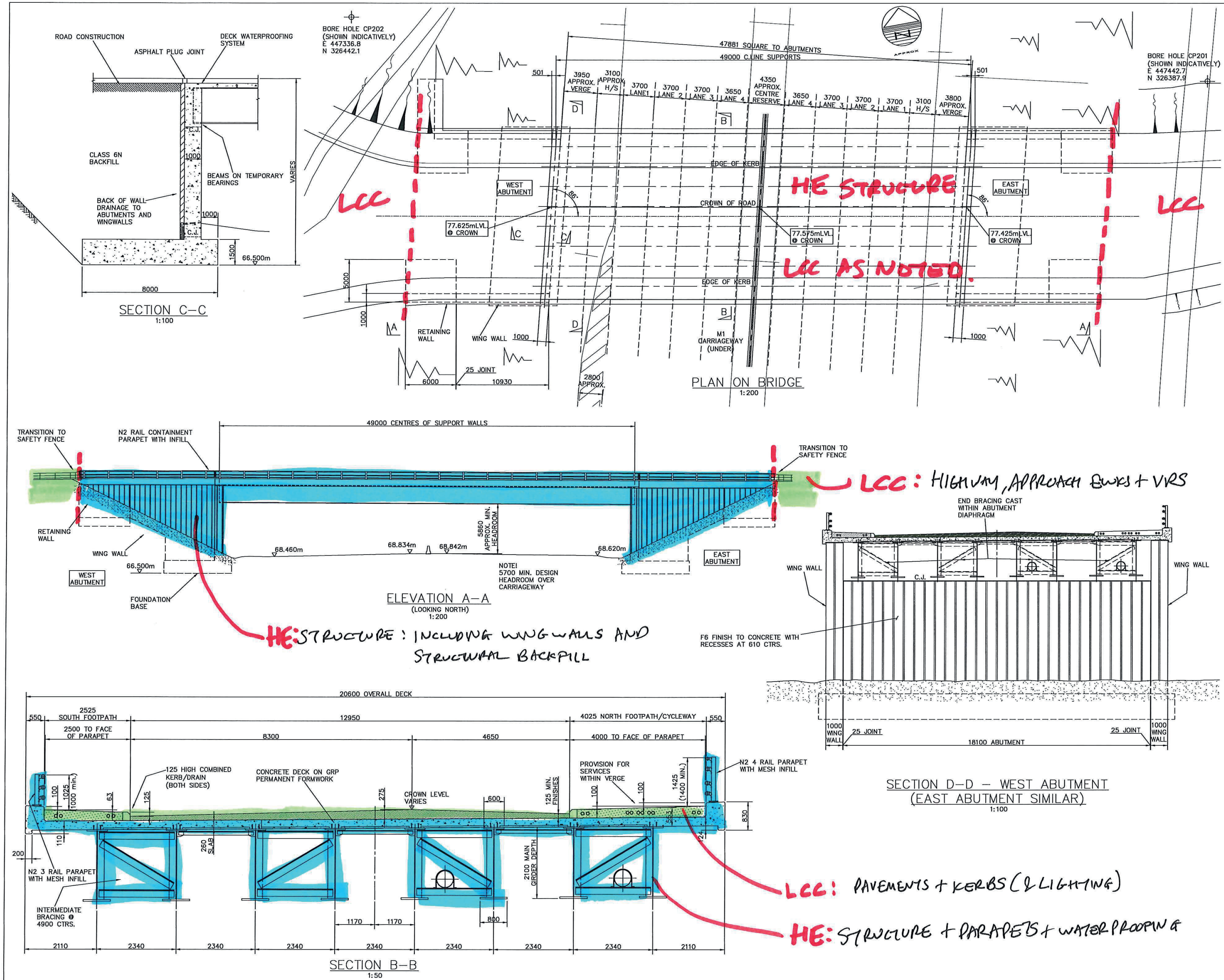
DRAINAGE LAYOUT SHEET 21A

Drawn:	R.Twell	Reviewed:	N. Lowe
BWB Ref:	NTH 209	Date: 29.03.17	Scale@A1: 1:500

Drawing Status

FOR APPROVAL

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
EMG-BWB-HDG-HW21a-DR-D-500	S4	P1



NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS IN METRES A.O.D. UNLESS NOTED OTHERWISE.
3. STEELWORK TO BE WEATHERING STEEL. (S355 J2W+N)

26/07/17

KEGWORTH BYPASS BRIDGE: MAINTENANCE RESPONSIBILITIES.

Rev	Date	Details of issue / revision	Drw	Chk
P01	28/02/17	FIRST ISSUE	RPF	JDP

ISSUES & REVISIONS

CASS HAYWARD CONSULTING ENGINEERS

ROXHILL

THE EAST MIDLANDS GATEWAY RAIL FREIGHT INTERCHANGE

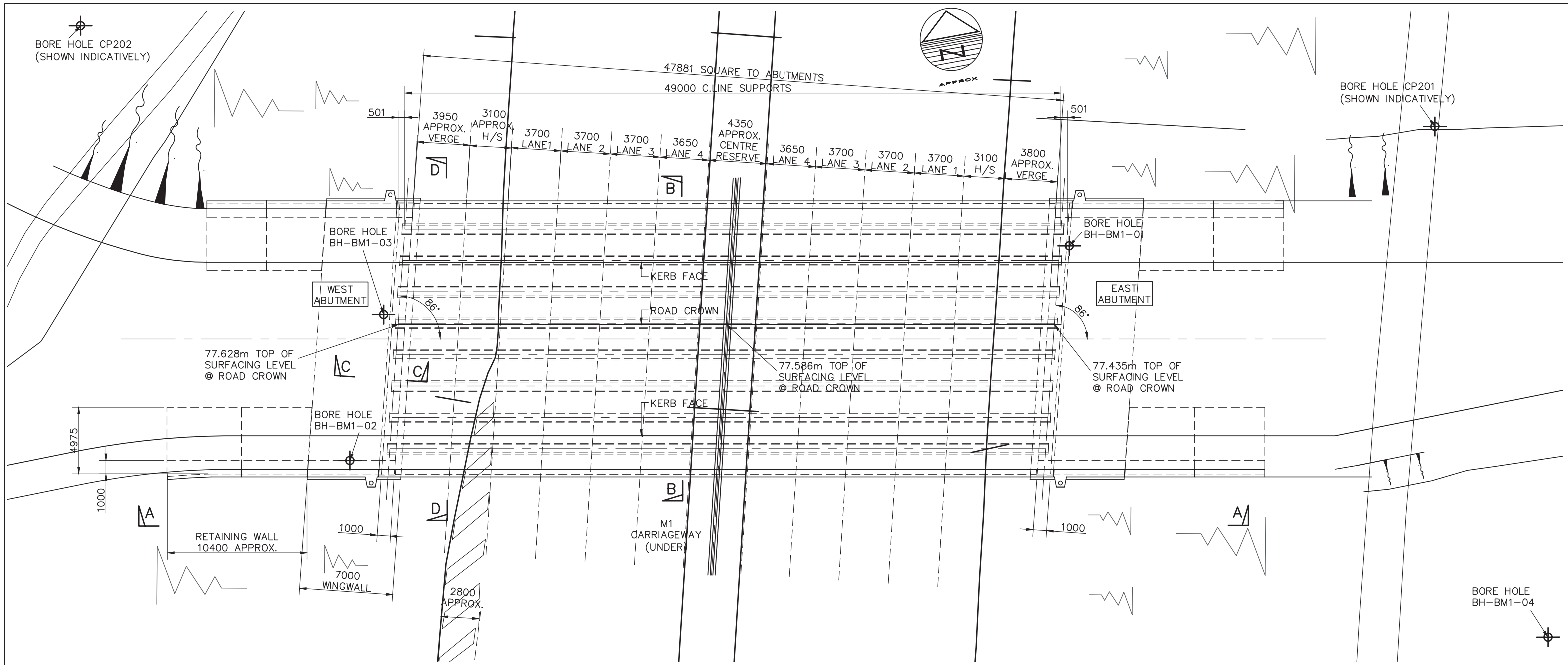
Drawing Title
Structure Key 35229
Structure Number M1//183.90.//
KEGWORTH BYPASS
M1 OVERBRIDGE
GENERAL ARRANGEMENT

Scale	As Shown	Drawn	RPF
Size	A1	Reviewed	JDP
Regulation		Document	-

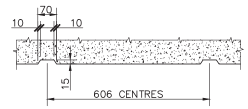
Drawing Status
FOR APPROVAL

Drawing No. EMG-CH-SBR-HW21-DR-CB-6001-S4

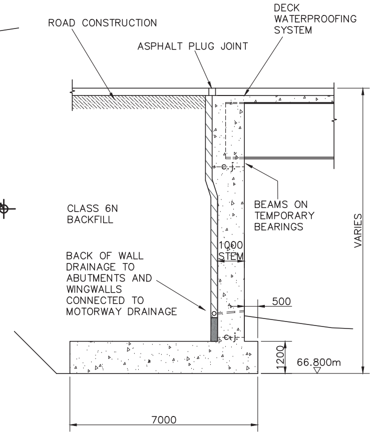
Revision P01



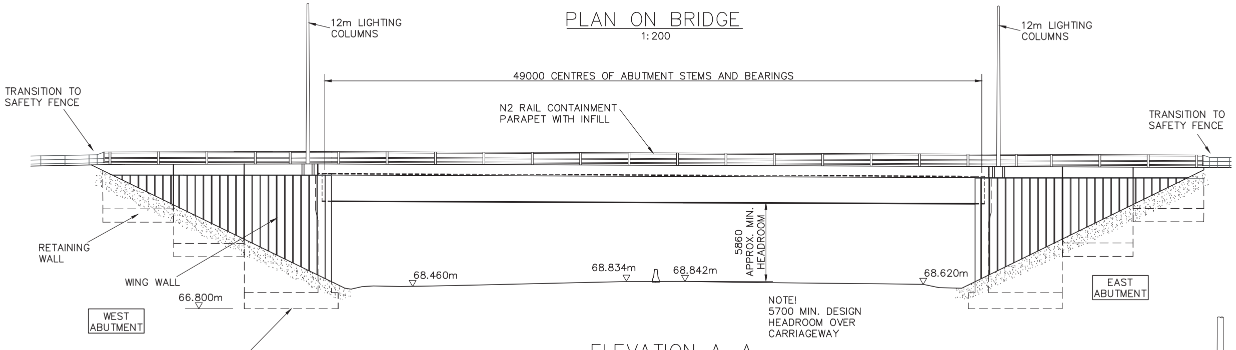
PLAN ON BRIDGE
1:200



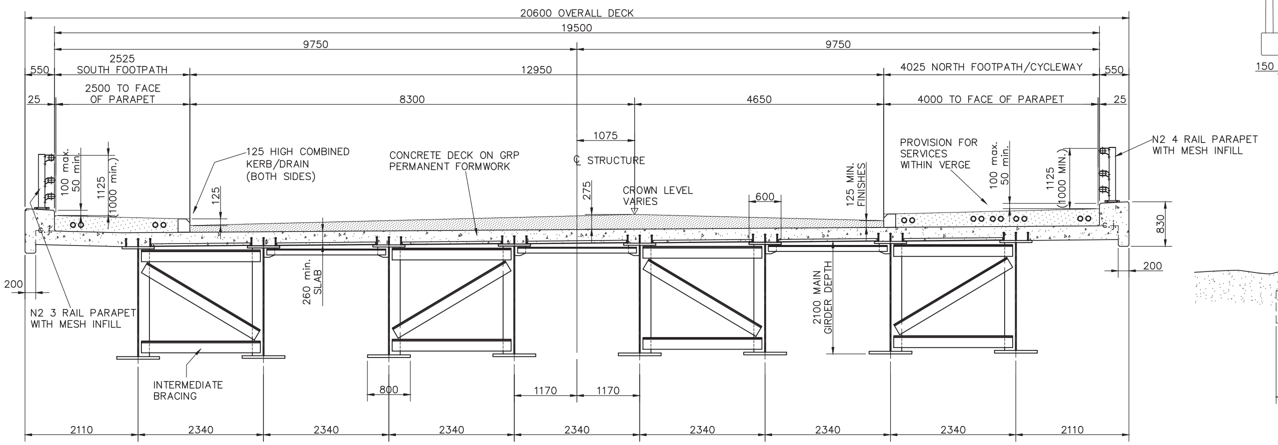
ENLARGED DETAIL AT ABUTMENT/WINGWALL/RET WALL RECESS



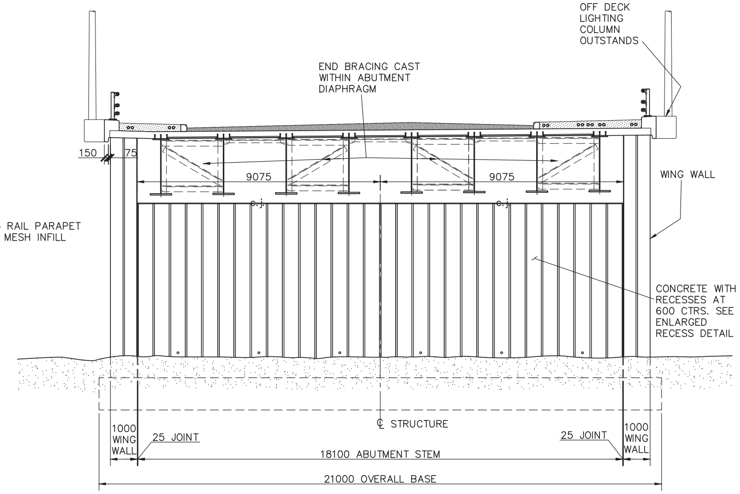
SECTION C–C
1:100



ELEVATION A–A
(LOOKING NORTH)
1:200



SECTION B–B
1:50



SECTION D–D – WEST ABUTMENT
(EAST ABUTMENT SIMILAR)
1:100

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS IN METRES A.O.D. UNLESS NOTED OTHERWISE.
3. STEELWORK TO BE WEATHERING STEEL. (S355 J2W+N)
4. BOREHOLE LOCATIONS :

CP201	E 447442.7	N 326387.9
CP202	E 447336.8	N 326442.1
BH-BM1-01	E 447400	N 326389
BH-BM1-02	E 447344	N 326386
BH-BM1-03	E 447349	N 326396
BH-BM1-04	E 447432	N 326361

5. BRIDGE GEOMETRY BASED ON PROPOSED OVERBRIDGE ROAD GEOMETRY FILE EMG-BWB-SM7-XX-M3-C-102_Kegworth 3D Design-S0-P4.dwg

Rev	Date	Details of issue / revision	Drw	Chk
P04	18/07/17	Updated to suit design development	DRT	JDP
P03	02/06/17	LIGHTING COLUMNS INDICATED	DRT	JDP
P02	28/03/17	MINOR CORRECTION	RPF	JDP
P01	28/02/17	FIRST ISSUE	RPF	JDP

ISSUES & REVISIONS

CASS HAYWARD
CONSULTING ENGINEERS

ROXHILL

THE EAST MIDLANDS GATEWAY RAIL FREIGHT INTERCHANGE

Drawing Title

Structure Key 35229
Structure Number M1//183.90.//
KEGWORTH BYPASS
M1 OVERBRIDGE
GENERAL ARRANGEMENT

Scale	As Shown	Drawn	RPF
Size	A1	Reviewed	JDP

Regulation

Document
-

Drawing Status
FOR APPROVAL

Drawing No.
EMG-CH-SBR-HW21-DR-CB-6001-S4

Revision
P04

List B: List of Documents Brought into the Contract by Reference
East Midlands Gateway Strategic Rail Freight Interchange: Zone 1 Main Development Plateau and Rail Freight Terminal. Preliminary Ground Investigation Report, prepared by RSK, reference 312494/1 – 03 (00) on behalf of Roxhill Developments Ltd, dated December 2013.
East Midlands Gateway Strategic Rail Freight Interchange: Zone 3 Main Trunk Road Improvements. Preliminary Sources Study Report, prepared by RSK, reference 312494/3-02 (00), on behalf of Roxhill Developments Ltd, dated December 2013
East Midlands Gateway Strategic Rail Freight Interchange: Zone 3 Main Trunk Road Improvements. Factual Ground Investigation Report, prepared by RSK, reference 312494-03-03 (00), on behalf of Roxhill Developments Ltd, dated December 2013.
East Midlands Gateway Strategic Rail Freight Interchange: Zone 3 Main Trunk Road Improvements. Preliminary Ground Investigation Report, prepared by RSK, reference 312494/3-04 (00), on behalf of Roxhill Developments Ltd, dated December 2013.
Stage 1 Preliminary Ground Investigation at Kegworth, for Waterman Transport and Developments Limited. Project Number PC124998, dated October 2012.
BOUSSINESQ. J. 1883. Application des etermine a' L'Etude de L'Equilibre et du Mouvementes Solides Elastiques, Gauthier-Villars, Paris, France
BRAJA. M. DAS & NAGARATNAM SIVAKUGAN, 2007. Settlements of shallow foundations on granular soil – an overview, International Journal of Geotechnical Engineering, IJGE.2007.01.01.19-29
BRITISH GEOLOGICAL SURVEY. 2002. Engineering geology of British rocks and soils. Mudstones of the Mercia Mudstone Group. Keyworth Nottingham. BGS. 2002 ISBN 085272 403 9.
BRITISH STANDARDS INSTITUTION. 1990. Method of tests for soils for civil engineering purposes. BS 1377. Parts 1 – 9. BSI, London
BRITISH STANDARDS INSTITUTION. 2004. Eurocode 7 – Geotechnical Design, Part 1 General rules, BS EN 1997-1. BSI, London
BRITISH STANDARDS INSTITUTION. 2007. Eurocode 7 – Geotechnical Design, Part 2 Ground investigation and testing, BS EN 1997-2. BSI, London
BRITISH STANDARDS INSTITUTION. 1999. Code of practice for Site Investigations. BS 5930. BSI, London
BRITISH STANDARDS INSTITUTION. 2008 + A1:2011. Code of practice for temporary works procedures and the permissible stress design of falsework. BS 5975. BSI London
BRITISH STANDARDS INSTITUTION, 2009. Code of practice for earthworks. BS 6031. BSI London
BRITISH STANDARDS INSTITUTION, 1989. Workmanship on building site. Part 1: Code of practice for excavation and filling. BS 8001-1. BSI London
BRITISH STANDARDS INSTITUTION. 2015. Foundations, BS 8004. BSI, London
BRITISH STANDARDS INSTITUTION. 2016. Code of practice for strengthened/reinforced soils and other fills. BS 8006-1:2010. BSI London
BRITISH STANDARDS INSTITUTION. 2001. Code of Practice for Investigation of Potentially Contaminated sites. BS 10175. BSI, London

List B: List of Documents Brought into the Contract by Reference
BRITISH STANDARDS INSTITUTION. 2004. Hydraulically bound unbound material for use in civil engineering and highway construction. BS EN 13242. BSI London
BRITISH STANDARDS INSTITUTION. Geotechnical investigation and testing – Identification and classification of soil. BS EN ISO 14688. BSI London
BRITISH STANDARDS INSTITUTION. Geotechnical investigation and testing – Identification and classification of rock. BS EN ISO 14689. BSI London
BRITISH STANDARDS INSTITUTION. 2003. Aggregates for unbound and hydraulically bound materials for use in civil engineering works and road construction. Guidance on the use of BS EN 13242. PD 6682-6: 2003. BSI, London.
BRITISH STANDARDS INSTITUTION. Geotechnical investigation and testing – Field testing. BS EN ISO 22476. BSI.
BRITPAVE ASSOCIATION, 2005 .Britpave Technical Guidelines for the Stabilisation of Sulfate-bearing Soils BP/16 (BP/16).
BROUWER, J.J.M. Guide to cone Penetrometer testing on shore and near shore. Lankelma. 2002
BURLAND, J.B. & BURBIDGE, M. C. 1985. Settlement of foundations on sand and gravel. Proc. , Institution of Civil Engineers, Part I, 78(6), pp 1325 -1391
BAUMANN, V. & BAUER, G.E.A. 1974. The performance of foundations on various soils stabilised by the vibro-compaction method. Can. Geotech. J. II, pp509-529
BUILDING RESEARCH ESTABLISHMENT. 2001. Building on fill: geotechnical aspects, 2nd Edition. BRE BR424. BRE, Garston
BUILDING RESEARCH ESTABLISHMENT. 2015. Building on fill: geotechnical aspects, 3rd Edition. BRE FB75. BRE Garston
BUILDING RESEARCH ESTABLISHMENT. 1997. Low rise building on fill. BRE BR427. BRE, Garston
BUILDING RESEARCH ESTABLISHMENT. 2005. Geotechniques for building professionals. BRE BR473. BRE, Garston
BUILDING RESEARCH ESTABLISHMENT. 2005. Brownfield sites, an integrated ground engineering strategy. BRE BR485. BRE, Garston
CHAI, J.C., CARTER, J.P., MIURA, N. & HINO, T. 2004. Coefficient of consolidation from piezocone dissipation tests. Proceedings of the International Symposium on Lowland Technology, September 2004
CIRIA. 2001. Engineering in Mercia Mudstone. CIRIA C570. CIRIA London 2001. ISBN 0 86017 570 7.
CLAYTON, C. R. I. 2001. Managing Geotechnical Risk. Improving productivity in UK building and construction. Thomas Telford, London. 80 pp
THE HIGHWAYS AGENCY. 1991. Design Manual, Road and Bridges: Volume 4, Geotechnics and Drainage; Section 1, Earthworks; Part 1, HA 44/91, Design and preparation of contract documents. HA 44/91
THE HIGHWAYS AGENCY. 2008. Design Manual for Roads and Bridges. Volume 4, Geotechnics and Drainage. Section 1 Earthworks, Part 2, Managing Geotechnical Risk. HD 22/08
THE HIGHWAYS AGENCY. 2009. Design guidance for road pavement foundations (Draft HD 25). Interim Advice Note 73/06 Revision 1. IAN 73/06 Rev 1

List B: List of Documents Brought into the Contract by Reference
THE HIGHWAYS AGENCY. 1994. Design Manual, Road and Bridges: Volume 4, Geotechnics and Drainage; Section 1, Earthworks; Part 5, HA 68/94 Design methods for the Reinforcement for Highway Slopes by Reinforced Soil and Soil Nailing Techniques. HA 68/94
THE HIGHWAYS AGENCY. 1994. Design Manual, Road and Bridges: Volume 4, Geotechnics and Drainage; Section 1, Earthworks; Part 5, HA 70/94, Construction of Highway earthworks. HA 70/94.
THE HIGHWAYS AGENCY. 1995. Design Manual, Road and Bridges: Volume 4, Geotechnics and Drainage; Section 1, Earthworks; Part 7, HA 73/95, Site investigation for Highway works on contaminated land. HA 73/95
THE HIGHWAYS AGENCY. 2007. Design Manual, Road and Bridges: Volume 4, Geotechnics and Drainage; Section 1, Earthworks; Part 6, HA 74/07, Treatment of Fill & Capping Materials Using Either Lime or Cement or Both. HA 74/07.
HIGHWAYS ENGLAND. 2016. Manual of Contract Documents for Highway Works, Specification for Highway Works: Volume 1. SHW
HOULSBY, G.T. & TEH, C.I. Analysis of the piezocone in clay. Penetration Testing 1988, ISOPT-1, De Ruiter (ed.)1988 Balkema Rotterdam. ISBN 90 6191 8014
INSTITUTION OF CIVIL ENGINEERS. 2012. ICE Manual of Geotechnical Engineering. Volume 1 Geotechnical Engineering Principals, Problematic Soils and Site Investigation. ICE Publishing, 2012. ISBN 978-0-72777-5707-4
INSTITUTION OF CIVIL ENGINEERS. 2012. ICE Manual of Geotechnical Engineering. Volume 2 Geotechnical Design, Construction and Verification. ICE Publishing, 2012. ISBN 978-0-72777-5709-8
JANBU, N., BJERRUM, L. & KJAERNSLI, B. 1956. "Veiledning Ved Losing av Fandamenteringsoppgaver," (Soil Mechanics Applied to Some Engineering Problems), in Norwegian with English Summary, Norwegian Geotechnical Institute Publication No. 16, Oslo
NATIONAL HOUSE-BUILDING COUNCIL. 2016. Ground Conditions. NHBC Standards, Part 4. NHBC, Amersham
NATIONAL HOUSE-BUILDING COUNCIL. 2011. Building near trees. NHBC Standards, Part 4.2. NHBC, Amersham.
NEWMARK, N. M, 1935. Simplified computations of vertical pressure in elastic foundations, University of Illinois Engineering Experiment Station Bulletin No 429
OSMAN, A. S. & BOLTON, M.D. 2004. A new approach to the estimation of undrained settlement of shallow foundations on soft clay. Engineering Practice and Performance of Soft Deposits, IS-OSAKA 2004. ISBN 4-88644-812-7
POULOS, H.G. Foundation settlement analysis – practice versus research. The 8th Spencer Buchanan Lecture. 2000.
ROBERTSON, P.K & CABAL, K.L. 2015. Guide to cone penetrometer testing for geotechnical engineering, 5th edition. Gregg Drilling & Testing Inc
SCHMERTMANN, J.H. 1970. Static cone to compute static settlement over sand. Journal of Soil Mechanics and Foundations. ASCE 96 (SM3).
SKEMPTON, A.W. 1951. The bearing capacity of the clay. Proceedings of Building Research Congress, Volume 1, pp 180-189.
SKEMPTON, A.W. & BJERRUM, L. 1957. Contribution to the settlement analysis of foundations on clay. Geotechnique, Volume 7, No. 4, pp 167-178
SMITH,I. 2006. Smith's elements of soil mechanics (8th Edition) Blackwell Publishing. ISBN10: 1-4051-3370-8

List B: List of Documents Brought into the Contract by Reference
TERZARGHI & PECK, 1967. Soil mechanics in engineering practice (2nd edition), Wiley International Edition
THORBURN, S. 1975. Building Structures supported by stabilised ground. Thorburn & Partners. Geotechnique 1975
TOMLINSON. M.J. 2001. Foundation Design & Construction (6th Edition & 7th Edition). Prentice Hall Press
US ARMY CORPS OF ENGINEERS, 1990. Engineer manual, settlement analysis. EM 1110-1-1904.
US ARMY CORPS OF ENGINEERS, 1994. Engineering manual, Chapter 5 deformation and settlement. EM 1110-1-2908. Department of the Army

APPENDIX 1/5: TESTING TO BE CARRIED OUT BY THE CONTRACTOR

Table 1/5.1 – Earthworks testing requirements

CLAUSE	WORK, GOODS OR MATERIAL		TEST	FREQUENCY	TEST CERTIFICATE	COMMENTS
Series 600	Earthworks					
601, 631 to 637, 640	Acceptable Limits				Required	[1] Only required where the use of hydraulic binders is proposed Test frequency relates to the class of material from each source. See Table 6/1 (Specification app 6/1) for specific testing requirements for individual material subclasses. Where Table 6/1 does not a test requirement Refer to Clause 612 for in situ testing requirements during the placement and compaction of fill. All Made Ground shall be tested in accordance with the requirements of Appendix 6/14 and 6/15 for chemical testing requirements. Refer to SHW Clause 601 for TPS Sulphate suite
	Class	General Description				
	1	General Granular Fill	MC, Grading and UC (U)	1 per $500m^3$		
			TPS Sulphate suite	1 per $500m^2$, min 5 per source		
			OMC/MDD (Vib Hammer)	1 per $1,000m^3$		
			CBR at OMC (U)	1 per $1,000m^3$		
	2	General Cohesive Fill	MC, PI, Grading (U)	1 per $500m^3$		
			OMC/MDD (U) with Hand Vane at each compaction point. Particle Density (2.5kg for 2A, 2C or 4.5kg for 2B)	1 per $1000m^3$		
			TPS Sulphate Suite	1 per $500m^3$, min 5 per source		
			Undrained Triaxial Shear Strength at OMC (U)	1 per $1,000m^3$		
	4	Fill to Landscape Area	MC (U) & HSV	1 per $500m^3$		
			Grading (U)	1 per $1,000m^3$		
	6	Selected granular fill	Grading/uniformity coefficient/mc (U)	1 per $500m^3$		
			OMC/MDD (Vib Hammer)	1 per $1,000m^3$, min 3 per source		
			CBR at OMC (U)	1 per $1,000m^3$, min 3 per source		
			PL/LL (U)	1 per $1,000m^3$, min 3 per source		
			Los Angeles Coefficient LA (U)	1 per source as delivered to site		
			Organic matter / water soluble sulphate (WS) content (U)	1 per $500m^3$, min 5 per source		
			Oxidisable sulphides (OS), total sulphur and total potential sulphate (TPS) content (U)	1 per $500m^3$, min 5 per source		
			Bitumen content (U)	1 per $1,000m^3$		
			Drained Shear Parameters SHW Clause 636 & 639	1 per source		
	7	Selected cohesive fill	MC, PI, Grading (U)	1 per $500m^3$		
			OMC/MDD (U) with Hand Vane at each compaction point. Particle Density (4.5kg Rammer)	1 per $1,000m^3$, min 3 per source		
			Undrained Triaxial Shear	1 per $1,000m^3$, min 3 per		

CLAUSE	WORK, GOODS OR MATERIAL		TEST	FREQUENCY	TEST CERTIFICATE	COMMENTS
Series 600	Earthworks					
			Strength at OMC (U)	source		
			Organic matter / water soluble sulphate (WS) content (U)	1 per 500m³, min 5 per source		
			Oxidisable sulphides (OS), total sulphur and total potential sulphate (TPS) content (U)	1 per 500m³, min 5 per source		
			Ph/Chloride ion content (U)	1 per 500m³, min 5 per source		
			Drained Shear Parameters (U)	1 per source		
			Permeability (U)	1 per source		
	9	Stabilised Material	Pulverisation	1 per 625m²		
			Bearing Ratio [CBR] recompacted 2.5kg Rammer (U)	1 per day		
			MCV (U)	1 per 250m³, max 5 per day		
602	Earthworks material beneath the surface of a road or paved area, if within 450mm of finished surface		Frost Heave (U)	Source Approval	Required	For ALL material within 450mm finished level.
612	Compaction of Fills				Required	Compaction Trial to be completed in accordance with App 6/3 and be witnessed by the Client and/or Client's Representative. Plate load testing to be carried out in accordance with DMRB IAN 73/06 Rev 1 for equivalent CBR at the formation of each & every class of fill material. Refer to Appendix 6/1 and 6/3 for minimum compaction requirements to be met.
		Method Compaction	Field Dry Density	1 per 400m³ per layer		
			CBR (Mexe, TRL DCP, ect), granular fill only	1 per 400m³ per layer		
			HSV undrained shear strength, cohesive fill only	1 per 400m³ per layer		
			Compaction Trial	1 per method per source. To be witnessed by Hydrock		
			Dual Cycle Static Plate Load Test using 0.60m Diameter	1 per 20m x v 2m per 1.0m of fill, base of foundation and at final formation		
		End Product	Field Dry Density	1 per 200m³ per layer		
			CBR (Mexe, TRL DCP, ect), granular fill only	1 per 200m³ per layer		
			HSV undrained shear strength, cohesive fill only	1 per 200m³ per layer		
			Compaction Trial	1 per method per source. To be witnessed by Hydrock		
			Dual Cycle Static Plate Load Test using 0.60m Diameter	1 per 20m x20m per 1.0m of fill, base of foundation and at final formation		
		Drainage layers	Grading	1 per 400 tonnes or 200m³ whichever is the lesser		

Notes to Table 1/5-1:

1. The minimum number of tests will be 3 per source, before the course can be approved by Hydrock for use. 2.(U) indicates that a UKAS test report or certificate is required.

3. Unless otherwise shown in this Appendix, tests and test certificates for works, goods or materials as scheduled under any one clause are required for all such work, goods or materials in the works.

4. Frequency of testing applies to each separate earthworks material within each of the earthworks material class.

5. Unless specifically stated to the contrary, all samples used in the testing shall be taken from materials after delivery to the site for incorporation into the works.

6. The Contractors attention is drawn to the requirements of the relevant Specification Appendices for the form of all deliverables, storage of test records and storage of records of materials imported to and exported from site.

7. Where source approval is specified, source testing shall be carried out at each quarry or stockpile used for supply to site and at each location of borrow/site winnings used for on-site material.

8. Definitions of abbreviations:

    - mc: natural moisture content.
    - Organic Matter: Organic Matter Content.
    - OMC: Optimum Moisture Content.
    - MDD: Maximum Dry Density.
    - CBR: California Bearing Ratio.
    - HSV: Hand Shear Vane for assessment of undrained shear strength.
    - IDD: Intact Dry Density.
    - ACM: Asbestos and Asbestos Containing Materials.
    - MEXE: In situ assessment of equivalent CBR by MEXE Probe
    - TRL DCP: Transport Research Laboratory Dyanmic Cone Penetrometer for in situ assessment of equivalent CBR.

9. All Made Ground shall be tested in accordance chemical testing requirements as defined in the relevant Appendix for class of material and the requirements of Appendix 6/14 and 6/15.

APPENDIX 1/23: RISKS TO HEALTH AND SAFETY FROM MATERIALS OR SUBSTANCES

1.0 GENERAL

1.1 In connection with substances hazardous to health the Contractor shall be responsible for taking all reasonable steps to secure the safety of his employees, members of the Employers team and members of the public through the carrying out of all reasonable steps in connection with:-

i) Restrictions in relation to traffic management measures

ii) Restrictions in relation to working practices

iii) Measures to be taken to protect members of the public

iv) Monitoring to be undertaken by the Contractor

v) Traffic management proposals

1.2 The Contractor's attention is also drawn to the Construction, Design and Management Regulations which shall apply to the Works.

2.0 DUST MITIGATION, HAUL ROADS AND MUD/DUST ON HIGHWAY

2.1 The Contractor shall provide to the Council for prior written approval a scheme for the provision of wheel cleansing facilities for heavy commercial vehicles and any mobile plant which has an operating weight exceeding three tonnes, or such other tonnage that may be agreed in writing with the Council.

2.2 Such approved wheel cleansing facilities shall be installed in accordance with a timescale approved in writing by the Council and shall be maintained throughout the period of Construction works by the Contractor unless any variation has been approved in writing by the Council.

2.3 All heavy commercial vehicles or other mobile plant which has an operating weight exceeding three tonnes, or other such tonnage that may be agreed in writing with the Council, associated with the construction of the Development leaving the Site, shall on each occasion, prior to leaving, pass through the wheel cleansing facilities.

2.4 Appropriate measures shall be implemented at all times to minimise any dust emissions.

2.5 Temporary haul roads shall be maintained for the duration of their use to minimise any build-up of loose spoil etc. Any damage to the existing site haul roads shall be repaired at the contractor's expense.

2.6 Traffic both entering and working on site shall obey a maximum speed limit of 10 mph.

2.7 Mobile water bowsers and sprayers shall be available on site at all times to water unpaved haul roads and working areas. The water spray may include chemical dust suppressants or wetting agents to improve dust control.

2.8 All open bodied Heavy Commercial Vehicles carrying dry or loose aggregate, cement or soil into and out of the site, shall be sheeted or sealed so as to prevent the release of such material into the local environment.

2.9 An adequate supply of water shall be maintained on site at all times to allow for dust suppression activities to be carried out at short notice.

2.10 Where mobile water bowsers are no effective in suppressing dust then vapour masts shall be used. Such vapour masts shall be deployed at 20m centres on the downwind side of haul roads or excavations giving rise to significant dust or emissions of odour.

2.11 Regular inspections of the public highway adjacent to the site shall be carried out. If deemed necessary by the Contractor or the Supervisor, the highway shall be swept regularly to remove any mud, slurry or dust deposited by vehicles entering or departing the site. If the Supervisor considers that significant amounts of any detritus have been deposited on the public highway then operations shall be temporarily suspended until appropriate cleaning operations have been undertaken.

2.12 The Contractor shall, as soon as reasonably practicable, but no later than the end of each working day, sweep or otherwise clear away any mud or similar material which may be carried onto the public highway by vehicles leaving the Site during the period of the Development.

3.0 ODOUR

3.1 In general terns the excavation works are not considered likely to give rise to any significant odour problems.

3.2 If highly odorous materials are encountered, which may give rise to nuisance to neighbouring properties, vapour masts shall be deployed to provide odour control.

3.3 Any odorous materials shall be covered at the end of each working day and any stockpiles will be located away from any sensitive areas.

3.4 Plant and machinery shall be serviced regularly to ensure that exhaust fumes are not excessive.

3.5 Compliance with Legislation and Regulatory Approvals

APPENDIX 1/24: QUALITY MANAGEMENT SYSTEMS

1.0 GENERAL

1.1 The Contractor shall institute and operate a quality management system complying with BS EN ISO 9001 and SHW Clause 104. The quality management system shall be described in a Quality Plan that shall be submitted to the Employers Representative for their acceptance before the commencement of any site works.

1.2 The Quality Plan shall cover the following items:

i) Contractor's organisation and management;

ii) Contractor's method statements and construction procedures

iii) Contractor's construction quality control

iv) Organisation's Quality Plans.

1.3 The Quality Plan shall conform to the requirements of Sections 2.0, 3.0 and 4.0 of this appendix.

1.4 Items i) and ii) of the Quality Plan shall be submitted to the Employers Representative for its acceptance not later than 28 days after award of contract.

1.5 Method statements are required for each major activity to be undertaken by the Contractor. The Contractor shall agree in writing with the Employers Representative the full scope of activities which require the production of individual Method Statements.

2.0 CONTRACTOR'S ORGANISATION AND MANAGEMENT

2.1 This section of the Quality Plan shall include:

i) Definition of the Contract and its documentation.

ii) The organisation of the Contract, including the line of command and communication and communication links between parties involved in the Contract.

iii) Names, roles responsibilities and authority of the principals and key personnel.

iv) Control of liaison and meetings with third parties.

v) Identification of the Contractors own staff responsible for overseeing each major activity.

vi) The Contractors control systems for any sub-contractors to be appointed by them.

vii) Document control.

viii) Programme for submission of Method Statements and Organisations Quality Plans.

ix) The quality plans for subcontractors and suppliers of work, goods and materials which are the subject of quality management schemes.

x) Procedure for the preparation, review and adjustment of programmes for the effective progression of the Works and the recording of this.

xi) Control and approval of purchases of materials.

xii) Control of off-site activities (where appropriate).

xiii) Procedures for the regular review and recording by the Contractor of the quality of the works.

xiv) Control of personnel selection, based on their care, skill and experience.

xv) Management review/audits to monitor and exercise adequate control over the implementation of the Quality Plan.

xvi) Any other relevant item, specific to the methods of work proposed by the Contractor.

3.0 CONTRACTOR'S METHOD STATEMENTS AND CONSTRUCTION PROCEDURES

3.1 This section of the Quality Plan shall include:

i) Detailed method statements for each major activity whether directly controlled or subcontracted.

ii) The method statements for all activities that might affect the quality of the permanent and temporary works shall identify hold points and invoke:

(1) Work instructions.

(2) Quality control procedures.

(3) Compliance testing and inspection arrangements.

(4) Work acceptance procedures.

ii) Identify the relevant construction procedures in the Contractor's own Quality Management System, and provide copies on request.

4.0 CONTRACTOR'S CONSTRUCTION QUALITY CONTROL

4.1 This section of the Quality Plan shall include:

i) Statement of the Contractors organisation for quality control.

4.2 The Quality Plan shall identify procedures (which may be part of the Contractors general procedures) that cover the topics listed below:

i) Arrangements for 'receiving' and 'in-process' testing.

ii) Control of test laboratories.

iii) Control of test, measuring and inspection equipment.

iv) Document control.

v) Procedures for monitoring and recording the inspection, test and approval status of the constructed/installed work.

vi) Procedures for tests and inspections for the purpose of the Contractor certifying that prior to covering up, each part of the Works is complete and conforms to the Contract.

vii) Procedures for the review of work submitted for review but not accepted as conforming to the Contract.

viii) Procedure for the collation of quality records as identified in BS EN ISO 9001 and provision of copies when requested by the Employers Representative.

5.0 ORGANISATION QUALITY PLANS

5.1 The Quality Plan shall include:

i) Definition of the product or service to be provided.

ii) The organisation organogram shall describe the line of command and state the name of the senior manager responsible for the contracted Work and the name of the Organisations on-site Management representative. Contact addresses, telephone numbers etc. shall be provided.

iii) Identification of the relevant parts of the Organisations quality system relevant to the product or service being provided. Copies to be provided to the Employers Representative on request.

iv) The control of personnel selection (at works and on site), including special requirements for skilled personnel e.g. certification of welders, training of operatives, experience requirements etc.

5.2 Specific procedures shall be provided for the following:

i) Receipt and examination of certificates of conformity and test results for purchased products.

ii) Product identification and traceability.

iii) Handling, storage, packaging and delivery to site and storage and handling on site.

iv) Quality records.

6.0 TESTING

6.1 The Contractor shall undertake all compliance testing required during the course of the filling operation to check the material classification, acceptance limits and, the method of compaction control as defined by Appendix 6/1. The minimum frequency of testing is defined in Appendix 1/5 of the specification with the material acceptance and compliance limits set out in Appendix 6/1 and specifically in Table 6/1.

6.2 The compliance testing of the earthworks materials shall be carried out by a laboratory which holds UKAS (for geotechnical tests) or MCERTS (for chemical and contaminations tests) accreditation for the specific test. Where it is not possible to obtain the testing of a material for a specific property to a UKAS or MCERTS accredited method, the Contractor shall obtain permission from the Employers Representative for the test that is to be completed by the proposed laboratory, before the test is undertaken.

6.3 The Contractor shall provide to the Supervisor, by mid-day on the first working day of each week, an updated electronic summary (Microsoft Excel 2010 or earlier) of all testing which has been completed up to the end of works for the previous week.

6.4 The testing summary shall be in a form agreed with the Supervisor, and shall include the results of all *in situ* test results (if the final validated report has not been issued by the appointed laboratory, these results shall be denoted with a draft to show that they are not final results). The summary shall also include a list of all samples submitted for laboratory testing, and provide the results of those laboratory tests where report certificates have been issued.

6.5 The information to be included for the summary of testing shall include, but not be limited to, the following:

i) sequential test number,

ii) date of test;

iii) coordinated position to include easting & northing, correct to National Grid Reference;

iv) reduced level, correct to m OD;

v) site reference;

vi) test grid reference;

vii) layer number (during placement of fill);

viii) test type;

ix) whether results are Draft (before the issue of certificate) or Final (certificate issued and received by Contractor); and

x) the results of the testing, compliance with the Specification and any comments relating to the test .

6.6 The contractor is to make available on site at all times a file containing all test certificates in addition to the testing summary, for inspection by the Supervisor.

6.7 The results of all testing shall be submitted to the Supervisor as soon as they are reported, and no more than 1 day after issue of the test certificate to the Contractor. It is recognised that different tests may take different time to complete; however the Contractor shall advise the Supervisor of any delay that they are aware of regarding the completion of any tests (e.g. a sample is being re-tested and the report will be delayed). The Supervisor shall be given sufficient time to review the content of the testing and the associated test results.

6.8 If in the opinion of the Supervisor, the material alters in classification or becomes unacceptable for whatever reason during the course of the filling operations, the Contractor will be required to repeat the compliance testing as required by the Supervisor. Equally, if the Contractor considers the classification of a material to have changed from that given in Appendix 6/1 they shall inform the Supervisor immediately.

6.9 The Contractor shall be responsible for removing from site any unacceptable material to suitably licensed facilities before the completion of their works.

7.0 SUPERVISOR

7.1 In addition to the detailed description of the role of the Supervisor, as defined by the NEC 3 Engineering and Construction Contract (ISBN 978 07277 3382 5), the Supervisor shall be on site with regular attendance and undertake the following role:

i) Liaison with the Contractor, Project Manager and Employers Representative.

ii) Reviewing of testing activities, this does not replace or absolve the Contractor from the responsibilities set out in the Specification requirements.

iii) Observing and commenting on the quality of the earthworks activities. This does not replace or absolve the Contractor from the responsibilities set out in the Specification requirements.

iv) Reviewing of soil/fill sampling as required under the specification and advising the Contractor of the results in order to allow the satisfactory progress of the works.

8.0 CONTRACTOR’S VALIDATION AND VERIFICATION REPORT

8.1 The Contractor will maintain records of the works to include, but not be limited to, the following:

i) daily record sheets to include a summary of the day’s activities;

ii) progress photographs (not less than weekly);

iii) weather conditions;

iv) plant, personnel and visitors present;

v) aspects relating to Health and Safety, Environmental Control; and

vi) test results (refer to Sections 7.0).

8.2 The Contractor will ensure that the requirements of this Specification are complied with. Upon receipt of satisfactory demonstration that all of the works have been undertaken in accordance with the Specification, the Contractor shall provide a validation report. This report will include relevant site records and illustrate that the remedial and ground preparation works have been carried out in accordance with the Specification.

8.3 During the works and in areas of excavation, compaction or fill placement the Contractor will be required to undertake weekly topographical survey of the earthworks profile to provide a continuous record of the earthworks operations.

8.4 A verification report in accordance with the RMS and MMP is required to be prepared by the Contractor on those aspects of the works they have completed and are responsible for. The Contractor's report will include, where appropriate, the following:

i) daily record sheets to include a summary of the day's activities;

ii) progress photographs;

iii) general description of the works completed, including any earthworks, excavations (including excavations of hard obstructions or foundations), placement and compaction methodology and plant used;

iv) detailed weather conditions;

v) formation and foundation treatment, including drainage and treatment of soft areas;

vi) plant, personnel and visitors present;

vii) aspects relating to Health and Safety, Environmental control;

viii) waste transfer notes;

ix) application of acceptability criteria and summary of control test results for each specific earthworks material placed during the earthworks operations;

x) chemical and geotechnical test certificates and monitoring data including location and level with associated drawings;

xi) as built surveys, including base of excavations to include drawings;

xii) coordinates, levels, invert levels and diameters of services remaining on site;

xiii) drawings showing the location and level of each specific earthworks material placed during the earthworks operations, any feature or operation relevant to the earthworks including any instrumentation and the location of trial areas and control tests; and

xiv) all correspondence with Statutory Authorities.

APPENDIX 6/1: REQUIREMENTS FOR ACCEPTABILITY AND TESTING ETC. OF EARTHWORKS MATERIALS

1.0 ACCEPTABLE LIMITS FOR FILLS

Earthworks materials are to comply in general with the 600 series of the Highways Agency 'The Manual of Contract Documents for Highway Works', BS 6031:2009 and with the specific requirements of this appendix. Permitted classes of construction materials are defined in the following tables:

- Table 6/1 Acceptable Earthworks Materials: Classification and Compaction Requirements
- SHW Table 6/2 Grading Requirements for Acceptable Earthworks Materials.
- Table 6/7 Material Sources and Source Codes for Imported Materials.

All earthworks materials are to meet the acceptability limits as set out in Table 6/1 and SHW Table 6/2

In general, engineered fill to raise site levels are to be constructed of Class 1 or Class 2 General Fill, Class 6 or Class 7Selected Fill with an upper 0.60m of hydraulically modified Class 9D unless otherwise indicated on the Drawings. Where relevant any restrictions on the use of Class 2 materials are detailed in Specification Appendix 6/3, 6/14 and 6/15.

1.1 Processed Class U1A or U1B material may be used as earthworks materials subject to meeting the target acceptability limits as set out in Table 6/1, SHW Table 6/2, Appendix 6/14, 6/15 and site specific requirements.

1.2 The Drawings show the general approach to where each Class of fill is to be used, including the requirements for zoning of general fill, selected fill and processed fill.

1.3 Earthworks materials derived from processed Class U1B material and used in the works are to be identified separately on the Contractor's drawings.

1.4 Where undrained shear strength is specified as the method of acceptability testing, the Contractor may use a hand vane provided that it is initially calibrated against the unconsolidated undrained shear strength laboratory triaxial test to BS 1377:Part 7, clause 8 on 100mm nominal diameter samples, and the MCV test in accordance with BS 1377:Part 4. Otherwise, shear strength testing requirements is to be as set out in 633 of the SHW.

1.5 Where 'recycled aggregate' is used in this Specification, the material shall be aggregate resulting from the processing of material used in a construction process. The aggregate shall have been tested in accordance with SHW Clause 710, and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass.

1.6 Where 'recycled aggregate except recycled asphalt' is used in this Series, the aggregate shall have been tested in accordance with SHW Clause 710. Content of asphalt (mineral aggregate with a bituminous binder) shall not exceed 2% by mass, and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass.

2.0 SPECIAL REQUIREMENTS FOR DETERMINING ACCEPTABILITY, WHO CLASSIFIES WHERE, AND WHETHER TRIAL PITTING IS REQUIRED

2.1 Acceptability testing is to be the responsibility of the Contractor and be carried out in accordance with Specification Appendix 6/1 and at the frequencies given in Appendix 1/5 in a UKAS accredited testing laboratory. The Contractor is to include the location for each sampling point or in situ test position with the relevant test result which shall have a unique identification number.

2.2 Where source approval of imported material is shown, the testing is to be the responsibility of the Contractor and be carried out in accordance with Specification Appendix 6/1. Source approval will comprise (as a minimum) 3 sets of the relevant test on each sub-unit of material to be used in the Contract.

2.3 The Contractor is to maintain full records on each sub-unit of imported materials including but not limited to, the location of the sources, the suppliers details, the acceptability testing and the location it has been incorporated within the works.

2.4 On completion of each site specific earthworks operations a Geotechnical Feedback Report (GFR) is to be prepared by the Contractor and submitted to the Project Manager and is to comply with the requirements of HD 22/08 and shall include as a minimum the following information:

a) General description of the earthworks, excavations, placement and compaction methodology and plant used;

b) Detailed weather conditions;

c) Formation and foundation treatment including ground improvement, drainage measures and treatment of soft areas;

d) Application of acceptability criteria and summary of the control test results for each specific earthworks material placed during the earthworks operations;

e) A copy of all relevant test results including grid location and level;

f) Drawings showing the location of each specific earthworks material placed during the earthworks operations, any feature or operation relevant to the earthworks including instrumentation and the location of the trial areas and control tests; and

g) An electronic copy of all the test results and monitoring associated with the earthworks operations

2.5 Should any material be placed which has not been given prior written approval from Hydrock, the Contractor will have done this at their own risk and they will be responsible for any and all remedial works required to rectify the situation. All costs associated with this remedial work are to be borne by the Contractor.

3.0 RENDERING UNACCEPTABLE MATERIAL ACCEPTABLE

3.1 The Engineer must be informed if Class U1B material is to be processed to meet the target acceptability limits as set out in Table 6/1 so that appropriate acceptability criteria for the control of contamination can be set and agreed upon by all parties before the commencement of such remedial works.

3.2 Earthworks materials generated by demolition works or from excavation of concrete hardstanding/foundations/piles, not classified as Class U1B or Class U2, are to be classified as Class U1A and be processed to meet the 'recycled aggregate' requirements of Clause 601.12 of SHW and the target acceptability limits as set out in Table 6/1, Table 6/2 and site specific requirements. As far as it is practical, the Contractor should process Class U1A Made Ground material or excavated material into Selected Fill in preference to General Fill.

3.3 Rendering Class U1A material acceptable by lime (quicklime) modification is permitted, subject to the requisite testing being completed and permissible values for sulfate (including Total Potential Sulfate, TPS) being achieved. For the purposes of this Specification, soils with a TPS content in excess of 1% shall be deemed to be unsuitable for treatment with hydraulic binders, including lime & quicklime.

4.0 REQUIREMENTS FOR GROUNDWATER LOWERING OR OTHER TREATMENT

4.1 The Contractor is responsible for all groundwater lowering where this is required for the purposes of the construction works. Based upon the available geotechnical records, it is not perceived that there will be a requirement for de-watering, however the underlying geology is known to contain relatively high permeability soils, therefore during periods of inclement weather temporary measures may be required for the control of groundwater.

4.2 The Contractor is responsible for obtaining all permits and/or licences required to undertake groundwater lowering and for treatment and/or disposal of said groundwater.

4.3 Where earthworks operations or ground improvement measures result in the expelling of groundwater into drainage layers or onto earthworks surfaces the discharged water shall be collected, treated if necessary and disposed of by the Contractor.

5.0 REQUIREMENTS FOR REMOVAL OFF SITE OF EXCAVATED ACCEPTABLE MATERIAL OR UNACCEPTABLE MATERIAL REQUIRING PROCESSING OR RETENTION OF SURPLUS MATERIAL ON SITE

5.1 No material is to be removed off site without the agreement of the Employer or NR.

5.2 Surplus material is to be temporarily stockpiled in areas designated for spoil storage. The earthworks design of the temporary stockpile is the responsibility of the Earthworks Contractor's Temporary Works Designer.

6.0 PERMITTED USE OF ACCEPTABLE MATERIAL OR UNACCEPTABLE MATERIAL REQUIRED TO BE PROCESSED FOR PURPOSES OTHER THAN GENERAL FILL

6.1 Earthworks materials derived from processed Class U1B material is to be used in the works only where shown on the Drawings or where agreed with the NR.

7.0 REQUIREMENTS FOR IN SITU RESISTIVITY TESTS

7.1 Where required, the determination of resistivity is to be measured by in situ testing.

8.0 REQUIREMENTS FOR IN SITU REDOX POTENTIAL TESTS

8.1 Where required, the determination of redox potential is to be measured by in situ testing.

9.0 REQUIREMENTS FOR THE ASSESSMENT OF THE EFFECTS OF WATER SOLUBLE (WS) SULPHATE, OXIDISABLE SULPHIDES AND TOTAL POTENTIAL SULPHATE IN ACCORDANCE WITH TRL 447, TEST NOS. 1 TO 5

9.1 Where required as part of any lime modification or improvement works, the water soluble (WS) sulphate, oxidisable sulphides (OS) and total potential sulphate (TPS) are to be determined in accordance with Clause 644 of SHW and HA 74/07.

10.0 RESPONSIBILITY FOR THE WORKS

10.1 The Contractor is be responsible for the works covered by the specification and is permitted to self certify the works, in accordance with the requirements of the specification. The right of self certification is not to be delegated or extended to any of the following parties:

- Subcontractors, employed by the Contractor,
- Service owners contractors undertaking backfilling of diverted service trenches,
- Other third party contractors undertaking works on the site.

11.0 COMPACTION COMPLIANCE ENVELOPES

11.1 Table 6/1 defines the acceptability limits for the earthworks material to be used for this project. In order to clarify the requirements for the placement and compaction of the material, a series of compaction compliance envelopes have been developed for each of the major classes of fill material described in Table 6/1, including:

- Figure 6/3-1: Compaction Compliance Envelope for Class 1A, Class 1B and Class 1C;
- Figure 6/3-2: Compaction Compliance Envelope for Class 2A, and Class 2C;
- Figure 6/3-3: Compaction Compliance Envelope for Class 2B;
- Figure 6/3-4: Compaction Compliance Envelope for Class 6F1 and Class 6F2; and
- Figure 6/3-5: Compaction Compliance Envelope for Class 6I, 6N and Class 6P.

TABLE 6/1: ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within: Lower	Upper				
GENERAL GRANULAR FILL	1	A	-	Well graded granular material	General fill	Any material, or combination of material designated as Class 3 in the Contract. Recycled aggregate	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 2 modified as required to ensure minimum 95% of MDD OMC/MDD determined using Vibrating Hammer	1	A	-
							(ii) uniformity coefficient	See note 5	10	-				
							(iii) mc	BS 1377-2	OMC -2%	OMC +2%				
							(iv) OMC / MDD	BS 1377-4	-	-				
							(v) CBR at OMC	BS 1377-4	5%	-				
	1	B	-	Uniformly graded granular material	General fill	Any material, or combination of material designated as Class 3 in the Contract. Recycled aggregate	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 3 modified as required to ensure minimum 95% MDD OMC/MDD determined using Vibrating Hammer	1	B	-
							(ii) uniformity coefficient	See note 5	-	10				
							(iii) mc	BS 1377-2	OMC -2%	OMC +2%				
							(iv) OMC / MDD	BS 1377-4	Declared	Declared				
							(v) CBR at OMC	BS 1377-4	5%	-				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within: Lower	Upper				
GENERAL COHESIVE FILL	2	A	-	Wet cohesive material	General fill	Any material, or combination of materials other than material designated as Class 3 in the contract	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 1 modified as required to ensure minimum 95% MDD or C of 50kN/m² whichever is the most onerous OMC/MDD determined using 2.5kg Rammer Except for materials with liquid limit greater than 50, only deadweight tamping or vibratory tamping rollers or grid rollers shall be used	2	A	-
							(ii) plasticity index (PI)	BS 1377-2	-	-				
							(iii) mc	BS 1377-2	105% MDD	Min c of 50kN/m²				
							(iv) undrained shear strength I	SHW Clause 633	50 kN/m²	-				
							(v) OMC/MDD	BS 1377-4	-	-				
							(vi) Particle Density	BS 1377-2	-	-				
	2	B	-	Dry cohesive material	General fill	Any material, or combination of materials other than material designated as Class 3 in the contract	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 2 modified as required to ensure 95% MDD or minimum C of 80kN/m² whichever is the most onerous OMC/MDD determined using 4.5kg Rammer	2	B	-
							(ii) plasticity index (PI)	BS 1377-2	-	-				
							(iii) mc & MCV	BS 1377-2	105% MDD	Min c of 80kN/m²				
							(iv) undrained shear strength I	SHW Clause 633	80 kN/m²	-				
							(vi) OMC/MDD	BS 1377-4	-	-				
							(vi) Particle Density	BS 1377-2	-	-				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
GENERAL COHESIVE FILL	2	C	-	Stony cohesive material	General fill	Any material, or combination of materials other than material designated as Class 3 in the contract	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 2 modified as required to ensure 95% MDD or C of 50KN/m² whichever is the most onerous OMC/MDD determined using 2.5kg Rammer.	2	C	-
							(ii) plasticity index (PI)	BS 1377-2	-	-				
							(iii) mc	BS 1377-2	105% MDD	Min c of 50KN/m²				
							(v) undrained shear strength I	SHW Clause 633	50 KN/m²	-				
							(vi) OMC/MDD	BS 1377-4	-	-				
							(vii) Particle Density	BS 1377-2	Declared	Declared				
	2	D	-	Silty cohesive material	General fill	Any material, or combination of materials other than material designated as Class 3 in the contract	(i) grading & sedimentation analysis	BS 1377-2	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 3 modified as required to ensure 95% MDD or C of 50KN/m² whichever is the most onerous OMC/MDD determined using 2.5kg Rammer.	2	D	-
							(ii) plasticity index (PI)	BS 1377-2	-	-				
							(iii) mc	BS 1377-2	105% MDD	Min c of 50KN/m²				
							(v) undrained shear strength I	SHW Clause 633	50 KN/m²	-				
							(vi) OMC/MDD	BS 1377-4	-	-				
							(vii) Particle Density	BS 1377-2	-	-				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within: Lower	Acceptable limits Within: Upper				
LANDSCAPE FILL	4	-	-	Various	Fill to landscape areas	Any material, or combination of materials	(i) grading	BS 1377-2	-	-	SHW Clause 620 Material to be placed to an appropriate method so as to ensure a minimum undrained shear of 45KN/m² is achieved in the placed and compacted material	4	-	-
							(ii) MC	BS 1377-2	-	Equivalent of C of 45KN/m²				
							(iii) undrained shear strength by HSV	Manufacturers Instruction	45KN/m²	150 KN/m²				
TOPSOIL	5	A	-	Topsoil, or turf, or existing on site	Topsoiling	Topsoil designated as Class 5A in the Contract	(i) grading	SHW Clause 618	-	SHW Clause 618	-	5	A	-
	5	B	-	Imported topsoil	Topsoiling	General purpose grade complying with BS 3882	-	-	-	-	-	5	B	-

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
	6	F	1	Selected granular material (fine grading)	Capping	Any material, or combination of materials (other than colliery spoil, argillaceous rock or chalk). Recycled aggregate	(i) grading	BS 1377-2	Table 6/2	Table 6/2	SHW Table 6/4 Method 6 modified as required to ensure minimum 95% MDD OMC/MDD to be determined using Vibrating Hammer	6	F	1
							(ii) OMC/MDD	BS 1377-4: 3.7	-	-				
							(iii) mc	BS 1377-2	OMC -2%	OMC				
							(iii) Los Angeles coefficient	SHW Clause 635	-	50				
	6	F	2	Selected granular material (fine grading)	Capping	Any material, or combination of materials (other than colliery spoil, argillaceous rock or chalk). Recycled aggregate	(i) grading	BS 1377-2	Table 6/2	Table 6/2	SHW Table 6/4 Method 6 modified as required to ensure minimum 95% MDD OMC/MDD to be determined using Vibrating Hammer	6	F	2
							(ii) OMC/MDD	BS 1377-4: 3.7	-	-				
							(iii) mc	BS 1377-2	OMC -2%	OMC				
							(iii) Los Angeles coefficient	SHW Clause 635	-	50				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within: Lower	Upper				
SELECTED GRANULAR FILL	6	F	3	Selected granular material	Capping (Not to be used below structures)	Recycled bituminous road planings and granulated asphalt, but excluding materials containing tar or tar-bitumen binders. Recycled aggregates	(i) grading and constituent parts	BS 1377-2 (on-site)	SHW Table 6/2	SHW Table 6/2	SHW Table 6/4 Method 6 modified as required to ensure minimum 95% MDD OMC/MDD to be determined using the Vibrating Hammer Maximum compacted layer thickness shall be 200mm Constituent materials determined in accordance with SHW Clause 710	6	F	3
								BS EN 933-2 (Off-site)	SHW Table 6/5	SHW Table 6/5				
							(ii) OMC/MDD	BS 1377-4: 3.7	-	-				
							(iii) mc	BS 1377-2	OMC -2%	OMC				
							(iv) bitumen content	BS 598-102	-	10%				
	6	F	4	Selected granular material (fine grading)	Imported Capping	Unbound mixtures complying with BS EN 13285	Size designation and overall category	BS EN 13285- 0/31.5 and G_E	SHW Table 6/5	SHW Table 6/5	SHW Table 6/4 Method 6 modified as required to ensure minimum 95% MDD OMC/MDD to be determined in accordance with BS EN 13285-5.3	6	F	4
						Any material or combination of materials – including recycled aggregate, but excluding colliery spoil, argillaceous rock, chalk, recycled bituminous planings and granulated asphalt	Maximum fines and oversize categories	BS EN 13285- UF_{15} and OC_{75}	SHW Table 6/5	SHW Table 6/5				
							Los Angeles coefficient	BS EN 13242-LA_{60}	-	60				
							Volume stability of blast furnace slag	BS EN 13242	Free from dicalcium silicate and iron disintegration					
							Volume stability of steel (BOF) and EAF slag	BS EN 13242 – V_5	-	-				
							Other aggregate requirements	BS EN 13242	Category $_{NR}$ (no requirement)					
							Laboratory dry density and OMC	BS EN 13285-Clause 5.3 -	-	-				
							Water content	BS EN 1097-5	OMC-2%	OMC				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within: Lower	Upper				
SELECTED GRANULAR FILL	6	F	5	Selected granular material (fine grading)	Imported Capping	Unbound mixtures complying with BS EN 13285	Size designation and overall category	BS EN 13285- 0/80 and G_E	SHW Table 6/5	SHW Table 6/5	SHW Table 6/4 Method 6 modified as required to ensure minimum 95% MDD OMC to be determined in accordance with BS EN 13285-5.3	6	F	5
						Any material or combination of materials – including recycled aggregate, but excluding colliery spoil, argillaceous rock, chalk, recycled bituminous planings and granulated asphalt	Maximum fines and oversize categories	BS EN 13285- UF_{12} and OC_{75}	SHW Table 6/5	SHW Table 6/5				
							Los Angeles coefficient	BS EN 13242-LA_{50}	-	50				
							Volume stability of blast furnace slag	BS EN 13242	Free from dicalcium silicate and iron disintegration					
							Volume stability of steel (BOF) and EAF slag	BS EN 13242 – V_5	-	-				
							Other aggregate requirements	BS EN 13242	Category $_{NR}$ (no requirement)					
							Laboratory dry density and OMC	BS EN 13285-Clause 5.3 -	-	-				
							Water content	BS EN 1097-5	OMC-2%	OMC-2%				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	I	-	Selected well graded granular material	Fill to reinforced soil and anchored earth structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt.	(i) grading	BS EN 933-2	SHW Tab 6/5	SHW Tab 6/5	End product 95% MDD OMC/MDD determined using Vibrating Hammer	6	I	-
							(ii) uniformity coefficient	See note 5	10	-				
							(iii) Los Angeles coefficient	Clause 635	-	40				
							(iv) Effective angle of internal friction (ϕ’)	Clause 636	ϕ’ = 38º	-				
							(v) Coefficient of Friction & adhesion	Clause 639	δ = 15º	-				
							(vi) MC	BS 1377-2	OMC -2%	OMC +1%				
							(vii) OMC/MDD	BS 1377-4: 3.7	-	-				
							(viii)CBR at OMC	BS 1377-4	12%	-				
							(ix) Chloride, water soluble sulfate (WS), oxdisable sulfate (OS), total sulphur (S) and Total Potential Sulphate (TPS)	BS EN 1744-1	-	SHW Table 6/3				
							(x) Organic content	BS 1377-3	-	SHW Table 6/3				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within: Lower	Upper				
SELECTED GRANULAR FILL	6	N	-	Selected well graded granular material	Fill to structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt.	(xi) grading	BS1377-2	SHW Tab 6/2	SHW Tab 6/2	End product 95% MDD OMC/MDD determined using Vibrating Hammer	6	N	-
							(xii) uniformity coefficient	See note 5	10	-				
							(xiii)Los Angeles coefficient	Clause 635	-	40				
							(xiv)Effective angle of internal friction (ϕ')	Clause 636	ϕ'_{pk} 37.5º ϕ'_{crit} 31.5º	$\phi'_{pk} \leq$ 44º $\phi'_{crit} \leq$ 38º				
							(xv) MC	BS 1377-2	OMC -2%	OMC +1%				
							(xvi)OMC/MDD	BS 1377-4: 3.7	-	-				
							(xvii)CBR at OMC	BS 1377-4	12%	-				
							(xviii) Sulphate $(S0_4)$ total sulphur (S) and Total Potential Sulphate (TPS)	TRL 447	-	SHW Clause 601				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
SELECTED GRANULAR FILL	6	P	-	Selected granular material	Fill to structures	Natural gravel, natural sand, crushed gravel, crushed rock, crushed concrete, slag, well burnt colliery spoil or any combination thereof. None of these constituents shall include any argillaceous rock. Recycled aggregate except recycled asphalt.	(i)grading	BS1377-2	SHW Tab 6/2	SHW Tab 6/2	End product 95% MDD OMC/MDD determined using Vibrating Hammer	6	P	-
							(ii) uniformity coefficient	See note 5	5	-				
							(iii) Los Angeles coefficient	Clause 635	-	60				
							(iv) Effective angle of internal friction (ϕ') and effective cohesion (c')	Clause 636	ϕ' = 38º	-				
							(v) MC	BS 1377-2	OMC -2%	OMC +1%				
							(vi) OMC/MDD	BS 1377-4: 3.7	-	-				
							(vii) CBR at OMC	BS 1377-4	8%	-				
							(viii) Sulphate (S04) total sulphur (S) and Total Potential Sulphate (TPS)	TRL 447	-	SHW Clause 601				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within: Lower	Upper				
SELECTED COHESIVE FILL	7	A	-	Selected cohesive material	Fill to structures	Any material, or combination of materials, other than argillaceous rock, chalk or colliery spoil	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	End product of 95% of MDD and/or minimum undrained shear strength of 80 KN/m² (whichever is the more onerous) with less than 5% air voids MDD to be determined using 4.5kg Rammer and to include measurement of particle density ² Where the Liquid Limit and/or plasticity index are in excess of the values defined in this Table, the Contractor shall inform Hydrock for further guidance on the use of this material.	7	A	-
							(ii) mc	BS 1377-2	Equivalent to 110% MDD and maximum of 5% air voids	Equivalent to 100% MDD and/or c of 80 KN/m²				
							(iii) Sulphate (S04) total sulphur (S) and Total Potential Sulphate (TPS)	TRL 447	-	SHW Clause 601				
							(iv) undrained shear parameters (c and ϕ)	SHW Clause 633	c = 80 KN/m²	-				
							(v) effective angle of friction (ϕ') and effective cohesion (c')	SHW Clause 636	c' = 2 kPa ϕ' = 25º	-				
							(vi) liquid limit	BS 1377-2	-	² 45				
							(vii) plasticity index	BS 1377-2	-	² 25				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within:					
									Lower	Upper				
SELECTED COHESIVE FILL	7	E	-	Selected cohesive material	For stabilisation with lime to form capping (9D) and for the upper 0.60m of engineered fill below carriageway where Class 3 foundation is required	Any material, or combination of materials, other than unburnt colliery spoil	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	Not applicable	7	E	-
							(ii) mc	BS 1377-2	As per Contractors Mix Design	As per Contractors Mix Design				
							(iii) MCV	SHW Clause 632	As per Contractors Mix Design	-				
							(iv) plasticity index	BS 1377-2	10	-				
							(v) organic matter	BS 1377-3	-	2%				
							(vi) water soluble (WS) sulfate content	BS EN 1744-1 clause 10	-	300 mg/l				
							(vii) Oxidisable sulphides (OS)	BS EN 1744-1 clause 13	-	0.06 %				
							(viii) total potential sulfate (TPS) content	BS EN 1744-1 clause 11	-	1.0 %				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within: Lower	Acceptable limits Within: Upper				
SELECTED COHESIVE FILL	7	I	-	Selected cohesive material	For stabilisation with lime and cement to form capping (Class 9E)	Any material, or combination of materials, other than unburnt colliery spoil	(i) grading	BS 1377-2	SHW Table 6/2	SHW Table 6/2	Not applicable	7	E	-
							(ii) mc	BS 1377-2	As per Contractors Mix Design	As per Contractors Mix Design				
							(iii) MCV	SHW Clause 632	As per Contractors Mix Design	-				
							(iv) plasticity index	BS 1377-2	10	-				
							(v) organic matter	BS 1377-3	-	2%				
							(vi) water soluble (WS) sulfate content	BS EN 1744-1 clause 10	-	300 mg/l				
							(vii) Oxidisable sulphides (OS)	BS EN 1744-1 clause 13	-	0.06 %				
							(viii) total potential sulfate (TPS) content	BS EN 1744-1 clause 11	-	1.0 %				

TABLE 6/1 (continued): ACCEPTABLE EARTHWORKS MATERIALS: CLASSIFICATION AND COMPACTION REQUIREMENTS (SEE FOOTNOTES)

Class				General Material Description	Typical Use	Permitted Constituents (All Subject to Requirements of Clause 601 and Appendix 6/1)	Material Properties Required for Acceptability In Addition to Requirements on Use of Fill Materials in Clause 601 and Testing in Clause 631				COMPACTION REQUIREMENTS IN CLAUSE 612 & ADDITIONAL NOTES	Class		
							Property (See Exceptions in Previous Column)	Defined and Tested in Accordance with:	Acceptable limits Within: Lower	Upper				
STABILISED MATERIALS	9	D	-	Lime stabilised cohesive material	Capping and the upper 0.60m of earthworks fill below Class 3 foundation	Class 7E with addition of lime according to SHW Clause 615	(i) pulverisation	BS EN 13286-48	30%	-	SHW Table 6/4 Method 7, modified as required to achieve minimum 95% MDD	9	D	-
							(ii) MCV immediately before compaction	SHW Clause 632	As per Contractors Mix Design	As per Contractors Mix Design				
							(iii) bearing ratio	BS EN 13286-47	10% -upper 0.60m fill 15% - Capping	-				
							(iv) mc	BS EN 13286-2	As per Contractors Mix Design	As per Contractors Mix Design				
	9	E	-	Lime and cement stabilised cohesive material	Capping	Class 7I with addition of lime and cement according to SHW Clause 643	(i) pulverisation	BS EN 13286-48	30%	-	SHW Table 6/4 Method 7, modified as required to achieve minimum 95% MDD	9	E	-
							(ii) MCV immediately before compaction	SHW Clause 632	As per Contractors Mix Design	As per Contractors Mix Design				
							(iii) bearing ratio	BS EN 13286-47	15%	-				
							(iv) mc	BS EN 13286-2	As per Contractors Mix Design	As per Contractors Mix Design				

Footnotes to Table 6/1:

1. App = Appendix
2. Tab = Table
3. Where in the Acceptable Limits column reference is made to App 6/1, only those properties having limits ascribed to them in Appendix 6/1 shall apply. Where Appendix 6/1 gives limits for other properties not listed in this Table such limits shall also apply.
4. Where BS 1377:Part 2 is specified for mc, this shall mean BS 1377:Part 2 or BS EN 1097-5 as appropriate.
5. Uniformity coefficient is defined as the ratio of the particle diameters D60 to D10 on the particle-size distribution curve, where: D60 = particle diameter at which 60% of the soil by weight is finer and D10 = particle diameter at which 10% of the soil by weight is finer.
6. The limiting values for Class U1B material are given in Appendix 6/14 and Appendix 6/15.
7. Where undrained shear strength is specified as the method of acceptability testing, the Contractor may use a hand vane provided that it is initially calibrated against the unconsolidated undrained shear strength laboratory triaxial test to BS 1377:Part 7, clause 8 on 100mm nominal diameter samples, and the MCV test in accordance with BS 1377:Part 4. Otherwise, shear strength testing requirements is to be as set out in 633 of the Specification.
8. The contents of this table may be revised following periodic engineering assessments and design by the Project Manager.
9. Where supplementary clauses and tables are reference in Table 6/1 above, they shall refer to the equivalent clause or table from the Manual of Contract Documents for Highway Works, Specification for Highway Works: Volume 1: (SHW).

APPENDIX 6/2: REQUIREMENTS FOR DEALING WITH CLASS U1B AND CLASS U2 UNSUITABLE MATERIALS

1.0 General

1.1 Unacceptable material, Class U2 shall be defined as in SHW Clause 601.3. The Contractor is referred to the site specific earthworks and remediation method statements and specifications for the requirements regarding Class U1B and Class U2 Unacceptable Material.

1.2 If unacceptable material is encountered within the works, a risk assessment will be carried out and the contractor shall make all necessary arrangements for their safe handling and disposal after consultation with the appropriate environmental authority in accordance with SHW Clause 602. As such the Contractor shall put in place contingency measures to deal with U2 materials if encountered during the earthworks.

1.3 The Contractor shall make all necessary enquiries and arrangements for the transfer of U1B and U2 materials for their disposal off-site and shall liaise with the relevant regulatory bodies prior to initiating removal of any material from site.

1.4 Where Class U1B material is identified and are unsuitable for treatment on site, the Contractor shall undertake appropriate testing including Waste Acceptance Criteria (WAC) Tests to determine the waste type and whether the waste will comprise U2 material, i.e. Hazardous Waste.

1.5 The Contractor shall inform the Engineer immediately of the discovery of U1B or U2 materials, asbestos or other gross contamination. The Contractor shall define in their Method Statement the procedures for handling asbestos, U1B or U2 materials or other waste.

1.6 No groundwater or surface water encountered during excavation shall be discharged to foul or storm sewer, nor to watercourses without the prior written approval of the Sewer provider or the Environment Agency respectively.

1.7 The Contractor shall ensure at all times that:

- The exposure of site personnel and the general public to hazards is avoided; and
- Contamination or pollution migrating within the site or beyond the site boundaries is prevented.

20.8 Throughout the Works the Contractor shall pay particular attention to the following:

Handling and disposal of contaminated soils and water

a) Keep the waste safe. Holders should protect the waste both whilst in their possession and for its future handling requirements. Security precautions where waste is to be held prior to removal from site should prevent theft, vandalism, waste scavenging and fly tipping. Waste shall be removed from site in appropriate containers.

b) Transfer to the correct person. Waste may only be handed on to authorised persons or to persons authorised for transport purposes. The Contractor shall pay due regard to Duty of Care and associated regulations.

c) The Contractor shall ensure that waste is collected regularly. The maximum volume of material in a single stockpile on site at any time shall not exceed 500m³.

d) The Contractor shall ensure that all waste is stockpiled in accordance with a method statement approved by the Engineer and shall as a minimum included for bunding, basal membrane and top cover membrane to prevent rainfall infiltration and run-off.

e) The Contractor shall comply with Duty of Care Regulations and shall keep records of waste dispatched from site, including waste transfer notes. All records are to be made available to the Engineer and/or Regulator upon request. The Contractor shall ensure that all landfill gate receipts are copied to the Engineer within two working days of dispatch from site.

(f) The Contractor shall ensure that all waste is taken to a disposal facility which is licensed to receive that specific waste type (as determined by chemical analyses and WAC tests).

g) All waste leaving the site shall be sheeted, without holes or tears in the sheeting fabric. Where possible, the Contractor shall use self sheeting lorries to haul waste from the site. Where these are not available, the Contractor shall take appropriate measures to construct a safe and suitable sheeting gantry. Where sheets are to be laid over the container, they shall be secured in place. In the event of any loss of waste during transit, the Contractor shall ensure that the lost waste is collected and transported correctly to the receiving facility.

h) The Contractor shall supply the Engineer with a schedule containing vehicle registration number, owner, weight (unladen and gross maximum permitted) and driver details of each vehicle used for transport of materials off-site.

Sub-contracting

20) In order to ensure compliance with the Duty of Care Regulations, the Contractor must nominate all Sub-Contractors before a contract is entered into for undertaking this work.

Site Monitoring

a) The Contractor shall be responsible for all documentation of waste leaving the site and for validation of the chemical composition of waste.

b) A designated person must be made responsible for co-ordinating and ensuring that all appropriate precautions are taken against the escape of hazardous substances. This designated person shall maintain an up to date site record. The Contractor shall demonstrate the competence of this person to the satisfaction of the Engineer.

c) Only authorised persons shall be allowed access to the site. All site personnel shall be required to attend a site safety induction prior to commencement of works on the site.

d) All persons entering the site must be made fully aware of the hazards and risks on site prior to entering the site. Instructions shall be issued by the Contractor regarding Health and

Safety precautions required. All persons will be required to sign a declaration of understanding and acceptance of site instructions. This is to protect both the individual and other personnel on the site. Non-compliance with this regime must in all cases result in refused entry to site.

e) If any person fails to comply with the health and safety precautions that person is to be removed from site immediately. Return to site would be at the discretion of the Engineer. The Contractor shall ensure that any individual who deliberately flaunts the health and safety precautions is dismissed from site and not permitted to return to the site.

f) In the instance of a possible danger occurring, safety on site shall be of utmost priority. Immediate action must be taken for the health and safety of all personnel on site. The location of the danger and any exclusion zone shall be evacuated immediately. The Contractor shall produce a method statement to set out the measures and steps to be followed in the event of such an occurrence and shall include, where applicable, for notification of emergency services, HSE, Planning Co-ordinator and the like.

g) All persons entering the site shall wear appropriate Personal Protective Equipment (PPE), which is to include but not be limited to: safety Wellingtons or boots (steel mid-sole and toe caps); overalls and/or impermeable outer garments; nitrile or other suitable gloves; safety goggles; and ear defenders.

h) First Aid facilities and suitably competent personnel shall be available at clearly identifiable locations on site.

i) A Site Safety Officer shall be appointed by the Contractor and shall be responsible for health surveillance on the site.

j) The Contractor shall take appropriate measures to avoid and prevent cross contamination of plant and personnel and also to ensure that all plant and personnel are free from contaminants and mud upon exiting the site.

APPENDIX 6/3: REQUIREMENTS FOR EXCAVATION, DEPOSITION, COMPACTION (OTHER THAN DYNAMIC COMPACTION)

1.0 EARTHWORKS GENERAL

1.1 Earthworks requirements including constraints on earthworks in relation to structures and water courses are shown on Drawings. The earthworks associated with the highways are part of a wider scheme, and as such any additional fill requirements are to be provided from cut materials from within the development plateaus, as identified on the drawings.

1.2 No ground disturbing activities, including any earthmoving activities, are to commence prior to the Contractor obtaining any necessary permits or licences relating to protected species or habitats. If a licence or permit for such works is granted, those works shall only be undertaken during the periods as stated on the licence or permit under the direction of the licence or permit holder. A copy of the licence and/or permit shall be provided to the Employer prior to commencement of the relevant activities.

1.3 Material excavated and designated for processing shall be transported to the appropriate process area for stockpiling and treatment. Clearly defined segregated stockpiles are required for different sub-classes of processed material. The maximum permitted height of stockpiles, excluding topsoil Class 5, shall be 5.0 m unless otherwise agreed. The maximum volume of any single stockpile shall not exceed 500m^3 unless otherwise agreed.

1.4 For temporary storage of earthworks materials, except topsoil Class 5, maximum permitted height of stockpiles shall be 5.0 metres unless otherwise agreed, subject to other restrictions noted elsewhere in this specification. Earthworks materials requiring to be stockpiled shall be stored in individual stockpiles for each earthworks class and end-use.

1.5 On completion of a stockpile the slopes shall be trimmed to falls to shed rain water and the surface sealed to limit infiltration. Temporary drainage shall be provided at the base of the stockpile to collect runoff from the stockpile and to carry any surface water away from the base of the stockpile.

1.6 The Contractor shall provide and maintain such measures as necessary to eliminate the production of dust from the stockpile during the life of the stockpile.

2.0 CUTTING FACES

2.1 No specific limitations or restrictions on undercutting are included, but the Contractor shall comply with the Temporary Works Designer requirements when excavating trenches at the toe of any slopes.

2.2 Clearing loose material from cutting slopes by airline hose is not permitted.

2.3 The Contractor shall provide additional drainage measures to intercept and discharge seepages from cutting slopes in general accordance with the details provided in the Drawings. The Contractor is responsible for all drainage required to carry out the works and to protect them upon completion, which will include, where necessary, temporary drainage measures.

2.4 Cutting faces which are to have topsoil shall be made good prior to topsoil placement as shown on the Drawings. If the drawings do not show details then any of the methods set out in Clause 603.7 of SHW shall be used as required except that the use of concrete, grout, masonry infill and sprayed concrete is not permitted.

3.0 WATER COURSES

3.1 Details of regrading existing water courses, construction of new water courses and earthworks drainage ditches are shown on the Drawings.

3.2 Redundant watercourses shall be drained and cleaned as described on the Drawings. Excavated arisings are to be treated as described in Appendix 6/2. Watercourses shall be filled with earthworks materials as shown on the Drawings.

3.3 The Contractor shall provide for such measures as may be necessary to ensure that water, whether ground water, from precipitation or any other source does not accumulate in excavations or on sub-grades.

3.4 The Contractor shall arrange for the rapid dispersal of water shed on to the surface of earthworks or completed formation during construction or which enters the earthworks from any other source.

3.5 The Contractor shall provide where necessary temporary watercourses, ditches, drains, pumping or other means of maintaining the earthworks free from water. Such provision shall include carrying out the work of forming the earthworks in such a manner that their surfaces have at all times a sufficient minimum cross-fall and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding. This shall include the provision of temporary measures to remove water expelled from the ground due to the change in imposed load from the construction or construction activities (including ground improvement).

3.6 All works and associated costs relating the control and management of water on site, from existing, proposed or redundant watercourses or from any other sources including groundwater, rainfall and surface water is the responsibility of the Contractor. All costs are to be borne by the Contractor and the Contractor is deemed to have read, understood and fully accounted for these costs within their Tender submission. Any uncertainty over the issues associated with water or groundwater control should be submitted to the Engineer for clarification, as soon as any such issue is noted or identified by any party.

4.0 CONSTRUCTION GENERAL REQUIREMENTS

4.1 Location of fill types are shown on the Drawings. In addition to this, General fill is only to be used in areas outside of the influence of the proposed structures. Any fill placed within the influencing zone of structures shall comply with the requirements of Class 6.

4.2 The Contractor is responsible for agreeing with the Supervising Engineer the extents of the General Fill and Selected Fill.

4.3 Locations of starter layers are shown on the BWB Drawings presented under a separate cover.

4.4 Details of benching are to be a maximum of 0.50m in height with the length of the bench cut to meet the profile of the excavation. In addition to this, where structural loads may span across an excavation where benching has been employed, the length of each bench must be at least twice the height.

4.5 The height of each bench shall reflect the thickness of the compacted layer, and shall be no more than 2 compacted layers in height.

4.6 All bench details shall be agreed with the Engineer.

4.7 Over-steepening of embankment side slopes shall only be permitted with the approval of the Engineer.

5.0 CONSTRUCTION OF FILL

5.1 Embankment slopes shall not be constructed steeper than that shown on the Drawings. Temporary over-widening or steepening to achieve adequate compaction of the shoulders of the embankment is permitted.

5.2 Any areas requiring staged construction of fills, the details for the staged construction and hold periods are to be shown on the Drawings and are to be under the direction of the Engineer.

5.3 Any areas requiring surcharging, the relevant details including levels, time periods for surcharging, type of surcharge material are to be shown on the Drawings.

5.4 Any areas requiring protection of the formation or sub-formation against weather, shall be carried out in accordance with Clause 608.9(ii) of SHW, are shown on the Drawings.

5.5 Any areas requiring starter layer, together with class type and thicknesses are shown on the Drawings.

5.6 The proposed staged process of earthworks are as detailed within this Specification.

5.7 Formation for earthworks construction and cutting formations shall be proof-rolled using a minimum compactive effort as detailed in Specification Clause 613.11 and 613.12. This minimum compactive effort shall be increased for cutting formations where different compactive efforts, dependent on the type of follow-on earthworks operations, are required by the Specification. The identification of a ‘soft spot’ is qualitative and depends on the response of the ground to the compactive effort during the proof-rolling.

5.8 For the purposes of this contract, the definition of a soft area will correspond to a CBR of less than 2%. As a minimum excessive mattressing, bow-waving or ground heave shall be indicative of a ‘soft spot’ which will then require testing by the contractor to determine the CBR of the subgrade. The Contractor is to agree with the Supervising Engineer the extent of ‘soft spot’ treatment.

5.9 It is considered likely that localised ‘soft spots’ may occur during the during the proof rolling exercise and as such detailed discussion and agreement will be required with the Supervising Engineer at the outset in order to adopt a standardised procedure for dealing with this occurrence.

5.10 Where a soft-spot is identified, the sequence of activities shall include the following:

- Delineation at the current formation the extent of soft spot.
- Excavation of soft spot.
- Inspection of the area of the soft spot post removal of affected material by the Geotechnical Supervisor (Hydrock).
- In situ assessment on strength (hand vane shear strength in the case of cohesive soils) at the base and sides of the excavation.
- Survey of the extent of the soft spot excavation by the Contractor.
- Replacement of affected material with suitable engineered fill, compliant with the requirements of Appendix 1/5 and Table 6/1.
- Where the depth of the soft spot exceeds 0.50m, the sides of the excavation shall be benched in, in accordance with Hydrock Drawing EMG-HYD-ZZ-XX-DR-GE-0649.
- Records of extent of soft spots to be presented in accordance with the requirements set out in Appendix 1/24.

6.0 COMPACTION

General

6.1 It is envisaged that most of the fill to be used on this site will be derived from site won materials which will either be classed as general fill to external areas, or as selected fill to form the capping below the sub base in the highway pavement. Requirements for compaction of earthworks materials shall comply with Clause 612 of SHW and HA 70. Compaction requirements shall be as described below.

Method Compaction

6.2 For method compaction of earthworks materials extra compaction in the top 600mm is required and this shall comprise an improved/modified material with a minimum subgrade stiffness modulus at the top of the material of 77 Mpa. Requirements for compaction of drainage material, if a geocomposite is not used, are shown on the Drawings. The frequency of field dry density testing shall be as set out in Appendix 1/5.

6.3 A series of Compaction Compliance Envelopes, presented as figures, have been produced which represent the requirements from Table 6/1 on the compaction requirements for the main types of fill to be used in this project. Reference shall be made to these figures and a source specific envelope shall be provided by the Contractor based upon the results of the classification testing for each material and shall be used in the assessment of compliance.

6.4 The *in situ* testing shall be undertaken in accordance with the frequency defined in Appendix 1/5 and shall demonstrate that the adopted method achieves the minimum end product performance detailed in Table 6/1. Where the testing identifies that the minimum end product performance is not being met, then the method of compaction shall change, and a new compaction trial shall be undertaken

End Product Compaction

6.6 Where the compaction requirements specified in Table 6/1 state that End Product Compaction is required, the fill shall be tested in accordance with the frequency defined in Appendix 1/5.

6.7 The minimum compliance requirements to be met by fill placed to either Method Placement to End Product Compaction are defined in Section 6.26 of this Appendix.

Figure 6/3-1
Compaction Compliance Envelope - Class 1A, Class 1B and Class 6C

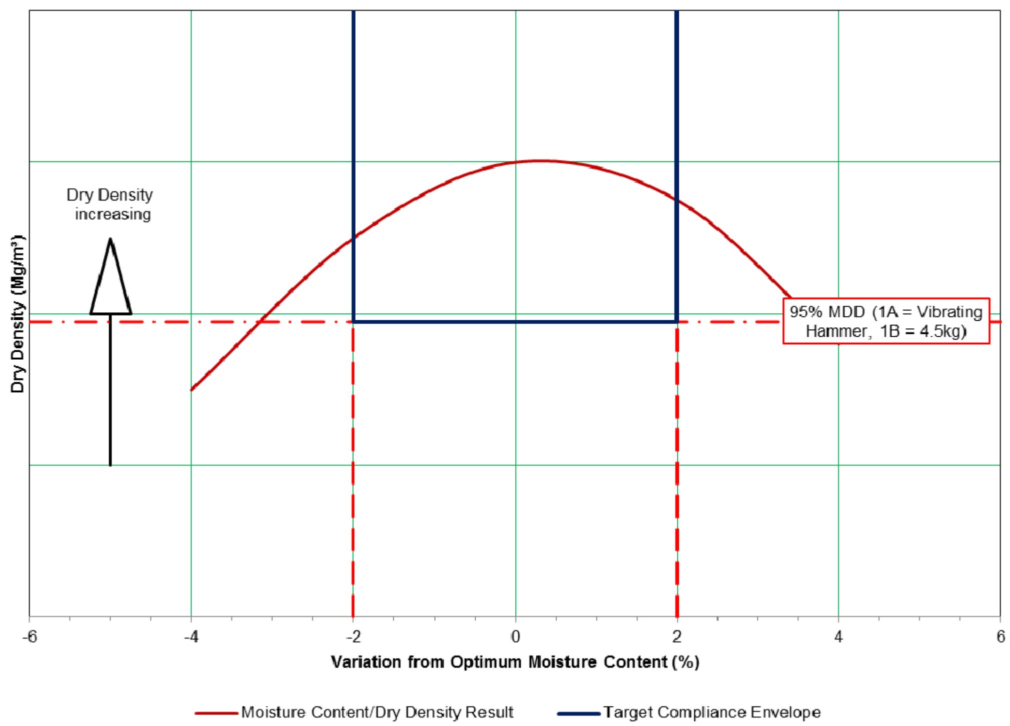


Figure 6/3-2
Compaction Compliance Envelope - Class 2A and Class 2C

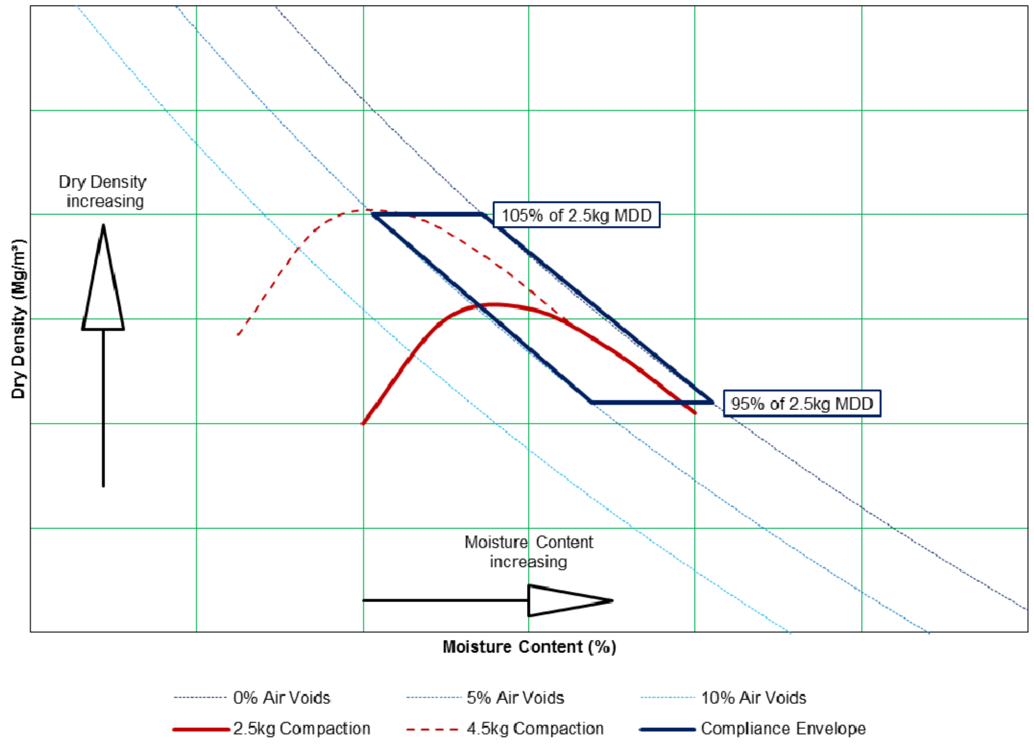
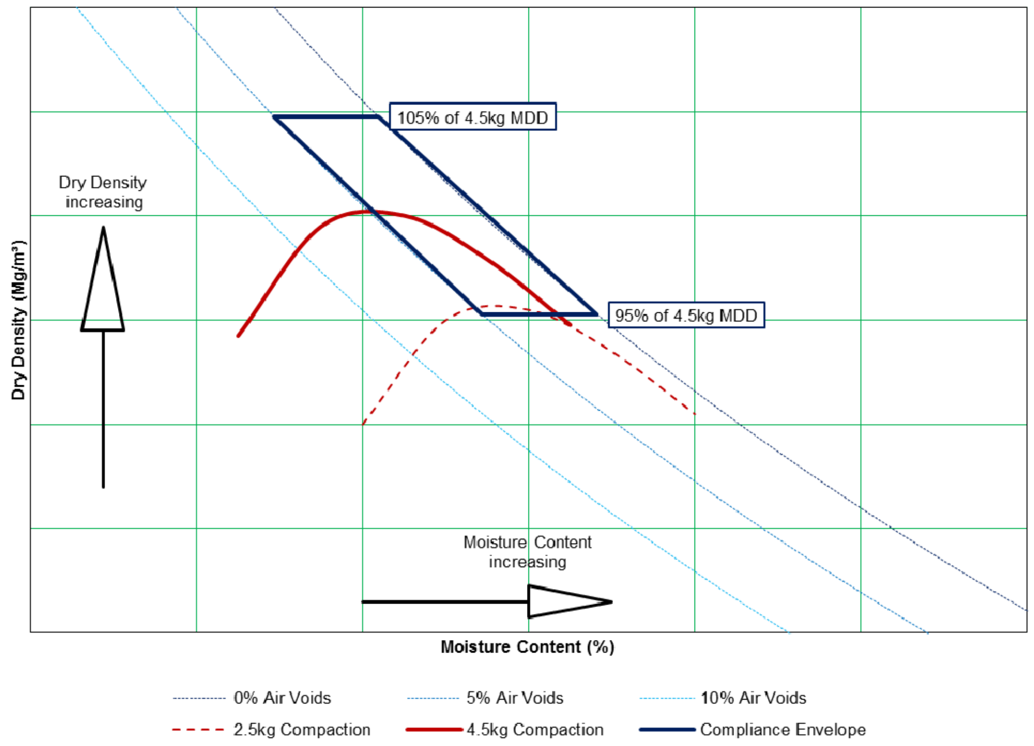


Figure 6/3-3
Compaction Compliance Envelope - Class 2B



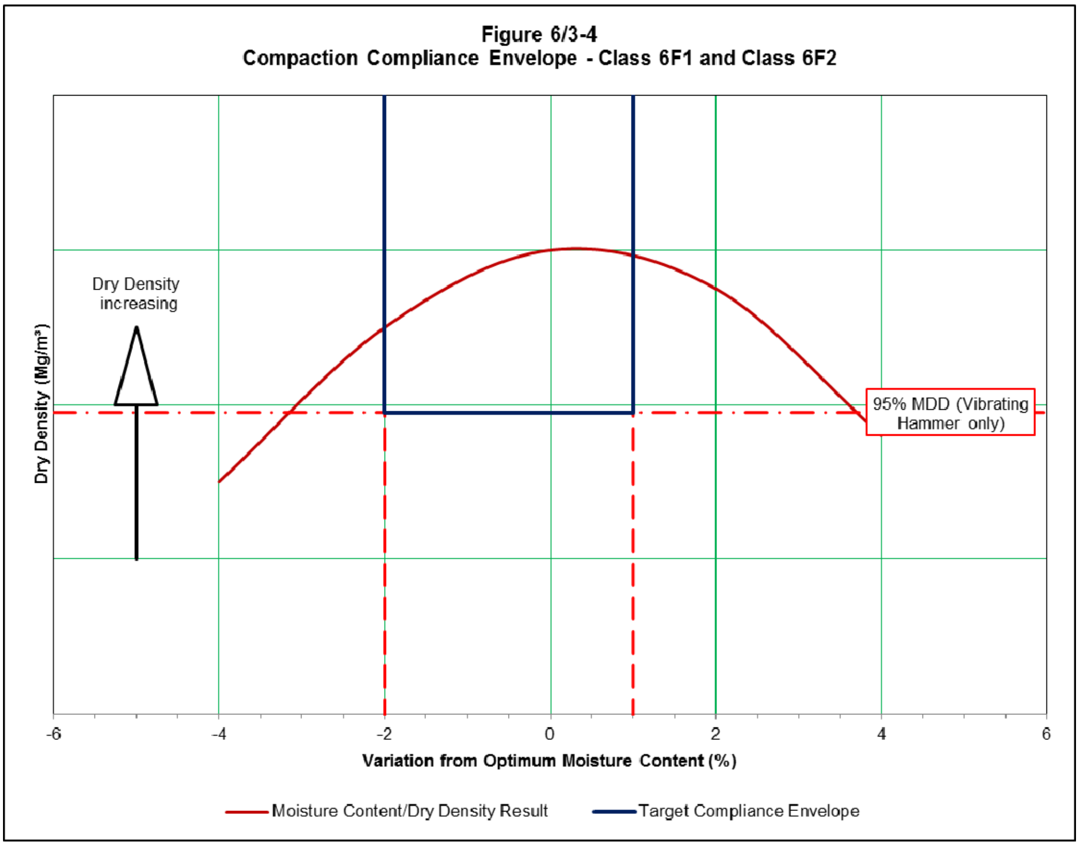


Figure 6/3-4
Compaction Compliance Envelope - Class 6F1 and Class 6F2
Dry Density increasing
Dry Density (Mg/m³)
95% MDD (Vibrating Hammer only)
-6
-4
-2
0
2
4
6
Variation from Optimum Moisture Content (%)
Moisture Content/Dry Density Result
Target Compliance Envelope

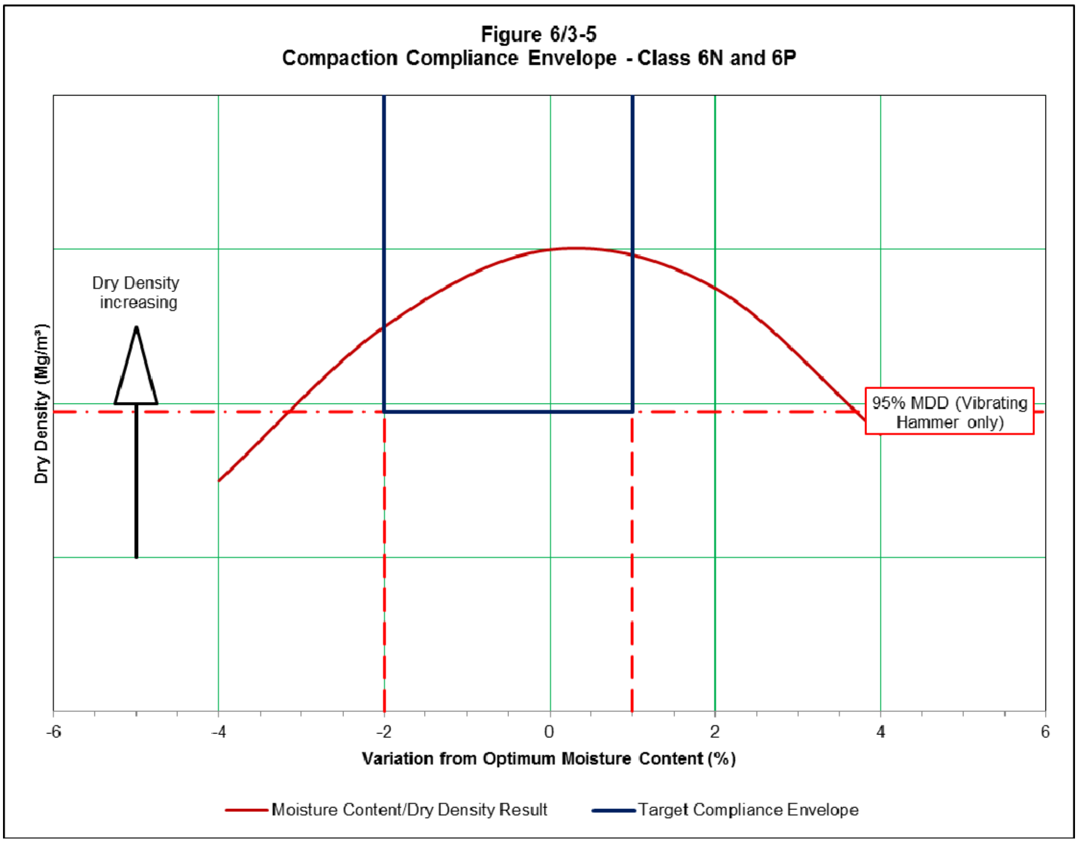


Figure 6/3-5
Compaction Compliance Envelope - Class 6N and 6P
Dry Density increasing
Dry Density (Mg/m³)
95% MDD (Vibrating Hammer only)
-6
-4
-2
0
2
4
6
Variation from Optimum Moisture Content (%)
Moisture Content/Dry Density Result
Target Compliance Envelope

Compaction Trial

6.8 A compaction trial is required to be completed for each compaction method to be used and for each source of material. Prior to undertaking the trial, the Contractor shall confirm to the Hydrock the following:

- What method of compaction is to be used in the trial and whether or not it has been based upon the guidance from SHW Table 6/4.
- What compaction plant is to be used, including but not limited to the type of equipment, manufacture, mass per meter width and any other relevant information which can be used to assess its suitability for the material to be compacted.
- Confirmation of the source of material to be used, and whether or not there are any geotechnical results available from source suitability testing prior to the commencement of the trial.
- Confirmation that they understand the minimum specification requirements for end-performance of the fill which are to be assessed and demonstrated during the trial.
- The methodology for assessing fill, including test type and frequency and who will be undertaking the testing both on site and for the subsequent laboratory analysis.
- Confirmation that all parties who are to attend the trial have been informed of when and where the trial will be undertaken.

6.9 For each Class of material as defined in Table 6/1, and each proposed compaction method, a number of test panels shall be constructed in order to allow a full assessment to be completed. Key criteria to identify during the compaction trial will be:

- Change in density and air voids against number of passes.
- Change in density and air voids against depth of layer.
- Change in engineering performance against compactive effort.
- Identification of point of over-compaction/softening of fill.
- Comparative analysis between different plant [where more than one roller is proposed]
- Suitability of material for use on site for the proposed end-use.
- Confirmation of classification and engineering performance of material, including sampling, laboratory testing and classification of the material.
- Comparison of actual performance of material against specification design values.
- Calibration of testing equipment, in particular where the use of a Nuclear Density Gauge [NDG] is proposed for the monitoring of earthworks operation.

Selection of End Product Requirements to be Demonstrated during Compaction Trial

6.10 Reference shall be made to the Compaction Compliance Envelopes, presented as Figures 6/3-1 to 6/3-5 inclusive.

6.11 For the Class 1 General Fill material, it shall be placed and compacted at a moisture content equivalent to the OMC-2% to the OMC+2% and that it should achieve an *in situ* dry density greater than 95% of the MDD when determined using the Vibrating Hammer.

6.12 For Class 2A, 2C, 2D and 2E General Fill, it shall achieve an *in situ* dry density of at least 95% of the MDD determined using the 2.5kg Rammer and have a minimum undrained shear strength in accordance with Table 6/1 of this Specification.

6.13 For Class 2B and Class 7 selected fill, the degree of compaction shall be either 100% of the MDD from the 2.5kg Rammer or 95% of the MDD determined from the 4.5kg Rammer. The Contractor is to confirm with the Engineer/NR which method of laboratory compaction is to be used for Class 2B material before it is tested. Additional requirements for the fill such as strength, bearing capacity and settlement are shown on the Drawings.

6.14 This degree of compaction and additional requirements from Table 6/1 shall form the basis of the compaction specification of Class 1, Class 2, Class 6 and Class 7 fill used as part of the earthworks operation.

6.15 The Contractor shall carry out a compaction trial for each type of material and compaction method to be used to demonstrate that the required degree of compaction and additional requirements can be met. The site of the trials shall be clearly marked and levels taken to determine the thickness of each layer before and after compaction.

Construction of Compaction Trial Test Panels

6.16 For each material type, a number of test panels may be required in order that a full assessment of the material and compaction method can be completed, which would then constitute the Compaction Trial. Although the size of each panel will need to reflect the size of the compaction plant and methodology of work proposed, a minimum width of 8m by 20m in length is recommended, with a number of different layer depths as indicated in Figure 6/3-6.

6.17 Each test panel should be laid out and clearly identified and defined separately from any other test panel to avoid cross-contamination, accidental influence from adjacent works and located on site away from other works.

6.18 The depth of each layer forming the test panel should reflect the likely depth of compacted material, post completion of the compaction trial, i.e. sufficient material should be placed so that the final depth of the compacted layer is in accordance with the guidance provided in Table 6/4 of the SHW. In the unlikely event that a material is proposed to be compacted and it is not possible to classify the material in order to identify the most likely method of compaction, a significantly higher number of test panels will be required in order to identify the optimum plant, layer thickness and number of passes.

Compaction of Test Panels

6.19 Unless specifically instructed within the site specific documentation, earthmoving plant shall not be accepted as compaction equipment, nor the use of lighter compaction plant to provide any preliminary compaction prior to the use of heavier equipment.

6.20 Although the guidance from Table 6/4 of the SHW may indicate the optimum number of passes of the appropriate plant, it is important that the progression of improvement of the material is monitored throughout the compaction process. Therefore, after each and every two passes of the appropriate roller, *in situ* assessment of the density of the material is to be undertaken. One pass of the roller is defined as a single movement of the compaction plant, in one direction, over a given strip of the test panel.

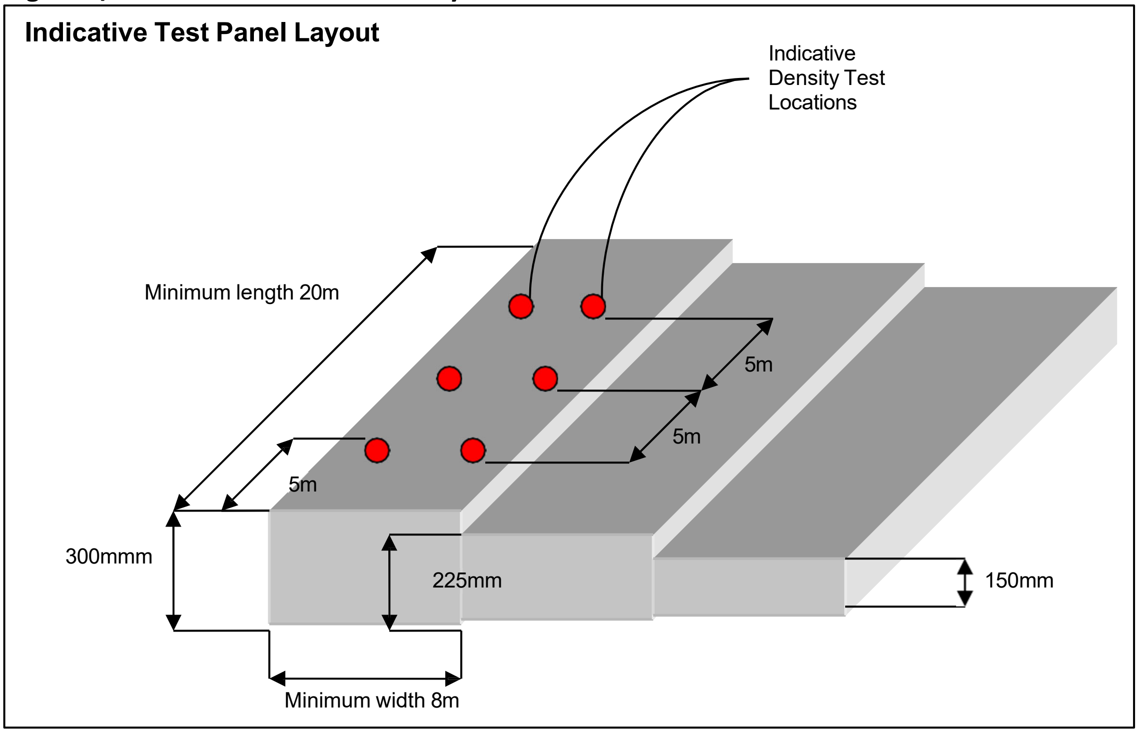
6.21 Where the width of the test panel or roller requires a number of passes in order to ensure the full width of the surface is compacted, it is acceptable for the roller to overlap the previous strip by a small margin (no more than 25% of the maximum roller width). However it should be ensured that no in situ testing is undertaken in this zone to prevent the effect of over-compaction influencing the assessment of the performance of the plant and material.

6.22 The compaction of the test panel should continue incrementally until a clear indication has been obtained to show that the soil has either achieved a maximum density, i.e. where after a number of repeat passes is completed no change is identified or has been over compacted and the performance of the material begins to deteriorate. The exception to this will be where the final performance of the test panel is required to be confirmed using plate load testing, and in this instance it is recommended that a separate panel is constructed, to the same specification as has been identified during the compaction trial, in order that the assessment of the performance can be completed without the detrimental influence of over-compacted material.

6.23 Guidance on the point of over compaction may be readily identifiable on site from a number of key parameters:

- Reduction in bulk density/dry density with increasing compaction.
- Increase in moisture content, where the over-compaction of the material drives moisture up through the material to the surface [mobilisation of excess pore pressure]. This may also be observed during the passage of the roller, with material adhering to the roller, and/or the surface of the compacted layer beginning to tear.
- Reduction in engineering performance of the material with increasing compaction.
- Visible movement of the surface of the material during the passage of the compaction plant, typically exhibited as a ‘bow wave’ in front of the roller.

Figure 6/3-6: Indicative Trial Panel Layout



6.24 The importance of identifying the point at which the materials become over-compacted is important for a number of reasons. Should the material not be competent to undergo additional compaction and/or trafficking, then an engineering decision will be required by the Supervising Engineer prior to the commencement of the main earthworks program.

Assessment of Test Panels

6.25 In order to assess the compaction trials fully, a stringent series of *in situ* testing is to be undertaken after each incremental compactive effort. The type and nature of the tests which can be used to achieve this will be dependent upon the material type/class, proposed end-use of the material and the adopted specification requirements as detailed within this site documentation.

6.26 For each compaction increment the determination of in situ density should be completed with a minimum of 6 number of tests evenly spaced in two rows at distances of 5m, 10m and 15m along the test panel. Each row shall be separated by sufficient distance in order to prevent accidental influence from overlapping roller passes and adjacent test panels. Given the high number of tests that this requires and unless the nature of the material precludes its use, testing shall be undertaken using a Nuclear Density Gauge [NDG]. The results of this test are to be used to assess the following key engineering parameters:

- Bulk Density;
- Moisture Content;
- Dry Density;

- Air Void Content; and
- Degree of Compaction, compared against the MDD.

6.27 In conjunction with the assessment of the density of the material, the following tests shall be included as part of the compaction trial:

- 2 no bulk samples for lab classification, 1 to be sampled prior to compacting the test panel and 1 post completion of the test panel. In order to confirm the engineering characteristics of the material, each source should be sampled and submitted to the laboratory and the scope of testing shall be to determine the grading before and after compaction as well as the MDD using the using the method defined in Table 6/1.
- For Class 1 General Granular Fill & Class 6 Selected Granular Fill, measurement of the CBR using the Mexe Probe equipment, completed at each and every location of the in situ density measurement.
- For Class 2 General Cohesive Fill & Class 7 Selected Cohesive Fill, measurement of the undrained shear strength using the hand vane equipment, completed at each and every location of the in situ density measurement.
- Plate Load Testing, to be completed at the end of the trial in order to define the following:
  - Equivalent CBR;
  - Modulus of Subgrade Reaction, k; and
  - Modulus of Subgrade Reaction, k_{760} based on 760mm diameter plate.

6.28 For the purposes of the compaction trials only, the plate load tests should be completed in accordance with IAN 73/06 in order to determine the Modulus of Sub-grade Reaction and Equivalent CBR value. This testing will require multiple cycles to be completed and as such consideration of the time element to complete each test should be taken.

6.29 In order to adopt a standard procedure for assessing compaction trials, Table 6/3-1 summarises the recommended testing requirements.

6.30 The purpose of the compaction trials will be to prove the engineering performance of the placed and compacted fill and the suitability of the method to be adopted by the Contractor. The method to be adopted for the main earthworks program should satisfy the following key criteria, which will be further reviewed upon receipt of the results of the compaction trials:

- No single dry density result shall be less than 92% of the MDD, and no more than 20% of results of any one layer shall fall between 92% and 95% MDD. Where the 2.5kg rammer is used for Class 2B, the compliance requirement shall increase to no results less than 98% of the MDD and no more than 20% of results of any one layer shall fall between 98% and 100% MDD.
- For Class 1 granular fill, the compliance criteria for CBR is no single result shall be less than 3% CBR, and no more than 20% of results of any one layer shall fall between 3% and 5% CBR.

- For Class 6 granular fill, the compliance criteria for CBR is no single result shall be less than 8% and no more than 20% of results of any one layer shall fall between 8% and 12% CBR.

- For Class 2A and Class 2C Cohesive fill, the compliance criteria for the Hand Vane shear strength shall be no single result below 45KN/m², and no more than 20% of results of any one layer shall fall between 45KN/m² and 50KN/m².

- For Class 2B and Class 7 cohesive fill, the compliance criteria for the Hand Vane shear strength shall be no single result below 70KN/m², and no more than 20% of results of any one layer shall fall between 70KN/m² and 80KN/m².

- For Class 2 and Class 7 Cohesive fill, no single air void content result shall be greater than 10%, and no more than 20% of results of any one layer shall fall between 5% and 10%.

- For Class 9D fill, minimum degree of compaction of 95% MDD.

6.31 Plate load test completed in accordance with IAN 73/06 Rev 1 and HD25/94 using cyclic loading and shall be used to assess the equivalent CBR value and compared against the data recorded using the other *in situ* apparatus.

Table 6/3-1 Compaction Trial Testing Requirements

Test Property	Recommended Frequency of Testing
Bulk Sample before compaction	1 sample per material for MC, PSD, OMC and particle density
Bulk Sample post compaction	1 sample per material for MC, PSD, OMC and particle density
Bulk Sample for MC/MCV Calibration	1 sample per cohesive material
Bulk Density	6 tests per compaction increment per layer using NDG
Moisture Content	6 tests per compaction increment per layer using NDG
Dry Density	6 tests per compaction increment per layer using NDG
NDG Calibration	1 per material/test panel.
CBR by Mexe Probe (Granular Fill)	1 test per density location.
Cu by Hand Vane (Cohesive Fill)	1 test per density location.
Plate Load Test to IAN 73/06	1 per trial panel, multiple cycles as defined in IAN 73/06

Earthworks Testing

6.32 The Contractor will be required to undertake material acceptability testing of all earthworks materials used in the Works. The testing requirements, including the test type and frequency of testing, are described Appendix 1/5, 6/1 & 6/3 of the Earthworks Specification.

6.33 It should be noted that *in situ* testing will be required even where Method Placement is to adopted by the Contractor, in order to monitor and check that the adopted method is achieving the requisite end-performance. The testing to be undertaken is to demonstrate the method achieves the minimum requirements as detailed in Table 6/1 of this Specification.

6.34 The *in situ* measurement of the material will be required to confirm the applied loadings on the ground and the suitability of the imported material for subsequent inclusion within the permanent works.

6.35 The selected method of placement, depth of layer and selection of compaction plant may be derived initially from Table 6/1 and SHW Table 6/4 but will be subject to confirmation following site compaction trials to prove this method can achieve the required end-performance. Any necessary amendments to the guidance from SHW Table 6/4 to ensure the requisite end-performance of the fill material will be made and issued as part of the adopted earthworks specification.

Placing and Compacting Fill

6.36 Where different classes of fill material are to be employed, they shall be deposited in such a way that all parts of the fill area receive roughly equal amounts of a given material in roughly the same sequence, thus ensuring a uniform distribution of fill types over the whole fill thickness unless otherwise shown on the Drawings.

6.37 The Contractor shall take all necessary steps to ensure that the fill is placed at the moisture content necessary to achieve the compaction specification and shall, where necessary, add water to or dry the fill, in order to obtain this value. Where it is necessary to add water, this shall be done as a fine spray and in such a way that there is time for the water to be absorbed into the fill before being rolled by the plant.

6.38 Compaction plant and compaction method shall be selected having regard to the proximity of existing trenches, excavations, retaining walls or other structures and all work shall be performed in such a way as to ensure that their stability is not impaired. Any restrictions on size of compaction plant shall be shown on the Drawings. Each compaction method shall only be approved through the completion of a satisfactory compaction trial which can demonstrate that the minimum engineering performance can be met.

6.39 If the results of control tests indicate that the fill is being placed and compacted in such a way that the desired end product is not being achieved, the Contractor shall further compact or, if necessary, shall excavate the affected work and replace with new fill, compacted to meet the specification requirements.

6.40 If the results of control tests indicate that antecedent weather conditions (such as frost or heavy rain) have caused deterioration of finished work such that the work no longer meets specification, the Contractor shall take such steps as are necessary to bring the fill to the specification requirements.

Control Testing

6.41 The compliance of the fill meeting the compaction specification shall be demonstrated by undertaking the *in situ* and laboratory testing as detailed in Appendix 1/5 and meet the requirements of Table 6/1 and Appendix 6/3.

6.42 Plate bearing tests (in accordance with BS1377-9, 1990 method 4.1) shall be undertaken to demonstrate compliance with the additional requirements for the fill shown on the Drawing EMG-HYD-C4-M1OB-DR-GE-0654. The test requirements for the plate loading tests are shown on the Drawings.

6.43 Test locations shall be evenly distributed throughout the fill area at the frequency defined in Table 1/5. The earthworks fill shall comply with the following minimum requirements:

- No single dry density result shall be less than 92% of the MDD, and no more than 10% of results of any one layer shall fall between 92% and 95% MDD. Where the 2.5kg rammer is used for Class 2B, the compliance requirement shall increase to no results less than 98% of the MDD and no more than 10% of results of any one layer shall fall between 98% and 100% MDD.

- For Class 1 granular fill, the compliance criteria for CBR is no single result shall be less than 3% CBR, and no more than 10% of results of any one layer shall fall between 3% and 5% CBR or where the fill is placed below adoptable highways, this shall be increased to no result below 12% and no more than 105 of the results for any layer between 12% and 15%.

- For Class 6I and 6N granular fill, the compliance criteria for the Mexe Probe CBR is no single result shall be less than 8% and no more than 10% of results of any one layer shall fall between 8% and 12% CBR. For Class 6P, this shall be reduced to no single CBR below 5% and no more than 10% of results of any one layer shall be between 5% and 8%.

- For Class 2A and Class 2C Cohesive fill, the compliance criteria for the Hand Vane shear strength shall be no single result below 45KN/m², and no more than 10% of results of any one layer shall fall between 45KN/m² and 50KN/m².

- For Class 2B and Class 7 Cohesive fill, the compliance criteria for the Hand Vane shear strength shall be no single result below 70KN/m², and no more than 10% of results of any one layer shall fall between 70KN/m² and 80KN/m².

- For Class 2 and Class 7 Cohesive fill, no single air void content result shall be greater than 10%, and no more than 10% of results of any one layer shall fall between 5% and 10%.

- For Class 9D fill to the upper 0.60m, the minimum degree of compaction shall be 95% of the MDD, and a minimum subgrade surface stiffness at the top of the final layer of 77 Mpa.

6.44 All earthworks materials used shall comply with the earthworks specification. Prior to the commencement of the placement of the bulk fill, for each and every compaction method and each material source a compaction trial will be required to be completed.

7.0 ADDITIONAL LIMITATIONS OF DEPOSITION OF MATERIALS REFERRED TO IN 601.13, 601.14 AND 601.17

7.1 Cobbles having an equivalent diameter of more than 150mm shall not be deposited within 1.3 m of the finished surface at any location.

8.0 RESTRICTIONS ON BATTERING OF EXCAVATIONS FOR FOUNDATIONS AND TRENCHES AND REQUIREMENTS FOR BENCHING

8.1 No specific limitations or restrictions are included for the battering of excavations for foundations, but the Contractor shall comply with the Temporary Works Designer's requirements. Battered excavations are to be benched prior to backfilling. Benching requirements are shown on the Drawings.

9.0 EXCAVATION SUPPORTS TO BE LEFT IN PLACE

9.1 No excavation supports are to be left in place.

10.0 BENCHING OR SHAPING OF EARTHWORKS SLOPE FACES TO RECEIVE FILL

10.1. Where existing embankments are to be extended and where embankments are to be constructed on ground with a slope steeper than one in eight, such slope being measured at right angles across the width of the embankment, benching of the existing slope shall be formed as shown on the Drawings. Bench heights are to be a multiple of the relevant compaction layer thickness.

10.2 Fill material in areas of benching shall be carefully placed and compacted to ensure that no voids occur at the upright steps of the benching.

10.3 Placing and compaction of the fill material shall continue to a level above an adjacent bench before material is placed upon that bench.

10.4 Four additional passes of the roller shall be made on the area within two metres each side of the upright face immediately following the compaction of the first layer of fill material on each bench.

11.0 MIXING OF EXCAVATED MATERIALS

11.1 Mixing of acceptable and unacceptable excavated material is not permitted. All excavated material are to be stored in individual stockpiles, not exceeding 500m³.

12.0 FILL TO EXCAVATED VOIDS OR NATURAL VOIDS IN FOUNDATION EXCAVATIONS

12.1 Areas of inadequate strength shall be removed and backfilled. For small areas and depths, blinding concrete class ST1 shall be used. For more extensive areas and depths, backfill shall be 6N granular material compacted to Table 6/1 of the Specification unless otherwise shown on the drawings.

13 FILL TO LANDSCAPE AREAS

13.1 Where landscape fill material (Class 3D or Class 4) is to be used within approved locations on site, the material shall be placed in accordance with Clause 620 of the SHW.

APPENDIX 6/6: FILL TO STRUCTURES AND FILL ABOVE STRUCTURAL FOUNDATIONS

1. FILL TO STRUCTURES

1.1 Requirements and material classes for fill to structures and fill above structural foundations are shown on the relevant Cass Hayward substructure drawings (presented under a separate cover) and Hydrock drawing EMG-HYD-C4-M1OB-DR-GE-0654.

1.2 Prior to placing blinding concrete at the design foundation level, or immediately prior to filling the excavation where no blinding layer is required, the formation shall be investigated by the Contractor in the presence of the Supervising Engineer to confirm that the design assumptions with regard to formation strength have been met as follows:

i) Cohesive Soils: by use of a shear vane test to prove that the undrained shear strength value at a depth of 0.2m below excavation formation level is greater than the minimum stated on the substructure drawings.

ii) Granular Soils: by use of a Dynamic Probe to prove that the equivalent SPT 'N' value is greater than the minimum stated on the substructure drawings.

iii) Plate Load Testing using 600mm diameter plate, to the loads defined in Appendix 1/5 and on the drawings and to achieve the associated settlement requirements.

1.3 The tests referred to above shall be taken at representative locations across the formation in accordance with Appendix 1/5 or as directed by the Supervising Engineer. The tests shall undertake using suitably calibrated equipment. Additional tests shall be undertaken at any apparent areas of inadequate strength identified visually by the Supervisor.

1.4 The locations, results and correlation of the equipment used shall be recorded. The Contractor shall keep records of the inspections, testing and any subsequent remedial measures, including the test locations, test values and calibrations of the equipment used.

2. FULL SCALE DETERMINATION OF SLOPE STABILITY

2.1 Material for use as 'Fill to Structures' does not require full scale determination of slope stability in accordance with Clause 610.6 of SHW unless this is a specific requirement of the Contractors alternative design.

APPENDIX 6/7: SUB-FORMATION AND CAPPING AND PREPARATION AND SURFACE

20.8 TREATMENT OF FORMATION

GENERAL REQUIREMENTS

1.1 The locations and required thickness of capping and/or sub-base thickness are shown on the Engineer's Drawings.

1.2 Cut to fill transitions zones shall be constructed as shown on the Engineer's Drawings.

1.3 Final preparation of the sub-formation and formation shall only be carried out after installation of the scheduled drainage at that location.

1.4 The minimum California Bearing Ratio (CBR) or undrained shear strength of the subgrade for each location is given on the Engineer's Drawings and in Table 6/1. Areas of subgrade that are below the minimum shall be improved by the methods shown on the Engineer's Drawings.

1.5 The CBR of the subgrade shall be determined at the frequency shown on the Drawings and as required by the Supervising Engineer. The Contractor shall test the subgrade to determine the CBR value using one of the following test methods appropriate to the subgrade material being tested in accordance with IAN 73/06 Rev 1:

- Dual Cycles Static Plate Load Test (PLT)
- Dynamic Plate Load Test.

2.0 ALLOWED SURFACE LEVEL TOLERANCES

2.1 Surface level tolerances shall comply with Clause 616.1

3.0 CAPPING MATERIALS

3.1 The permitted capping materials are shown as described in Clause 613.3 of SHW.

3.2 Material used within 450mm of the designated final road or external surface level shall not be frost susceptible.

4.0 PROCEDURE FOR CONSTRUCTION OF CAPPING FOR CUTTINGS AND EMBANKMENTS

4.1 The procedures for construction of capping for cuttings and embankments are as stated in Clauses 613.11 and 613.12 respectively of SHW unless otherwise shown on the Drawings.

5.0 DEMONSTRATION AREA AND TESTING

5.1 The Contractor shall provide a demonstration area to trial the proposed capping materials. If the trial area is outside the location of the permanent works the trial area formation shall be of similar strength and characteristics as to the permanent works formation. The laying and compaction methods used within the trial area shall be the same as those proposed for the permanent works.

5.2 The demonstration area may form part of the permanent works but shall only be accepted if the results of testing comply with the Specification.

6.0 SUB-FORMATION SHAPING

6.1 The sub-formation shall be shaped as Clause 613.8 of SHW unless shown otherwise on the Drawings.

7.0 LIME STABILISATION

7.1 Modification and stabilisation is permitted but shall not be undertaken without the prior written approval of the Supervising Engineer, and testing undertaken to demonstrate that the maximum permissible TPS is not exceeded.

8.0 TREATMENT OF FORMATION

8.1 Treatment of soft spots shall be completed prior to final preparation of sub-formation. Replacement of soft materials, to formation level, shall be with either additional approved Class 6F or Class 9 Selected Capping Material or as agreed with the Supervising Engineer using selected granular material with geosynthetic reinforcement.

8.2 Areas of formation that do not have a surface tolerance within the limits stated in Clause 616.1 of SHW are to be excavated to depths given on the Drawings and infilled with either additional approved capping or as agreed with the Supervising Engineer using selected granular material with geosynthetic reinforcement.

8.3 Details and locations of formation treatment and removal of soft material are to be kept by the Contractor.

9.0 RATE OF SPREAD OF LIME

9.1 Testing for the rate of lime spreading shall be in accordance with Clause 615.6 of SHW.

10.0 CHEMICAL ANALYSIS REPORTS

10.1 Chemical analysis reports for ‘available lime’ are to be provided weekly in accordance with Clause 615.4 of SHW.

11.0 PREPARATION OF FORMATION ON EXISTING SUB-BASE MATERIAL

11.1 Preparation of formation on existing sub-base material shall be in accordance with Clause 616 of SHW.

12.0 REQUIREMENTS FOR CEMENT TYPE IN LIME AND CEMENT STABILISATION

12.1 The level of sulphates is to be confirmed before the use of hydraulic binders can be approved. Modification and stabilisation shall not be undertaken without the prior written approval of the Supervising Engineer.

13.0 REQUIREMENTS FOR ALTERNATIVE THICKNESS OF LAYERS TO BE STABILISED

13.1 The layer thickness shall comply with the requirements of Clause 643.9 of SHW.

14.0 ALTERNATIVE TREATMENT REQUIREMENTS FOR LAYERS TO BE STABILISED

14.1 The treatment of layers to be stabilised shall comply with the requirements of Clauses 643.10 and 643.16 of SHW.

APPENDIX 6/8: TOPSOILING

1. Topsoiling shall be carried out using Class 5 material complying with Table 6/1 and in accordance with the requirements of the Written Landscape Scheme, Barry Chinn Associates document reference 148/14-RP01, presented under a separate cover.

2. The topsoil depth shall be as specified in .Written Landscape Scheme.

3. Imported topsoil shall comply with BS 3882:1994, General Purpose Grade.

4. No topsoil shall be supplied from any source until a sample of the topsoil from each source has been inspected and approved by the Engineer. All topsoil supplied must be of the same quality as the approved sample(s).

5. Topsoil shall be spread, graded and consolidated by hand or mechanical means.

6. Any materials deemed unsuitable by the Engineer, that are brought to the surface by the spreading, grading and consolidation of topsoil shall be collected up disposed of off site.

7. Topsoiled areas shall not be traversed by machinery or used for storage purposes

APPENDIX 6/9: EARTHWORK ENVIRONMENTAL BUNDS, LANDSCAPE AREAS & STRENGTHENING EMBANKMENTS

20.EARTHWORK ENVIRONMENTAL BUNDS

Location and types of construction

1.1 Requirements for Earthwork Environmental Bunds are shown on the Drawings.

1.2 Earthwork Environmental Bunds are to be constructed of materials as shown on the Drawings.

Requirements for etermine

1.3 Environmental Bunds that are to be topsoiled are shown on the Drawings and in agreement with the requirements of the Ecological Consultant and the Written Landscape Scheme, Barry Chinn Associates document reference 1484/14-TP01, presented under a spate cover.

1.4 All imported topsoil shall comply with the requirements for General Purpose in accordance with BS 3882.

2. LANDSCAPE AREAS

Locations

2.1 Locations of Landscape Areas are shown on the Drawings.

Requirements for Compaction

2.2 Class 4 material shall be compacted in accordance with Clause 620 of SHW.

Construction requirements

2.3 Construction requirements and contouring of Landscape Areas are shown on the Drawings.

Requirements for etermine

2.4 The requirements for etermine Landscape Areas are shown on the Drawings.

APPENDIX 6/12: INSTRUMENTATION AND MONITORING

1 LOCATION OF INSTRUMENTATION

1.1 All instrumentation and associated equipment shall be approved by the Hydrock and shall be suitable for installation at the locations described, notably where the thickness of fill is in excess of 2.50m. The alignment of each settlement marker shall be such that it falls within the verge of the final embankment, in the area of deepest fill.

1.2 Instrumentation shall be installed to measure vertical displacement of the subsoil and where the thickness of fill exceeds 2.50m a second installation shall be installed at mid-depth of the fill. Instrumentation shall remain operational during the construction contract.

1.3 The Contractor shall be responsible for and shall follow the manufacturers' instructions and the requirements of this Specification in the installation, calibration and testing of all measuring instruments and equipment, which shall be carried out in the presence of Hydrock.

1.4 The Contractor shall inform Hydrock at least 2 working days prior to undertaking installation of the equipment. The Contractor shall make due allowances in his construction programme for delays which may arise on account of the installation of the instruments and of their maintenance.

1.5 The Contractor shall provide suitably qualified and competent staff to take readings of instruments during construction and provide measurements/data at the time the instruments are read. The Contractor shall submit names and evidence of competence of personnel to carry out the instrumentation installation and commissioning for the approval of the Engineer before the commencement of the Works.

1.6 The Contractor shall maintain the instrumentation in working order throughout the Contract or until Hydrock informs them that monitoring is no longer required. The Contractor shall ensure that the frequency of monitoring is adequate and in compliance with all requirements for control of construction and associated monitoring of constructions, as detailed on the Drawings.

1.7 The Contractor shall agree with Hydrock the tolerances for the installation, and the instrument's calibration, accuracy and repeatability.

1.8 The Contractor shall be responsible for preparing a factual report (paper and pdf copy) of the instrumentation, installation and monitoring, and including graphical plots of the monitoring results. A draft report shall be forwarded to Hydrock for comment within 2 weeks following substantial completion of the Contract or Section of the Contract. All details of the instrumentation, installation and monitoring results shall be provided to the Supervisor electronically in AGS format with the factual report.

1.9 Details of instrumentation are given on the Drawings.

2 INSTRUMENTATION SCHEDULE

2.1 Details of the type, number and location of instruments are given on the Drawings.

3 HOUSING DETAILS

3.1 Housing details are given on the Drawings.

4 INSTALLATION DETAILS

4.1 The instruments shall be installed in accordance with this Appendix and the Drawings.

4.2 All instruments shall be labelled with their reference number at the location where readings or measurements are to be taken. The labelling shall be permanent using a method or material to be agreed with the Engineer.

Survey Equipment

4.3 All surveying equipment used in conjunction with the monitoring of instrumentation, including measuring tapes, levels and EDM shall be maintained and calibrated as required by the manufacturers and good surveying practice. Levels shall be checked every four weeks. Where the rate of settlement reduces to below 2mm per week, or as directed by the Engineer on site, the Contractor shall undertake all further levelling of instrumentation by precise levelling techniques.

Rod Settlement Gauges and Settlement Markers

4.4 The details of the Rod Settlement Gauges and Settlement Markers shall be as shown on the Drawings and the Contractor shall be responsible for the installation of all gauges and markers as works proceed. The Rod Settlement Gauge base plate and first length of rod shall be placed as early as possible during the earthworks, i.e. before any significant filling has taken place. Extension lengths shall be installed when the level of the compacted embankment is 250mm below the top of the preceding level.

4.5 Should a Rod Settlement Gauge or Settlement Marker be damaged or should the Contractor fail to extend the gauge when required, he shall stop all works in the vicinity of the gauge until the necessary remedial works have been completed. The Contractor shall be liable for any delay in his programme or any additional work that has to be done as a result of such damage.

4.6 Rod Settlement Gauges and Settlement Markers shall be monitored by levelling techniques as defined by this Appendix. Levels shall be taken of the top of the rod and the fill adjacent to the gauge on each occasion. When rods are extended, levels shall be measured immediately before and immediately after adding the extension. Good levelling practice should be observed.

Permanent Datum

4.7 Permanent datum is required to provide a reference for measurement of ground and instrument levels in areas of soft ground. The datum itself is to be fixed into deeper, competent ground and isolated from soft and compressible strata at shallower depth.

4.8 The Contractor shall be responsible for establishing a permanent datum at locations, and with depths and details, as specified and agreed with the Engineer. The installation of a permanent datum shall be completed prior to the installation of instruments and the commencement of earthworks.

4.9 A permanent datum shall consist of a 25mm galvanised steel pipe fixed into competent ground with a cement ground and shall penetrate the competent stratum by at least 3m. The datum pipe shall be isolated from the overlying soft ground by a 75mm diameter galvanised steel outer pipe bedded into the top 500mm of the cement grout.

4.10 The datum pipe shall, where necessary, be connected by screw threaded couplings, shall have a domed top and shall protrude 30mm to 50mm above the outer pipe. The outer pipe shall also be connected where necessary by screw threaded couplings. The portion of the outer pipe which passes through the soft ground shall be surrounded by a sand backfill from the top of the cement grout to the underside of the concrete plinth to be cast at ground level.

4.11 The plinth shall comprise a square concrete slab of not less than 0.06m3 of concrete (approximately 0.4m x 0.4m x 0.4m). The surface of the concrete plinth shall be scored with the reference for the individual permanent datum.

4.12 The level of the permanent datum shall be established by the levelling techniques set out in Section 8.0 of this Appendix, with reference to agreed benchmarks in the vicinity. Levelling shall be closed back to the benchmarks to check accuracy.

4.13 The level value and co-ordinate position shall be measured three times soon after installation of the datum and shall be checked at intervals to be established by the Engineer.

Installation Records

4.14 All records produced for the instrumentation must include the following data:

- Project name.
- Contract name and number.
- Instrument reference number and type.
- Dates of installation, reading or summary.
- Times of installation or reading.
- Chainage and offset (or co-ordinates if appropriate).
- Personnel responsible for undertaking the monitoring.
- Any relevant comments or remarks.

4.15 The Contractor shall prepare an installation record sheet for each instrument installed. The format of the sheet shall be prepared by the Contractor and submitted to the Engineer for approval at least one week before installation commences. The record sheet shall include the following information in addition to the general information required:

- Existing ground level at the time of installation, measured at 5m intervals in the case of hydrostatic profile gauges.
- Location in plan and elevation – Planned and 'As Built'.
- Orientation – Planned and 'As Built'.
- Lengths, widths, diameters, depth and volumes of backfill – Planned and 'As Built'.
- Type of backfill used.
- Weather conditions.
- Space for notes, including problems encountered, delays, unusual features of the installation and any events that may have a bearing on instrument behaviour.
- A record of commissioning information and readings.
- Any colour coding used.

4.16 The Contractor shall submit to the Engineer three copies of each installation report sheet within one working day of completion of the installation, including taking of base readings.

4.17 The following data shall be recorded for the Settlement Gauges and similar settlement monitoring equipment:

- Original ground level at the gauge location (m OD).
- Reduced level of the top of the rod (m OD).
- Reduced level of the ground adjacent to the gauge (m OD).
- A record of the height of fill placed and the start/finish dates of filling.
- The total thickness of the fill (m).
- A record of extensions to the gauge, including before/after reduced levels of the gauge.
- The settlement of the plate relative to base readings and previous readings (m).

4.18 The following data shall be recorded for a permanent datum/s:

- Reduced level of datum (m OD).
- Plan position.

5 CALIBRATION REQUIRMENTS

5.1 The Contractor shall test the whole instrumentation installation by taking three sets of base readings at suitable intervals and shall provide two copies of the results for the CGD and shall satisfy the CGD that all instruments are functioning correctly and readings are repeatable before the associated earthworks are commenced.

5.2 In cases where instruments are installed during earthworks, three sets of readings shall be taken in quick succession and the results compared. These results shall be used to provide base readings in a manner to be agreed with the Engineer

6 INSTRUMENTATION PROTECTION

6.1 The Contractor shall take measures to prevent damage to underground services and drains during boring, excavation and trenching for the installation of all instruments.

6.2 The Contractor shall take all necessary precautions to protect the instruments and maintain the instruments in good working order after commissioning. For all instruments which project through and above the fill, special precautions shall be taken to provide protection from vehicles and plant, including substantial and readily visible barriers at a distance of no less than 750mm around each instrument

6.3 Heavy compaction equipment shall not approach within 1.5m of projecting instruments. Any damage to instruments shall be reported to the Engineer within one working day of the damage occurring. Damaged instruments shall be replaced or repaired by the Contractor at his own expense within seven days of its reported damage.

6.4 Adequate protection measures shall be provided for all new and existing instrumentation to protect it from vandalism or damage during construction. All damaged instrumentation shall be replaced by the Contractor as soon as possible.

7.0 ELECTRICAL POWER REQUIREMENTS

7.1 The electric power requirements if required, are to be shown on the relevant Contractor's Drawings.

8.0 MONITORING FREQUENCY AND REPORTING REQUIREMENTS

8.1 The Contractor shall monitor the instruments and supply Hydrock with records of all readings and graphical plots thereof.

8.2 All earthworks instrumentation shall be installed, surveyed and monitored at least two weeks ahead of adjacent earthworks construction.

8.3 All equipment, shall be professionally monitored, including levelling of the surface of the fill, levelling of the settlement plates and settlement markers in accordance with Table 6/12-1, as required by the Supervising Engineer and as shown on the drawings.

8.4 All monitoring records shall be provided to the Supervising Engineer electronically as soon as they become available and at the request of the Supervising Engineer.

Table 6/12-1: Minimum frequency of levelling and monitoring

Period	Monitoring Frequency	Comments
Before Fill Placed	Immediately after installation of Settlement Plates	Determination of base line ground level
During Fill Placement	Every week Before and after any extension added to settlement plate	Assessment of Immediate Settlement Accurate measurement of any extension rod
Week 1 to Week 4	Every week	Assessment of commencement of Primary Settlement
Week 4 to Week 16	Every two weeks	Profile of Primary Settlement, compared to model settlement curves
> Week 16	As agreed with Hydrock	End of Primary Settlement Stage and commencement of onset of Secondary Settlement

APPENDIX 6/14: LIMITING VALUES FOR POLLUTION OF CONTROLLED WATERS

1.0 GENERAL

1.1 All Made Ground and secondary materials shall be assessed for contamination, at a rate of 1 test per 500m³ unless otherwise agreed with Hydrock, for the contamination suite defined in Table 6/14-1.

Table 6/14-1 Contaminant Suite

Source	Determinant	Maximum Permitted Concentration (ml/kg)
SGV report + CLEA 1.07	Arsenic	640
LQM/CIEH + CLEA 1.07	Beryllium	390
LQM/CIEH + CLEA 1.07	Boron	190000
SGV report + CLEA 1.07	Cadmium	220
LQM/CIEH + CLEA 1.07	Chromium (III)	8400
LQM/CIEH + CLEA 1.07	Chromium (VI)	33
LQM/CIEH + CLEA 1.07	Copper	69000
C4SL	Lead	2330
SGV report + CLEA 1.07	Mercury, inorganic	3600
Hydrock + CLEA 1.07	Nickel	1700
SGV report + CLEA 1.07	Selenium	13000
LQM/CIEH + CLEA 1.07	Vanadium	9000
LQM/CIEH + CLEA 1.07	Zinc	670000
Hydrock + CLEA 1.07	Cyanide (free)	16000
SGV report + CLEA 1.07	Phenol (total)	1500
LQM/CIEH + CLEA 1.07	Acenaphthene	97000
LQM/CIEH + CLEA 1.07	Acenaphthylene	97000
LQM/CIEH + CLEA 1.07	Anthracene	540000
LQM/CIEH + CLEA 1.07	Benz(a)anthracene	91
LQM/CIEH + CLEA 1.07	Benzo(a)pyrene	14
LQM/CIEH + CLEA 1.07	Benzo(b)fluoranthene	98
LQM/CIEH + CLEA 1.07	Benzo(ghi)perylene	640
LQM/CIEH + CLEA 1.07	Benzo(k)fluoranthene	140
LQM/CIEH + CLEA 1.07	Chrysene	140
LQM/CIEH + CLEA 1.07	Dibenz(a,h)anthracene	12
LQM/CIEH + CLEA 1.07	Fluoranthene	23000
LQM/CIEH + CLEA 1.07	Fluorene	68000
LQM/CIEH + CLEA 1.07	Indeno(1,2,3,cd)pyrene	59
LQM/CIEH + CLEA 1.07	Naphthalene	460
LQM/CIEH + CLEA 1.07	Phenanthrene	22000
LQM/CIEH + CLEA 1.07	Pyrene	54000
LQM/CIEH + CLEA 1.07	Aliphatics EC5-EC6	560
LQM/CIEH + CLEA 1.07	Aliphatics >EC6-EC8	320
LQM/CIEH + CLEA 1.07	Aliphatics >EC8-EC10	190

Source	Determinant	Maximum Permitted Concentration (ml/kg)
LQM/CIEH + CLEA 1.07	Aliphatics >EC10-EC12	120
LQM/CIEH + CLEA 1.07	Aliphatics >EC12-EC16	59
LQM/CIEH + CLEA 1.07	Aliphatics >EC16-EC35	1000000
LQM/CIEH + CLEA 1.07	Aliphatics >EC35-EC44	1000000
LQM/CIEH + CLEA 1.07	Aromatics EC5-EC7	2300
LQM/CIEH + CLEA 1.07	Aromatics >EC7-EC8	1900
LQM/CIEH + CLEA 1.07	Aromatics >EC8-EC10	1500
LQM/CIEH + CLEA 1.07	Aromatics >EC10-EC12	900
LQM/CIEH + CLEA 1.07	Aromatics >EC12-EC16	37000
LQM/CIEH + CLEA 1.07	Aromatics >EC16-EC21	28000
LQM/CIEH + CLEA 1.07	Aromatics >EC21-EC35	28000
LQM/CIEH + CLEA 1.07	Aromatics >EC35-EC44	28000

APPENDIX 6/15: LIMITING VALUES FOR HARM TO HUMAN HEALTH AND THE ENVIRONMENT

1.0 GENERAL

1.1 All Made Ground and secondary materials shall be assessed for contamination, at a rate of 1 test per 500m³ unless otherwise agreed with Hydrock, for the contamination suite defined in Table 6/15-1.

Table 6/15-1 Contaminant Suite.

Source	Determinant	Maximum Permitted Concentration (mg/kg)
SGV report + CLEA 1.07	Arsenic	640
LQM/CIEH + CLEA 1.07	Beryllium	390
LQM/CIEH + CLEA 1.07	Boron	190000
SGV report + CLEA 1.07	Cadmium	220
LQM/CIEH + CLEA 1.07	Chromium (III)	8400
LQM/CIEH + CLEA 1.07	Chromium (VI)	33
LQM/CIEH + CLEA 1.07	Copper	69000
C4SL	Lead	2330
SGV report + CLEA 1.07	Mercury, inorganic	3600
Hydrock + CLEA 1.07	Nickel	1700
SGV report + CLEA 1.07	Selenium	13000
LQM/CIEH + CLEA 1.07	Vanadium	9000
LQM/CIEH + CLEA 1.07	Zinc	670000
Hydrock + CLEA 1.07	Cyanide (free)	16000
SGV report + CLEA 1.07	Phenol (total)	1500
LQM/CIEH + CLEA 1.07	Acenaphthene	97000
LQM/CIEH + CLEA 1.07	Acenaphthylene	97000
LQM/CIEH + CLEA 1.07	Anthracene	540000
LQM/CIEH + CLEA 1.07	Benz(a)anthracene	91
LQM/CIEH + CLEA 1.07	Benzo(a)pyrene	14
LQM/CIEH + CLEA 1.07	Benzo(b)fluoranthene	98
LQM/CIEH + CLEA 1.07	Benzo(ghi)perylene	640
LQM/CIEH + CLEA 1.07	Benzo(k)fluoranthene	140
LQM/CIEH + CLEA 1.07	Chrysene	140
LQM/CIEH + CLEA 1.07	Dibenz(a,h)anthracene	12
LQM/CIEH + CLEA 1.07	Fluoranthene	23000
LQM/CIEH + CLEA 1.07	Fluorene	68000
LQM/CIEH + CLEA 1.07	Indeno(1,2,3,cd)pyrene	59
LQM/CIEH + CLEA 1.07	Naphthalene	460
LQM/CIEH + CLEA 1.07	Phenanthrene	22000
LQM/CIEH + CLEA 1.07	Pyrene	54000
LQM/CIEH + CLEA 1.07	Aliphatics EC5-EC6	560
LQM/CIEH + CLEA 1.07	Aliphatics >EC6-EC8	320
LQM/CIEH + CLEA 1.07	Aliphatics >EC8-EC10	190

Source	Determinant	Maximum Permitted Concentration (mg/kg)
LQM/CIEH + CLEA 1.07	Aliphatics >EC10-EC12	120
LQM/CIEH + CLEA 1.07	Aliphatics >EC12-EC16	59
LQM/CIEH + CLEA 1.07	Aliphatics >EC16-EC35	1000000
LQM/CIEH + CLEA 1.07	Aliphatics >EC35-EC44	1000000
LQM/CIEH + CLEA 1.07	Aromatics EC5-EC7	2300
LQM/CIEH + CLEA 1.07	Aromatics >EC7-EC8	1900
LQM/CIEH + CLEA 1.07	Aromatics >EC8-EC10	1500
LQM/CIEH + CLEA 1.07	Aromatics >EC10-EC12	900
LQM/CIEH + CLEA 1.07	Aromatics >EC12-EC16	37000
LQM/CIEH + CLEA 1.07	Aromatics >EC16-EC21	28000
LQM/CIEH + CLEA 1.07	Aromatics >EC21-EC35	28000
LQM/CIEH + CLEA 1.07	Aromatics >EC35-EC44	28000
-	Asbestos	<0.001%

ANNEX B

GEOSTRUCTURAL ANALYSIS REPORTS

ANNEX B.1
GEOTECHNICAL PARAMETERS

GEOLOGICAL LAYER						CHARACTERISITIC DESIGN VALUE - GEOSTRUCTURAL ANALYSIS									
Mercia Mudstone Group - Weathering Grade	Reduced Ground Level m OD			Depth below Ground Level m BEGL From top of Embankment		Bulk Unit Weight	Satruated Unit Weigth	Undrained Shear Strength	Effective Cohesion	Effective Angle of Internal Friction	Adhesion Strcut-soil	Angle of Friction Struct-Soil	Oedometric Modulus E_{oed}	Elastic Modulus Small Strain E_s	Poisson's Ratio
	From	To	Avergae	From	To	γ_b	γ_{sat}	S_u	c'	φ'	α	δ	E_{oed}	E_s	υ
						kN/m^3	kN/m^3	kN/m^2	kN/m^2	°	kN/m^2	°	MPa	MPa	
IVB	78.00 mOD	77.00 mOD	77.50 mOD	0.00 m BEGL	1.00 m BEGL	19.50 kN/m^3	20.50 kN/m^3	33 kN/m^2	2 kN/m^2	25 °	23 kN/m^2	8.3 °	5.53 MN/m^2	13.33 MN/m^2	0.40
IVB	77.00 mOD	76.00 mOD	76.50 mOD	1.00 m BEGL	2.00 m BEGL	19.50 kN/m^3	20.50 kN/m^3	67 kN/m^2	2 kN/m^2	25 °	47 kN/m^2	8.3 °	11.07 MN/m^2	26.67 MN/m^2	0.40
IVB	76.00 mOD	75.00 mOD	75.50 mOD	2.00 m BEGL	3.00 m BEGL	19.50 kN/m^3	20.50 kN/m^3	100 kN/m^2	2 kN/m^2	25 °	58 kN/m^2	8.3 °	16.60 MN/m^2	40.00 MN/m^2	0.40
IVA	75.00 mOD	74.00 mOD	74.50 mOD	3.00 m BEGL	4.00 m BEGL	20.50 kN/m^3	21.00 kN/m^3	133 kN/m^2	4 kN/m^2	32 °	63 kN/m^2	10.7 °	22.13 MN/m^2	53.33 MN/m^2	0.40
IVA	74.00 mOD	73.00 mOD	73.50 mOD	4.00 m BEGL	5.00 m BEGL	20.50 kN/m^3	21.00 kN/m^3	167 kN/m^2	4 kN/m^2	32 °	67 kN/m^2	10.7 °	27.67 MN/m^2	66.67 MN/m^2	0.40
IVA	73.00 mOD	72.00 mOD	72.50 mOD	5.00 m BEGL	6.00 m BEGL	20.50 kN/m^3	21.00 kN/m^3	200 kN/m^2	4 kN/m^2	32 °	71 kN/m^2	10.7 °	33.20 MN/m^2	80.00 MN/m^2	0.40
IVA	72.00 mOD	71.00 mOD	71.50 mOD	6.00 m BEGL	7.00 m BEGL	20.50 kN/m^3	21.00 kN/m^3	233 kN/m^2	4 kN/m^2	32 °	74 kN/m^2	10.7 °	38.73 MN/m^2	93.33 MN/m^2	0.40
III	71.00 mOD	70.00 mOD	70.50 mOD	7.00 m BEGL	8.00 m BEGL	22.00 kN/m^3	22.00 kN/m^3	267 kN/m^2	10 kN/m^2	32 °	77 kN/m^2	10.7 °	44.27 MN/m^2	106.67 MN/m^2	0.30
III	70.00 mOD	69.00 mOD	69.50 mOD	8.00 m BEGL	9.00 m BEGL	22.00 kN/m^3	22.00 kN/m^3	300 kN/m^2	10 kN/m^2	32 °	80 kN/m^2	10.7 °	49.80 MN/m^2	120.00 MN/m^2	0.30
III	69.00 mOD	68.00 mOD	68.50 mOD	9.00 m BEGL	10.00 m BEGL	22.00 kN/m^3	22.00 kN/m^3	333 kN/m^2	10 kN/m^2	32 °	82 kN/m^2	10.7 °	55.33 MN/m^2	133.33 MN/m^2	0.30
III	68.00 mOD	67.00 mOD	67.50 mOD	10.00 m BEGL	11.00 m BEGL	22.00 kN/m^3	22.00 kN/m^3	367 kN/m^2	10 kN/m^2	32 °	85 kN/m^2	10.7 °	60.87 MN/m^2	146.67 MN/m^2	0.30
III	67.00 mOD	66.00 mOD	66.50 mOD	11.00 m BEGL	12.00 m BEGL	22.00 kN/m^3	22.00 kN/m^3	400 kN/m^2	10 kN/m^2	32 °	87 kN/m^2	10.7 °	66.40 MN/m^2	160.00 MN/m^2	0.30
III	66.00 mOD	65.00 mOD	65.50 mOD	12.00 m BEGL	13.00 m BEGL	22.00 kN/m^3	22.00 kN/m^3	433 kN/m^2	10 kN/m^2	32 °	89 kN/m^2	10.7 °	71.93 MN/m^2	173.33 MN/m^2	0.30
II	65.00 mOD	64.00 mOD	64.50 mOD	13.00 m BEGL	14.00 m BEGL	22.50 kN/m^3	22.50 kN/m^3	505 kN/m^2	16 kN/m^2	42 °	93 kN/m^2	14.0 °	83.83 MN/m^2	202.00 MN/m^2	0.25
II	64.00 mOD	63.00 mOD	63.50 mOD	14.00 m BEGL	15.00 m BEGL	22.50 kN/m^3	22.50 kN/m^3	615 kN/m^2	16 kN/m^2	42 °	98 kN/m^2	14.0 °	102.09 MN/m^2	246.00 MN/m^2	0.25
II	63.00 mOD	62.00 mOD	62.50 mOD	15.00 m BEGL	16.00 m BEGL	22.50 kN/m^3	22.50 kN/m^3	725 kN/m^2	16 kN/m^2	42 °	103 kN/m^2	14.0 °	120.35 MN/m^2	290.00 MN/m^2	0.25
II	62.00 mOD	61.00 mOD	61.50 mOD	16.00 m BEGL	17.00 m BEGL	22.50 kN/m^3	22.50 kN/m^3	835 kN/m^2	16 kN/m^2	42 °	107 kN/m^2	14.0 °	138.61 MN/m^2	334.00 MN/m^2	0.25
II	61.00 mOD	60.00 mOD	60.50 mOD	17.00 m BEGL	18.00 m BEGL	22.50 kN/m^3	22.50 kN/m^3	945 kN/m^2	16 kN/m^2	42 °	111 kN/m^2	14.0 °	156.87 MN/m^2	378.00 MN/m^2	0.25
I	60.00 mOD	59.00 mOD	59.50 mOD	18.00 m BEGL	19.00 m BEGL	23.00 kN/m^3	23.00 kN/m^3	1097 kN/m^2	25 kN/m^2	42 °	116 kN/m^2	14.0 °	182.14 MN/m^2	438.89 MN/m^2	0.25

Notes

Refer to Hydrock Report EMG-HYD-HGT-C4-RP-GE-0014 Table 2.1 for Bulk and Saturated unit weights for each weathering grade

Refer to Hydrock Report EMG-HYD-HGT-C4-RP-GE-0014 Table 2.1 and Figure 2.1 for derivaiton of Effective Angle of Friction and Effectice Cohesion for each weathering grade

Refer to Hydrock Report EMG-HYD-HGT-C4-RP-GE-0014 Table 2.3 for regression analysis factors for conversion of reduced ground level in m OD to equivalent Undrained Shear Strength

Derivation of Adhesion between Structure and Soil based upon either $\alpha = S_u \times 0.7$ or $\alpha = S_u \times (15.346 \times (S_u$ ^-0.7108$))$, as derived from Tomlinson *et al.* which ever is the lesser.

Derivation of Angle of Friction between Strcuture and Soil is based on a lower bound value of $\delta = 1/3\ \varphi'$ where δ is typically in the range of 1/3 φ' to 2/3 φ'.

Refer to Hydrock Report EMG-HYD-HGT-C4-RP-GE-0014, Annex C for the derivation of equivalent Oedometric Modulus E_{oed} is based upon $S_u \times 0.166$, where S_u is in kN/m^2 and E_{oed} is in MN/m^2.

Refer to Hydrock Report EMG-HYD-HGT-C4-RP-GE-0014, Annex C for the derivation of equivalent Elastic Modulus E_s is based upon $S_u \times 0.400$, where S_u is in kN/m^2 and E_s is in MN/m^2.

Derivation of equivalent Poisson's Ratio is based upon the guidnace from CIRIA C570, Engineering in Mercia Mudstone

ANNEX B.2 EMG-HYD-C4-M1OB-CA-GE-

0649

Spread footing verification

Input data

Settings

United Kingdom - EN 1997

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
Analysis of uplift : Standard
Allowable eccentricity : 0.333
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)									
Permanent design situation									
		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	ψ_G =	1.35	[–]	1.00	[–]	1.00	[–]	1.00	[–]

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	ψ_ϕ =	1.00	[–]	1.25	[–]
Partial factor on effective cohesion :	ψ_c =	1.00	[–]	1.25	[–]
Partial factor on undrained shear strength :	ψ_{cu} =	1.00	[–]	1.40	[–]
Partial factor on unconfined strength :	ψ_v =	1.00	[–]	1.40	[–]

Basic soil parameters - (effective stress-state)

No.	Name	Pattern	$\chi\pi_{ef}$ [°]	c_{ef} [kPa]	ψ [kN/m^3]	ψ_{su} [kN/m^3]	δ [°]
2	Firm to stiff red brown silty CLAY - MMG IVB		25.00	2.00	19.50	10.50	7.50
3	Stiff red brown silty CLAY - MMG IVA		32.00	4.00	20.50	11.00	10.00
4	Weathered Mudstone - MMG III		32.00	10.00	22.00	12.00	10.00
5	Weathered Mudstone - MMG II		42.00	16.00	22.50	12.50	14.00
6	Intact Mudstone - MMG I		42.00	25.00	23.00	13.00	14.00
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		40.00	8.00	22.50	13.00	12.00
8	Existing Highway General Fill		25.00	2.00	19.50	10.50	10.00

No.	Name	Pattern	$\chi\pi_{ef}$ [°]	c_{ef} [kPa]	ψ [kN/m^3]	ψ_{su} [kN/m^3]	δ [°]
9	Class 2 Fill (Site Won MMG IV)		25.00	2.00	19.50	10.50	10.00
10	Class 6F Capping/Subbase/Surfacing		35.00	0.00	21.00	11.50	15.00
12	Terrace Sands & Gravels		35.00	0.00	22.00	12.50	15.00
13	Class 7A Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
14	Class 7C Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
15	Pre-existing Made Ground		25.00	0.00	19.00	9.50	8.00
16	Culvert		41.50	0.00	2.40	0.00	25.00
17	Granular Backfill to Culvert		41.50	0.00	18.00	8.00	16.00
18	Class 6N Selected Backfill to Structures		41.50	0.00	22.50	13.00	16.60
19	Redcued Level 78 - 77 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
20	Redcued Level 77 - 76 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
21	Redcued Level 76 - 75 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
22	Redcued Level 75 - 74 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
23	Redcued Level 74 - 73 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
24	Redcued Level 73 - 72 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
25	Redcued Level 72 - 71 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
26	Redcued Level 71 - 70 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
27	Redcued Level 70 - 69 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
28	Redcued Level 69 - 68 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
29	Redcued Level 68 - 67 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
30	Redcued Level 67 - 66 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
31	Redcued Level 66 - 65 m OD - MMG III		32.00	10.00	22.00	12.00	10.70

No.	Name	Pattern	$\chi\pi_{ef}$ [°]	c_{ef} [kPa]	ψ [kN/m^3]	ψ_{su} [kN/m^3]	δ [°]
32	Redcued Level 65 - 64 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
33	Redcued Level 64 - 63 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
34	Redcued Level 63 - 62 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
35	Redcued Level 62 - 61 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
36	Redcued Level 61 - 60 m OD - MMG II		42.00	16.00	22.50	12.50	14.00

Basic soil parameters - (total stress-state)

No.	Name	Pattern	c_u [kPa]	a [kPa]	ψ [kN/m^3]
1	Topsoil/Subsoil		35.00	28.00	16.50
11	Landscape Fill - Class 4		50.00	20.00	20.00
37	Redcued Level 60 - 59 m OD - MMG I		1097.00	116.00	23.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	$\chi\pi_{ef}$ [°]	ς [–]	OCR [–]	K_r [–]
1	Topsoil/Subsoil		cohesionless	0.00	-	-	-
2	Firm to stiff red brown silty CLAY - MMG IVB		cohesive	-	0.40	-	-
3	Stiff red brown silty CLAY - MMG IVA		cohesive	-	0.40	-	-
4	Weathered Mudstone - MMG III		overconsolidated	-	-	2.00	-
5	Weathered Mudstone - MMG II		overconsolidated	-	-	3.00	-
6	Intact Mudstone - MMG I		overconsolidated	-	-	6.00	-
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		cohesionless	40.00	-	-	-
8	Existing Highway General Fill		cohesive	-	0.35	-	-
9	Class 2 Fill (Site Won MMG IV)		cohesive	-	0.35	-	-
10	Class 6F Capping/Subbase/Surfacing		cohesionless	35.00	-	-	-

No.	Name	Pattern	Type calculation	$\chi\pi_{ef}$ [°]	ς [–]	OCR [–]	K_r [–]
11	Landscape Fill - Class 4		cohesive	-	0.40	-	-
12	Terrace Sands & Gravels		cohesionless	35.00	-	-	-
13	Class 7A Selected Cohesive Fill		cohesive	-	0.40	-	-
14	Class 7C Selected Cohesive Fill		cohesive	-	0.40	-	-
15	Pre-existing Made Ground		cohesive	-	0.35	-	-
16	Culvert		cohesionless	41.50	-	-	-
17	Granular Backfill to Culvert		cohesionless	41.50	-	-	-
18	Class 6N Selected Backfill to Structures		cohesionless	41.50	-	-	-
19	Redcued Level 78 - 77 m OD - MMG IVB		cohesive	-	0.40	-	-
20	Redcued Level 77 - 76 m OD - MMG IVB		cohesive	-	0.40	-	-
21	Redcued Level 76 - 75 m OD - MMG IVB		cohesive	-	0.40	-	-
22	Redcued Level 75 - 74 m OD - MMG IVA		cohesive	-	0.40	-	-
23	Redcued Level 74 - 73 m OD - MMG IVA		cohesive	-	0.40	-	-
24	Redcued Level 73 - 72 m OD - MMG IVA		cohesive	-	0.40	-	-
25	Redcued Level 72 - 71 m OD - MMG IVA		cohesive	-	0.40	-	-
26	Redcued Level 71 - 70 m OD - MMG III		overconsolidated	-	-	2.00	-
27	Redcued Level 70 - 69 m OD - MMG III		overconsolidated	-	-	2.00	-
28	Redcued Level 69 - 68 m OD - MMG III		overconsolidated	-	-	2.00	-
29	Redcued Level 68 - 67 m OD - MMG III		overconsolidated	-	-	2.00	-
30	Redcued Level 67 - 66 m OD - MMG III		overconsolidated	-	-	2.00	-
31	Redcued Level 66 - 65 m OD - MMG III		overconsolidated	-	-	2.00	-
32	Redcued Level 65 - 64 m OD - MMG II		overconsolidated	-	-	2.00	-

No.	Name	Pattern	Type calculation	$\chi\pi_{ef}$ [°]	ς [–]	OCR [–]	K_r [–]
33	Redcued Level 64 - 63 m OD - MMG II		overconsolidated	-	-	2.00	-
34	Redcued Level 63 - 62 m OD - MMG II		overconsolidated	-	-	2.00	-
35	Redcued Level 62 - 61 m OD - MMG II		overconsolidated	-	-	2.00	-
36	Redcued Level 61 - 60 m OD - MMG II		overconsolidated	-	-	2.00	-
37	Redcued Level 60 - 59 m OD - MMG I		overconsolidated	-	-	2.00	-

Soil parameters

Topsoil/Subsoil

Unit weight : ψ = 16.50 kN/m3
Angle of internal friction : $\chi\pi_{ef}$ = 24.50 °
Cohesion of soil : c_{ef} = 14.00 kPa
Oedometric modulus : E_{oed} = 2.50 MPa
Saturated unit weight : ψ_{sat} = 18.50 kN/m3

Firm to stiff red brown silty CLAY - MMG IVB

Unit weight : ψ = 19.50 kN/m3
Angle of internal friction : $\chi\pi_{ef}$ = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Oedometric modulus : E_{oed} = 44.00 MPa
Saturated unit weight : ψ_{sat} = 20.50 kN/m3

Stiff red brown silty CLAY - MMG IVA

Unit weight : ψ = 20.50 kN/m3
Angle of internal friction : $\chi\pi_{ef}$ = 32.00 °
Cohesion of soil : c_{ef} = 4.00 kPa
Oedometric modulus : E_{oed} = 68.00 MPa
Saturated unit weight : ψ_{sat} = 21.00 kN/m3

Weathered Mudstone - MMG III

Unit weight : ψ = 22.00 kN/m3
Angle of internal friction : $\chi\pi_{ef}$ = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Oedometric modulus : E_{oed} = 120.00 MPa
Saturated unit weight : ψ_{sat} = 22.00 kN/m3

Weathered Mudstone - MMG II

Unit weight : ψ = 22.50 kN/m3
Angle of internal friction : $\chi\pi_{ef}$ = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Oedometric modulus : E_{oed} = 200.00 MPa
Saturated unit weight : ψ_{sat} = 22.50 kN/m3

Intact Mudstone - MMG I

Unit weight : ψ = 23.00 kN/m3

Angle of internal friction : φ_{ef} = 42.00 °
Cohesion of soil : c_{ef} = 25.00 kPa
Oedometric modulus : E_{oed} = 400.00 MPa
Saturated unit weight : γ_{sat} = 23.00 kN/m3

Bromsgrove Sandstone - Interbedded Mudstone & Sandstone
Unit weight : γ = 22.50 kN/m3
Angle of internal friction : φ_{ef} = 40.00 °
Cohesion of soil : c_{ef} = 8.00 kPa
Oedometric modulus : E_{oed} = 250.00 MPa
Saturated unit weight : γ_{sat} = 23.00 kN/m3

Existing Highway General Fill
Unit weight : γ = 19.50 kN/m3
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Oedometric modulus : E_{oed} = 17.50 MPa
Saturated unit weight : γ_{sat} = 20.50 kN/m3

Class 2 Fill (Site Won MMG IV)
Unit weight : γ = 19.50 kN/m3
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Oedometric modulus : E_{oed} = 8.50 MPa
Saturated unit weight : γ_{sat} = 20.50 kN/m3

Class 6F Capping/Subbase/Surfacing
Unit weight : γ = 21.00 kN/m3
Angle of internal friction : φ_{ef} = 35.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Oedometric modulus : E_{oed} = 478.00 MPa
Saturated unit weight : γ_{sat} = 21.50 kN/m3

Landscape Fill - Class 4
Unit weight : γ = 20.00 kN/m3
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 1.00 kPa
Oedometric modulus : E_{oed} = 8.50 MPa
Saturated unit weight : γ_{sat} = 20.50 kN/m3

Terrace Sands & Gravels
Unit weight : γ = 22.00 kN/m3
Angle of internal friction : φ_{ef} = 35.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Oedometric modulus : E_{oed} = 65.00 MPa
Saturated unit weight : γ_{sat} = 22.50 kN/m3

Class 7A Selected Cohesive Fill
Unit weight : γ = 20.50 kN/m3
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Oedometric modulus : E_{oed} = 20.00 MPa
Saturated unit weight : γ_{sat} = 21.00 kN/m3

Class 7C Selected Cohesive Fill

Unit weight :	ψ	=	20.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Oedometric modulus :	E_{oed}	=	20.00 MPa
Saturated unit weight :	ψ_{sat}	=	21.00 kN/m^3

Pre-existing Made Ground

Unit weight :	ψ	=	19.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	25.00 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	17.50 MPa
Saturated unit weight :	ψ_{sat}	=	19.50 kN/m^3

Culvert

Unit weight :	ψ	=	2.40 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	41.50 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	478.00 MPa
Saturated unit weight :	ψ_{sat}	=	2.40 kN/m^3

Granular Backfill to Culvert

Unit weight :	ψ	=	18.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	41.50 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	478.00 MPa
Saturated unit weight :	ψ_{sat}	=	18.00 kN/m^3

Class 6N Selected Backfill to Structures

Unit weight :	ψ	=	22.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	41.50 °
Cohesion of soil :	c_{ef}	=	0.00 kPa
Oedometric modulus :	E_{oed}	=	478.00 MPa
Saturated unit weight :	ψ_{sat}	=	23.00 kN/m^3

Redcued Level 78 - 77 m OD - MMG IVB

Unit weight :	ψ	=	19.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Deformation modulus :	E_{def}	=	10.00 MPa
Poisson's ratio :	ς	=	0.40
Saturated unit weight :	ψ_{sat}	=	20.50 kN/m^3

Redcued Level 77 - 76 m OD - MMG IVB

Unit weight :	ψ	=	19.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Deformation modulus :	E_{def}	=	20.00 MPa
Poisson's ratio :	ς	=	0.40
Saturated unit weight :	ψ_{sat}	=	20.50 kN/m^3

Redcued Level 76 - 75 m OD - MMG IVB

Unit weight :	ψ =	19.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	25.00 °
Cohesion of soil :	c_{ef} =	2.00 kPa
Deformation modulus :	E_{def} =	30.00 MPa
Poisson's ratio :	ς =	0.40
Saturated unit weight :	ψ_{sat} =	20.50 kN/m^3

Redcued Level 75 - 74 m OD - MMG IVA

Unit weight :	ψ =	20.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Deformation modulus :	E_{def} =	40.00 MPa
Poisson's ratio :	ς =	0.40
Saturated unit weight :	ψ_{sat} =	21.00 kN/m^3

Redcued Level 74 - 73 m OD - MMG IVA

Unit weight :	ψ =	20.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Deformation modulus :	E_{def} =	50.00 MPa
Poisson's ratio :	ς =	0.40
Saturated unit weight :	ψ_{sat} =	21.00 kN/m^3

Redcued Level 73 - 72 m OD - MMG IVA

Unit weight :	ψ =	20.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Deformation modulus :	E_{def} =	60.00 MPa
Poisson's ratio :	ς =	0.40
Saturated unit weight :	ψ_{sat} =	21.00 kN/m^3

Redcued Level 72 - 71 m OD - MMG IVA

Unit weight :	ψ =	20.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Deformation modulus :	E_{def} =	70.00 MPa
Poisson's ratio :	ς =	0.40
Saturated unit weight :	ψ_{sat} =	21.00 kN/m^3

Redcued Level 71 - 70 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Deformation modulus :	E_{def} =	80.00 MPa
Poisson's ratio :	ς =	0.30
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 70 - 69 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Deformation modulus :	E_{def} =	90.00 MPa
Poisson's ratio :	ς =	0.30

Saturated unit weight : ψ_{sat} = 22.00 kN/m^3

Redcued Level 69 - 68 m OD - MMG III

Unit weight : ψ = 22.00 kN/m^3
Angle of internal friction : $\chi\pi_{ef}$ = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Deformation modulus : E_{def} = 100.00 MPa
Poisson's ratio : ς = 0.30
Saturated unit weight : ψ_{sat} = 22.00 kN/m^3

Redcued Level 68 - 67 m OD - MMG III

Unit weight : ψ = 22.00 kN/m^3
Angle of internal friction : $\chi\pi_{ef}$ = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Deformation modulus : E_{def} = 110.00 MPa
Poisson's ratio : ς = 0.30
Saturated unit weight : ψ_{sat} = 22.00 kN/m^3

Redcued Level 67 - 66 m OD - MMG III

Unit weight : ψ = 22.00 kN/m^3
Angle of internal friction : $\chi\pi_{ef}$ = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Deformation modulus : E_{def} = 120.00 MPa
Poisson's ratio : ς = 0.30
Saturated unit weight : ψ_{sat} = 22.00 kN/m^3

Redcued Level 66 - 65 m OD - MMG III

Unit weight : ψ = 22.00 kN/m^3
Angle of internal friction : $\chi\pi_{ef}$ = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Deformation modulus : E_{def} = 130.00 MPa
Poisson's ratio : ς = 0.30
Saturated unit weight : ψ_{sat} = 22.00 kN/m^3

Redcued Level 65 - 64 m OD - MMG II

Unit weight : ψ = 22.50 kN/m^3
Angle of internal friction : $\chi\pi_{ef}$ = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Deformation modulus : E_{def} = 151.50 MPa
Poisson's ratio : ς = 0.25
Saturated unit weight : ψ_{sat} = 22.50 kN/m^3

Redcued Level 64 - 63 m OD - MMG II

Unit weight : ψ = 22.50 kN/m^3
Angle of internal friction : $\chi\pi_{ef}$ = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Deformation modulus : E_{def} = 184.50 MPa
Poisson's ratio : ς = 0.25
Saturated unit weight : ψ_{sat} = 22.50 kN/m^3

Redcued Level 63 - 62 m OD - MMG II

Unit weight : ψ = 22.50 kN/m^3
Angle of internal friction : $\chi\pi_{ef}$ = 42.00 °

Cohesion of soil :	c_{ef} =	16.00 kPa
Deformation modulus :	E_{def} =	217.50 MPa
Poisson's ratio :	ς =	0.25
Saturated unit weight :	ψ_{sat} =	22.50 kN/m^3

Redcued Level 62 - 61 m OD - MMG II

Unit weight :	ψ =	22.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Deformation modulus :	E_{def} =	250.50 MPa
Poisson's ratio :	ς =	0.25
Saturated unit weight :	ψ_{sat} =	22.50 kN/m^3

Redcued Level 61 - 60 m OD - MMG II

Unit weight :	ψ =	22.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Deformation modulus :	E_{def} =	283.50 MPa
Poisson's ratio :	ς =	0.25
Saturated unit weight :	ψ_{sat} =	22.50 kN/m^3

Redcued Level 60 - 59 m OD - MMG I

Unit weight :	ψ =	23.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	42.00 °
Cohesion of soil :	c_{ef} =	25.00 kPa
Deformation modulus :	E_{def} =	329.17 MPa
Poisson's ratio :	ς =	0.25
Saturated unit weight :	ψ_{sat} =	23.00 kN/m^3

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z =	10.30	m
Depth of footing bottom	d =	1.75	m
Foundation thickness	t =	1.50	m
Incl. of finished grade	s_1 =	0.00	°
Incl. of footing bottom	s_2 =	0.00	°

Unit weight of soil above foundation = 22.00 kN/m^3

Geometry of structure

Foundation type: strip footing

Overall strip footing length	= 21.00	m
Strip footing width (x)	= 7.00	m
Column width in the direction of x	= 0.10	m
Volume of strip footing	= 10.50	m^3/m

Inserted loading is considered per unit length of continuous footing span.

Material of structure

Unit weight ψ = 23.50 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 35/45

Cylinder compressive strength	f_{ck} =	35.00	MPa
Tensile strength	f_{ctm} =	3.20	MPa

Elasticity modulus E_{cm} = 34000.00 MPa

Longitudinal steel : B500

Yield strength f_{yk} = 500.00 MPa

Transverse steel: B500

Yield strength f_{yk} = 500.00 MPa

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	1.00	Redcued Level 77 - 76 m OD - MMG IVB	
2	1.00	Redcued Level 76 - 75 m OD - MMG IVB	
3	1.00	Redcued Level 75 - 74 m OD - MMG IVA	
4	1.00	Redcued Level 74 - 73 m OD - MMG IVA	
5	1.00	Redcued Level 73 - 72 m OD - MMG IVA	
6	1.00	Redcued Level 72 - 71 m OD - MMG IVA	
7	1.00	Redcued Level 71 - 70 m OD - MMG III	
8	1.00	Redcued Level 70 - 69 m OD - MMG III	
9	1.00	Redcued Level 69 - 68 m OD - MMG III	
10	1.00	Redcued Level 68 - 67 m OD - MMG III	
11	1.00	Redcued Level 67 - 66 m OD - MMG III	
12	1.00	Redcued Level 66 - 65 m OD - MMG III	
13	1.00	Redcued Level 65 - 64 m OD - MMG II	
14	1.00	Redcued Level 64 - 63 m OD - MMG II	
15	1.00	Redcued Level 63 - 62 m OD - MMG II	
16	1.00	Redcued Level 62 - 61 m OD - MMG II	
17	1.00	Redcued Level 61 - 60 m OD - MMG II	
18	1.00	Redcued Level 60 - 59 m OD - MMG I	
19	-	Redcued Level 60 - 59 m OD - MMG I	

Load

No.	Load new	Load change	Name	Type	N [kN/m]	M_y [kNm/m]	H_x [kN/m]
1	Yes		LC 1	Design	3929.41	2763.85	-297.39
2	Yes		LC 2	Design	3447.81	3242.51	-482.42
3	Yes		LC 3	Design	3447.81	3206.42	-391.43
4	Yes		LC 4	Design	3447.81	3206.42	-391.43
5	Yes		LC 5	Service	3447.81	2977.85	-316.43

Surface surcharges in the vicinity of footing

No.	Surcharge new	Surcharge change	Name	x_s [m]	y_s [m]	x [m]	y [m]	q [kPa]	α [°]	h [m]
1	Yes		Embankment Backfill	10.50	0.00	20.00	21.00	212.50	0.00	0.00

Ground water table

The ground water table is at a depth of 11.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

No. 1

Load case verification

Name	Self w. in favor	e_x [m]	e_y [m]	σ [kPa]	R_d [kPa]	Utilization [%]	Is satisfied
LC 1	Yes	-0.76	0.00	769.48	8207.39	9.38	Yes
LC 1	No	-0.76	0.00	769.48	8207.39	9.38	Yes
LC 2	Yes	-1.06	0.00	765.67	6754.32	11.34	Yes
LC 2	No	-1.06	0.00	765.67	6754.32	11.34	Yes
LC 3	Yes	-1.02	0.00	751.42	7228.24	10.40	Yes
LC 3	No	-1.02	0.00	751.42	7228.24	10.40	Yes
LC 4	Yes	-1.02	0.00	751.42	7228.24	10.40	Yes
LC 4	No	-1.02	0.00	751.42	7228.24	10.40	Yes
LC 5	Yes	-0.92	0.00	724.75	3051.66	23.75	Yes
LC 5	No	-0.92	0.00	724.75	3051.66	23.75	Yes

Analysis carried out with automatic selection of the most unfavourable load cases.

Computed self weight of strip foundation $G = 246.75$ kN/m
Computed weight of overburden $Z = 37.95$ kN/m

Vertical bearing capacity check

Shape of contact stress : rectangle
Most severe load case No. 5. (LC 5)

Parameters of slip surface below foundation:
Depth of slip surface $z_{sp} = 13.31$ m
Length of slip surface $l_{sp} = 43.81$ m

Design bearing capacity of found.soil $R_d = 3051.66$ kPa

Extreme contact stress α = 724.75 kPa

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.152<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.152<0.333

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Most severe load case No. 2. (LC 2)

Earth resistance: not considered

Horizontal bearing capacity R_{dh} = 2381.08 kN
Extreme horizontal force H = 482.42 kN

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
Analysis carried out with accounting for coefficient K_1 (influence of foundation depth).
Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation G = 246.75 kN/m
Computed weight of overburden Z = 37.95 kN/m

Settlement of mid point of longitudinal edge = 14.6 mm
Settlement of mid point of transverse edge 1 = 20.6 mm
Settlement of mid point of transverse edge 2 = 13.7 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:
Computed weighted average modulus of deformation E_{def} = 262.10 MPa
Foundation in the longitudinal direction is rigid (k=1.28)
Foundation in the direction of width is rigid (k=437.81)

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.132<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.132<0.333

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:
Foundation settlement = 18.2 mm
Depth of influence zone = 29.60 m

Rotation in direction of width = 0.978 (tan*1000); (5.6E-02 °)

ANNEX B.3 EMG-HYD-C4-M1OB-CA-GE-0661

Slope stability analysis

Input data

Project

Task :	EAST MIDLANDS GATEWAY - STRATEGIC RAIL FREIGHT INTERCHANGE
Part :	M1 OVERBRIDGE, ELEMENT 11, WORKS COMPONENTS 5, HIGHWAY VII & VIII
Description :	M1 OVERBRIDGE LONG-TERM STABILITY - EXISTING M1 CUTTING
Customer :	ROXHILL KEGWORTH LTD
Author :	Ian Gardner
Date :	08/07/2017 16:38:13
Project ID :	C14792
Project number :	EMG-HYD-C4-M1OB-CA-GE-0661-S4-P1

Settings

United Kingdom - EN 1997

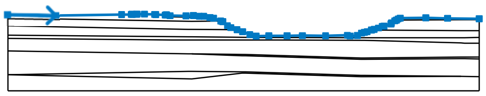
Stability analysis

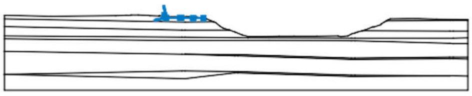
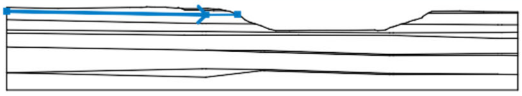
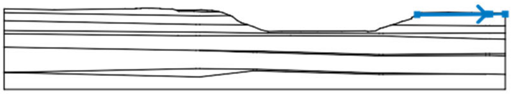
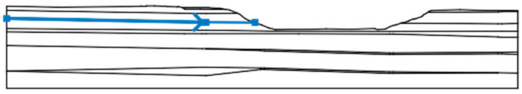
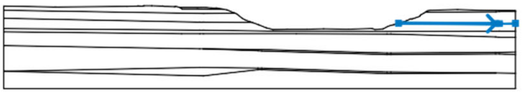
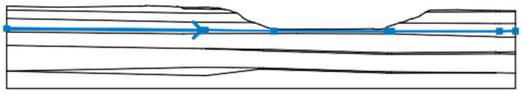
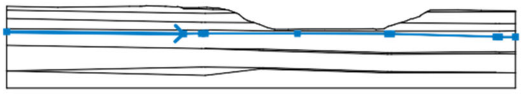
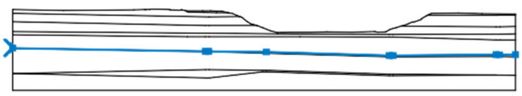
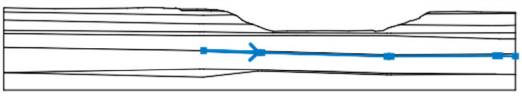
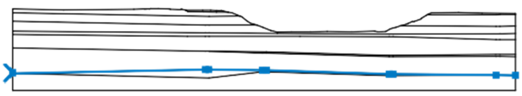
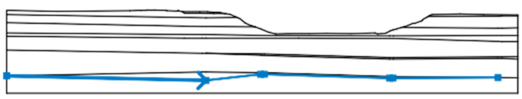
Earthquake analysis :	Standard
Verification methodology :	according to EN 1997
Design approach :	1 - reduction of actions and soil parameters

Partial factors on actions (A)					
Permanent design situation					
		Combination 1		Combination 2	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	ψ_G =	1.35 [–]	1.00 [–]	1.00 [–]	1.00 [–]
Variable actions :	ψ_Q =	1.50 [–]	0.00 [–]	1.30 [–]	0.00 [–]
Water load :	ψ_w =	1.35 [–]		1.00 [–]	

Partial factors for soil parameters (M)			
Permanent design situation			
		Combination 1	Combination 2
Partial factor on internal friction :	ψ_ϕ =	1.00 [–]	1.25 [–]
Partial factor on effective cohesion :	ψ_c =	1.00 [–]	1.25 [–]
Partial factor on undrained shear strength :	ψ_{cu} =	1.00 [–]	1.40 [–]

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	27.19	20.20	26.82	48.22	27.14
		52.38	27.21	52.62	27.28	53.00	27.22
		54.50	27.26	54.81	27.38	57.90	27.36
		62.22	27.24	62.77	27.12	66.74	26.97
		67.08	27.09	67.31	27.06	68.81	26.70
		75.55	26.66	78.71	26.77	81.20	26.53
		83.12	26.53	85.72	25.98	87.25	25.67
		90.29	24.48	91.14	24.15	93.15	22.46
		94.54	21.65	97.22	20.81	99.55	20.01
		102.64	18.75	105.37	18.10	110.76	18.16
		118.47	18.25	125.01	18.28	134.80	18.25
		144.04	18.41	145.20	18.13	148.32	18.35
		150.11	19.37	151.27	19.68	152.44	19.98
		154.30	20.61	155.43	20.89	157.30	21.51
		158.91	22.21	159.63	22.26	162.52	23.22
		162.76	23.66	164.19	24.50	164.83	24.88

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
		165.61	25.34	166.50	25.65	177.34	25.78
		186.58	25.59	200.01	25.44		
2		68.81	26.70	69.64	26.15	75.82	26.13
		81.08	25.91	85.72	25.98		
3		0.00	25.63	78.07	24.35	90.29	24.48
4		164.83	24.88	192.34	24.99	193.71	25.04
		200.01	25.05				
5		0.00	22.41	76.57	20.90	78.07	20.90
		97.22	20.81				
6		154.30	20.61	192.23	20.38	193.71	20.39
		200.01	20.43				
7		0.00	18.42	76.57	17.80	78.07	17.81
		105.15	17.50	149.75	17.34	151.25	17.34
		193.71	17.40	200.01	17.50		
8		0.00	17.17	69.49	16.39	76.58	16.43
		78.07	16.45	114.29	16.43	149.75	16.34
		151.25	16.34	192.26	15.17	193.71	15.10
		200.01	15.09				
9		0.00	11.78	0.01	11.78	76.57	10.55
		78.07	10.55	100.86	10.36	149.75	8.89
		151.25	8.89	192.15	9.24	193.71	9.23
		200.01	9.28				
10		78.07	10.55	99.39	9.77	100.86	9.74
		149.75	8.34	151.25	8.34	192.23	8.53
		193.71	8.53	200.01	8.37		
11		0.00	1.78	0.01	1.78	76.58	3.30
		78.07	3.30	99.36	3.06	100.86	3.06
		149.75	1.54	151.25	1.54	192.23	1.16
		200.01	1.02				
12		0.00	1.78	78.07	0.00	99.36	2.46
		100.86	2.46	149.75	0.94	151.25	0.94
		192.23	1.16				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	Firm to stiff red brown silty CLAY - MMG IVB		25.00	2.00	19.50
2	Stiff red brown silty CLAY - MMG IVA		32.00	4.00	20.50

No.	Name	Pattern	$\chi\pi_{ef}$ [°]	c_{ef} [kPa]	ψ [kN/m^3]
3	Weathered Mudstone - MMG III		32.00	10.00	22.00
4	Weathered Mudstone - MMG II		42.00	16.00	22.50
5	Intact Mudstone - MMG I		42.00	25.00	23.00
6	Sandstone - Interbedded Mudstone & Sandstone		40.00	8.00	22.50
7	Existing Highway General Fill		25.00	2.00	19.50
8	Class 2 Fill (Site Won MMG IV)		25.00	2.00	19.50
9	Class 6F Capping/Subbase/Surfacing		35.00	0.00	21.00
10	Terrace Sands & Gravels		35.00	0.00	22.00
11	Class 7A Selected Cohesive Fill		25.00	2.00	20.50
12	Class 7C Selected Cohesive Fill		25.00	2.00	20.50
13	Pre-existing Made Ground		25.00	0.00	19.00
14	Culvert		41.50	0.00	2.40
15	Granular Backfill to Culvert		41.50	0.00	18.00
16	Class 6N Selected Backfill to Structures		41.50	0.00	22.50

No.	Name	Pattern	$\chi\pi_{ef}$ [°]	c_{ef} [kPa]	ψ [kN/m^3]
17	Redcued Level 78 - 77 m OD - MMG IVB		25.00	2.00	19.50
18	Redcued Level 77 - 76 m OD - MMG IVB		25.00	2.00	19.50
19	Redcued Level 76 - 75 m OD - MMG IVB		25.00	2.00	19.50
20	Redcued Level 75 - 74 m OD - MMG IVA		32.00	4.00	20.50
21	Redcued Level 74 - 73 m OD - MMG IVA		32.00	4.00	20.50
22	Redcued Level 73 - 72 m OD - MMG IVA		32.00	4.00	20.50
23	Redcued Level 72 - 71 m OD - MMG IVA		32.00	4.00	20.50
24	Redcued Level 71 - 70 m OD - MMG III		32.00	10.00	22.00
25	Redcued Level 70 - 69 m OD - MMG III		32.00	10.00	22.00
26	Redcued Level 69 - 68 m OD - MMG III		32.00	10.00	22.00
27	Redcued Level 68 - 67 m OD - MMG III		32.00	10.00	22.00
28	Redcued Level 67 - 66 m OD - MMG III		32.00	10.00	22.00
29	Redcued Level 66 - 65 m OD - MMG III		32.00	10.00	22.00
30	Redcued Level 65 - 64 m OD - MMG II		42.00	16.00	22.50

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	ψ [kN/m³]
31	Redcued Level 64 - 63 m OD - MMG II		42.00	16.00	22.50
32	Redcued Level 63 - 62 m OD - MMG II		42.00	16.00	22.50
33	Redcued Level 62 - 61 m OD - MMG II		42.00	16.00	22.50
34	Redcued Level 61 - 60 m OD - MMG II		42.00	16.00	22.50
35	Redcued Level 60 - 59 m OD - MMG I		42.00	25.00	23.00

Soil parameters - uplift

No.	Name	Pattern	ψ_{sat} [kN/m³]	ψ_s [kN/m³]	n [–]
1	Firm to stiff red brown silty CLAY - MMG IVB		20.50		
2	Stiff red brown silty CLAY - MMG IVA		21.00		
3	Weathered Mudstone - MMG III		22.00		
4	Weathered Mudstone - MMG II		22.50		
5	Intact Mudstone - MMG I		23.00		
6	Sandstone - Interbedded Mudstone & Sandstone		23.00		
7	Existing Highway General Fill		20.50		
8	Class 2 Fill (Site Won MMG IV)		20.50		

No.	Name	Pattern	ψ_{sat} [kN/m^3]	ψ_s [kN/m^3]	n [–]
9	Class 6F Capping/Subbase/Surfacing		21.50		
10	Terrace Sands & Gravels		22.50		
11	Class 7A Selected Cohesive Fill		21.00		
12	Class 7C Selected Cohesive Fill		21.00		
13	Pre-existing Made Ground		19.50		
14	Culvert		2.40		
15	Granular Backfill to Culvert		18.00		
16	Class 6N Selected Backfill to Structures		23.00		
17	Redcued Level 78 - 77 m OD - MMG IVB		20.50		
18	Redcued Level 77 - 76 m OD - MMG IVB		20.50		
19	Redcued Level 76 - 75 m OD - MMG IVB		20.50		
20	Redcued Level 75 - 74 m OD - MMG IVA		21.00		
21	Redcued Level 74 - 73 m OD - MMG IVA		21.00		
22	Redcued Level 73 - 72 m OD - MMG IVA		21.00		

No.	Name	Pattern	ψ_{sat} [kN/m^3]	ψ_s [kN/m^3]	n [–]
23	Redcued Level 72 - 71 m OD - MMG IVA		21.00		
24	Redcued Level 71 - 70 m OD - MMG III		22.00		
25	Redcued Level 70 - 69 m OD - MMG III		22.00		
26	Redcued Level 69 - 68 m OD - MMG III		22.00		
27	Redcued Level 68 - 67 m OD - MMG III		22.00		
28	Redcued Level 67 - 66 m OD - MMG III		22.00		
29	Redcued Level 66 - 65 m OD - MMG III		22.00		
30	Redcued Level 65 - 64 m OD - MMG II		22.50		
31	Redcued Level 64 - 63 m OD - MMG II		22.50		
32	Redcued Level 63 - 62 m OD - MMG II		22.50		
33	Redcued Level 62 - 61 m OD - MMG II		22.50		
34	Redcued Level 61 - 60 m OD - MMG II		22.50		
35	Redcued Level 60 - 59 m OD - MMG I		23.00		

Soil parameters - total stress state

No.	Name	Pattern	c_u [kPa]	ψ [kN/m³]
1	Topsoil/Subsoil		35.00	16.50
2	Landscape Fill - Class 4		50.00	20.00

Soil parameters

Topsoil/Subsoil

Unit weight :	ψ =	16.50 kN/m³
Stress-state :	total	
Cohesion of soil :	c_u =	35.00 kPa

Firm to stiff red brown silty CLAY - MMG IVB

Unit weight :	ψ =	19.50 kN/m³
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	25.00 °
Cohesion of soil :	c_{ef} =	2.00 kPa
Saturated unit weight :	ψ_{sat} =	20.50 kN/m³

Stiff red brown silty CLAY - MMG IVA

Unit weight :	ψ =	20.50 kN/m³
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Saturated unit weight :	ψ_{sat} =	21.00 kN/m³

Weathered Mudstone - MMG III

Unit weight :	ψ =	22.00 kN/m³
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Saturated unit weight :	ψ_{sat} =	22.00 kN/m³

Weathered Mudstone - MMG II

Unit weight :	ψ =	22.50 kN/m³
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Saturated unit weight :	ψ_{sat} =	22.50 kN/m³

Intact Mudstone - MMG I

Unit weight :	ψ =	23.00 kN/m³
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	42.00 °
Cohesion of soil :	c_{ef} =	25.00 kPa
Saturated unit weight :	ψ_{sat} =	23.00 kN/m³

Sandstone - Interbedded Mudstone & Sandstone

Unit weight :	ψ =	22.50 kN/m³

Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 40.00 °
Cohesion of soil : c_{ef} = 8.00 kPa
Saturated unit weight : ψ_{sat} = 23.00 kN/m3

Existing Highway General Fill
Unit weight : ψ = 19.50 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : ψ_{sat} = 20.50 kN/m3

Class 2 Fill (Site Won MMG IV)
Unit weight : ψ = 19.50 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : ψ_{sat} = 20.50 kN/m3

Class 6F Capping/Subbase/Surfacing
Unit weight : ψ = 21.00 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 35.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : ψ_{sat} = 21.50 kN/m3

Landscape Fill - Class 4
Unit weight : ψ = 20.00 kN/m3
Stress-state : total
Cohesion of soil : c_u = 50.00 kPa

Terrace Sands & Gravels
Unit weight : ψ = 22.00 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 35.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : ψ_{sat} = 22.50 kN/m3

Class 7A Selected Cohesive Fill
Unit weight : ψ = 20.50 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : ψ_{sat} = 21.00 kN/m3

Class 7C Selected Cohesive Fill
Unit weight : ψ = 20.50 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : ψ_{sat} = 21.00 kN/m3

Pre-existing Made Ground
Unit weight : ψ = 19.00 kN/m3

Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 25.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : ψ_{sat} = 19.50 kN/m^3

Culvert
Unit weight : ψ = 2.40 kN/m^3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : ψ_{sat} = 2.40 kN/m^3

Granular Backfill to Culvert
Unit weight : ψ = 18.00 kN/m^3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : ψ_{sat} = 18.00 kN/m^3

Class 6N Selected Backfill to Structures
Unit weight : ψ = 22.50 kN/m^3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : ψ_{sat} = 23.00 kN/m^3

Redcued Level 78 - 77 m OD - MMG IVB
Unit weight : ψ = 19.50 kN/m^3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : ψ_{sat} = 20.50 kN/m^3

Redcued Level 77 - 76 m OD - MMG IVB
Unit weight : ψ = 19.50 kN/m^3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : ψ_{sat} = 20.50 kN/m^3

Redcued Level 76 - 75 m OD - MMG IVB
Unit weight : ψ = 19.50 kN/m^3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Saturated unit weight : ψ_{sat} = 20.50 kN/m^3

Redcued Level 75 - 74 m OD - MMG IVA
Unit weight : ψ = 20.50 kN/m^3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 32.00 °
Cohesion of soil : c_{ef} = 4.00 kPa
Saturated unit weight : ψ_{sat} = 21.00 kN/m^3

Redcued Level 74 - 73 m OD - MMG IVA

Unit weight :	ψ =	20.50 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Saturated unit weight :	ψ_{sat} =	21.00 kN/m^3

Redcued Level 73 - 72 m OD - MMG IVA

Unit weight :	ψ =	20.50 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Saturated unit weight :	ψ_{sat} =	21.00 kN/m^3

Redcued Level 72 - 71 m OD - MMG IVA

Unit weight :	ψ =	20.50 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Saturated unit weight :	ψ_{sat} =	21.00 kN/m^3

Redcued Level 71 - 70 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 70 - 69 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 69 - 68 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 68 - 67 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 67 - 66 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa

Saturated unit weight : ψ_{sat} = 22.00 kN/m3

Redcued Level 66 - 65 m OD - MMG III
Unit weight : ψ = 22.00 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Saturated unit weight : ψ_{sat} = 22.00 kN/m3

Redcued Level 65 - 64 m OD - MMG II
Unit weight : ψ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Saturated unit weight : ψ_{sat} = 22.50 kN/m3

Redcued Level 64 - 63 m OD - MMG II
Unit weight : ψ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Saturated unit weight : ψ_{sat} = 22.50 kN/m3

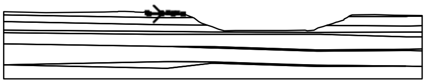
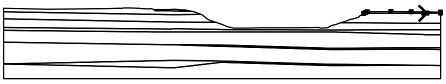
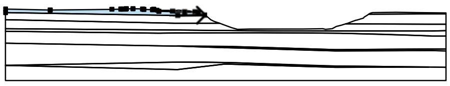
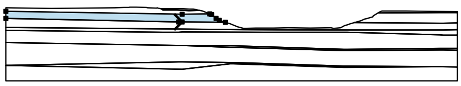
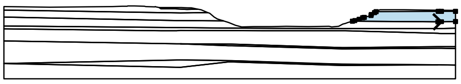
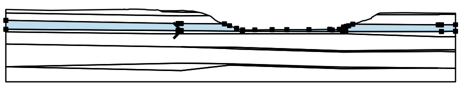
Redcued Level 63 - 62 m OD - MMG II
Unit weight : ψ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Saturated unit weight : ψ_{sat} = 22.50 kN/m3

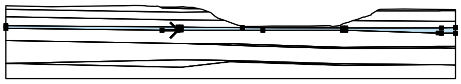
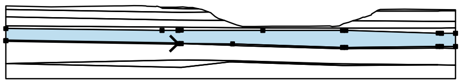
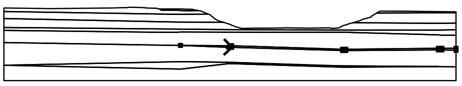
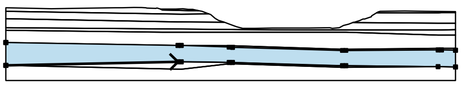
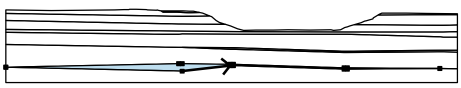
Redcued Level 62 - 61 m OD - MMG II
Unit weight : ψ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Saturated unit weight : ψ_{sat} = 22.50 kN/m3

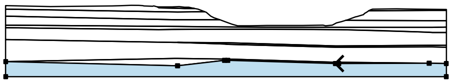
Redcued Level 61 - 60 m OD - MMG II
Unit weight : ψ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Saturated unit weight : ψ_{sat} = 22.50 kN/m3

Redcued Level 60 - 59 m OD - MMG I
Unit weight : ψ = 23.00 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 42.00 °
Cohesion of soil : c_{ef} = 25.00 kPa
Saturated unit weight : ψ_{sat} = 23.00 kN/m3

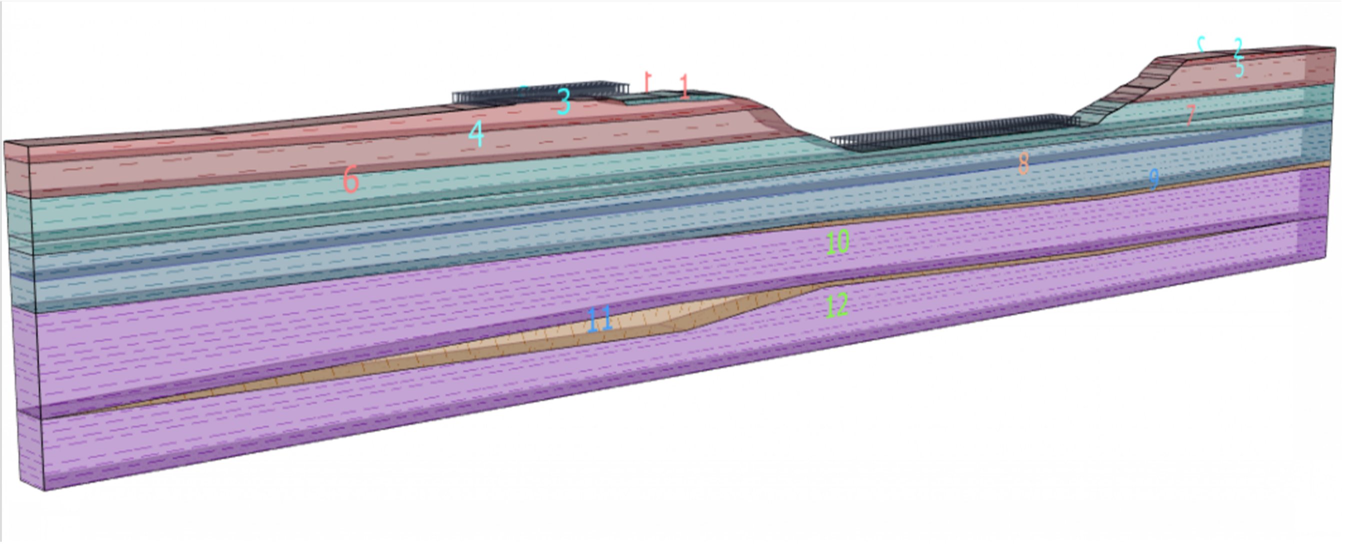
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		69.64	26.15	75.82	26.13	Topsoil/Subsoil
		81.08	25.91	85.72	25.98	
		83.12	26.53	81.20	26.53	
		78.71	26.77	75.55	26.66	
		68.81	26.70			
2		192.34	24.99	193.71	25.04	Firm to stiff red brown silty CLAY - MMG IVB
		200.01	25.05	200.01	25.44	
		186.58	25.59	177.34	25.78	
		166.50	25.65	165.61	25.34	
		164.83	24.88			
3		78.07	24.35	90.29	24.48	Firm to stiff red brown silty CLAY - MMG IVB
		87.25	25.67	85.72	25.98	
		81.08	25.91	75.82	26.13	
		69.64	26.15	68.81	26.70	
		67.31	27.06	67.08	27.09	
		66.74	26.97	62.77	27.12	
		62.22	27.24	57.90	27.36	
		54.81	27.38	54.50	27.26	
		53.00	27.22	52.62	27.28	
		52.38	27.21	48.22	27.14	
		20.20	26.82	0.00	27.19	
		0.00	25.63			
4		76.57	20.90	78.07	20.90	Stiff red brown silty CLAY - MMG IVA
		97.22	20.81	94.54	21.65	
		93.15	22.46	91.14	24.15	
		90.29	24.48	78.07	24.35	
		0.00	25.63	0.00	22.41	
5		192.23	20.38	193.71	20.39	Stiff red brown silty CLAY - MMG IVA
		200.01	20.43	200.01	25.05	
		193.71	25.04	192.34	24.99	
		164.83	24.88	164.19	24.50	
		162.76	23.66	162.52	23.22	
		159.63	22.26	158.91	22.21	
		157.30	21.51	155.43	20.89	
		154.30	20.61			
6		76.57	17.80	78.07	17.81	Weathered Mudstone - MMG III
		105.15	17.50	149.75	17.34	
		151.25	17.34	193.71	17.40	
		200.01	17.50	200.01	20.43	
		193.71	20.39	192.23	20.38	
		154.30	20.61	152.44	19.98	
		151.27	19.68	150.11	19.37	
		148.32	18.35	145.20	18.13	
		144.04	18.41	134.80	18.25	
		125.01	18.28	118.47	18.25	
		110.76	18.16	105.37	18.10	
		102.64	18.75	99.55	20.01	
		97.22	20.81	78.07	20.90	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
		76.57	20.90	0.00	22.41	
		0.00	18.42			
7		69.49	16.39	76.58	16.43	Weathered Mudstone - MMG III
		78.07	16.45	114.29	16.43	
		149.75	16.34	151.25	16.34	
		192.26	15.17	193.71	15.10	
		200.01	15.09	200.01	17.50	
		193.71	17.40	151.25	17.34	
		149.75	17.34	105.15	17.50	
		78.07	17.81	76.57	17.80	
		0.00	18.42	0.00	17.17	
8		0.01	11.78	76.57	10.55	Weathered Mudstone - MMG II
		78.07	10.55	100.86	10.36	
		149.75	8.89	151.25	8.89	
		192.15	9.24	193.71	9.23	
		200.01	9.28	200.01	15.09	
		193.71	15.10	192.26	15.17	
		151.25	16.34	149.75	16.34	
		114.29	16.43	78.07	16.45	
		76.58	16.43	69.49	16.39	
		0.00	17.17	0.00	11.78	
9		99.39	9.77	100.86	9.74	Sandstone - Interbedded Mudstone & Sandstone
		149.75	8.34	151.25	8.34	
		192.23	8.53	193.71	8.53	
		200.01	8.37	200.01	9.28	
		193.71	9.23	192.15	9.24	
		151.25	8.89	149.75	8.89	
		100.86	10.36	78.07	10.55	
10		0.01	1.78	76.58	3.30	Intact Mudstone - MMG I
		78.07	3.30	99.36	3.06	
		100.86	3.06	149.75	1.54	
		151.25	1.54	192.23	1.16	
		200.01	1.02	200.01	8.37	
		193.71	8.53	192.23	8.53	
		151.25	8.34	149.75	8.34	
		100.86	9.74	99.39	9.77	
		78.07	10.55	76.57	10.55	
		0.01	11.78	0.00	11.78	
		0.00	1.78			
11		78.07	0.00	99.36	2.46	Sandstone - Interbedded Mudstone & Sandstone
		100.86	2.46	149.75	0.94	
		151.25	0.94	192.23	1.16	
		151.25	1.54	149.75	1.54	
		100.86	3.06	99.36	3.06	
		78.07	3.30	76.58	3.30	
		0.01	1.78	0.00	1.78	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
12		151.25	0.94	149.75	0.94	Intact Mudstone - MMG I
		100.86	2.46	99.36	2.46	
		78.07	0.00	0.00	1.78	
		0.00	-5.00	200.01	-5.00	
		200.01	1.02	192.23	1.16	

Name : Soils and assignment — Stage : 1



Surcharge

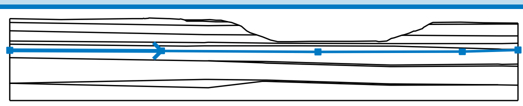
No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q_1, f, F	q_2	unit
1	strip	permanent	on terrain	x = 50.00	l = 20.00		0.00	20.00		kN/m2
2	strip	permanent	on terrain	x = 105.00	l = 40.00		0.00	20.00		kN/m2

Surcharges

No.	Name
1	A453 Highway UDL
2	M1 Highway UDL

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	14.74	59.68	14.51	121.33	14.05
		178.10	14.16	200.01	14.86		

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1

Circular slip surface

Slip surface parameters								
Center :	x =	94.61	[m]	Angles :	α_1 =	-61.23	[°]
	z =	28.23	[m]		α_2 =	-0.05	[°]
Radius :	R =	6.60	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1
Sum of active forces : F_a = 54.40 kN/m
Sum of passive forces : F_p = 83.53 kN/m
Sliding moment : M_a = 299.19 kNm/m
Resisting moment : M_p = 459.44 kNm/m
Utilization : 65.1 %

Slope stability ACCEPTABLE
Combination 2
Sum of active forces : F_a = 50.42 kN/m
Sum of passive forces : F_p = 68.44 kN/m
Sliding moment : M_a = 332.76 kNm/m
Resisting moment : M_p = 451.69 kNm/m
Utilization : 73.7 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

Name : Analysis	Stage - analysis : 1 - 1

Analysis 2

Polygonal slip surface

Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
86.83	25.75	89.24	23.96	90.05	23.40	90.82	22.87	91.78	22.26
92.75	21.84	93.74	21.65	94.55	21.65				
The slip surface after optimization.									

Slope stability verification (Sarma)
Combination 1
Utilization : 66.6 %

Slope stability ACCEPTABLE
Combination 2
Utilization : 74.6 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

Name : Analysis	Stage - analysis : 1 - 2

Analysis 3

Circular slip surface

Slip surface parameters								
Center :	x =	161.90	[m]	Angles :	α_1 =	-1.26	[°]
	z =	28.83	[m]		α_2 =	57.18	[°]
Radius :	R =	5.86	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1
Sum of active forces : F_a = 38.05 kN/m
Sum of passive forces : F_p = 65.24 kN/m
Sliding moment : M_a = 195.57 kNm/m
Resisting moment : M_p = 335.33 kNm/m
Utilization : 58.3 %

Slope stability ACCEPTABLE
Combination 2
Sum of active forces : F_a = 34.52 kN/m
Sum of passive forces : F_p = 52.39 kN/m
Sliding moment : M_a = 202.27 kNm/m
Resisting moment : M_p = 306.98 kNm/m
Utilization : 65.9 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

Name : Analysis **Stage - analysis : 1 - 3**

Name : Analysis **Stage - analysis : 1 - 3**

Analysis 4

Polygonal slip surface

Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
161.82	22.99	162.56	22.91	163.44	23.16	164.18	23.48	164.92	23.91
165.62	24.43	166.33	25.06	166.96	25.66				
The slip surface after optimization.									

Slope stability verification (Sarma)
Combination 1
Utilization : 59.0 %

Slope stability ACCEPTABLE
Combination 2
Utilization : 66.4 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

ANNEX B.4 EMG-HYD-C4-M1OB-CA-GE-

0662

Slope stability analysis

Input data

Project

Task : EAST MIDLANDS GATEWAY - STRATEGIC RAIL FREIGHT INTERCHANGE
Part : M1 OVERBRIDGE, ELEMENT 11, WORKS COMPONENTS 5, HIGHWAY VII & VIII
Description : M1 OVERBRIDGE SHORT-TERM STABILITY - DURING CONSTRUCTION
Customer : ROXHILL KEGWORTH LTD
Author : Ian Gardner
Date : 03/08/2017 16:38:13
Project ID : C14792
Project number : EMG-HYD-C4-M1OB-CA-GE-0662-S4-P2

Settings

United Kingdom - EN 1997

Stability analysis

Earthquake analysis : Standard
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

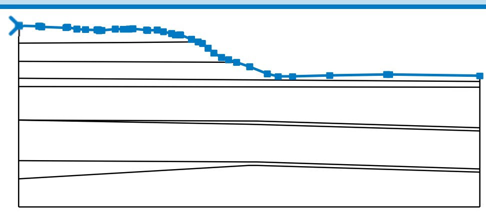
Partial factors on actions (A)
Permanent design situation

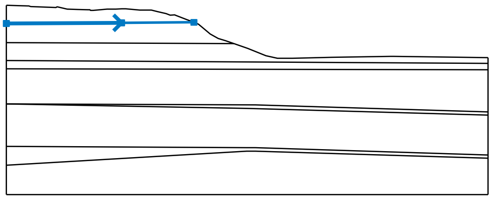
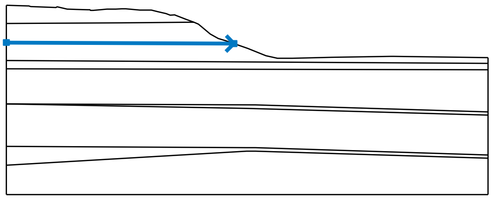
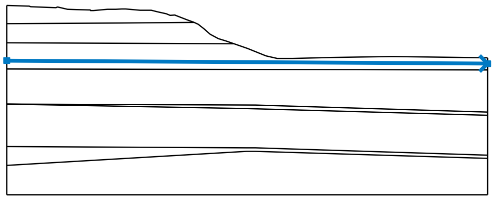
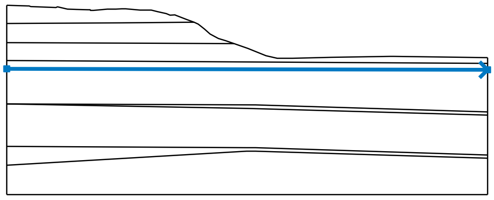
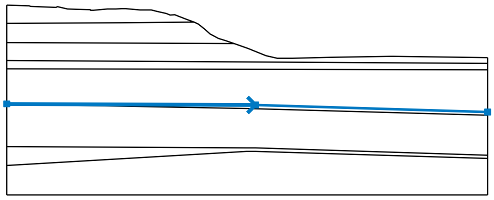
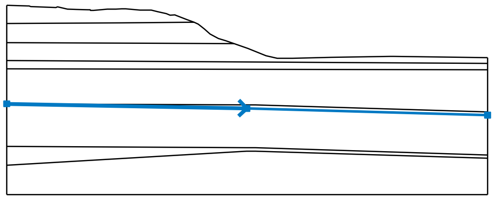
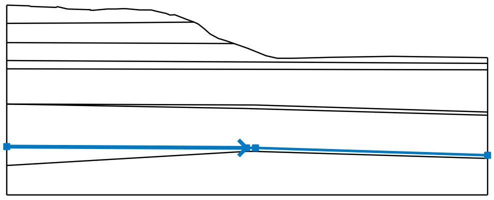
		Combination 1		Combination 2	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	ψ_G =	1.35 [–]	1.00 [–]	1.00 [–]	1.00 [–]
Variable actions :	ψ_Q =	1.50 [–]	0.00 [–]	1.30 [–]	0.00 [–]
Water load :	ψ_w =	1.35 [–]		1.00 [–]	

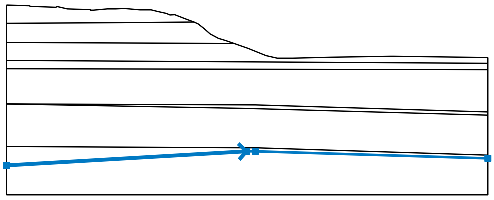
Partial factors for soil parameters (M)
Permanent design situation

		Combination 1	Combination 2
Partial factor on internal friction :	ψ_ϕ =	1.00 [–]	1.25 [–]
Partial factor on effective cohesion :	ψ_c =	1.00 [–]	1.25 [–]
Partial factor on undrained shear strength :	ψ_{cu} =	1.00 [–]	1.40 [–]

Interface

No.	Interface location	x [m]	z [m]	x [m]	z [m]	x [m]	z [m]
1		0.00	27.29	0.06	27.29	3.58	27.18
		3.80	27.20	4.10	27.06	8.41	26.92
		8.59	27.04	8.71	27.03	10.35	26.65
		11.86	26.58	13.90	26.52	14.05	26.55
		14.20	26.52	14.29	26.40	14.76	26.43
		17.15	26.66	18.60	26.64	19.64	26.68
		20.28	26.71	22.71	26.48	22.91	26.46
		24.63	26.48	25.72	26.22	27.16	25.88
		27.85	25.61	28.65	25.64	28.76	25.62
		30.70	24.86	31.90	24.38	32.65	24.10
		33.65	23.25	34.66	22.41	36.05	21.60
		37.30	21.23	38.73	20.76	41.06	19.96
		44.15	18.70	46.09	18.23	48.68	18.23
		55.24	18.40	65.36	18.58	65.88	18.57
		81.92	18.34				

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
2		0.00	24.19	19.58	24.30	31.90	24.38
3		0.00	20.94	38.73	20.76		
4		0.00	17.89	81.92	17.36		
5		0.00	16.44	81.92	16.30		
6		0.00	10.49	42.37	10.31	81.92	9.12
7		0.00	10.49	40.90	9.72	81.92	8.55
8		0.00	3.24	40.87	3.01	42.37	3.01
		81.92	1.76				

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
9		0.00	0.00	40.87	2.41	42.37	2.41
		81.92	1.19				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	Intact Mudstone - MMG I		42.00	25.00	23.00
2	Sandstone - Interbedded Mudstone & Sandstone		40.00	8.00	22.50
3	Class 6F Capping/Subbase/Surfacing		35.00	0.00	21.00
4	Terrace Sands & Gravels		35.00	0.00	22.00
5	Culvert		41.50	0.00	2.40
6	Granular Backfill to Culvert		41.50	0.00	18.00
7	Class 6N Selected Backfill to Structures		41.50	0.00	22.50
8	Redcued Level 65 - 64 m OD - MMG II		42.00	16.00	22.50
9	Redcued Level 64 - 63 m OD - MMG II		42.00	16.00	22.50
10	Redcued Level 63 - 62 m OD - MMG II		42.00	16.00	22.50
11	Redcued Level 62 - 61 m OD - MMG II		42.00	16.00	22.50
12	Redcued Level 61 - 60 m OD - MMG II		42.00	16.00	22.50

No.	Name	Pattern	χπef [°]	cef [kPa]	ψ [kN/m3]
13	Redcued Level 60 - 59 m OD - MMG I		42.00	25.00	23.00

Soil parameters - uplift

No.	Name	Pattern	ψsat [kN/m3]	ψs [kN/m3]	n [–]
1	Intact Mudstone - MMG I		23.00		
2	Sandstone - Interbedded Mudstone & Sandstone		23.00		
3	Class 6F Capping/Subbase/Surfacing		21.50		
4	Terrace Sands & Gravels		22.50		
5	Culvert		2.40		
6	Granular Backfill to Culvert		18.00		
7	Class 6N Selected Backfill to Structures		23.00		
8	Redcued Level 65 - 64 m OD - MMG II		22.50		
9	Redcued Level 64 - 63 m OD - MMG II		22.50		
10	Redcued Level 63 - 62 m OD - MMG II		22.50		
11	Redcued Level 62 - 61 m OD - MMG II		22.50		
12	Redcued Level 61 - 60 m OD - MMG II		22.50		

No.	Name	Pattern	ψ_{sat} [kN/m^3]	ψ_s [kN/m^3]	n [–]
13	Redcued Level 60 - 59 m OD - MMG I		23.00		

Soil parameters - total stress state

No.	Name	Pattern	c_u [kPa]	ψ [kN/m^3]
1	Topsoil/Subsoil		35.00	16.50
2	Firm to stiff red brown silty CLAY - MMG IVB		65.00	19.50
3	Stiff red brown silty CLAY - MMG IVA		90.00	20.50
4	Weathered Mudstone - MMG III		150.00	22.00
5	Weathered Mudstone - MMG II		225.00	22.50
6	Existing Highway General Fill		60.00	19.50
7	Class 2 Fill (Site Won MMG IV)		50.00	19.50
8	Landscape Fill - Class 4		50.00	20.00
9	Class 7A Selected Cohesive Fill		100.00	20.50
10	Class 7C Selected Cohesive Fill		100.00	20.50
11	Pre-existing Made Ground		50.00	19.00
12	Redcued Level 78 - 77 m OD - MMG IVB		33.00	19.50

No.	Name	Pattern	c_u [kPa]	ψ [kN/m^3]
13	Redcued Level 77 - 76 m OD - MMG IVB		67.00	19.50
14	Redcued Level 76 - 75 m OD - MMG IVB		100.00	19.50
15	Redcued Level 75 - 74 m OD - MMG IVA		133.00	20.50
16	Redcued Level 74 - 73 m OD - MMG IVA		167.00	20.50
17	Redcued Level 73 - 72 m OD - MMG IVA		200.00	20.50
18	Redcued Level 72 - 71 m OD - MMG IVA		233.00	20.50
19	Redcued Level 71 - 70 m OD - MMG III		267.00	22.00
20	Redcued Level 70 - 69 m OD - MMG III		300.00	22.00
21	Redcued Level 69 - 68 m OD - MMG III		333.00	22.00
22	Redcued Level 68 - 67 m OD - MMG III		367.00	22.00
23	Redcued Level 67 - 66 m OD - MMG III		400.00	22.00
24	Redcued Level 66 - 65 m OD - MMG III		433.00	22.00

Soil parameters

Topsoil/Subsoil

Unit weight :	ψ =	16.50 kN/m^3
Stress-state :	total	
Cohesion of soil :	c_u =	35.00 kPa

Firm to stiff red brown silty CLAY - MMG IVB

Unit weight :	ψ =	19.50 kN/m^3
Stress-state :	total	
Cohesion of soil :	c_u =	65.00 kPa

Stiff red brown silty CLAY - MMG IVA

Unit weight :	ψ =	20.50 kN/m^3
Stress-state :	total	
Cohesion of soil :	c_u =	90.00 kPa

Weathered Mudstone - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Stress-state :	total	
Cohesion of soil :	c_u =	150.00 kPa

Weathered Mudstone - MMG II

Unit weight :	ψ =	22.50 kN/m^3
Stress-state :	total	
Cohesion of soil :	c_u =	225.00 kPa

Intact Mudstone - MMG I

Unit weight :	ψ =	23.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	42.00 °
Cohesion of soil :	c_{ef} =	25.00 kPa
Saturated unit weight :	ψ_{sat} =	23.00 kN/m^3

Sandstone - Interbedded Mudstone & Sandstone

Unit weight :	ψ =	22.50 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	40.00 °
Cohesion of soil :	c_{ef} =	8.00 kPa
Saturated unit weight :	ψ_{sat} =	23.00 kN/m^3

Existing Highway General Fill

Unit weight :	ψ =	19.50 kN/m^3
Stress-state :	total	
Cohesion of soil :	c_u =	60.00 kPa

Class 2 Fill (Site Won MMG IV)

Unit weight :	ψ =	19.50 kN/m^3
Stress-state :	total	
Cohesion of soil :	c_u =	50.00 kPa

Class 6F Capping/Subbase/Surfacing

Unit weight :	ψ =	21.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	35.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Saturated unit weight :	ψ_{sat} =	21.50 kN/m^3

Landscape Fill - Class 4

Unit weight :	ψ =	20.00 kN/m^3
Stress-state :	total	
Cohesion of soil :	c_u =	50.00 kPa

Terrace Sands & Gravels

Unit weight :	ψ =	22.00 kN/m^3
Stress-state :	effective	

Angle of internal friction : $\chi\pi_{ef}$ = 35.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : ψ_{sat} = 22.50 kN/m3

Class 7A Selected Cohesive Fill
Unit weight : ψ = 20.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 100.00 kPa

Class 7C Selected Cohesive Fill
Unit weight : ψ = 20.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 100.00 kPa

Pre-existing Made Ground
Unit weight : ψ = 19.00 kN/m3
Stress-state : total
Cohesion of soil : c_u = 50.00 kPa

Culvert
Unit weight : ψ = 2.40 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : ψ_{sat} = 2.40 kN/m3

Granular Backfill to Culvert
Unit weight : ψ = 18.00 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : ψ_{sat} = 18.00 kN/m3

Class 6N Selected Backfill to Structures
Unit weight : ψ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : ψ_{sat} = 23.00 kN/m3

Redcued Level 78 - 77 m OD - MMG IVB
Unit weight : ψ = 19.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 33.00 kPa

Redcued Level 77 - 76 m OD - MMG IVB
Unit weight : ψ = 19.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 67.00 kPa

Redcued Level 76 - 75 m OD - MMG IVB
Unit weight : ψ = 19.50 kN/m3
Stress-state : total
Cohesion of soil : c_u = 100.00 kPa

Redcued Level 75 - 74 m OD - MMG IVA

Unit weight :	ψ = 20.50 kN/m^3
Stress-state :	total
Cohesion of soil :	c_u = 133.00 kPa

Redcued Level 74 - 73 m OD - MMG IVA

Unit weight :	ψ = 20.50 kN/m^3
Stress-state :	total
Cohesion of soil :	c_u = 167.00 kPa

Redcued Level 73 - 72 m OD - MMG IVA

Unit weight :	ψ = 20.50 kN/m^3
Stress-state :	total
Cohesion of soil :	c_u = 200.00 kPa

Redcued Level 72 - 71 m OD - MMG IVA

Unit weight :	ψ = 20.50 kN/m^3
Stress-state :	total
Cohesion of soil :	c_u = 233.00 kPa

Redcued Level 71 - 70 m OD - MMG III

Unit weight :	ψ = 22.00 kN/m^3
Stress-state :	total
Cohesion of soil :	c_u = 267.00 kPa

Redcued Level 70 - 69 m OD - MMG III

Unit weight :	ψ = 22.00 kN/m^3
Stress-state :	total
Cohesion of soil :	c_u = 300.00 kPa

Redcued Level 69 - 68 m OD - MMG III

Unit weight :	ψ = 22.00 kN/m^3
Stress-state :	total
Cohesion of soil :	c_u = 333.00 kPa

Redcued Level 68 - 67 m OD - MMG III

Unit weight :	ψ = 22.00 kN/m^3
Stress-state :	total
Cohesion of soil :	c_u = 367.00 kPa

Redcued Level 67 - 66 m OD - MMG III

Unit weight :	ψ = 22.00 kN/m^3
Stress-state :	total
Cohesion of soil :	c_u = 400.00 kPa

Redcued Level 66 - 65 m OD - MMG III

Unit weight :	ψ = 22.00 kN/m^3
Stress-state :	total
Cohesion of soil :	c_u = 433.00 kPa

Redcued Level 65 - 64 m OD - MMG II

Unit weight :	ψ = 22.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 42.00 °
Cohesion of soil :	c_{ef} = 16.00 kPa
Saturated unit weight :	ψ_{sat} = 22.50 kN/m^3

Redcued Level 64 - 63 m OD - MMG II

Unit weight :	ψ =	22.50 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Saturated unit weight :	ψ_{sat} =	22.50 kN/m^3

Redcued Level 63 - 62 m OD - MMG II

Unit weight :	ψ =	22.50 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Saturated unit weight :	ψ_{sat} =	22.50 kN/m^3

Redcued Level 62 - 61 m OD - MMG II

Unit weight :	ψ =	22.50 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Saturated unit weight :	ψ_{sat} =	22.50 kN/m^3

Redcued Level 61 - 60 m OD - MMG II

Unit weight :	ψ =	22.50 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Saturated unit weight :	ψ_{sat} =	22.50 kN/m^3

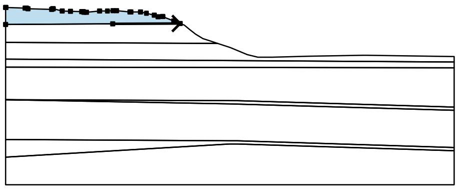
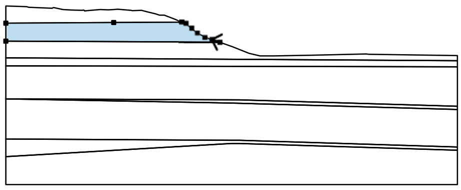
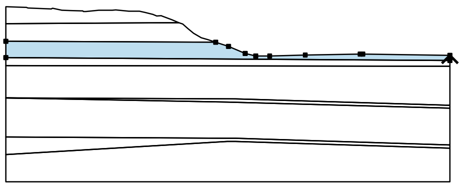
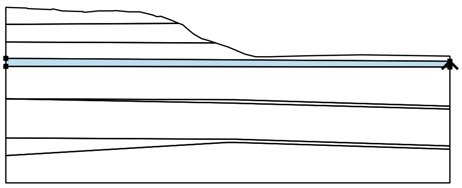
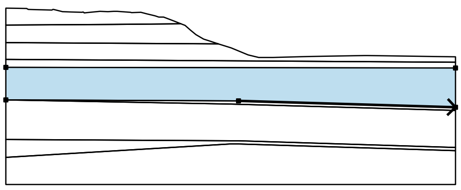
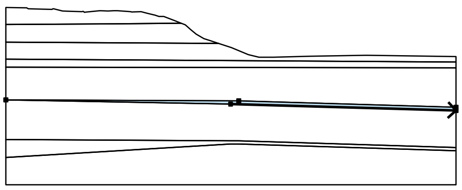
Redcued Level 60 - 59 m OD - MMG I

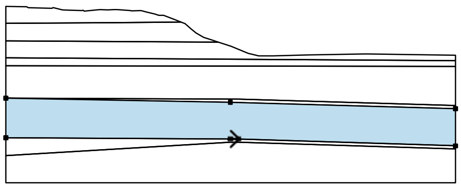
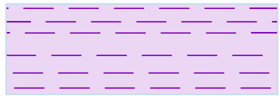
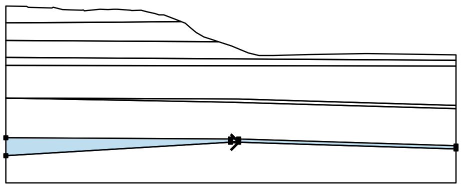
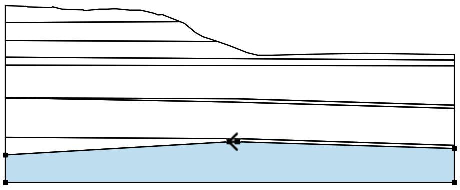
Unit weight :	ψ =	23.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	42.00 °
Cohesion of soil :	c_{ef} =	25.00 kPa
Saturated unit weight :	ψ_{sat} =	23.00 kN/m^3

Rigid bodies

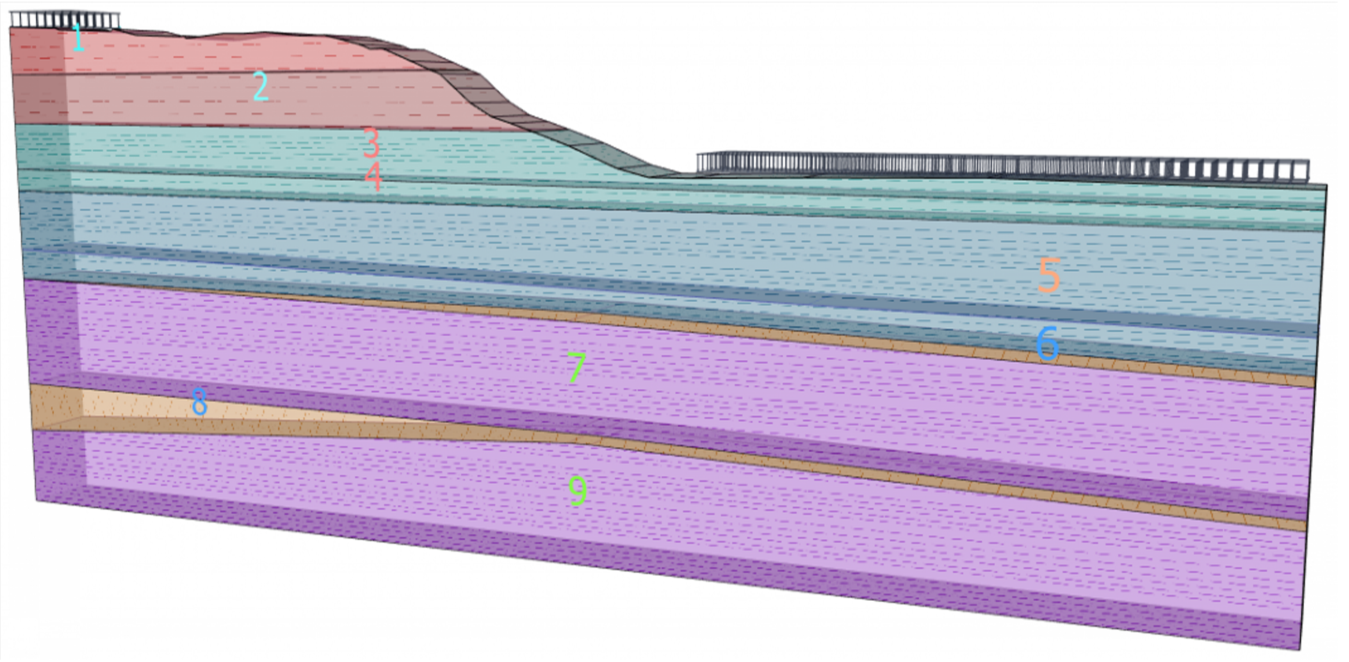
No.	Name	Sample	ψ [kN/m^3]
1	CONCRETE FOOTING		24.00
2	WING WALL		24.00
3	BRIDGE ABUTMENT		24.00

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
1		19.58	24.30	31.90	24.38	Firm to stiff red brown silty CLAY - MMG IVB
		30.70	24.86	28.76	25.62	
		28.65	25.64	27.85	25.61	
		27.16	25.88	25.72	26.22	
		24.63	26.48	22.91	26.46	
		22.71	26.48	20.28	26.71	
		19.64	26.68	18.60	26.64	
		17.15	26.66	14.76	26.43	
		14.29	26.40	14.20	26.52	
		14.05	26.55	13.90	26.52	
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		38.73	20.76	37.30	21.23	Stiff red brown silty CLAY - MMG IVA
		36.05	21.60	34.66	22.41	
		33.65	23.25	32.65	24.10	
		31.90	24.38	19.58	24.30	
		0.00	24.19	0.00	20.94	
3		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	44.15	18.70	
		41.06	19.96	38.73	20.76	
		0.00	20.94	0.00	17.89	
4		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		0.00	17.89	0.00	16.44	
5		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
6		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
7		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
8		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
9		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment — Stage : 1



Surcharge

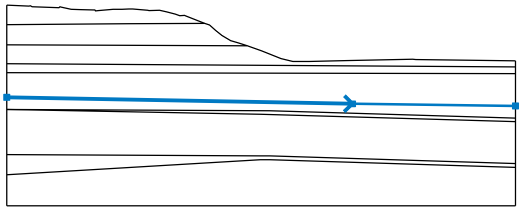
No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q_1, f, F	q_2	unit
1	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m2
2	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

Slip surface parameters								
Center :	x =	36.82	[m]	Angles :	α_1 =	-57.88	[°]
	z =	38.31	[m]		α_2 =	24.20	[°]
Radius :	R =	21.94	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1

Sum of active forces : F_a = 1004.21 kN/m
Sum of passive forces : F_p = 4076.13 kN/m

Sliding moment : M_a = 20556.08 kNm/m
Resisting moment : M_p = 83438.43 kNm/m
Utilization : 24.6 %

Slope stability ACCEPTABLE

Combination 2

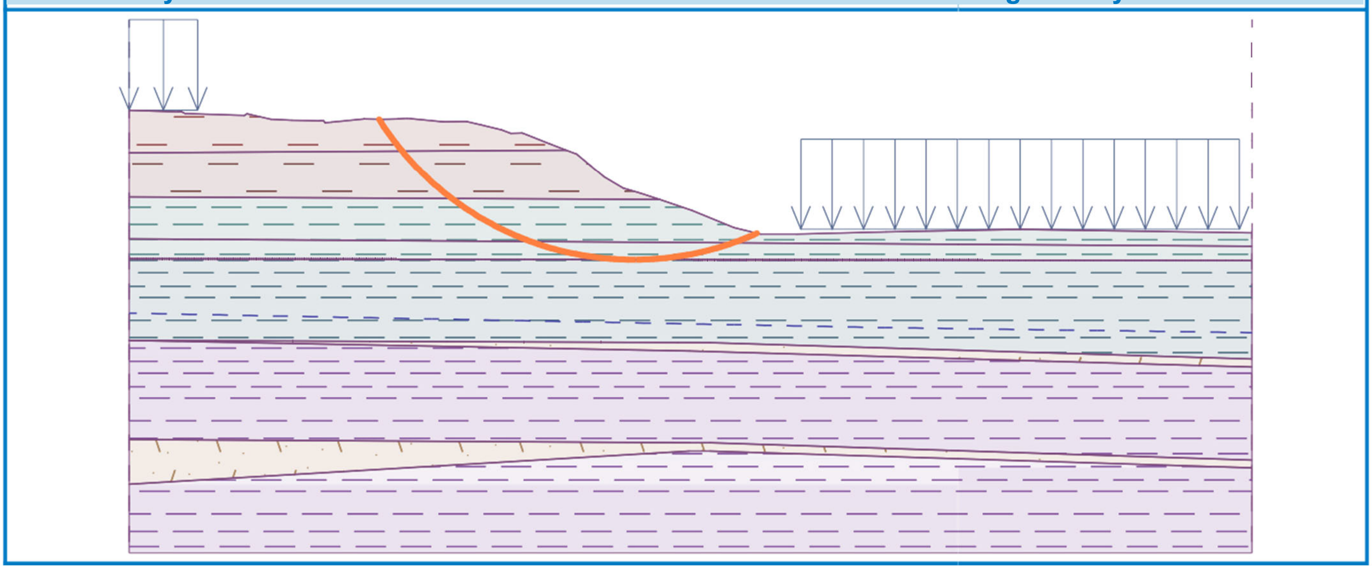
Sum of active forces : F_a = 735.47 kN/m
Sum of passive forces : F_p = 2969.75 kN/m

Sliding moment : M_a = 16136.29 kNm/m
Resisting moment : M_p = 65156.35 kNm/m
Utilization : 24.8 %

Slope stability ACCEPTABLE

Optimized slip surface for : Combination 2

Name : Analysis **Stage - analysis : 1 - 1**



Analysis 2 (stage 1)

Polygonal slip surface

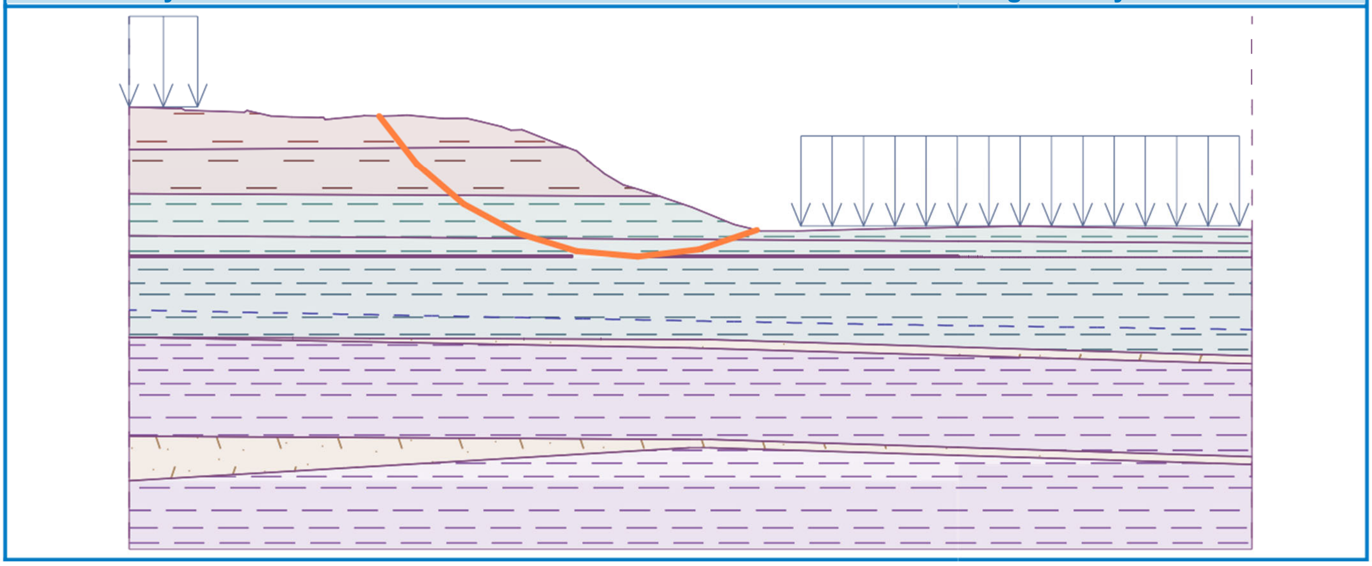
Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
18.24	26.64	21.00	23.11	24.41	20.21	28.35	18.07	32.64	16.77
37.11	16.37	41.56	16.89	45.81	18.30				
The slip surface after optimization.									

Slope stability verification (Sarma)
Combination 1
Utilization : 23.6 %

Slope stability ACCEPTABLE
Combination 2
Utilization : 23.8 %

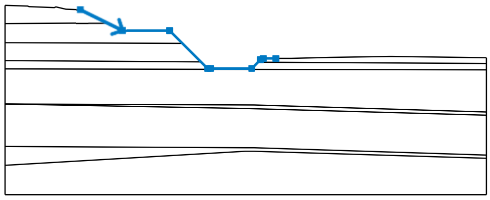
Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

Name : Analysis **Stage - analysis : 1 - 2**

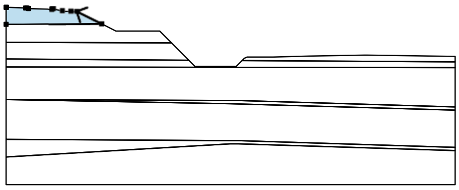
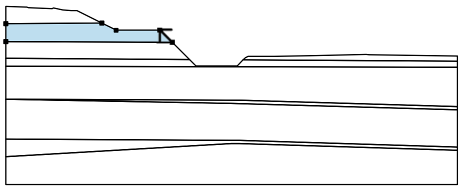
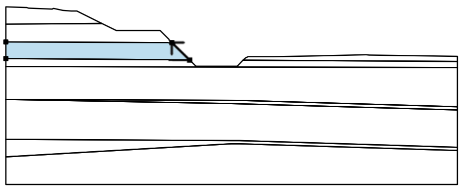
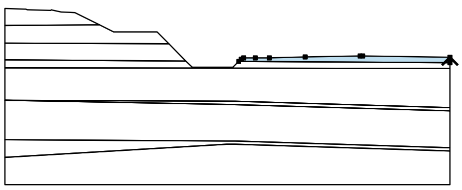
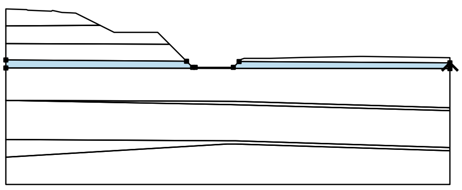
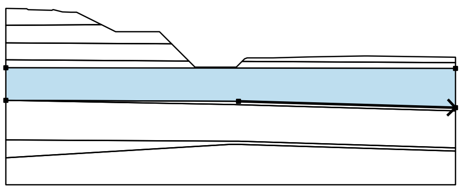


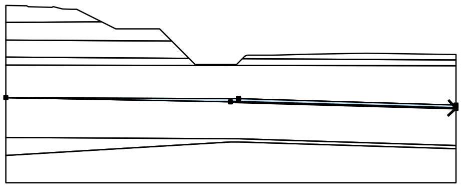
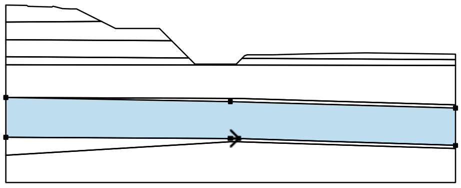
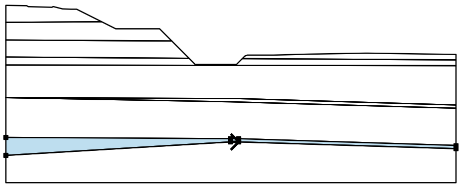
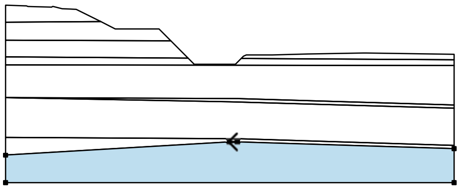
Input data (Stage of construction 2)

Earth cut

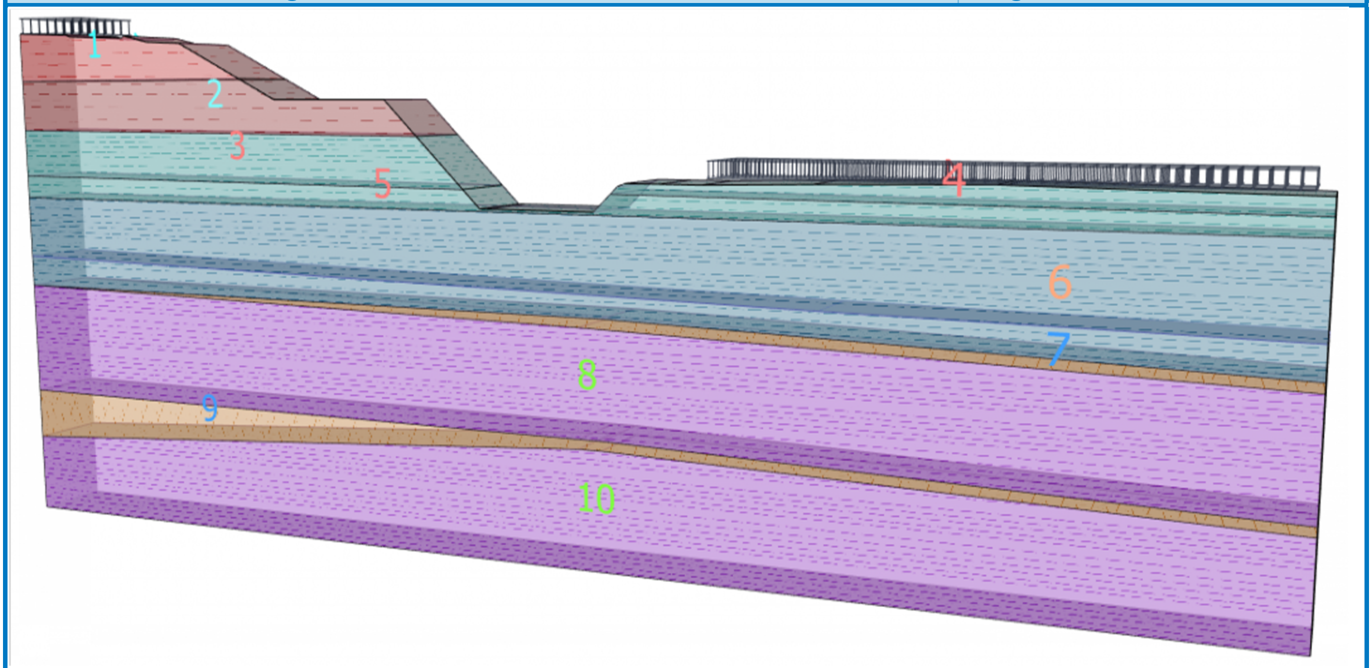
No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		12.89	26.55	20.01	22.99	28.01	22.99
		34.47	16.53	34.97	16.53	41.97	16.53
		43.47	18.03	43.97	18.23	46.09	18.23

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		30.20	20.80	28.01	22.99	Stiff red brown silty CLAY - MMG IVA
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		33.33	17.67	30.20	20.80	Weathered Mudstone - MMG III
		0.00	20.94	0.00	17.89	
4		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.47	18.03	43.05	17.61	
5		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.05	17.61	41.97	16.53	
		34.97	16.53	34.47	16.53	
		33.33	17.67	0.00	17.89	
		0.00	16.44			
6		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
7		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
8		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
9		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
10		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment **Stage : 2**



Surcharge

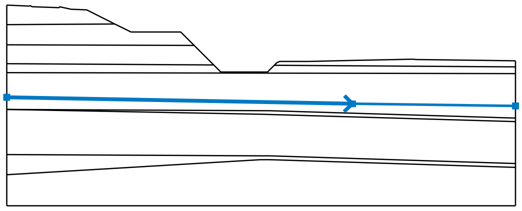
No.	Surcharge new	Surcharge change	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q_1, f, F	Magnitude q_2	Magnitude unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

No.	GWT location	x	z	x	z	x	z
		Coordinates of GWT points [m]					
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 2)

Analysis 1 (stage 2)

Polygonal slip surface

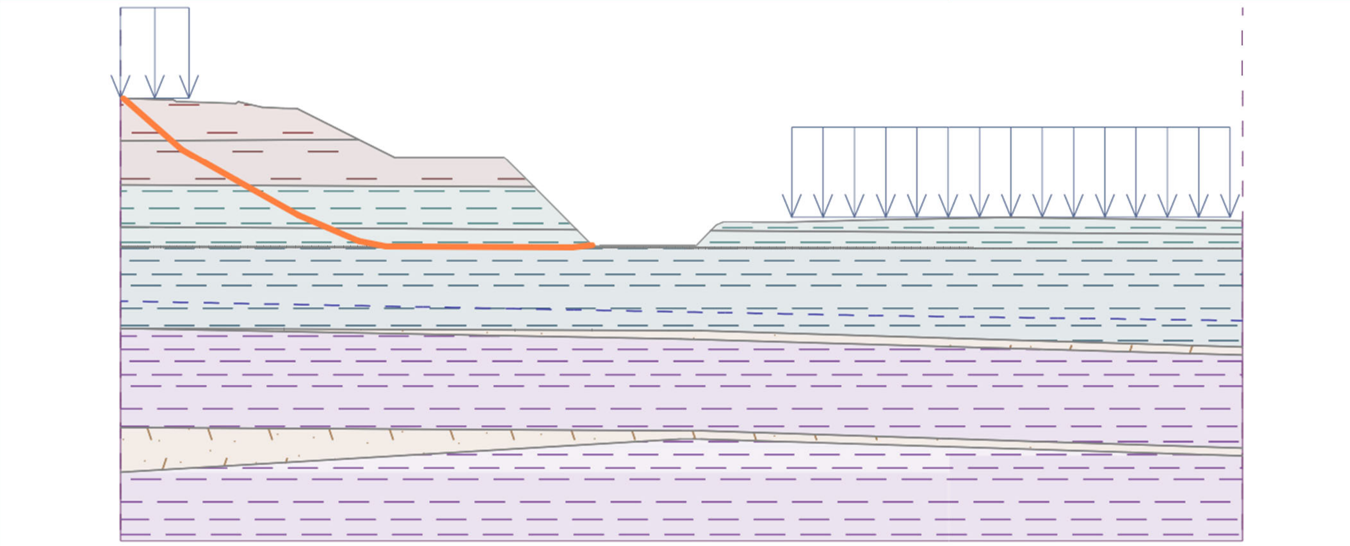
x	z	x	z	x	z	x	z	x	z
Coordinates of slip surface points [m]									
0.21	27.29	4.48	23.54	8.47	21.28	13.01	18.74	17.39	16.85
19.39	16.46	33.00	16.40	34.45	16.55				
The slip surface after optimization.									

Slope stability verification (Sarma)
Combination 1
Utilization : 27.8 %

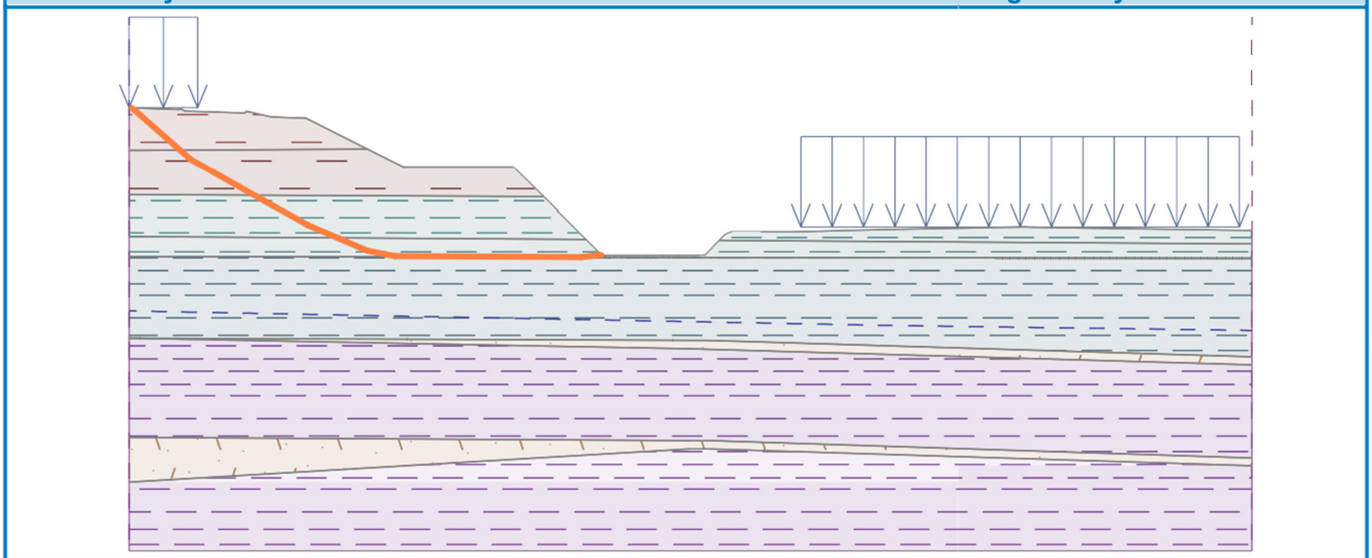
Slope stability ACCEPTABLE
Combination 2
Utilization : 27.9 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

Name : Analysis **Stage - analysis : 2 - 1**

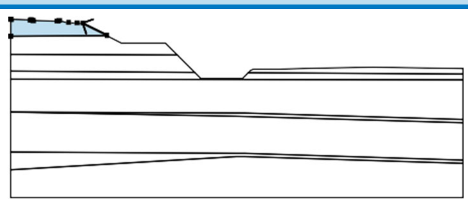


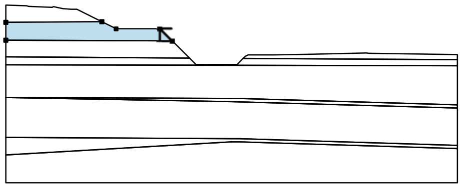
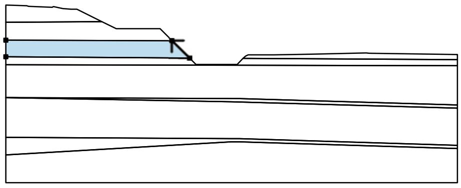
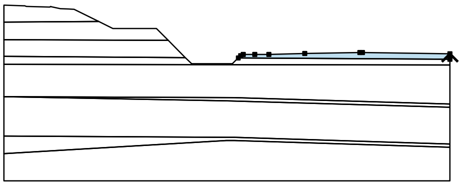
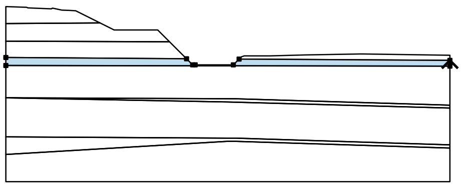
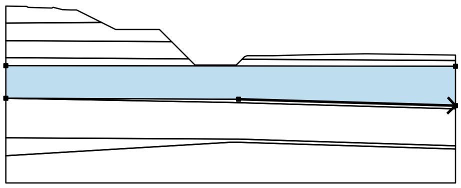
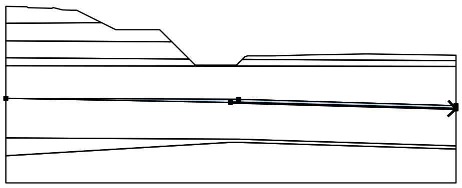
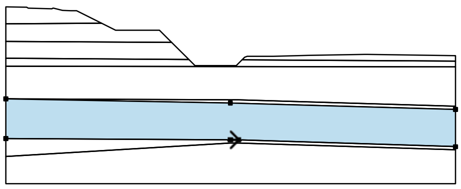
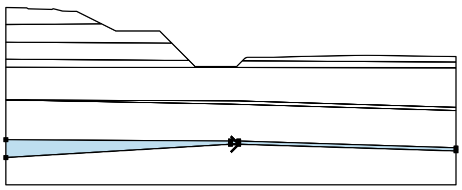
Name : Analysis **Stage - analysis : 2 - 1**

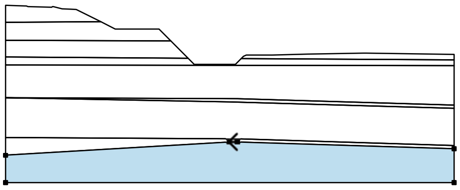


Input data (Stage of construction 3)

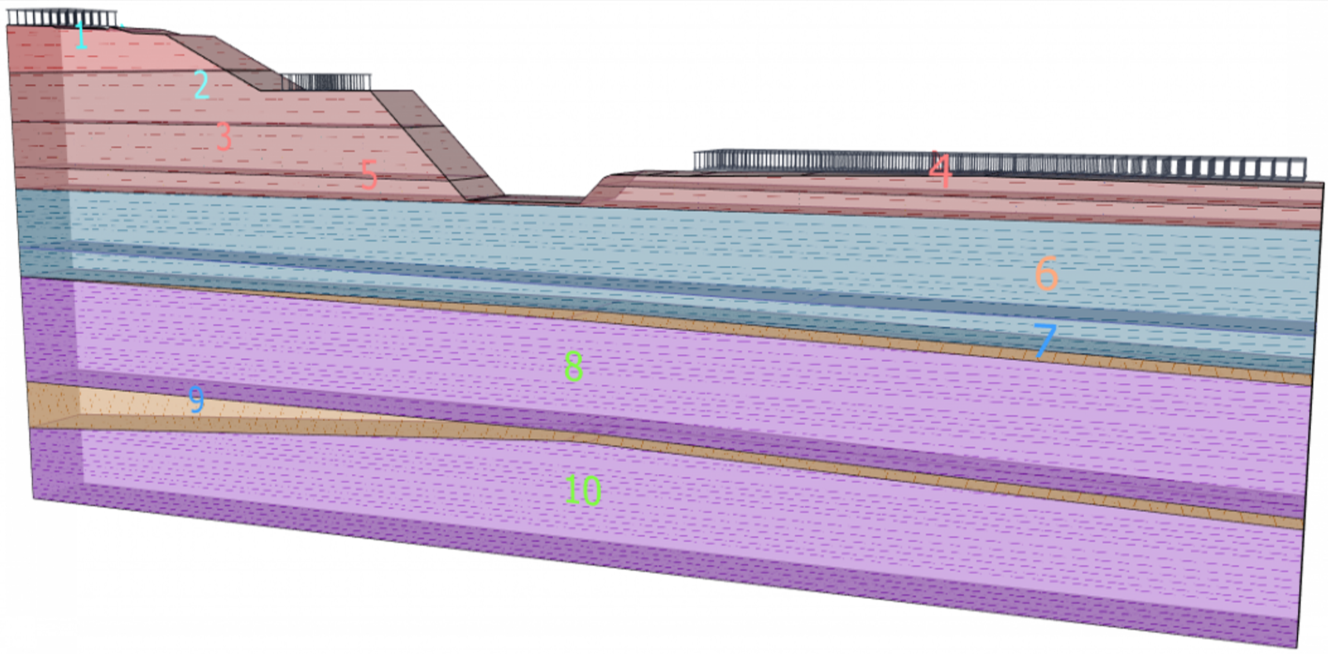
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
2		30.20	20.80	28.01	22.99	Stiff red brown silty CLAY - MMG IVA
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		33.33	17.67	30.20	20.80	Weathered Mudstone - MMG III
		0.00	20.94	0.00	17.89	
4		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.47	18.03	43.05	17.61	
5		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.05	17.61	41.97	16.53	
		34.97	16.53	34.47	16.53	
		33.33	17.67	0.00	17.89	
		0.00	16.44			
6		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
7		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
8		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
9		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
10		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment **Stage : 3**



Surcharge

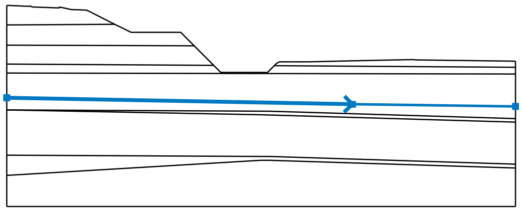
No.	Surcharge new	Surcharge change	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q1, f, F	Magnitude q2	Magnitude unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m2
3	No	No	strip	permanent	on terrain	x = 21.50	l = 3.50		0.00	20.00		kN/m2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic
3	TEMPORARY - SITE PLANT 20 kN/m2

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 3)

Analysis 1 (stage 3)

Circular slip surface

Slip surface parameters								
Center :	x =	32.60	[m]	Angles :	α_1 =	-64.30	[°]
	z =	28.05	[m]		α_2 =	9.22	[°]
Radius :	R =	11.67	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Combination 1

Sum of active forces : F_a = 2479.53 kN/m

Sum of passive forces : F_p = 9572.73 kN/m

Sliding moment : M_a = 63525.49 kNm/m

Resisting moment : M_p = 245253.45 kNm/m

Utilization : 25.9 %

Slope stability ACCEPTABLE

Combination 2

Sum of active forces : F_a = 389.59 kN/m

Sum of passive forces : F_p = 1494.92 kN/m

Sliding moment : M_a = 4546.49 kNm/m

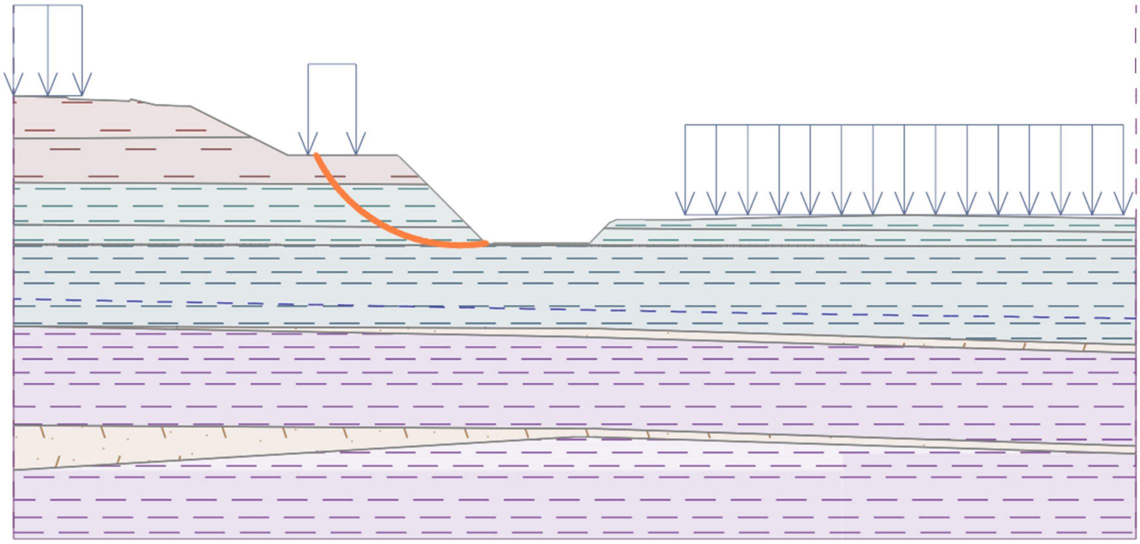
Resisting moment : M_p = 17445.70 kNm/m

Utilization : 26.1 %

Slope stability ACCEPTABLE

Optimized slip surface for : Combination 2

Name : Analysis **Stage - analysis : 3 - 1**



Analysis 2 (stage 3)

Polygonal slip surface

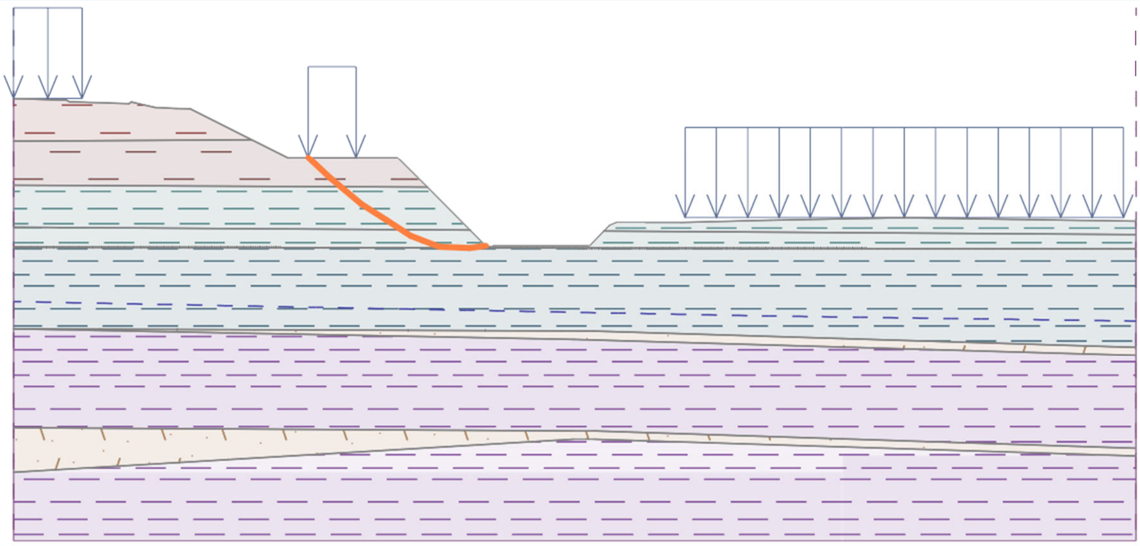
Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
21.51	22.99	23.07	21.52	25.39	19.56	27.19	18.43	28.98	17.25
31.06	16.46	33.31	16.38	34.47	16.53				
The slip surface after optimization.									

Slope stability verification (Sarma)
Combination 1
Utilization : 22.4 %

Slope stability ACCEPTABLE
Combination 2
Utilization : 23.2 %

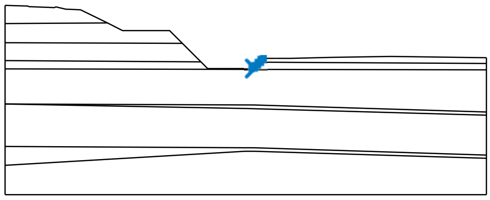
Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

Name : Analysis **Stage - analysis : 3 - 2**

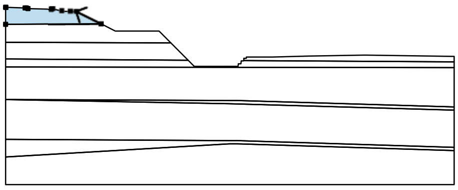
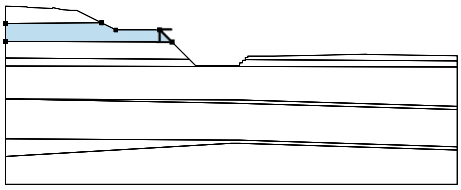
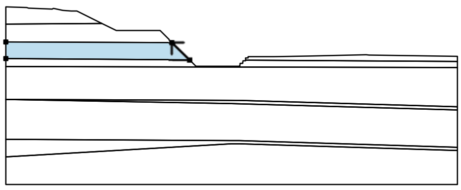
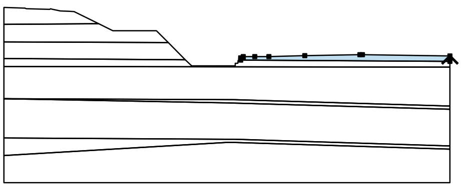
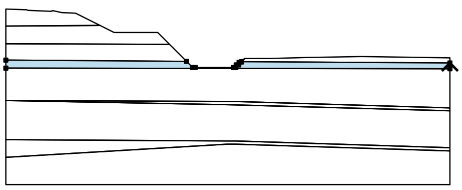
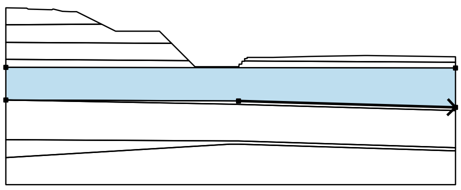


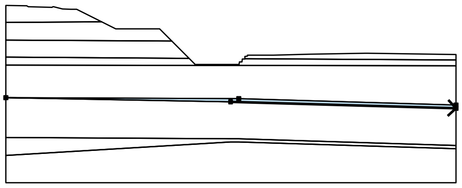
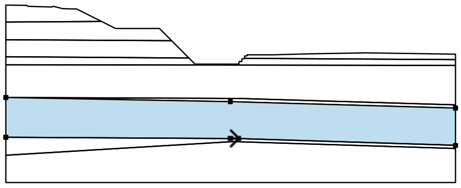
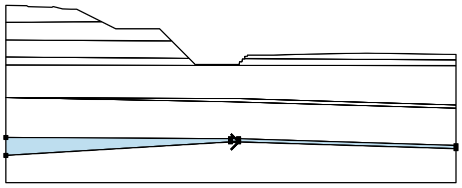
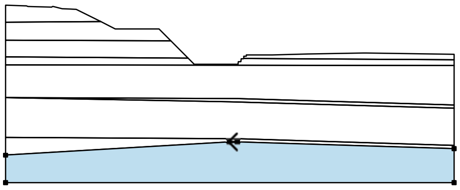
Input data (Stage of construction 4)

Earth cut

No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		41.97	16.53	42.47	16.53	42.51	17.03
		42.97	17.03	43.01	17.53	43.47	17.53
		43.51	18.02	43.97	18.03	43.97	18.23

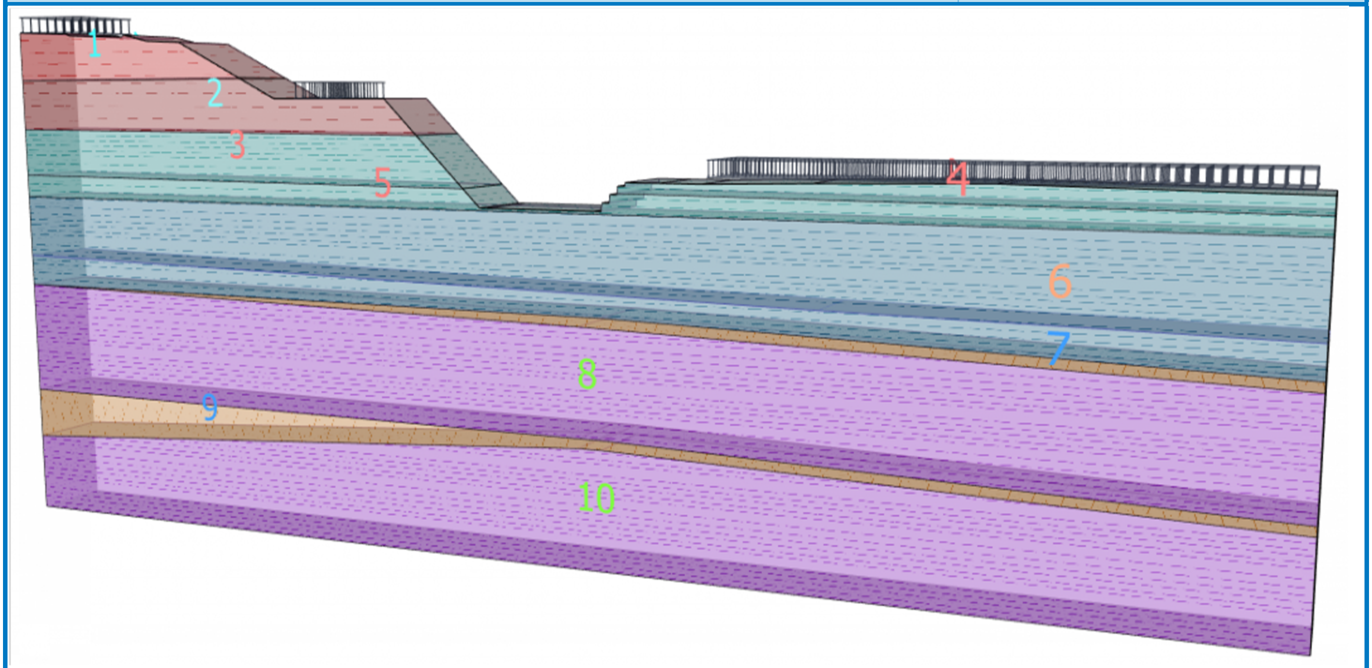
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		30.20	20.80	28.01	22.99	Stiff red brown silty CLAY - MMG IVA
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		33.33	17.67	30.20	20.80	Weathered Mudstone - MMG III
		0.00	20.94	0.00	17.89	
4		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
5		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.33	17.67	
		0.00	17.89	0.00	16.44	
6		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
7		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
8		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
9		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
10		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment

Stage : 4



Surcharge

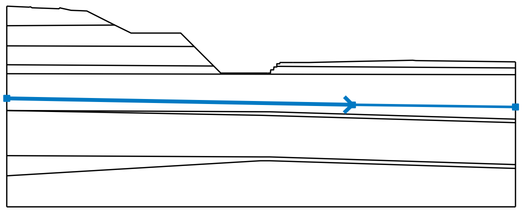
No.	Surcharge new	Surcharge change	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q1, f, F	Magnitude q2	Magnitude unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m2
3	No	No	strip	permanent	on terrain	x = 21.50	l = 3.50		0.00	20.00		kN/m2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic
3	TEMPORARY - SITE PLANT 20 kN/m2

Water

Water type : GWT

No.	GWT location	x	z	x	z	x	z
		Coordinates of GWT points [m]					
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 4)

Analysis 1 (stage 4)

Circular slip surface

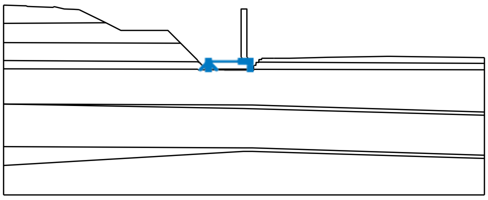
Slip surface is not specified

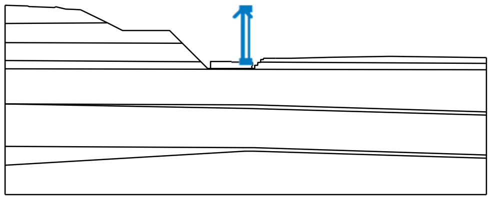
Slope stability verification (Bishop)

Analysis has not been performed.

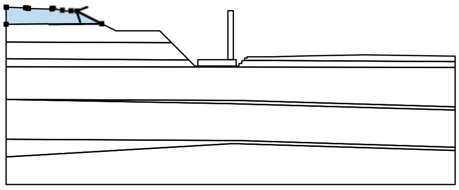
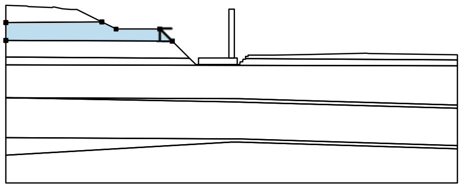
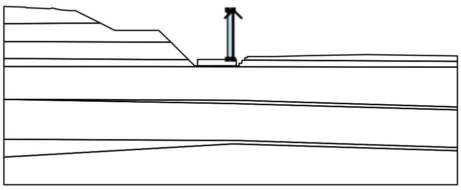
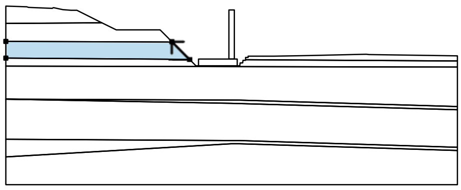
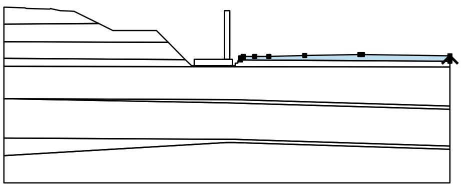
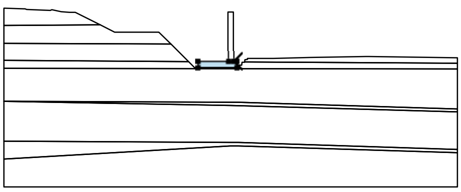
Input data (Stage of construction 5)

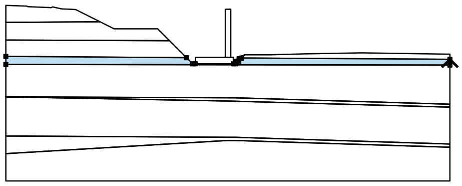
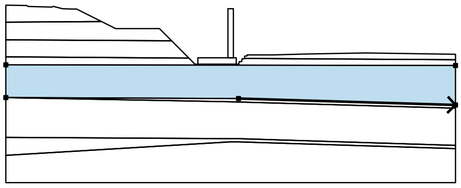
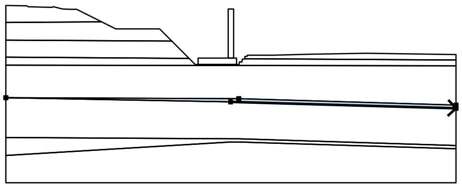
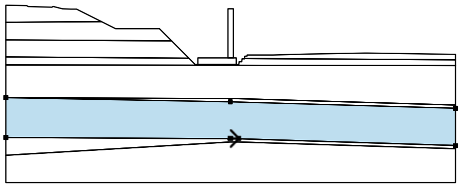
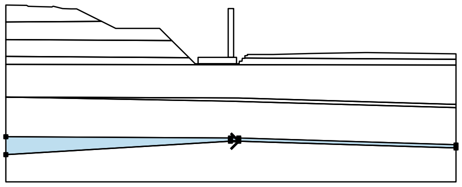
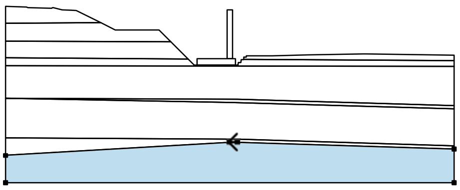
Embankment interface

No.	Interface location	x	z	x	z	x	z
		Coordinates of interface points [m]					
1		34.97	16.53	34.97	17.73	40.47	17.73
		41.47	17.73	41.97	17.73	41.97	16.53

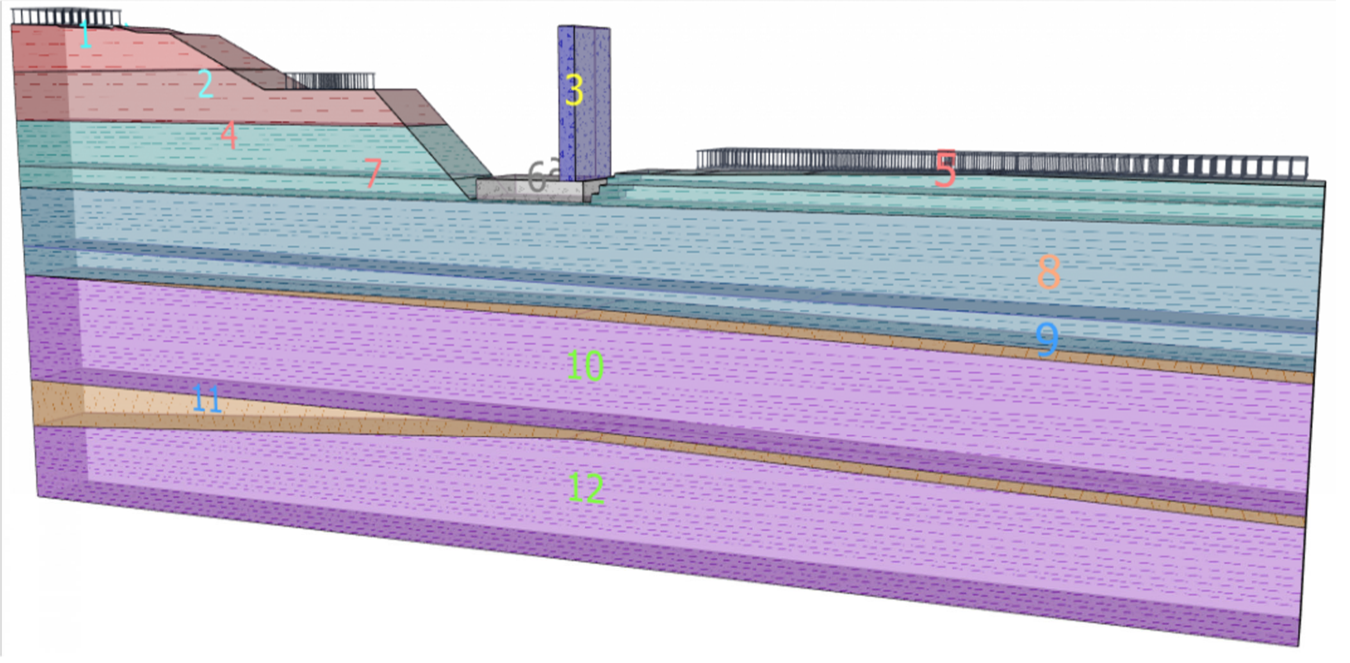
No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
2		40.47	17.73	40.47	26.63	41.47	26.63
		41.47	17.73				

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		30.20	20.80	28.01	22.99	Stiff red brown silty CLAY - MMG IVA
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		41.47	17.73	41.47	26.63	BRIDGE ABUTMENT
		40.47	26.63	40.47	17.73	
4		33.33	17.67	30.20	20.80	Weathered Mudstone - MMG III
		0.00	20.94	0.00	17.89	
5		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
6		41.97	17.73	41.47	17.73	CONCRETE FOOTING
		40.47	17.73	34.97	17.73	
		34.97	16.53	41.97	16.53	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
7		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.33	17.67	
		0.00	17.89	0.00	16.44	
8		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
9		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
10		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
11		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
12		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment **Stage : 5**



Surcharge

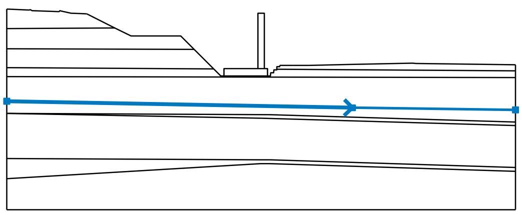
No.	Surcharge new	Surcharge change	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q1, f, F	Magnitude q2	Magnitude unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m2
3	No	No	strip	permanent	on terrain	x = 21.50	l = 3.50		0.00	20.00		kN/m2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic
3	TEMPORARY - SITE PLANT 20 kN/m2

Water

Water type : GWT

No.	GWT location	x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

(Coordinates of GWT points [m])

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 5)

Analysis 1 (stage 5)

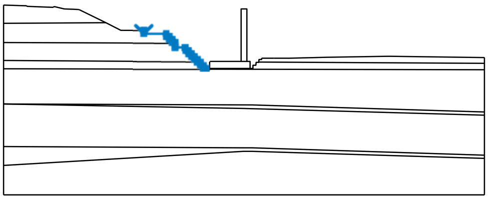
Circular slip surface

Slip surface is not specified

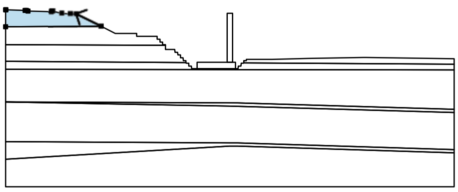
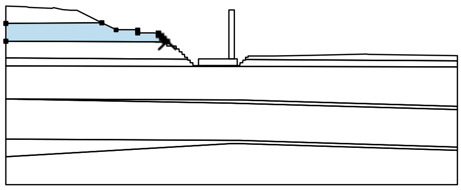
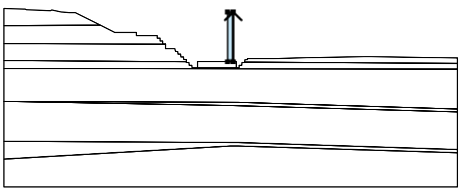
Slope stability verification (Bishop)
Analysis has not been performed.

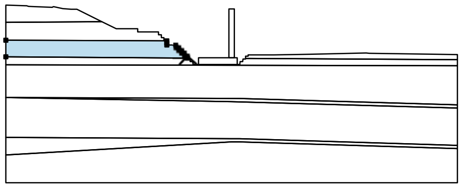
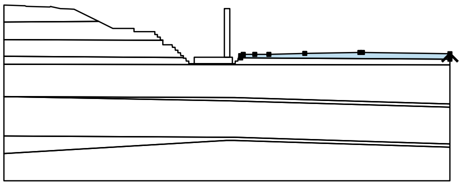
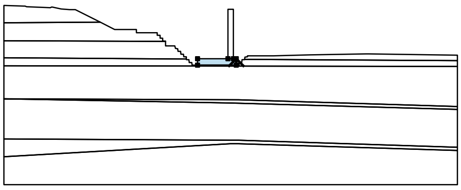
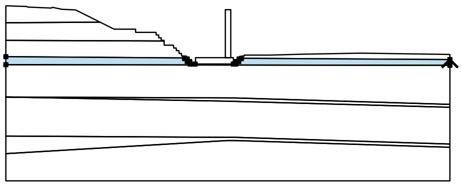
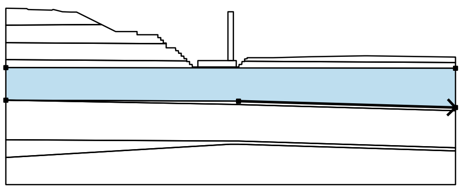
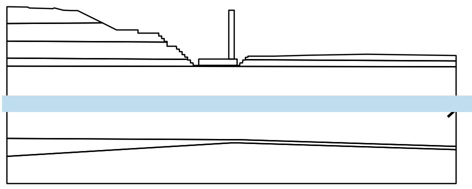
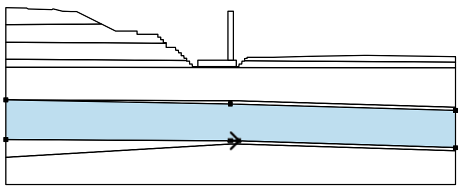
Input data (Stage of construction 6)

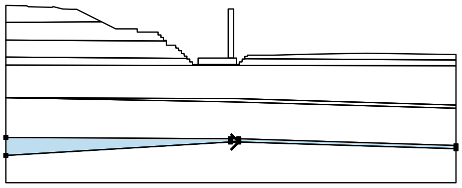
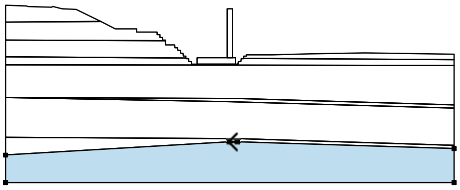
Earth cut

No.	Cut location	Coordinates of cut points [m] x	z	x	z	x	z
1		23.92	22.99	23.92	22.41	27.70	22.41
		27.70	21.91	28.20	21.91	28.20	21.41
		28.70	21.41	28.70	20.91	29.20	20.91
		29.20	20.41	29.20	20.03	30.90	20.03
		30.97	19.53	31.42	19.52	31.47	19.03
		31.93	19.03	31.97	18.53	32.42	18.53
		32.47	18.03	32.94	18.03	32.97	17.53
		33.44	17.53	33.47	17.03	33.93	17.03
		33.97	16.53	34.47	16.53		

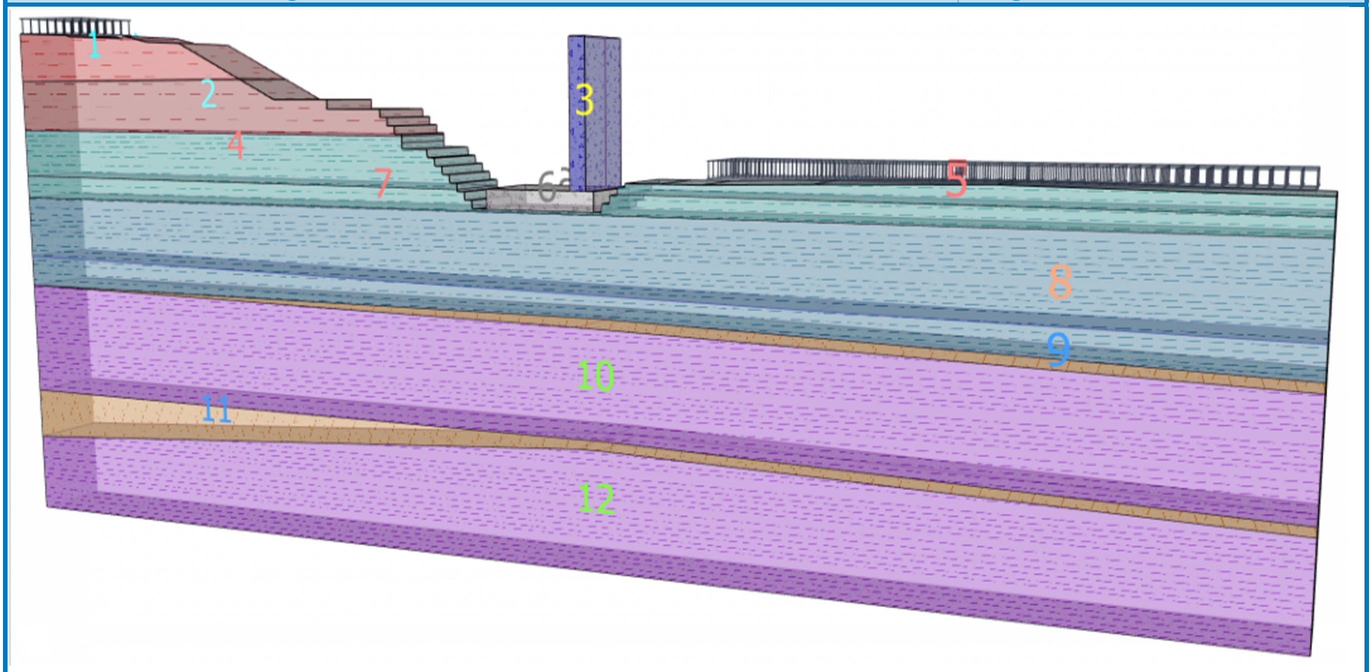
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		41.47	17.73	41.47	26.63	BRIDGE ABUTMENT
		40.47	26.63	40.47	17.73	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
4		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
5		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
6		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
7		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
8		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
9		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
10		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
11		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone 
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
12		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I 
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment — Stage : 6



Surcharge

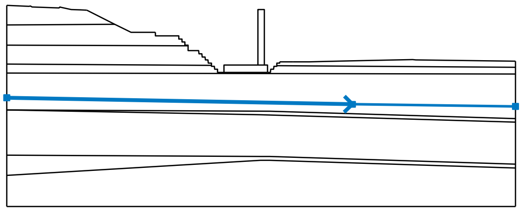
No.	Surcharge new	Surcharge change	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q1, f, F	Magnitude q2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 6)

Analysis 1 (stage 6)

Circular slip surface

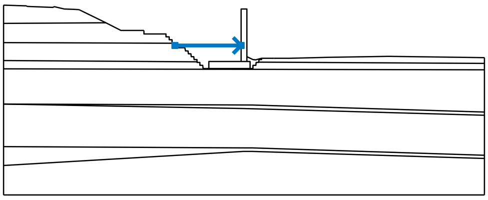
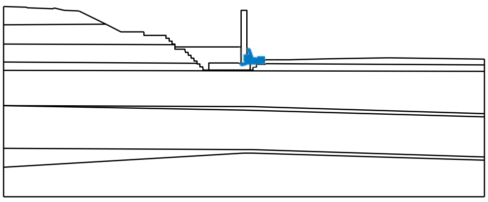
Slip surface is not specified

Slope stability verification (Bishop)

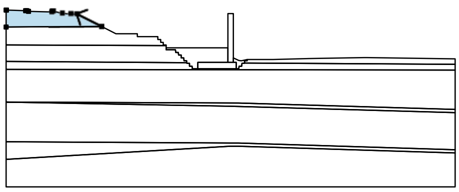
Analysis has not been performed.

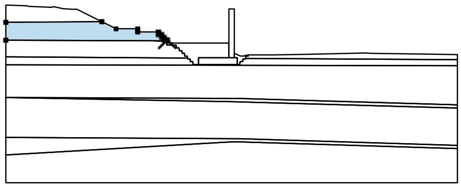
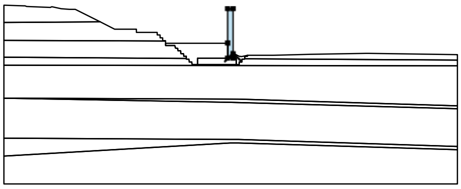
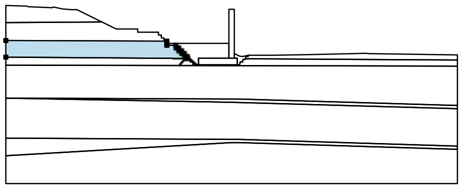
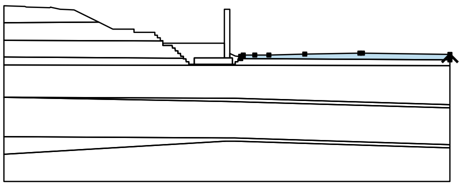
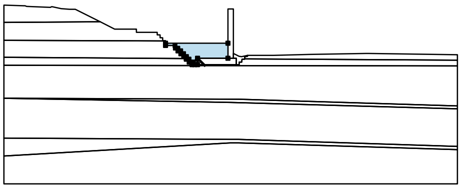
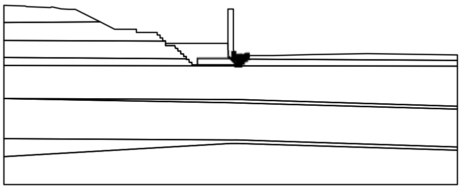
Input data (Stage of construction 7)

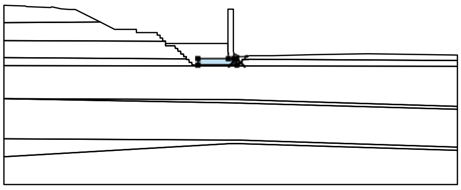
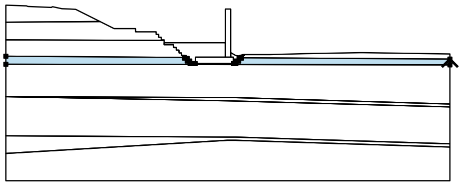
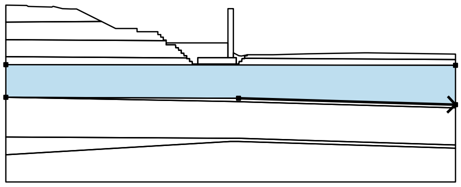
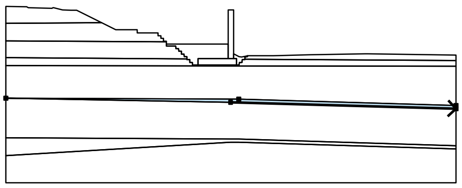
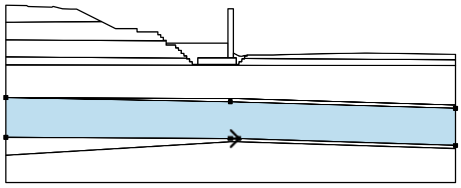
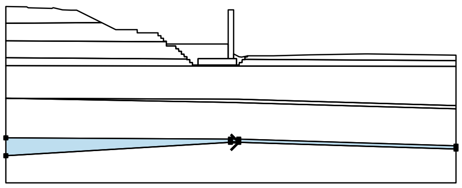
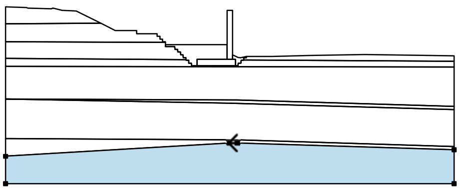
Embankment interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		29.20	20.41	40.47	20.41		
2		41.47	18.55	42.47	18.06	42.93	18.00
		43.76	18.19	43.97	18.23		

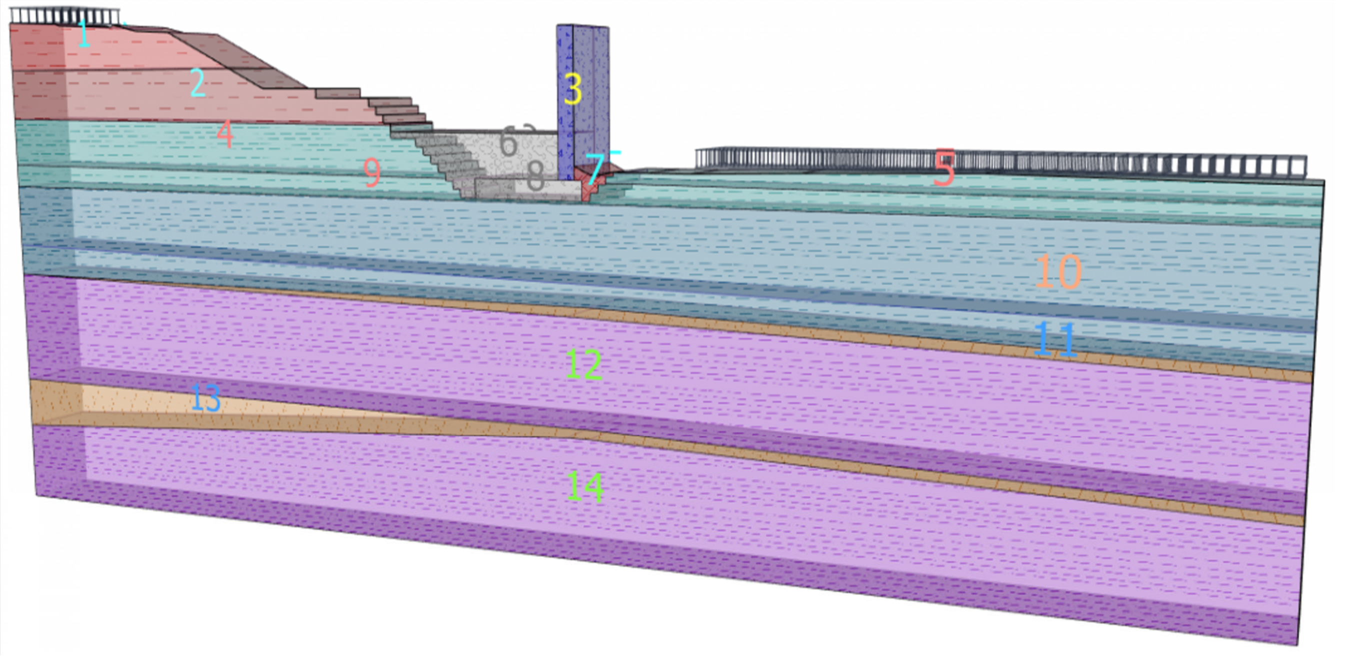
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
2		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	20.41	40.47	17.73	
4		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
5		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
6		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	
7		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
8		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
9		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
10		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
11		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
12		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
13		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
14		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment **Stage : 7**



Surcharge

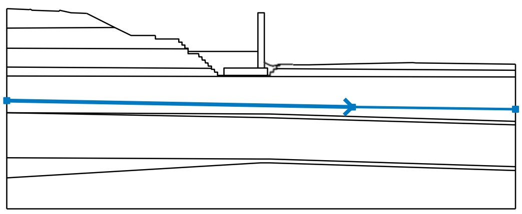
No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 7)

Analysis 1 (stage 7)

Circular slip surface

Slip surface parameters							
Center :	x =	20.43	[m]	Angles :	α_1 =	-56.60	[°]
	z =	40.60	[m]		α_2 =	33.42	[°]
Radius :	R =	24.19	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1

Sum of active forces : F_a = 1131.82 kN/m
Sum of passive forces : F_p = 4699.25 kN/m
Sliding moment : M_a = 27378.77 kNm/m
Resisting moment : M_p = 113674.84 kNm/m
Utilization : 24.1 %

Slope stability ACCEPTABLE

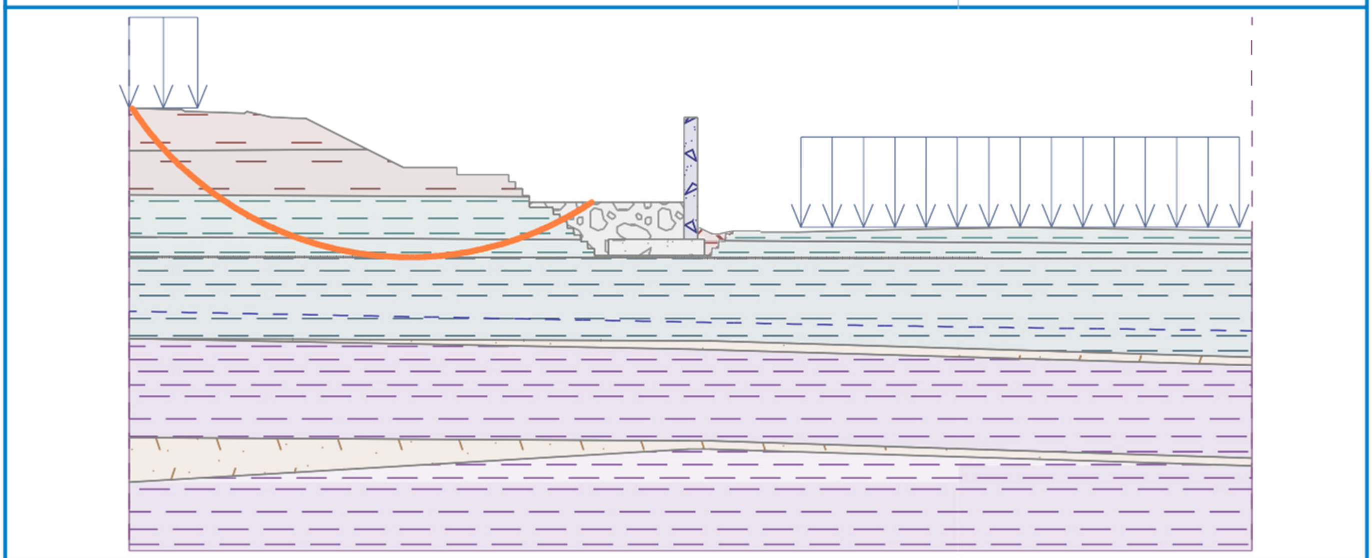
Combination 2

Sum of active forces : F_a = 795.73 kN/m
Sum of passive forces : F_p = 3397.06 kN/m
Sliding moment : M_a = 20880.01 kNm/m
Resisting moment : M_p = 89138.79 kNm/m
Utilization : 23.4 %

Slope stability ACCEPTABLE

Optimized slip surface for : Combination 1

Name : Analysis | Stage - analysis : 7 - 1



Analysis 2 (stage 7)

Polygonal slip surface

x	z	x	z	x	z	x	z	x	z
0.23	27.28	4.40	23.12	8.17	20.79	13.65	17.62	17.06	16.51
24.25	16.94	29.34	17.95	34.23	20.41				

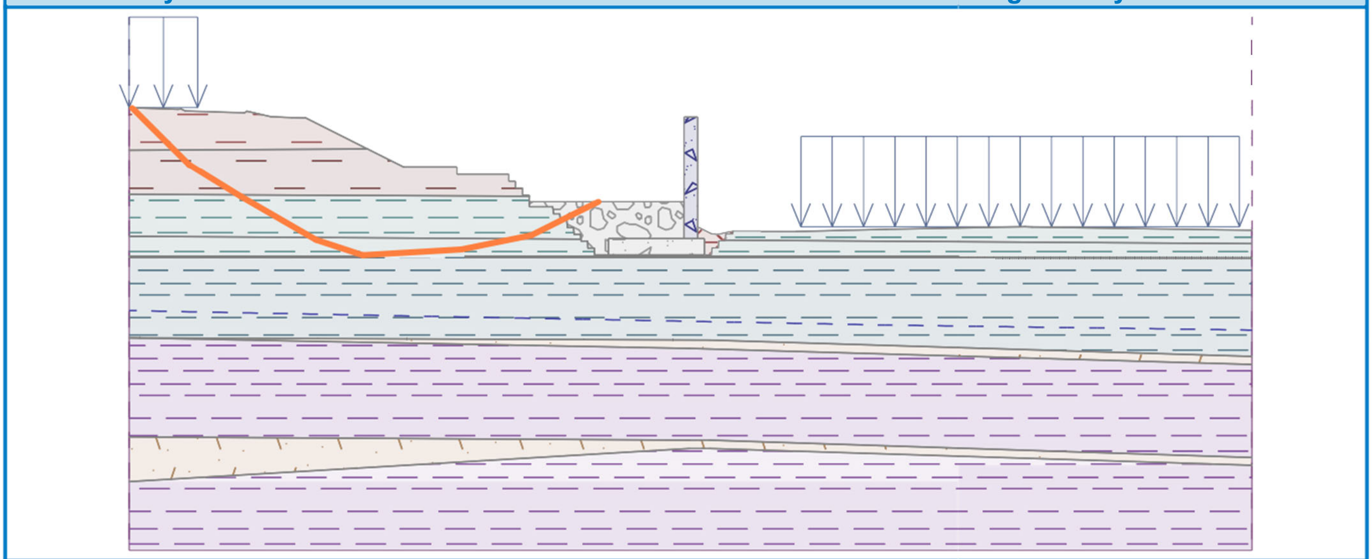
Coordinates of slip surface points [m] — The slip surface after optimization.

Slope stability verification (Sarma)
Combination 1
Utilization : 22.6 %

Slope stability ACCEPTABLE
Combination 2
Utilization : 22.1 %

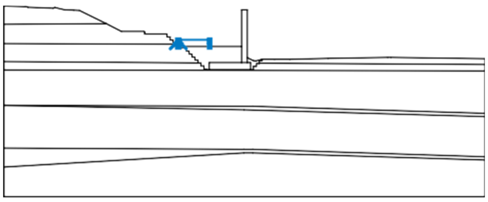
Slope stability ACCEPTABLE
Optimized slip surface for : Combination 1

Name : Analysis	Stage - analysis : 7 - 2

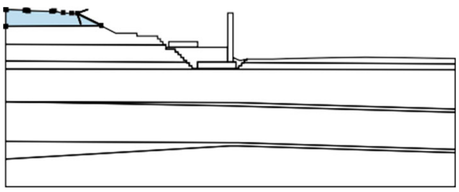
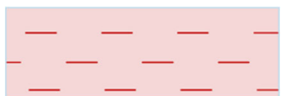


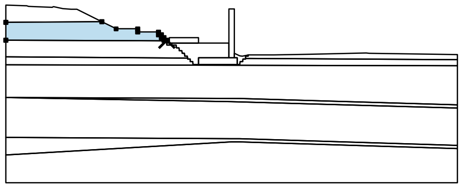
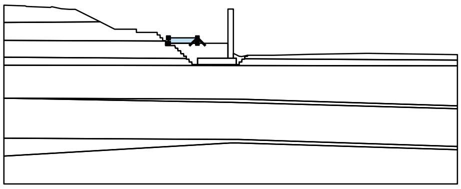
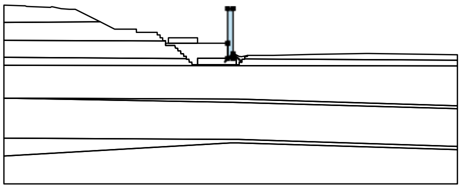
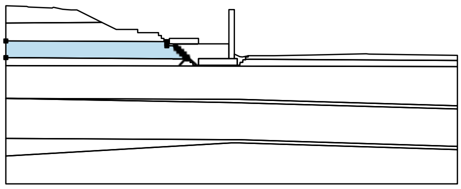
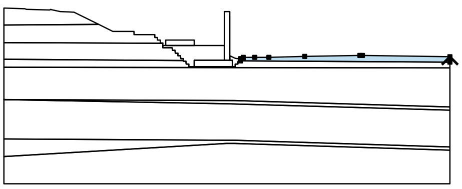
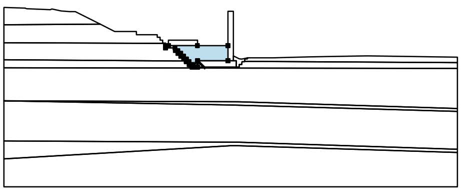
Input data (Stage of construction 8)

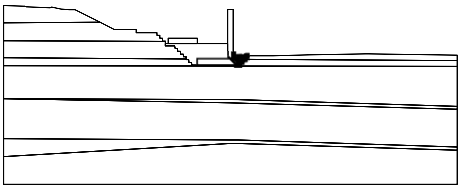
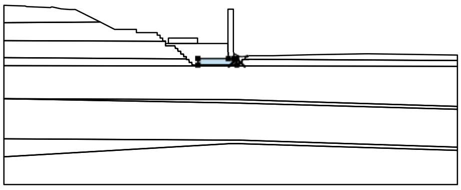
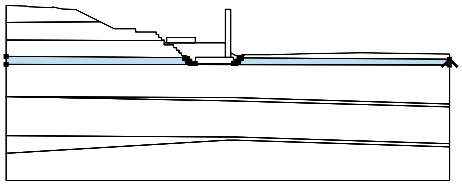
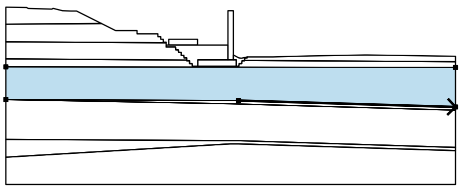
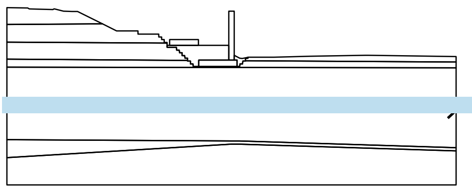
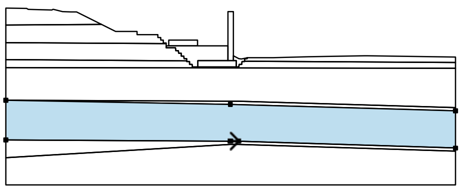
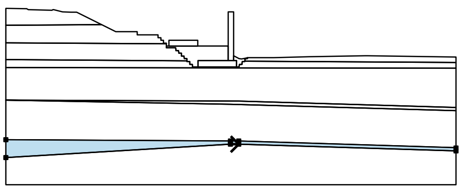
Embankment interface

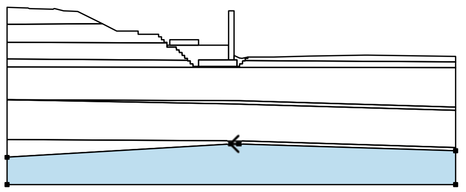
No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		29.70	20.41	29.70	21.41	34.95	21.41
		34.95	20.41				

Assigning and surfaces

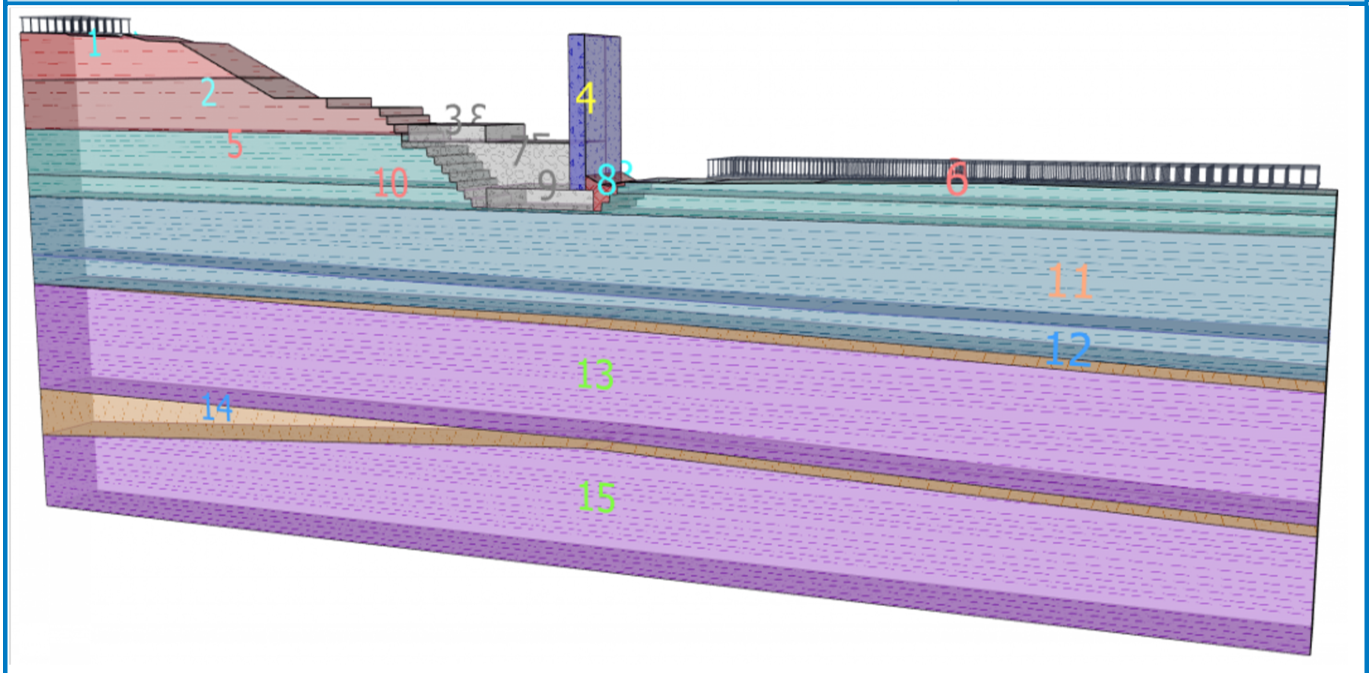
No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
2		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
3		34.95	20.41	34.95	21.41	CONCRETE FOOTING
		29.70	21.41	29.70	20.41	
4		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	20.41	40.47	17.73	
5		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
6		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
7		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		34.95	20.41	29.70	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
8		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	
9		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
10		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
11		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
12		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
13		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
14		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
15		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment **Stage : 8**



Surcharge

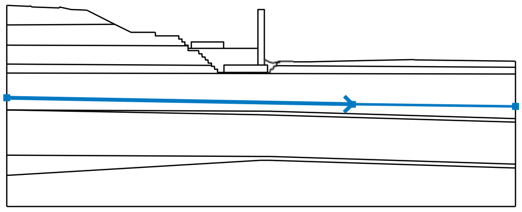
No.	Surcharge new	Surcharge change	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q1, f, F	Magnitude q2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 8)

Analysis 1 (stage 8)

Circular slip surface

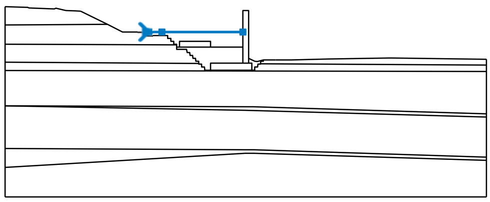
Slip surface is not specified

Slope stability verification (Bishop)

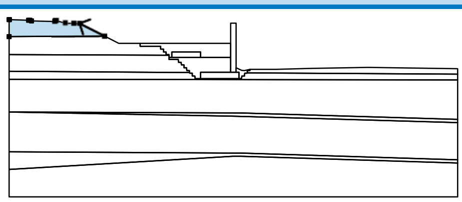
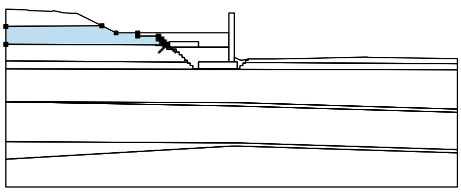
Analysis has not been performed.

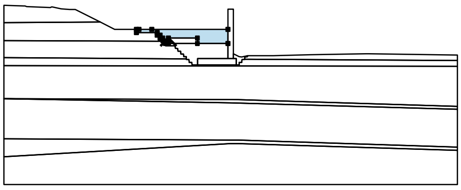
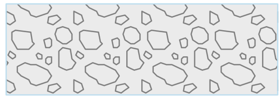
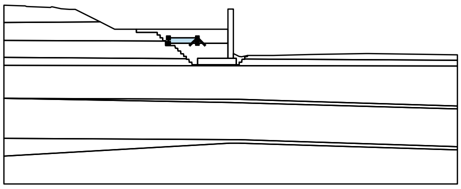
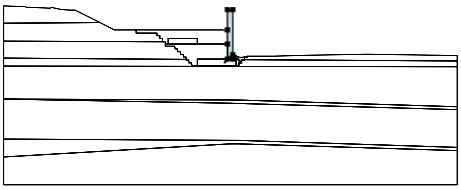
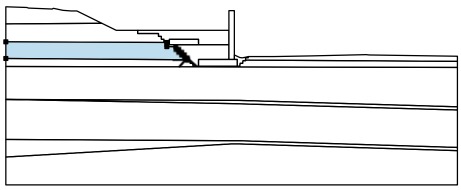
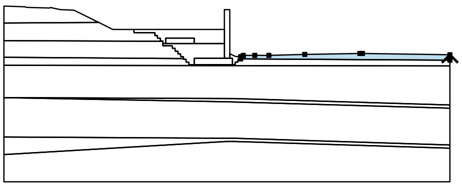
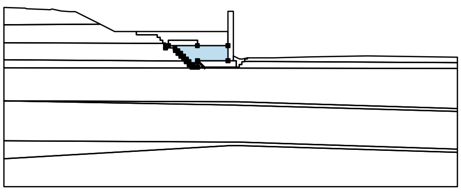
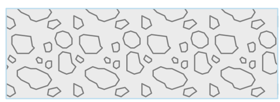
Input data (Stage of construction 9)

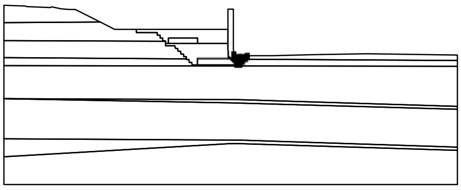
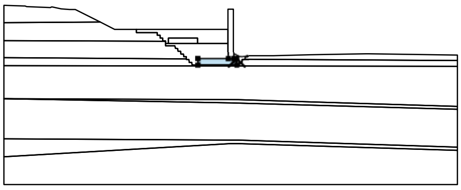
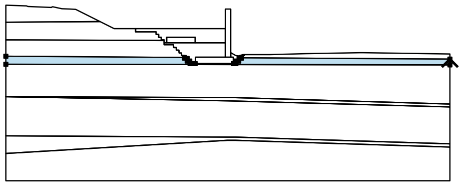
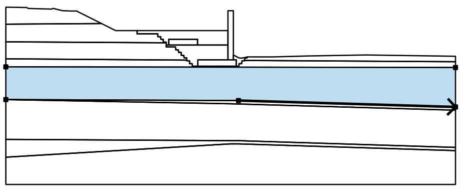
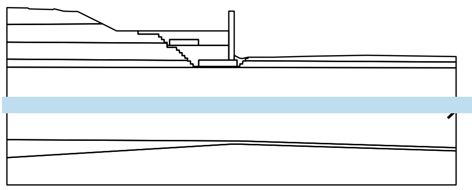
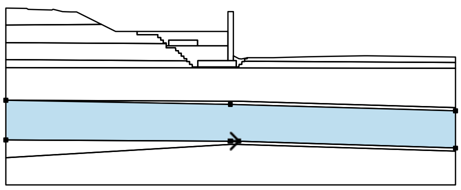
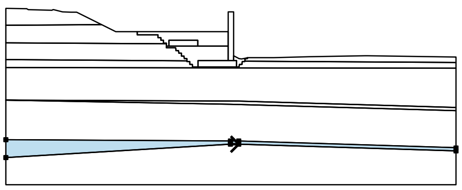
Embankment interface

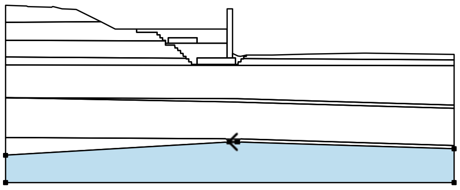
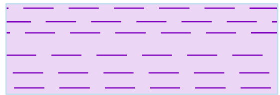
No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		23.92	22.99	24.42	22.99	26.70	22.99
		40.47	22.99				

Assigning and surfaces

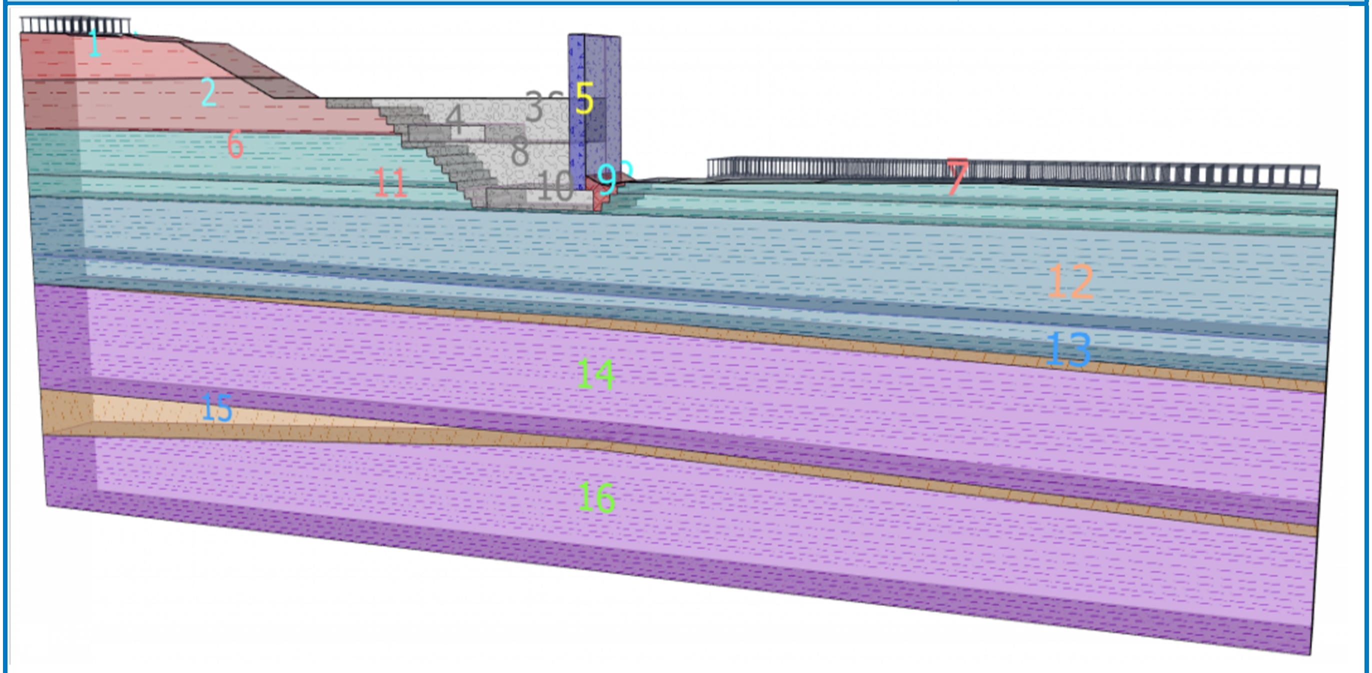
No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
3		29.70	20.41	29.70	21.41	Class 6N Selected Backfill to Structures
		34.95	21.41	34.95	20.41	
		40.47	20.41	40.47	22.99	
		26.70	22.99	24.42	22.99	
		23.92	22.99	23.92	22.41	
		27.70	22.41	27.70	21.91	
		28.20	21.91	28.20	21.41	
		28.70	21.41	28.70	20.91	
		29.20	20.91	29.20	20.80	
		29.20	20.41			
4		34.95	20.41	34.95	21.41	CONCRETE FOOTING
		29.70	21.41	29.70	20.41	
5		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	22.99	40.47	20.41	
		40.47	17.73			
6		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
7		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
8		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		34.95	20.41	29.70	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
9		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	
10		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
11		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
12		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
13		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
14		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
15		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
16		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment	Stage : 9



Surcharge

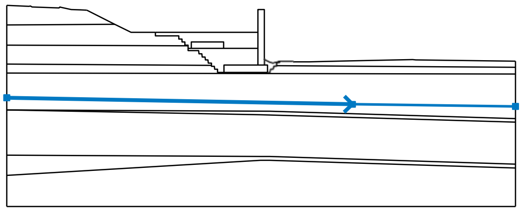
No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m] x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 9)

Analysis 1 (stage 9)

Circular slip surface

Slip surface parameters							
Center :	x =	13.32	[m]	Angles :	α_1 =	-52.11	[°]
	z =	37.50	[m]		α_2 =	29.25	[°]
Radius :	R =	16.63	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1

Sum of active forces : F_a = 2102.53 kN/m
Sum of passive forces : F_p = 11002.88 kN/m

Sliding moment : M_a = 66650.18 kNm/m
Resisting moment : M_p = 348791.21 kNm/m
Utilization : 19.1 %

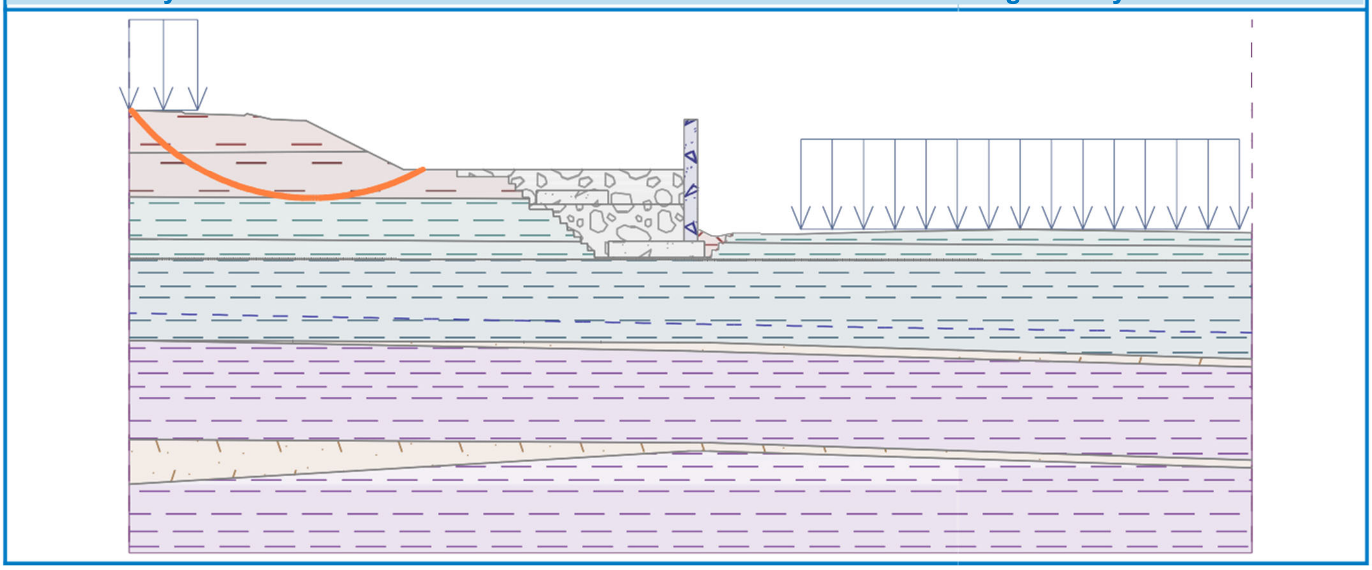
Slope stability ACCEPTABLE
Combination 2

Sum of active forces : F_a = 320.73 kN/m
Sum of passive forces : F_p = 1437.74 kN/m

Sliding moment : M_a = 5333.78 kNm/m
Resisting moment : M_p = 23909.65 kNm/m
Utilization : 22.3 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

Name : Analysis **Stage - analysis : 9 - 1**



Analysis 2 (stage 9)

Polygonal slip surface

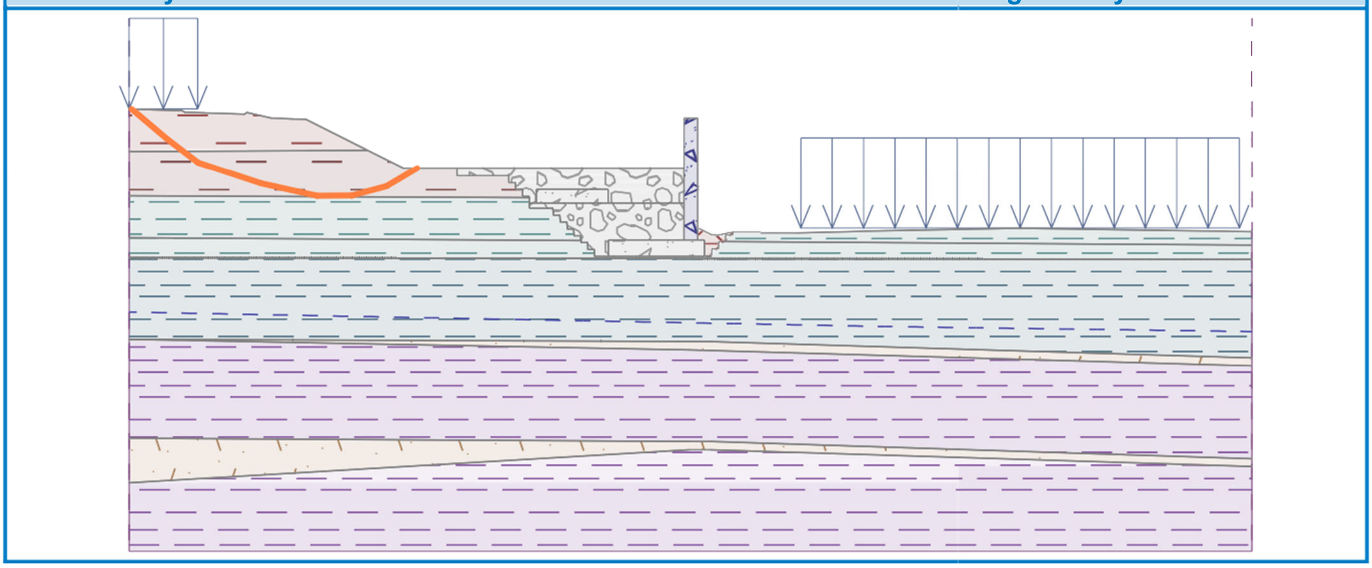
Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
0.20	27.29	2.77	25.11	5.05	23.38	9.62	21.86	13.72	20.95
16.25	20.96	18.77	21.64	21.02	22.99				
The slip surface after optimization.									

Slope stability verification (Sarma)
Combination 1
Utilization : 21.5 %

Slope stability ACCEPTABLE
Combination 2
Utilization : 21.4 %

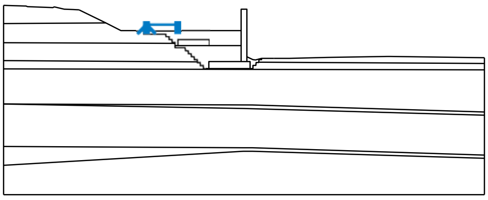
Slope stability ACCEPTABLE
Optimized slip surface for : Combination 1

Name : Analysis **Stage - analysis : 9 - 2**

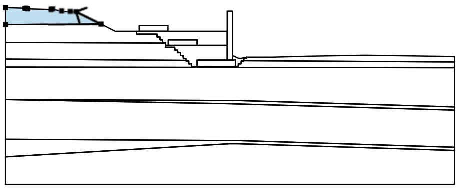
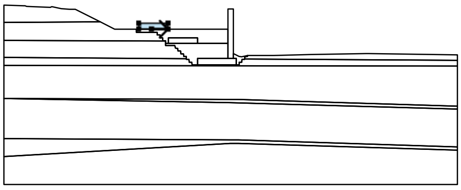
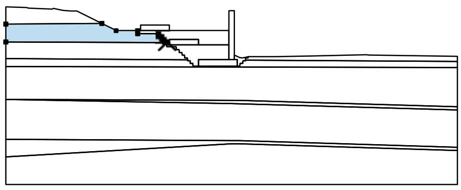
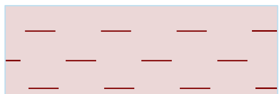
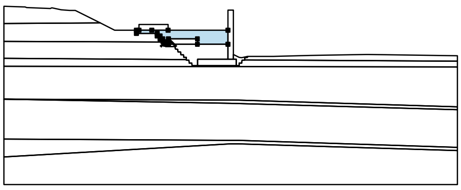
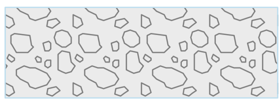
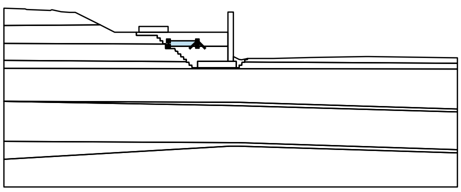


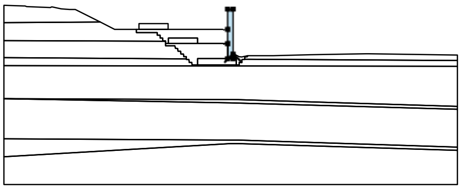
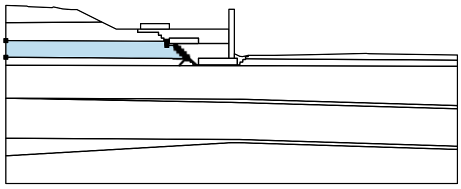
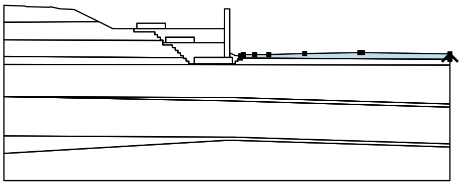
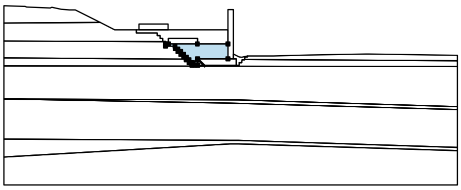
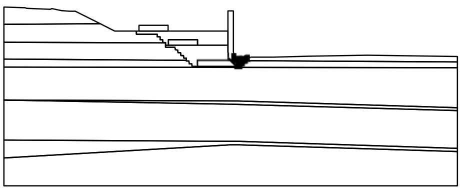
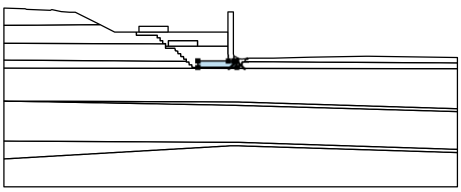
Input data (Stage of construction 10)

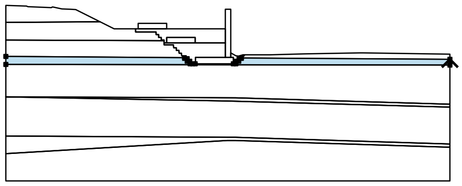
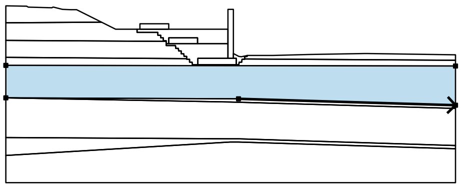
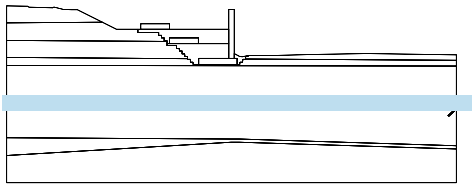
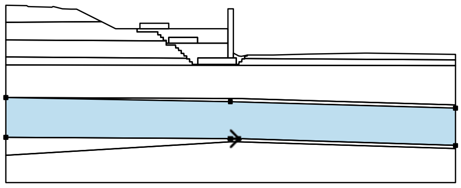
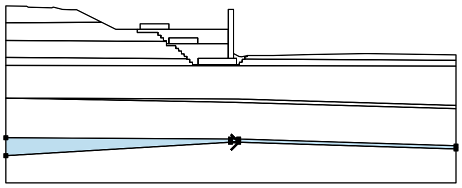
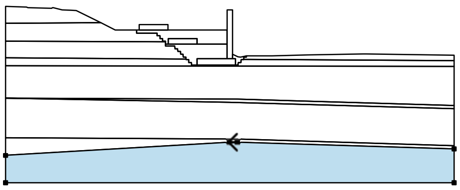
Embankment interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		24.42	22.99	24.42	23.99	29.67	23.99
		29.68	22.99				

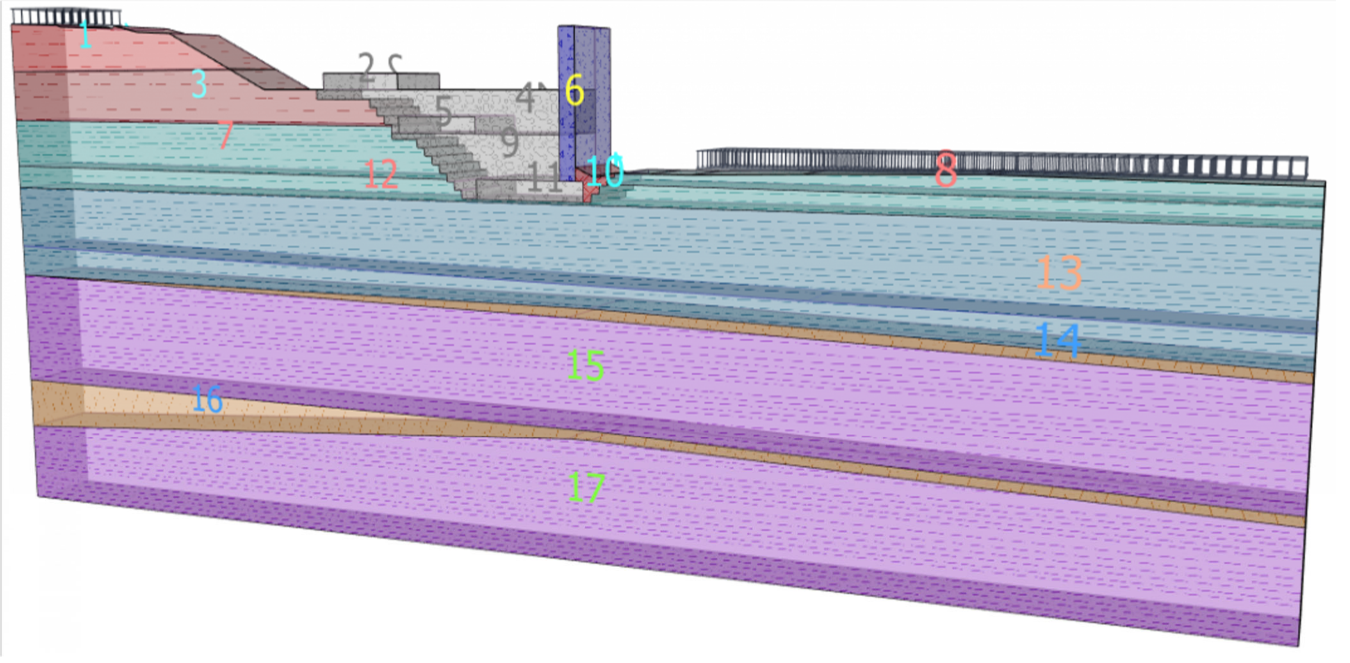
Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		17.41	24.29	12.89	26.55	Firm to stiff red brown silty CLAY - MMG IVB
		11.86	26.58	10.35	26.65	
		8.71	27.03	8.59	27.04	
		8.41	26.92	4.10	27.06	
		3.80	27.20	3.58	27.18	
		0.06	27.29	0.00	27.29	
		0.00	24.19			
2		26.70	22.99	29.68	22.99	CONCRETE FOOTING
		29.67	23.99	24.42	23.99	
		24.42	22.99			
3		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	17.41	24.29	
		0.00	24.19	0.00	20.94	
4		29.70	20.41	29.70	21.41	Class 6N Selected Backfill to Structures
		34.95	21.41	34.95	20.41	
		40.47	20.41	40.47	22.99	
		29.68	22.99	26.70	22.99	
		24.42	22.99	23.92	22.99	
		23.92	22.41	27.70	22.41	
		27.70	21.91	28.20	21.91	
		28.20	21.41	28.70	21.41	
		28.70	20.91	29.20	20.91	
		29.20	20.80	29.20	20.41	
5		34.95	20.41	34.95	21.41	CONCRETE FOOTING
		29.70	21.41	29.70	20.41	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
6		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	22.99	40.47	20.41	
		40.47	17.73			
7		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
8		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
9		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		34.95	20.41	29.70	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	
10		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	
11		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
12		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
13		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
14		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
15		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
16		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
17		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment **Stage : 10**



Surcharge

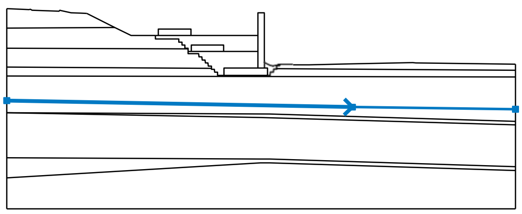
No.	Surcharge new	Surcharge change	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q1, f, F	Magnitude q2	Magnitude unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

No.	GWT location	x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

(Coordinates of GWT points [m])

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 10)

Analysis 1 (stage 10)

Circular slip surface

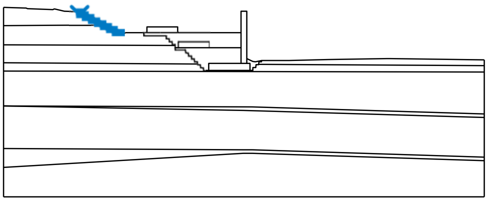
Slip surface is not specified

Slope stability verification (Bishop)

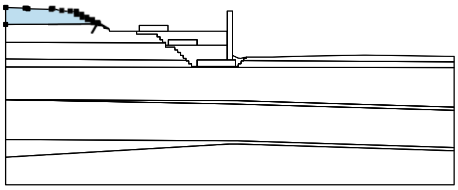
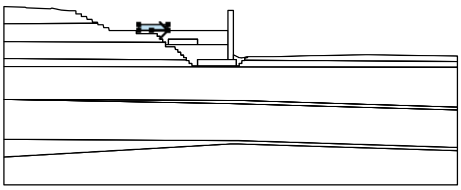
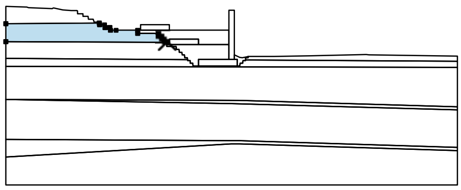
Analysis has not been performed.

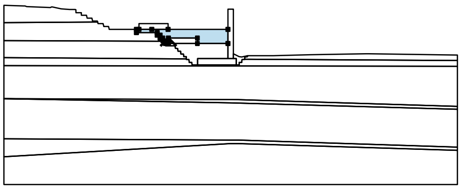
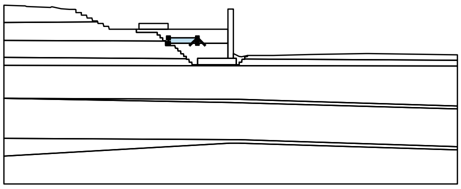
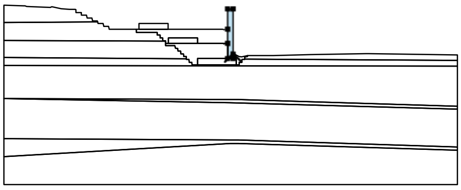
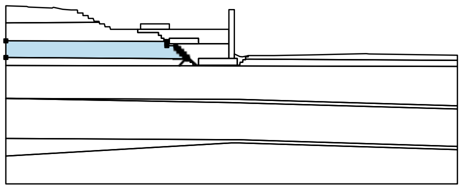
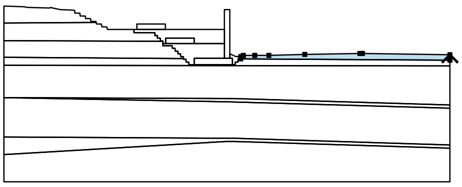
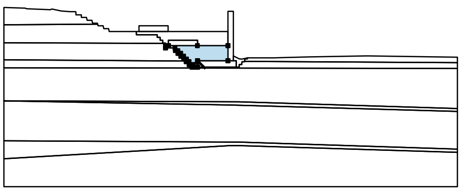
Input data (Stage of construction 11)

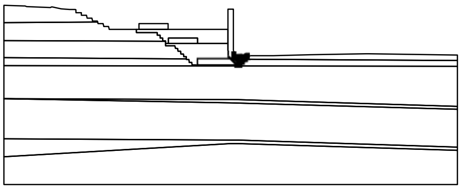
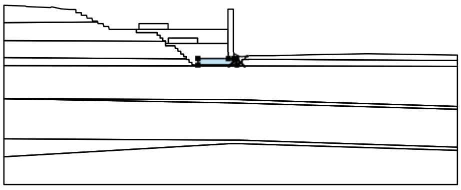
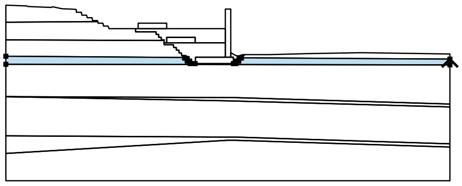
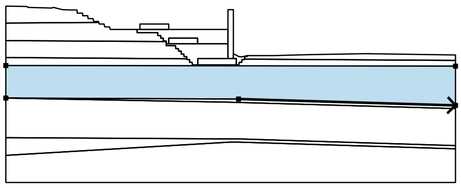
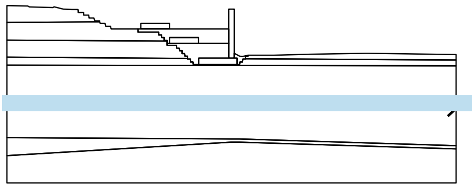
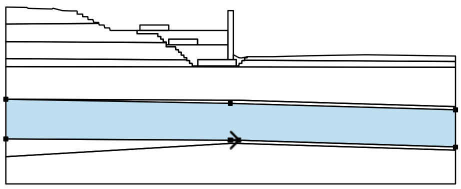
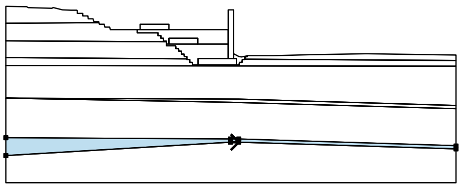
Earth cut

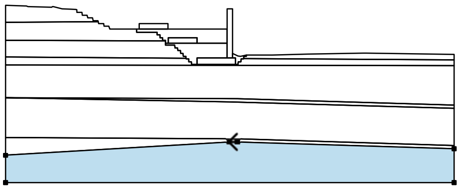
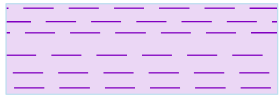
No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		13.01	26.49	13.01	25.99	13.97	25.99
		14.01	25.49	14.92	25.49	15.01	24.99
		15.88	24.99	16.01	24.49	16.89	24.48
		17.01	23.99	17.91	23.98	18.01	23.49
		18.88	23.49	19.01	22.99	20.01	22.99

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		16.94	24.29	16.89	24.48	Firm to stiff red brown silty CLAY - MMG IVB
		16.01	24.49	15.88	24.99	
		15.01	24.99	14.92	25.49	
		14.01	25.49	13.97	25.99	
		13.01	25.99	13.01	26.49	
		12.89	26.55	11.86	26.58	
		10.35	26.65	8.71	27.03	
		8.59	27.04	8.41	26.92	
		4.10	27.06	3.80	27.20	
		3.58	27.18	0.06	27.29	
		0.00	27.29	0.00	24.19	
2		26.70	22.99	29.68	22.99	CONCRETE FOOTING
		29.67	23.99	24.42	23.99	
		24.42	22.99			
3		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	19.01	22.99	
		18.88	23.49	18.01	23.49	
		17.91	23.98	17.01	23.99	
		16.94	24.29	0.00	24.19	
		0.00	20.94			

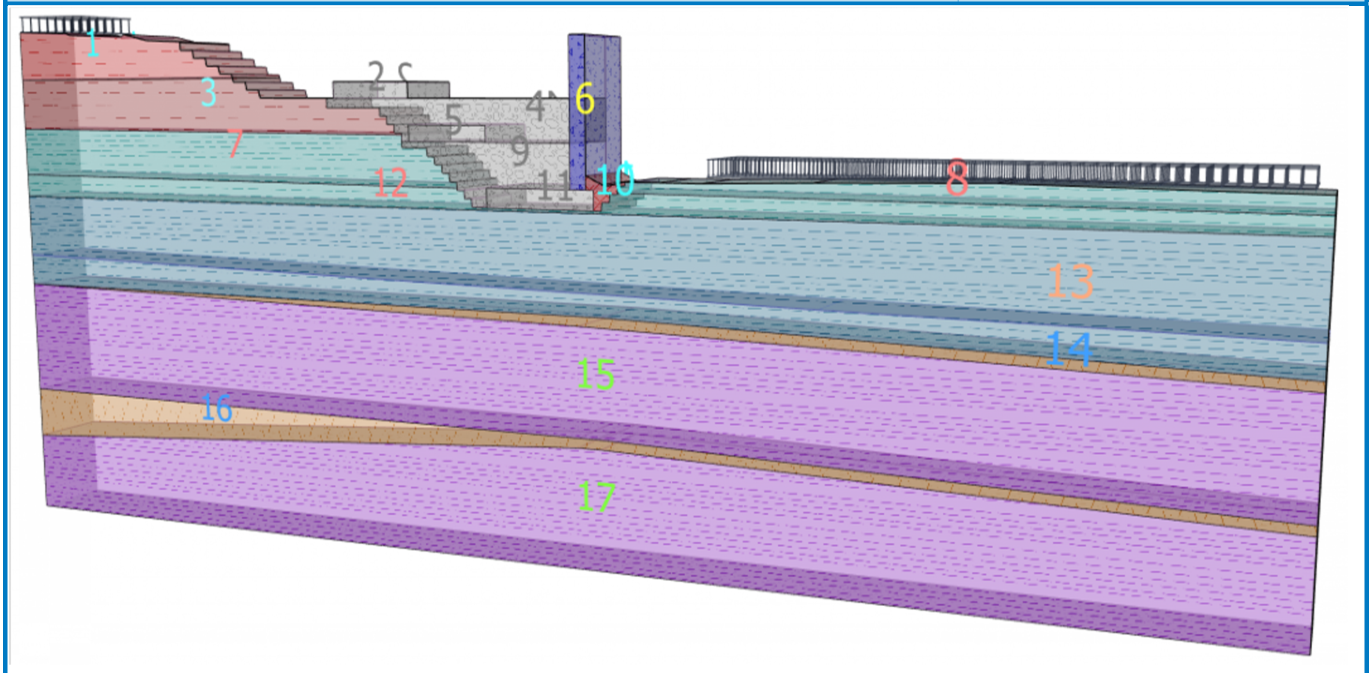
No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
4		29.70	20.41	29.70	21.41	Class 6N Selected Backfill to Structures
		34.95	21.41	34.95	20.41	
		40.47	20.41	40.47	22.99	
		29.68	22.99	26.70	22.99	
		24.42	22.99	23.92	22.99	
		23.92	22.41	27.70	22.41	
		27.70	21.91	28.20	21.91	
		28.20	21.41	28.70	21.41	
		28.70	20.91	29.20	20.91	
		29.20	20.80	29.20	20.41	
5		34.95	20.41	34.95	21.41	CONCRETE FOOTING
		29.70	21.41	29.70	20.41	
6		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	22.99	40.47	20.41	
		40.47	17.73			
7		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
8		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
9		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		34.95	20.41	29.70	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
10		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	
11		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
12		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
13		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			
14		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
15		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
16		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
17		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I 
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment

Stage : 11



Surcharge

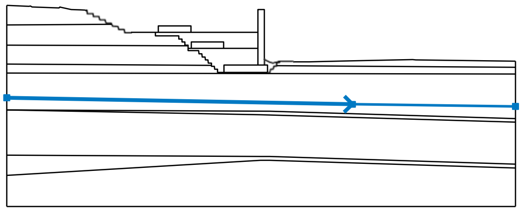
No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 11)

Analysis 1 (stage 11)

Circular slip surface

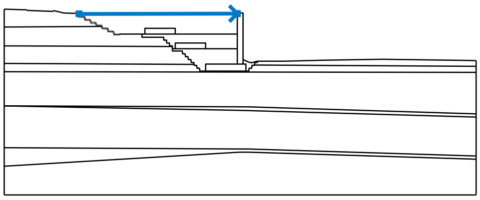
Slip surface is not specified

Slope stability verification (Bishop)

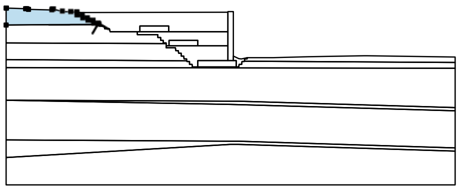
Analysis has not been performed.

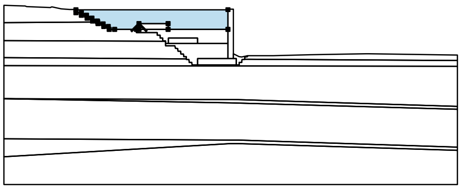
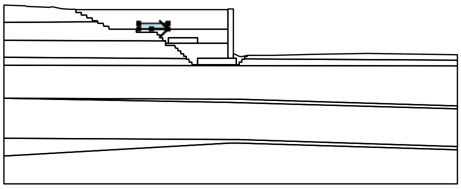
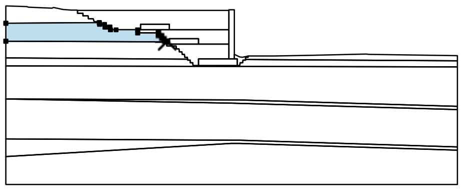
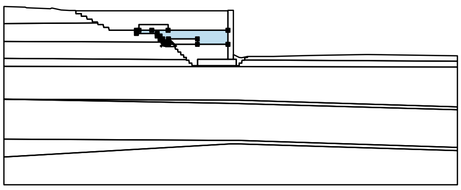
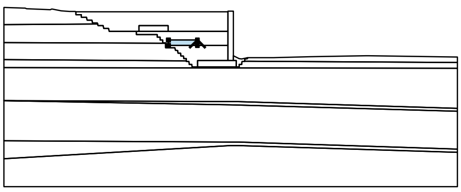
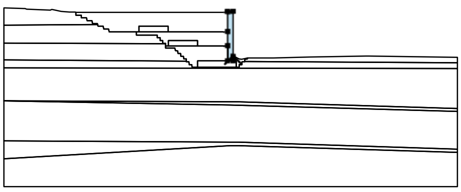
Input data (Stage of construction 12)

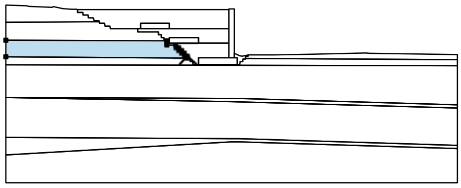
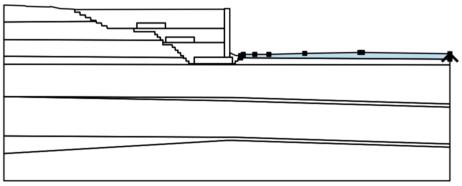
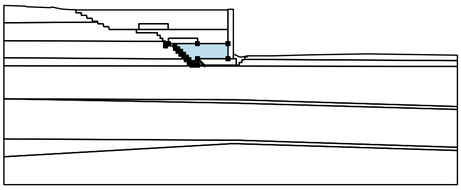
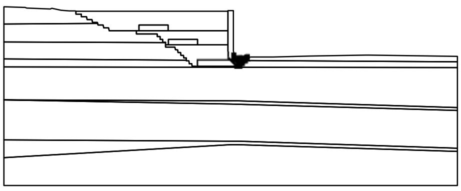
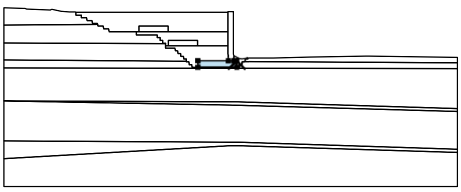
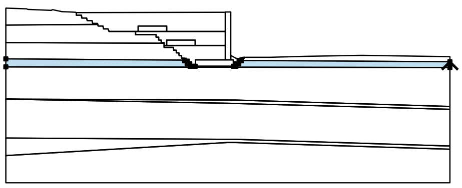
Embankment interface

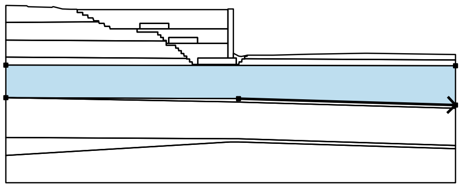
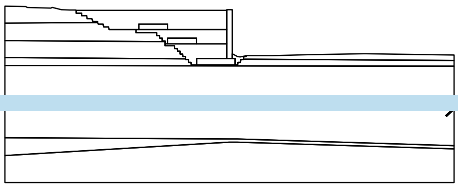
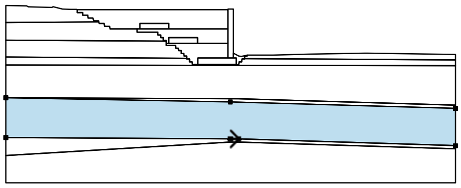
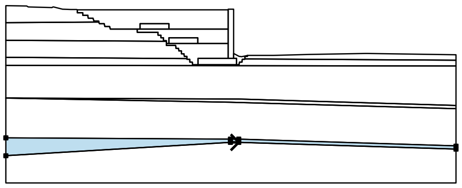
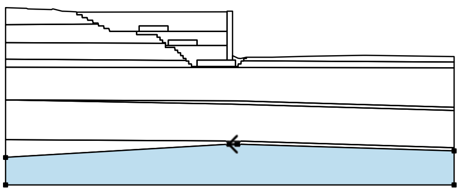
No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		13.01	26.49	40.47	26.52		

Assigning and surfaces

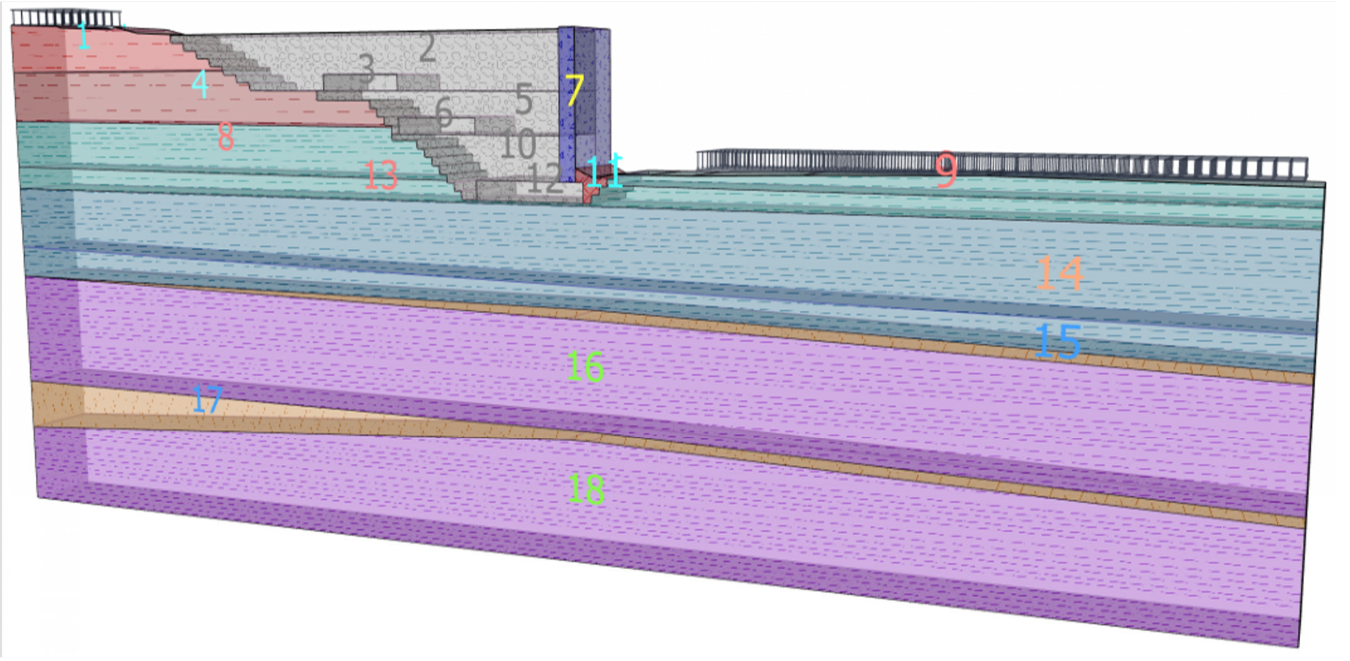
No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		16.94	24.29	16.89	24.48	Firm to stiff red brown silty CLAY - MMG IVB
		16.01	24.49	15.88	24.99	
		15.01	24.99	14.92	25.49	
		14.01	25.49	13.97	25.99	
		13.01	25.99	13.01	26.49	
		12.89	26.55	11.86	26.58	
		10.35	26.65	8.71	27.03	
		8.59	27.04	8.41	26.92	
		4.10	27.06	3.80	27.20	
		3.58	27.18	0.06	27.29	
		0.00	27.29	0.00	24.19	

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
2		24.42	22.99	24.42	23.99	Class 6N Selected Backfill to Structures
		29.67	23.99	29.68	22.99	
		40.47	22.99	40.47	26.52	
		13.01	26.49	13.01	25.99	
		13.97	25.99	14.01	25.49	
		14.92	25.49	15.01	24.99	
		15.88	24.99	16.01	24.49	
		16.89	24.48	16.94	24.29	
		17.01	23.99	17.91	23.98	
		18.01	23.49	18.88	23.49	
		19.01	22.99	20.01	22.99	
		23.92	22.99			
3		26.70	22.99	29.68	22.99	CONCRETE FOOTING
		29.67	23.99	24.42	23.99	
		24.42	22.99			
4		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	19.01	22.99	
		18.88	23.49	18.01	23.49	
		17.91	23.98	17.01	23.99	
		16.94	24.29	0.00	24.19	
		0.00	20.94			
5		29.70	20.41	29.70	21.41	Class 6N Selected Backfill to Structures
		34.95	21.41	34.95	20.41	
		40.47	20.41	40.47	22.99	
		29.68	22.99	26.70	22.99	
		24.42	22.99	23.92	22.99	
		23.92	22.41	27.70	22.41	
		27.70	21.91	28.20	21.91	
		28.20	21.41	28.70	21.41	
		28.70	20.91	29.20	20.91	
		29.20	20.80	29.20	20.41	
6		34.95	20.41	34.95	21.41	CONCRETE FOOTING
		29.70	21.41	29.70	20.41	
7		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	26.52	40.47	22.99	
		40.47	20.41	40.47	17.73	

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
8		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			
9		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
10		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		34.95	20.41	29.70	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	
11		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	
12		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
13		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
14		42.37 81.92 0.00	10.31 16.30 10.49	81.92 0.00	9.12 16.44	Weathered Mudstone - MMG II
15		40.90 81.92 0.00	9.72 9.12 10.49	81.92 42.37	8.55 10.31	Sandstone - Interbedded Mudstone & Sandstone
16		40.87 81.92 40.90 0.00	3.01 1.76 9.72 3.24	42.37 81.92 0.00	3.01 8.55 10.49	Intact Mudstone - MMG I
17		40.87 81.92 42.37 0.00	2.41 1.19 3.01 3.24	42.37 81.92 40.87 0.00	2.41 1.76 3.01 0.00	Sandstone - Interbedded Mudstone & Sandstone
18		42.37 0.00 81.92	2.41 0.00 -5.00	40.87 0.00 81.92	2.41 -5.00 1.19	Intact Mudstone - MMG I

Name : Soils and assignment **Stage : 12**



Surcharge

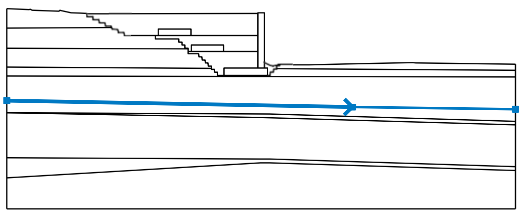
No.	Surcharge new	Surcharge change	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q1, f, F	Magnitude q2	Magnitude unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic

Water

Water type : GWT

No.	GWT location	x	z	x	z	x	z
1		0.00	12.47	55.65	11.41	81.92	11.05

(Coordinates of GWT points [m])

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 12)

Analysis 1 (stage 12)

Circular slip surface

Slip surface parameters							
Center :	x =	38.40	[m]	Angles :	α_1 =	-65.48	[°]
	z =	33.83	[m]		α_2 =	27.95	[°]
Radius :	R =	17.66	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Combination 1

Sum of active forces : F_a = 1217.67 kN/m
Sum of passive forces : F_p = 4157.17 kN/m
Sliding moment : M_a = 22356.36 kNm/m
Resisting moment : M_p = 76325.71 kNm/m
Utilization : 29.3 %

Slope stability ACCEPTABLE

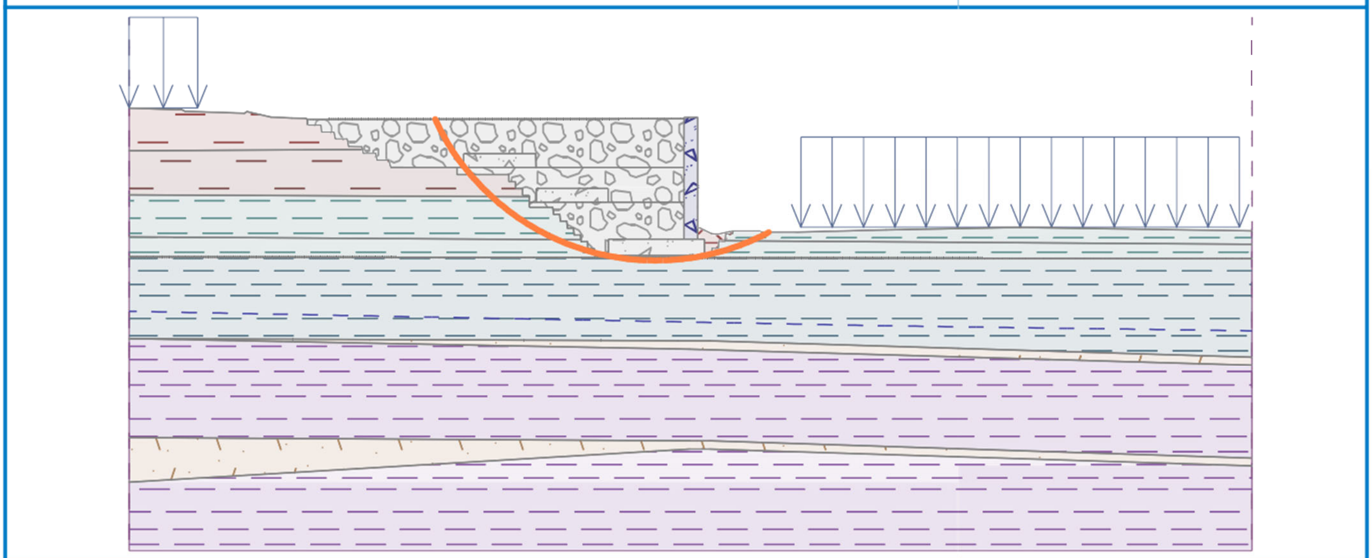
Combination 2

Sum of active forces : F_a = 868.14 kN/m
Sum of passive forces : F_p = 2856.08 kN/m
Sliding moment : M_a = 15331.41 kNm/m
Resisting moment : M_p = 50438.40 kNm/m
Utilization : 30.4 %

Slope stability ACCEPTABLE

Optimized slip surface for : Combination 2

Name : Analysis — Stage - analysis : 12 - 1



Analysis 2 (stage 12)

Polygonal slip surface

x	z	x	z	x	z	x	z	x	z
22.33	26.50	24.46	22.99	27.34	20.06	30.81	17.88	34.70	16.56
37.98	16.17	42.85	16.07	45.86	18.23				

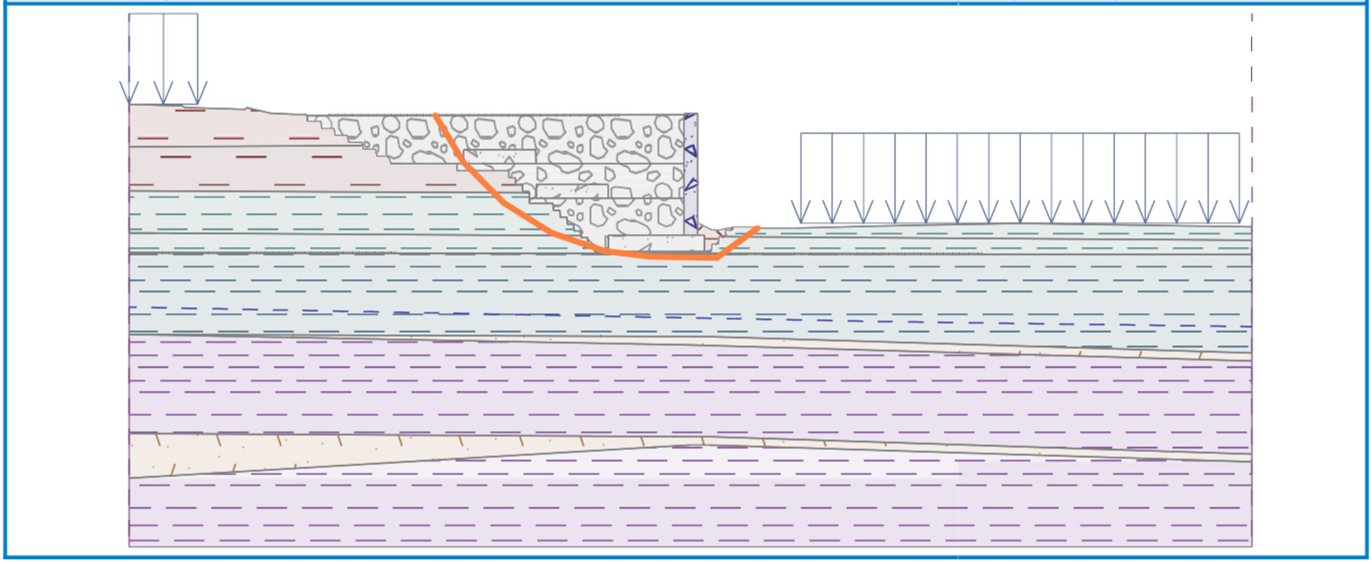
Coordinates of slip surface points [m]. The slip surface after optimization.

Slope stability verification (Sarma)
Combination 1
Utilization : 32.9 %

Slope stability ACCEPTABLE
One of the dividing planes cuts through the rigid body. The results can be overestimated.
Combination 2
Utilization : 35.0 %

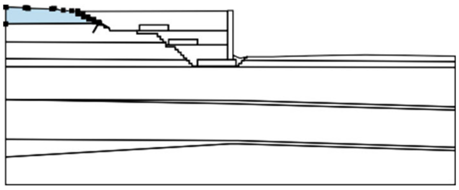
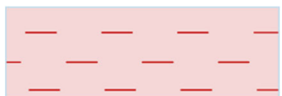
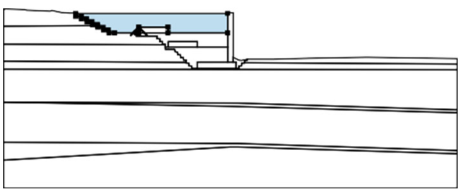
Slope stability ACCEPTABLE
One of the dividing planes cuts through the rigid body. The results can be overestimated.Optimized slip surface for : Combination 2

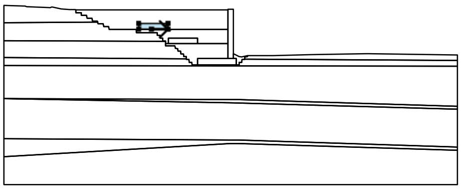
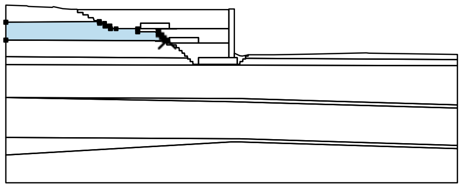
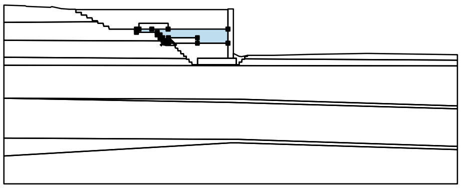
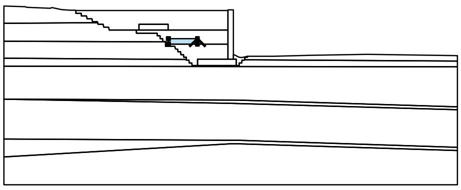
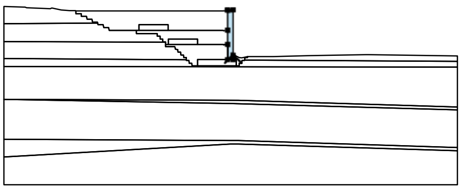
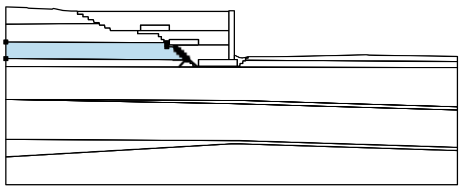
Name : Analysis **Stage - analysis : 12 - 2**

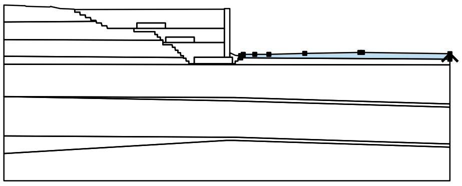
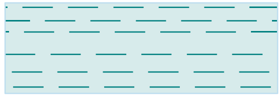
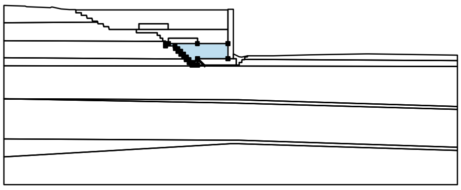
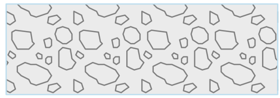
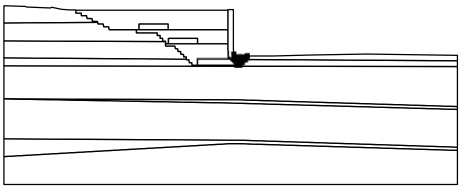
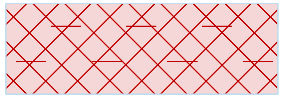
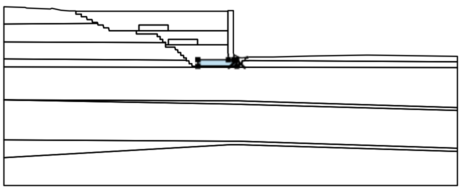
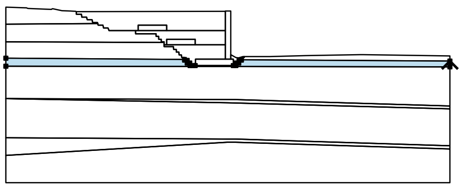
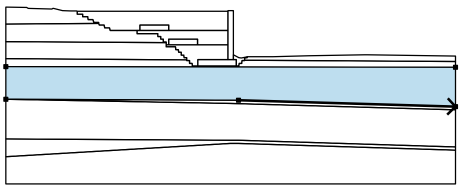


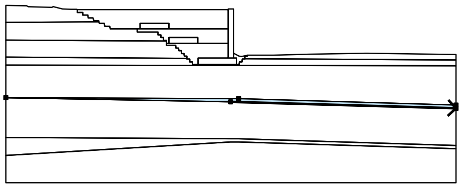
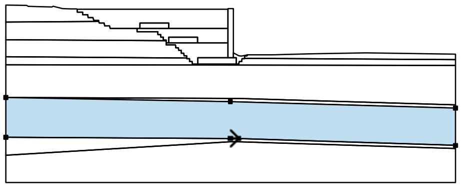
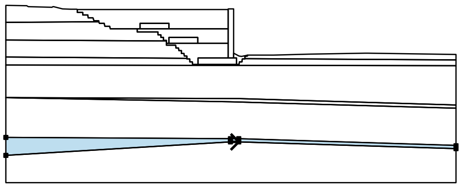
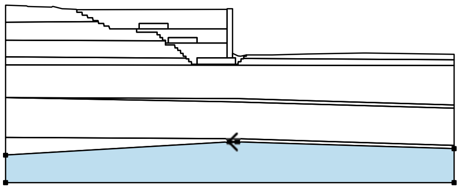
Input data (Stage of construction 13)

Assigning and surfaces

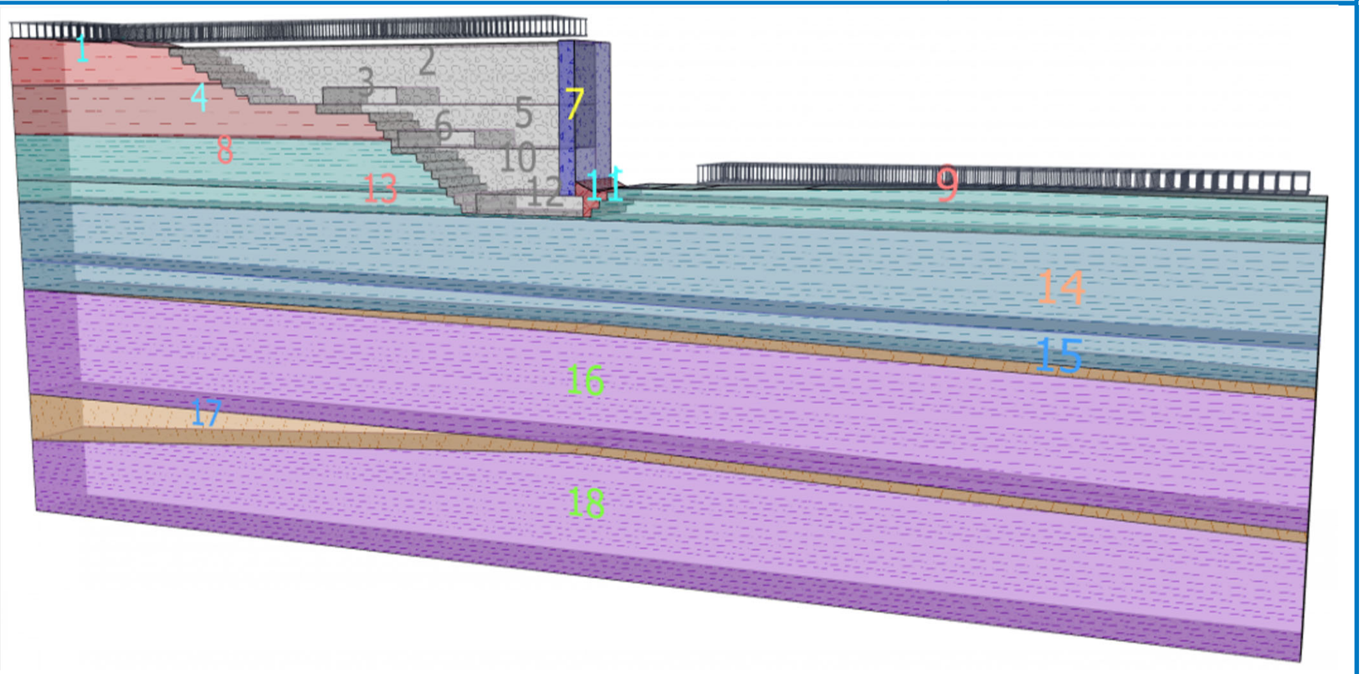
No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
1		16.94	24.29	16.89	24.48	Firm to stiff red brown silty CLAY - MMG IVB 
		16.01	24.49	15.88	24.99	
		15.01	24.99	14.92	25.49	
		14.01	25.49	13.97	25.99	
		13.01	25.99	13.01	26.49	
		12.89	26.55	11.86	26.58	
		10.35	26.65	8.71	27.03	
		8.59	27.04	8.41	26.92	
		4.10	27.06	3.80	27.20	
		3.58	27.18	0.06	27.29	
		0.00	27.29	0.00	24.19	
2		24.42	22.99	24.42	23.99	Class 6N Selected Backfill to Structures 
		29.67	23.99	29.68	22.99	
		40.47	22.99	40.47	26.52	
		13.01	26.49	13.01	25.99	
		13.97	25.99	14.01	25.49	
		14.92	25.49	15.01	24.99	
		15.88	24.99	16.01	24.49	
		16.89	24.48	16.94	24.29	
		17.01	23.99	17.91	23.98	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
		18.01	23.49	18.88	23.49	
		19.01	22.99	20.01	22.99	
		23.92	22.99			
3		26.70	22.99	29.68	22.99	CONCRETE FOOTING
		29.67	23.99	24.42	23.99	
		24.42	22.99			
4		29.20	20.80	29.20	20.91	Stiff red brown silty CLAY - MMG IVA
		28.70	20.91	28.70	21.41	
		28.20	21.41	28.20	21.91	
		27.70	21.91	27.70	22.41	
		23.92	22.41	23.92	22.99	
		20.01	22.99	19.01	22.99	
		18.88	23.49	18.01	23.49	
		17.91	23.98	17.01	23.99	
		16.94	24.29	0.00	24.19	
		0.00	20.94			
5		29.70	20.41	29.70	21.41	Class 6N Selected Backfill to Structures
		34.95	21.41	34.95	20.41	
		40.47	20.41	40.47	22.99	
		29.68	22.99	26.70	22.99	
		24.42	22.99	23.92	22.99	
		23.92	22.41	27.70	22.41	
		27.70	21.91	28.20	21.91	
		28.20	21.41	28.70	21.41	
		28.70	20.91	29.20	20.91	
		29.20	20.80	29.20	20.41	
6		34.95	20.41	34.95	21.41	CONCRETE FOOTING
		29.70	21.41	29.70	20.41	
7		41.47	17.73	41.47	18.55	BRIDGE ABUTMENT
		41.47	26.63	40.47	26.63	
		40.47	26.52	40.47	22.99	
		40.47	20.41	40.47	17.73	
8		32.96	17.67	32.94	18.03	Weathered Mudstone - MMG III
		32.47	18.03	32.42	18.53	
		31.97	18.53	31.93	19.03	
		31.47	19.03	31.42	19.52	
		30.97	19.53	30.90	20.03	
		29.20	20.03	29.20	20.41	
		29.20	20.80	0.00	20.94	
		0.00	17.89			

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
9		81.92	17.36	81.92	18.34	Weathered Mudstone - MMG III
		65.88	18.57	65.36	18.58	
		55.24	18.40	48.68	18.23	
		46.09	18.23	43.97	18.23	
		43.97	18.03	43.51	18.02	
		43.48	17.61			
10		34.97	16.53	34.97	17.73	Class 6N Selected Backfill to Structures
		40.47	17.73	40.47	20.41	
		34.95	20.41	29.70	20.41	
		29.20	20.41	29.20	20.03	
		30.90	20.03	30.97	19.53	
		31.42	19.52	31.47	19.03	
		31.93	19.03	31.97	18.53	
		32.42	18.53	32.47	18.03	
		32.94	18.03	32.96	17.67	
		32.97	17.53	33.44	17.53	
		33.47	17.03	33.93	17.03	
		33.97	16.53	34.47	16.53	
11		41.97	17.73	41.97	16.53	Class 2 Fill (Site Won MMG IV)
		42.47	16.53	42.51	17.03	
		42.97	17.03	43.01	17.53	
		43.47	17.53	43.48	17.61	
		43.51	18.02	43.97	18.03	
		43.97	18.23	43.76	18.19	
		42.93	18.00	42.47	18.06	
		41.47	18.55	41.47	17.73	
12		41.97	16.53	41.97	17.73	CONCRETE FOOTING
		41.47	17.73	40.47	17.73	
		34.97	17.73	34.97	16.53	
13		81.92	16.30	81.92	17.36	Weathered Mudstone - MMG III
		43.48	17.61	43.47	17.53	
		43.01	17.53	42.97	17.03	
		42.51	17.03	42.47	16.53	
		41.97	16.53	34.97	16.53	
		34.47	16.53	33.97	16.53	
		33.93	17.03	33.47	17.03	
		33.44	17.53	32.97	17.53	
		32.96	17.67	0.00	17.89	
		0.00	16.44			
14		42.37	10.31	81.92	9.12	Weathered Mudstone - MMG II
		81.92	16.30	0.00	16.44	
		0.00	10.49			

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
15		40.90	9.72	81.92	8.55	Sandstone - Interbedded Mudstone & Sandstone
		81.92	9.12	42.37	10.31	
		0.00	10.49			
16		40.87	3.01	42.37	3.01	Intact Mudstone - MMG I
		81.92	1.76	81.92	8.55	
		40.90	9.72	0.00	10.49	
		0.00	3.24			
17		40.87	2.41	42.37	2.41	Sandstone - Interbedded Mudstone & Sandstone
		81.92	1.19	81.92	1.76	
		42.37	3.01	40.87	3.01	
		0.00	3.24	0.00	0.00	
18		42.37	2.41	40.87	2.41	Intact Mudstone - MMG I
		0.00	0.00	0.00	-5.00	
		81.92	-5.00	81.92	1.19	

Name : Soils and assignment **Stage : 13**



Surcharge

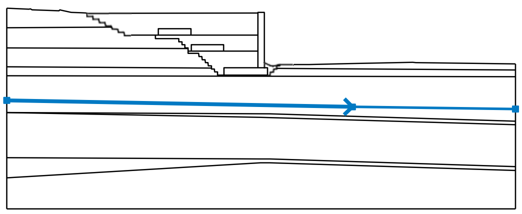
No.	Surcharge new	Surcharge change	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q1, f, F	Magnitude q2	Magnitude unit
1	No	No	strip	permanent	on terrain	x = 49.00	l = 32.00		0.00	20.00		kN/m2
2	No	No	strip	permanent	on terrain	x = 0.00	l = 5.00		0.00	20.00		kN/m2
3	No	No	strip	permanent	on terrain	x = 5.00	l = 35.00		0.00	20.00		kN/m2

Surcharges

No.	Name
1	M1 Traffic UDL
2	A453 Off-site Traffic
3	A6 Bypass Traffic onto new M1 Overbridge

Water

Water type : GWT

No.	GWT location	x	z	x	z	x	z
		Coordinates of GWT points [m]					
1		0.00	12.47	55.65	11.41	81.92	11.05

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 13)

Analysis 1 (stage 13)

Circular slip surface

Slip surface parameters							
Center :	x =	38.38	[m]	Angles :	α_1 =	-65.09	[°]
	z =	34.01	[m]		α_2 =	27.75	[°]
Radius :	R =	17.83	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)
Combination 1

Sum of active forces : F_a = 1408.16 kN/m
Sum of passive forces : F_p = 4178.97 kN/m

Sliding moment : M_a = 25403.23 kNm/m
Resisting moment : M_p = 75388.59 kNm/m
Utilization : 33.7 %

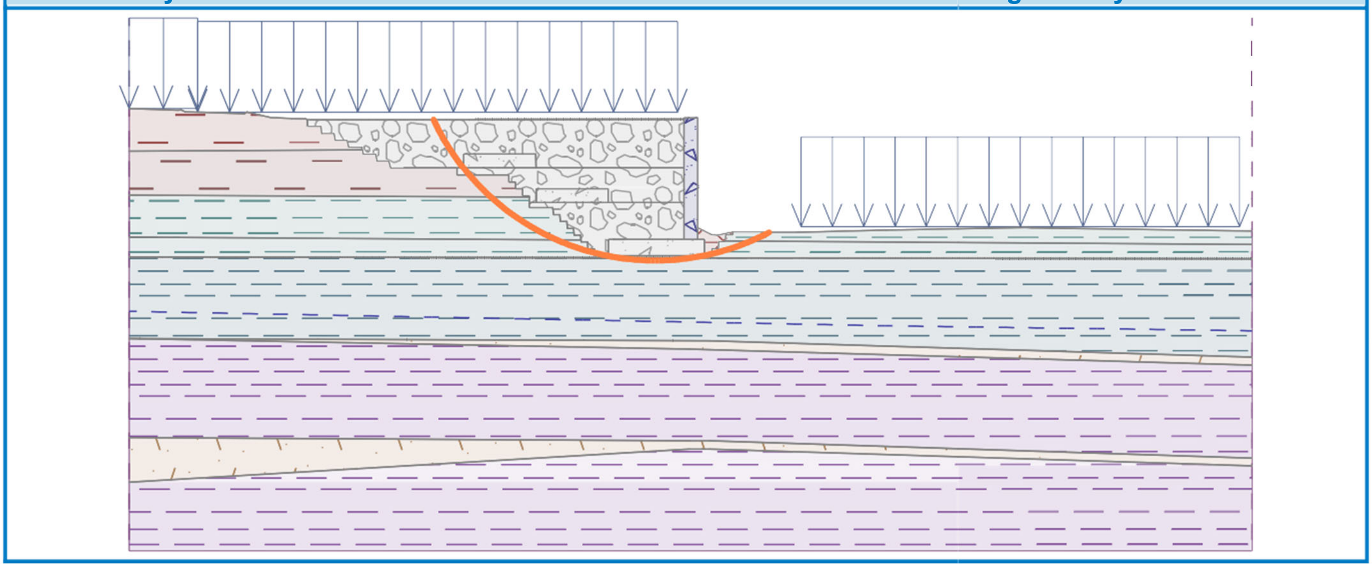
Slope stability ACCEPTABLE

Combination 2

Sum of active forces : F_a = 1015.57 kN/m
Sum of passive forces : F_p = 2919.79 kN/m
Sliding moment : M_a = 18107.63 kNm/m
Resisting moment : M_p = 52059.91 kNm/m
Utilization : 34.8 %

Slope stability ACCEPTABLE
Optimized slip surface for : Combination 2

Name : Analysis	Stage - analysis : 13 - 1



Analysis 2 (stage 13)

Polygonal slip surface

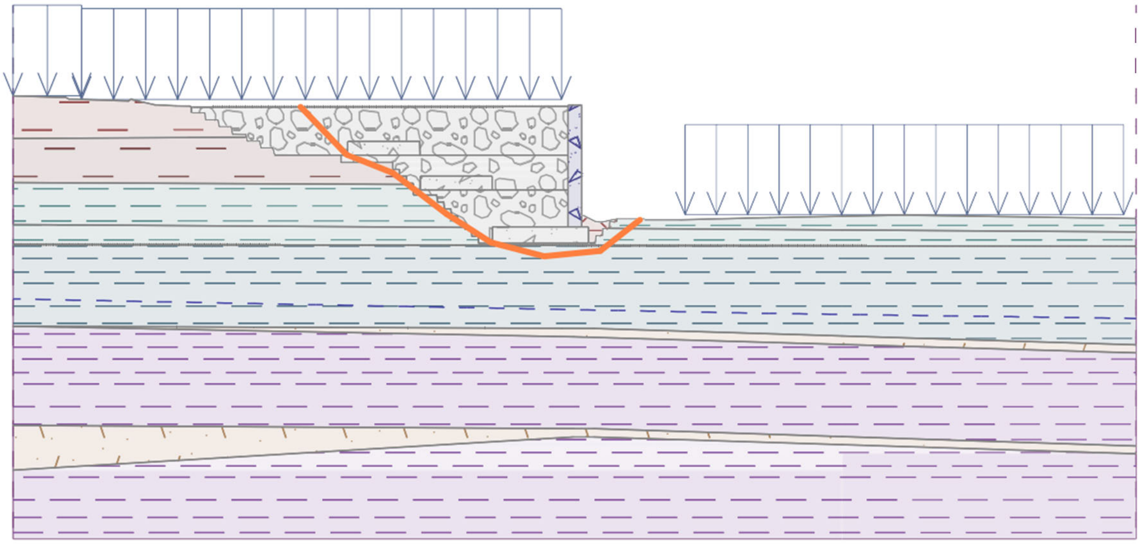
Coordinates of slip surface points [m]									
x	z	x	z	x	z	x	z	x	z
20.98	26.50	24.36	22.98	27.70	21.65	31.62	18.67	34.87	16.57
38.76	15.57	42.84	15.97	45.73	18.23				
The slip surface after optimization.									

Slope stability verification (Sarma)
Combination 1
Utilization : 41.0 %

Slope stability ACCEPTABLE
One of the dividing planes cuts through the rigid body. The results can be overestimated.
Combination 2
Utilization : 40.1 %

Slope stability ACCEPTABLE
One of the dividing planes cuts through the rigid body. The results can be overestimated.Optimized slip surface for : Combination 1

Name : Analysis **Stage - analysis : 13 - 2**



ANNEX B.5 EMG-HYD-C4-M1OB-CA-GE-0663

Cantilever wall analysis

Input data

Project

Task	:	EAST MIDLANDS GATEWAY - STRATEGIC RAIL FREIGHT INTERCHANGE
Part	:	M1 OVERBRIDGE, ELEMENT 11, WORKS COMPONENTS 5, HIGHWAY VII & VIII
Description	:	M1 OVERBRIDGE RETAINING WALL ASSESSMENT
Customer	:	ROXHILL KEGWORTH LTD
Author	:	Ian Gardner
Date	:	03/08/2017
Project ID	:	C14792
Project number	:	EMG-HYD-C4-M1OB-CA-GE-0663-S4-P3

Settings

United Kingdom - EN 1997

Materials and standards

Concrete structures :	EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 :	standard

Wall analysis

Active earth pressure calculation :	Coulomb
Passive earth pressure calculation :	Caquot-Kerisel
Earthquake analysis :	Mononobe-Okabe
Shape of earth wedge :	Calculate as skew
Base key :	The base key is considered as inclined footing bottom
Allowable eccentricity :	0.333
Verification methodology :	according to EN 1997
Design approach :	1 - reduction of actions and soil parameters

Partial factors on actions (A)
Permanent design situation

		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	$\psi_G =$	1.35	[–]	1.00	[–]	1.00	[–]	1.00	[–]
Variable actions :	$\psi_Q =$	1.50	[–]	0.00	[–]	1.30	[–]	0.00	[–]
Water load :	$\psi_w =$	1.35	[–]			1.00	[–]		

Partial factors for soil parameters (M)
Permanent design situation

		Combination 1		Combination 2	
Partial factor on internal friction :	$\psi_\phi =$	1.00	[–]	1.25	[–]
Partial factor on effective cohesion :	$\psi_c =$	1.00	[–]	1.25	[–]
Partial factor on undrained shear strength :	$\psi_{cu} =$	1.00	[–]	1.40	[–]
Partial factor on Poisson's ratio :	$\psi_v =$	1.00	[–]	1.00	[–]

Partial factors for variable actions
Permanent design situation

Factor for combination value :	$\psi_0 =$	0.70	[–]
Factor for frequent value :	$\psi_1 =$	0.50	[–]
Factor for quasi-permanent value :	$\psi_2 =$	0.30	[–]

Material of structure

Unit weight ψ = 23.00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 20/25

Cylinder compressive strength	f_{ck} =	20.00 MPa
Tensile strength	f_{ctm} =	2.20 MPa

Longitudinal steel : B500

Yield strength	f_{yk} =	500.00 MPa

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.00	5.00
3	4.00	5.00
4	4.00	6.00
5	-1.00	6.00
6	-1.00	5.00
7	-1.00	0.00

The origin [0,0] is located at the most upper right point of the wall.
Wall section area = 10.00 m^2.

Basic soil parameters - (effective stress-state)

No.	Name	Pattern	$\chi\pi_{ef}$ [°]	c_{ef} [kPa]	ψ [kN/m^3]	ψ_{su} [kN/m^3]	0 [°]
2	Firm to stiff red brown silty CLAY - MMG IVB		25.00	2.00	19.50	10.50	7.50
3	Stiff red brown silty CLAY - MMG IVA		32.00	4.00	20.50	11.00	10.00
4	Weathered Mudstone - MMG III		32.00	10.00	22.00	12.00	10.00
5	Weathered Mudstone - MMG II		42.00	16.00	22.50	12.50	14.00
6	Intact Mudstone - MMG I		42.00	25.00	23.00	13.00	14.00
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		40.00	8.00	22.50	13.00	12.00
8	Existing Highway General Fill		25.00	2.00	19.50	10.50	10.00
9	Class 2 Fill (Site Won MMG IV)		25.00	2.00	19.50	10.50	10.00
10	Class 6F Capping/Subbase/Surfacing		35.00	0.00	21.00	11.50	15.00
12	Terrace Sands & Gravels		35.00	0.00	22.00	12.50	15.00
13	Class 7A Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
14	Class 7C Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00

No.	Name	Pattern	$\chi\pi_{ef}$ [°]	c_{ef} [kPa]	ψ [kN/m^3]	ψ_{su} [kN/m^3]	0 [°]
15	Pre-existing Made Ground		25.00	0.00	19.00	9.50	8.00
16	Culvert		41.50	0.00	2.40	0.00	25.00
17	Granular Backfill to Culvert		41.50	0.00	18.00	8.00	16.00
18	Class 6N Selected Backfill to Structures		41.50	0.00	22.50	13.00	16.60
19	Redcued Level 78 - 77 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
20	Redcued Level 77 - 76 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
21	Redcued Level 76 - 75 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
22	Redcued Level 75 - 74 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
23	Redcued Level 74 - 73 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
24	Redcued Level 73 - 72 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
25	Redcued Level 72 - 71 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
26	Redcued Level 71 - 70 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
27	Redcued Level 70 - 69 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
28	Redcued Level 69 - 68 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
29	Redcued Level 68 - 67 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
30	Redcued Level 67 - 66 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
31	Redcued Level 66 - 65 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
32	Redcued Level 65 - 64 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
33	Redcued Level 64 - 63 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
34	Redcued Level 63 - 62 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
35	Redcued Level 62 - 61 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
36	Redcued Level 61 - 60 m OD - MMG II		42.00	16.00	22.50	12.50	14.00

Basic soil parameters - (total stress-state)

No.	Name	Pattern	c_u [kPa]	a [kPa]	ψ [kN/m³]
1	Topsoil/Subsoil		35.00	28.00	16.50
11	Landscape Fill - Class 4		50.00	20.00	20.00
37	Redcued Level 60 - 59 m OD - MMG I		1097.00	116.00	23.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	$\chi\pi_{ef}$ [°]	ς [–]	OCR [–]	K_r [–]
1	Topsoil/Subsoil		cohesionless	0.00	-	-	-
2	Firm to stiff red brown silty CLAY - MMG IVB		cohesive	-	0.40	-	-
3	Stiff red brown silty CLAY - MMG IVA		cohesive	-	0.40	-	-
4	Weathered Mudstone - MMG III		overconsolidated	-	-	2.00	-
5	Weathered Mudstone - MMG II		overconsolidated	-	-	3.00	-
6	Intact Mudstone - MMG I		overconsolidated	-	-	6.00	-
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		cohesionless	40.00	-	-	-
8	Existing Highway General Fill		cohesive	-	0.35	-	-
9	Class 2 Fill (Site Won MMG IV)		cohesive	-	0.35	-	-
10	Class 6F Capping/Subbase/Surfacing		cohesionless	35.00	-	-	-
11	Landscape Fill - Class 4		cohesive	-	0.40	-	-
12	Terrace Sands & Gravels		cohesionless	35.00	-	-	-
13	Class 7A Selected Cohesive Fill		cohesive	-	0.40	-	-
14	Class 7C Selected Cohesive Fill		cohesive	-	0.40	-	-
15	Pre-existing Made Ground		cohesive	-	0.35	-	-
16	Culvert		cohesionless	41.50	-	-	-
17	Granular Backfill to Culvert		cohesionless	41.50	-	-	-

No.	Name	Pattern	Type calculation	$\chi\pi_{ef}$ [°]	ς [–]	OCR [–]	K_r [–]
18	Class 6N Selected Backfill to Structures		cohesionless	41.50	-	-	-
19	Redcued Level 78 - 77 m OD - MMG IVB		cohesive	-	0.40	-	-
20	Redcued Level 77 - 76 m OD - MMG IVB		cohesive	-	0.40	-	-
21	Redcued Level 76 - 75 m OD - MMG IVB		cohesive	-	0.40	-	-
22	Redcued Level 75 - 74 m OD - MMG IVA		cohesive	-	0.40	-	-
23	Redcued Level 74 - 73 m OD - MMG IVA		cohesive	-	0.40	-	-
24	Redcued Level 73 - 72 m OD - MMG IVA		cohesive	-	0.40	-	-
25	Redcued Level 72 - 71 m OD - MMG IVA		cohesive	-	0.40	-	-
26	Redcued Level 71 - 70 m OD - MMG III		overconsolidated	-	-	2.00	-
27	Redcued Level 70 - 69 m OD - MMG III		overconsolidated	-	-	2.00	-
28	Redcued Level 69 - 68 m OD - MMG III		overconsolidated	-	-	2.00	-
29	Redcued Level 68 - 67 m OD - MMG III		overconsolidated	-	-	2.00	-
30	Redcued Level 67 - 66 m OD - MMG III		overconsolidated	-	-	2.00	-
31	Redcued Level 66 - 65 m OD - MMG III		overconsolidated	-	-	2.00	-
32	Redcued Level 65 - 64 m OD - MMG II		overconsolidated	-	-	2.00	-
33	Redcued Level 64 - 63 m OD - MMG II		overconsolidated	-	-	2.00	-
34	Redcued Level 63 - 62 m OD - MMG II		overconsolidated	-	-	2.00	-
35	Redcued Level 62 - 61 m OD - MMG II		overconsolidated	-	-	2.00	-
36	Redcued Level 61 - 60 m OD - MMG II		overconsolidated	-	-	2.00	-
37	Redcued Level 60 - 59 m OD - MMG I		overconsolidated	-	-	2.00	-

Soil parameters

Topsoil/Subsoil

Unit weight : ψ = 16.50 kN/m^3
Stress-state : total

Cohesion of soil :	c_u = 35.00 kPa
Adhesion struc.-soil :	a = 28.00 kPa
Soil :	cohesionless

Firm to stiff red brown silty CLAY - MMG IVB

Unit weight :	ψ = 19.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 25.00 °
Cohesion of soil :	c_{ef} = 2.00 kPa
Angle of friction struc.-soil :	0 = 7.50 °
Soil :	cohesive
Poisson's ratio :	ς = 0.40
Saturated unit weight :	ψ_{sat} = 20.50 kN/m^3

Stiff red brown silty CLAY - MMG IVA

Unit weight :	ψ = 20.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 32.00 °
Cohesion of soil :	c_{ef} = 4.00 kPa
Angle of friction struc.-soil :	0 = 10.00 °
Soil :	cohesive
Poisson's ratio :	ς = 0.40
Saturated unit weight :	ψ_{sat} = 21.00 kN/m^3

Weathered Mudstone - MMG III

Unit weight :	ψ = 22.00 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 32.00 °
Cohesion of soil :	c_{ef} = 10.00 kPa
Angle of friction struc.-soil :	0 = 10.00 °
Soil :	overconsolidated
Overconsolidation ratio :	OCR = 2.00
Saturated unit weight :	ψ_{sat} = 22.00 kN/m^3

Weathered Mudstone - MMG II

Unit weight :	ψ = 22.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 42.00 °
Cohesion of soil :	c_{ef} = 16.00 kPa
Angle of friction struc.-soil :	0 = 14.00 °
Soil :	overconsolidated
Overconsolidation ratio :	OCR = 3.00
Saturated unit weight :	ψ_{sat} = 22.50 kN/m^3

Intact Mudstone - MMG I

Unit weight :	ψ = 23.00 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 42.00 °
Cohesion of soil :	c_{ef} = 25.00 kPa
Angle of friction struc.-soil :	0 = 14.00 °
Soil :	overconsolidated
Overconsolidation ratio :	OCR = 6.00
Saturated unit weight :	ψ_{sat} = 23.00 kN/m^3

Bromsgrove Sandstone - Interbedded Mudstone & Sandstone

Unit weight :	ψ = 22.50 kN/m3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 40.00 °
Cohesion of soil :	c_{ef} = 8.00 kPa
Angle of friction struc.-soil :	0 = 12.00 °
Soil :	cohesionless
Saturated unit weight :	ψ_{sat} = 23.00 kN/m3

Existing Highway General Fill

Unit weight :	ψ = 19.50 kN/m3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 25.00 °
Cohesion of soil :	c_{ef} = 2.00 kPa
Angle of friction struc.-soil :	0 = 10.00 °
Soil :	cohesive
Poisson's ratio :	ς = 0.35
Saturated unit weight :	ψ_{sat} = 20.50 kN/m3

Class 2 Fill (Site Won MMG IV)

Unit weight :	ψ = 19.50 kN/m3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 25.00 °
Cohesion of soil :	c_{ef} = 2.00 kPa
Angle of friction struc.-soil :	0 = 10.00 °
Soil :	cohesive
Poisson's ratio :	ς = 0.35
Saturated unit weight :	ψ_{sat} = 20.50 kN/m3

Class 6F Capping/Subbase/Surfacing

Unit weight :	ψ = 21.00 kN/m3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 35.00 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	0 = 15.00 °
Soil :	cohesionless
Saturated unit weight :	ψ_{sat} = 21.50 kN/m3

Landscape Fill - Class 4

Unit weight :	ψ = 20.00 kN/m3
Stress-state :	total
Cohesion of soil :	c_u = 50.00 kPa
Adhesion struc.-soil :	a = 20.00 kPa
Soil :	cohesive
Poisson's ratio :	ς = 0.40

Terrace Sands & Gravels

Unit weight :	ψ = 22.00 kN/m3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 35.00 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	0 = 15.00 °
Soil :	cohesionless
Saturated unit weight :	ψ_{sat} = 22.50 kN/m3

Class 7A Selected Cohesive Fill

Unit weight : ψ = 20.50 kN/m^3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Angle of friction struc.-soil : 0 = 12.00 °
Soil : cohesive
Poisson's ratio : ς = 0.40
Saturated unit weight : ψ_{sat} = 21.00 kN/m^3

Class 7C Selected Cohesive Fill
Unit weight : ψ = 20.50 kN/m^3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 25.00 °
Cohesion of soil : c_{ef} = 2.00 kPa
Angle of friction struc.-soil : 0 = 12.00 °
Soil : cohesive
Poisson's ratio : ς = 0.40
Saturated unit weight : ψ_{sat} = 21.00 kN/m^3

Pre-existing Made Ground
Unit weight : ψ = 19.00 kN/m^3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 25.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Angle of friction struc.-soil : 0 = 8.00 °
Soil : cohesive
Poisson's ratio : ς = 0.35
Saturated unit weight : ψ_{sat} = 19.50 kN/m^3

Culvert
Unit weight : ψ = 2.40 kN/m^3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Angle of friction struc.-soil : 0 = 25.00 °
Soil : cohesionless
Saturated unit weight : ψ_{sat} = 2.40 kN/m^3

Granular Backfill to Culvert
Unit weight : ψ = 18.00 kN/m^3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Angle of friction struc.-soil : 0 = 16.00 °
Soil : cohesionless
Saturated unit weight : ψ_{sat} = 18.00 kN/m^3

Class 6N Selected Backfill to Structures
Unit weight : ψ = 22.50 kN/m^3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 41.50 °
Cohesion of soil : c_{ef} = 0.00 kPa
Angle of friction struc.-soil : 0 = 16.60 °
Soil : cohesionless

Saturated unit weight :	ψ_{sat} =	23.00 kN/m3

Redcued Level 78 - 77 m OD - MMG IVB

Unit weight :	ψ =	19.50 kN/m3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	25.00 °
Cohesion of soil :	c_{ef} =	2.00 kPa
Angle of friction struc.-soil :	0 =	8.30 °
Soil :	cohesive	
Poisson's ratio :	ς =	0.40
Saturated unit weight :	ψ_{sat} =	20.50 kN/m3

Redcued Level 77 - 76 m OD - MMG IVB

Unit weight :	ψ =	19.50 kN/m3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	25.00 °
Cohesion of soil :	c_{ef} =	2.00 kPa
Angle of friction struc.-soil :	0 =	8.30 °
Soil :	cohesive	
Poisson's ratio :	ς =	0.40
Saturated unit weight :	ψ_{sat} =	20.50 kN/m3

Redcued Level 76 - 75 m OD - MMG IVB

Unit weight :	ψ =	19.50 kN/m3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	25.00 °
Cohesion of soil :	c_{ef} =	2.00 kPa
Angle of friction struc.-soil :	0 =	8.30 °
Soil :	cohesive	
Poisson's ratio :	ς =	0.40
Saturated unit weight :	ψ_{sat} =	20.50 kN/m3

Redcued Level 75 - 74 m OD - MMG IVA

Unit weight :	ψ =	20.50 kN/m3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Angle of friction struc.-soil :	0 =	10.70 °
Soil :	cohesive	
Poisson's ratio :	ς =	0.40
Saturated unit weight :	ψ_{sat} =	21.00 kN/m3

Redcued Level 74 - 73 m OD - MMG IVA

Unit weight :	ψ =	20.50 kN/m3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Angle of friction struc.-soil :	0 =	10.70 °
Soil :	cohesive	
Poisson's ratio :	ς =	0.40
Saturated unit weight :	ψ_{sat} =	21.00 kN/m3

Redcued Level 73 - 72 m OD - MMG IVA

Unit weight :	ψ =	20.50 kN/m3
Stress-state :	effective	

Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Angle of friction struc.-soil :	0 =	10.70 °
Soil :	cohesive	
Poisson's ratio :	ς =	0.40
Saturated unit weight :	ψ_{sat} =	21.00 kN/m^3

Redcued Level 72 - 71 m OD - MMG IVA

Unit weight :	ψ =	20.50 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	4.00 kPa
Angle of friction struc.-soil :	0 =	10.70 °
Soil :	cohesive	
Poisson's ratio :	ς =	0.40
Saturated unit weight :	ψ_{sat} =	21.00 kN/m^3

Redcued Level 71 - 70 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Angle of friction struc.-soil :	0 =	10.70 °
Soil :	overconsolidated	
Overconsolidation ratio :	OCR =	2.00
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 70 - 69 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Angle of friction struc.-soil :	0 =	10.70 °
Soil :	overconsolidated	
Overconsolidation ratio :	OCR =	2.00
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 69 - 68 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Angle of friction struc.-soil :	0 =	10.70 °
Soil :	overconsolidated	
Overconsolidation ratio :	OCR =	2.00
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 68 - 67 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Angle of friction struc.-soil :	0 =	10.70 °
Soil :	overconsolidated	
Overconsolidation ratio :	OCR =	2.00

Saturated unit weight : ψ_{sat} = 22.00 kN/m3

Redcued Level 67 - 66 m OD - MMG III
Unit weight : ψ = 22.00 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Angle of friction struc.-soil : 0 = 10.70 °
Soil : overconsolidated
Overconsolidation ratio : OCR = 2.00
Saturated unit weight : ψ_{sat} = 22.00 kN/m3

Redcued Level 66 - 65 m OD - MMG III
Unit weight : ψ = 22.00 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 32.00 °
Cohesion of soil : c_{ef} = 10.00 kPa
Angle of friction struc.-soil : 0 = 10.70 °
Soil : overconsolidated
Overconsolidation ratio : OCR = 2.00
Saturated unit weight : ψ_{sat} = 22.00 kN/m3

Redcued Level 65 - 64 m OD - MMG II
Unit weight : ψ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Angle of friction struc.-soil : 0 = 14.00 °
Soil : overconsolidated
Overconsolidation ratio : OCR = 2.00
Saturated unit weight : ψ_{sat} = 22.50 kN/m3

Redcued Level 64 - 63 m OD - MMG II
Unit weight : ψ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Angle of friction struc.-soil : 0 = 14.00 °
Soil : overconsolidated
Overconsolidation ratio : OCR = 2.00
Saturated unit weight : ψ_{sat} = 22.50 kN/m3

Redcued Level 63 - 62 m OD - MMG II
Unit weight : ψ = 22.50 kN/m3
Stress-state : effective
Angle of internal friction : $\chi\pi_{ef}$ = 42.00 °
Cohesion of soil : c_{ef} = 16.00 kPa
Angle of friction struc.-soil : 0 = 14.00 °
Soil : overconsolidated
Overconsolidation ratio : OCR = 2.00
Saturated unit weight : ψ_{sat} = 22.50 kN/m3

Redcued Level 62 - 61 m OD - MMG II
Unit weight : ψ = 22.50 kN/m3
Stress-state : effective

Angle of internal friction :	$\chi\pi_{ef}$ =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Angle of friction struc.-soil :	0 =	14.00 °
Soil :	overconsolidated	
Overconsolidation ratio :	OCR =	2.00
Saturated unit weight :	ψ_{sat} =	22.50 kN/m^3

Redcued Level 61 - 60 m OD - MMG II

Unit weight :	ψ =	22.50 kN/m^3
Stress-state :	effective	
Angle of internal friction :	$\chi\pi_{ef}$ =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Angle of friction struc.-soil :	0 =	14.00 °
Soil :	overconsolidated	
Overconsolidation ratio :	OCR =	2.00
Saturated unit weight :	ψ_{sat} =	22.50 kN/m^3

Redcued Level 60 - 59 m OD - MMG I

Unit weight :	ψ =	23.00 kN/m^3
Stress-state :	total	
Cohesion of soil :	c_u =	1097.00 kPa
Adhesion struc.-soil :	a =	116.00 kPa
Soil :	overconsolidated	
Overconsolidation ratio :	OCR =	2.00

Backfill

Soil on front face of the structure - Class 6N Selected Backfill to Structures

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	1.00	Redcued Level 77 - 76 m OD - MMG IVB	
2	1.00	Redcued Level 76 - 75 m OD - MMG IVB	
3	1.00	Redcued Level 75 - 74 m OD - MMG IVA	
4	1.00	Redcued Level 74 - 73 m OD - MMG IVA	
5	1.00	Redcued Level 73 - 72 m OD - MMG IVA	
6	1.00	Redcued Level 72 - 71 m OD - MMG IVA	
7	0.50	Class 6N Selected Backfill to Structures	
8	0.50	Redcued Level 71 - 70 m OD - MMG III	
9	1.00	Redcued Level 70 - 69 m OD - MMG III	
10	1.00	Redcued Level 69 - 68 m OD - MMG III	

No.	Layer [m]	Assigned soil	Pattern
11	1.00	Redcued Level 68 - 67 m OD - MMG III	
12	1.00	Redcued Level 67 - 66 m OD - MMG III	
13	1.00	Redcued Level 66 - 65 m OD - MMG III	
14	1.00	Redcued Level 65 - 64 m OD - MMG II	
15	1.00	Redcued Level 64 - 63 m OD - MMG II	
16	1.00	Redcued Level 63 - 62 m OD - MMG II	
17	1.00	Redcued Level 62 - 61 m OD - MMG II	
18	1.00	Redcued Level 61 - 60 m OD - MMG II	
19	1.00	Redcued Level 60 - 59 m OD - MMG I	
20	-	Redcued Level 60 - 59 m OD - MMG I	

Foundation

Type of foundation : soil from geological profile

Terrain profile

Terrain behind the structure is flat.

Water influence

GWT behind the structure lies at a depth of 11.00 m
Uplift in foot. bottom due to different pressures is not considered.

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m²]	Mag.2 [kN/m²]	Ord.x x [m]	Length l [m]	Depth z [m]
1	Yes		permanent	20.00				on terrain

No.	Name
1	TYPICAL HIGHWAY UDL

Resistance on front face of the structure

Resistance on front face of the structure: at rest
Soil on front face of the structure - Class 6N Selected Backfill to Structures
Soil thickness in front of structure h = 1.00 m

Terrain in front of structure is flat.

Settings of the stage of construction

Design situation : permanent
The wall is free to move. Active earth pressure is therefore assumed.

No. 1

Forces acting on construction - combination 1

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-2.00	230.00	1.50	1.000	1.000	1.350
FF resistance	-3.80	-0.33	0.00	0.00	1.000	1.000	1.000
Weight - earth wedge	0.00	-3.17	323.31	2.51	1.000	1.000	1.350
Active pressure	79.32	-2.05	133.31	4.29	1.000	1.000	1.350
Water pressure	0.00	-6.00	0.00	2.75	1.000	1.000	1.000
TYPICAL HIGHWAY UDL	23.89	-3.05	46.11	3.90	1.350	1.000	1.350
TYPICAL HIGHWAY UDL	0.00	-6.00	34.95	1.87	1.000	1.000	1.350

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 2036.42 kNm/m
Overturning moment M_{ovr} = 260.00 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 497.83 kN/m
Active horizontal force H_{act} = 99.41 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 228.81 kPa

Forces acting on construction - combination 2

Name	F_{hor} [kN/m]	App.Pt. z [m]	F_{vert} [kN/m]	App.Pt. x [m]	Coeff. overtur.	Coeff. sliding	Coeff. stress
Weight - wall	0.00	-2.00	230.00	1.50	1.000	1.000	1.000
FF resistance	-4.75	-0.33	0.00	0.00	1.000	1.000	1.000
Weight - earth wedge	0.00	-3.17	323.31	2.51	1.000	1.000	1.000
Active pressure	104.39	-2.05	134.79	4.29	1.000	1.000	1.000
Water pressure	0.00	-6.00	0.00	2.75	1.000	1.000	1.000
TYPICAL HIGHWAY UDL	31.40	-3.04	46.49	3.90	1.000	1.000	1.000
TYPICAL HIGHWAY UDL	0.00	-6.00	34.95	1.87	1.000	1.000	1.000

Verification of complete wall

Check for overturning stability
Resisting moment M_{res} = 1981.93 kNm/m
Overturning moment M_{ovr} = 308.08 kNm/m

Wall for overturning is SATISFACTORY

Check for slip
Resisting horizontal force H_{res} = 398.61 kN/m
Active horizontal force H_{act} = 131.03 kN/m

Wall for slip is SATISFACTORY

Overall check - WALL is SATISFACTORY

Maximum stress in footing bottom : 176.90 kPa

Bearing capacity of foundation soil

Design load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]	Eccentricity [–]	Stress [kPa]
1	243.81	1036.38	135.53	0.047	228.81
2	183.16	783.83	99.41	0.047	172.93
3	250.02	769.54	131.03	0.065	176.90
4	250.02	769.54	131.03	0.065	176.90

Service load acting at the center of footing bottom

No.	Moment [kNm/m]	Norm. force [kN/m]	Shear Force [kN/m]
1	180.27	767.69	99.41

Spread footing verification

Input data

Settings

United Kingdom - EN 1997

Materials and standards

Concrete structures : EN 1992-1-1 (EC2)
Coefficients EN 1992-1-1 : standard

Settlement

Analysis method : Analysis using oedometric modulus
Restriction of influence zone : by percentage of Sigma,Or
Coeff. of restriction of influence zone : 10.0 [%]

Spread Footing

Analysis for drained conditions : EC 7-1 (EN 1997-1:2003)
Analysis of uplift : Standard
Allowable eccentricity : 0.333
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)									
Permanent design situation									
		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	γ_G =	1.35	[–]	1.00	[–]	1.00	[–]	1.00	[–]

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	γ_ϕ =	1.00	[–]	1.25	[–]
Partial factor on effective cohesion :	γ_c =	1.00	[–]	1.25	[–]
Partial factor on undrained shear strength :	γ_{cu} =	1.00	[–]	1.40	[–]
Partial factor on unconfined strength :	γ_v =	1.00	[–]	1.40	[–]

Basic soil parameters - (effective stress-state)

No.	Name	Pattern	$\chi\pi_{ef}$ [°]	c_{ef} [kPa]	ψ [kN/m^3]	ψ_{su} [kN/m^3]	0 [°]
2	Firm to stiff red brown silty CLAY - MMG IVB		25.00	2.00	19.50	10.50	7.50
3	Stiff red brown silty CLAY - MMG IVA		32.00	4.00	20.50	11.00	10.00
4	Weathered Mudstone - MMG III		32.00	10.00	22.00	12.00	10.00
5	Weathered Mudstone - MMG II		42.00	16.00	22.50	12.50	14.00
6	Intact Mudstone - MMG I		42.00	25.00	23.00	13.00	14.00
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		40.00	8.00	22.50	13.00	12.00
8	Existing Highway General Fill		25.00	2.00	19.50	10.50	10.00
9	Class 2 Fill (Site Won MMG IV)		25.00	2.00	19.50	10.50	10.00
10	Class 6F Capping/Subbase/Surfacing		35.00	0.00	21.00	11.50	15.00
12	Terrace Sands & Gravels		35.00	0.00	22.00	12.50	15.00
13	Class 7A Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
14	Class 7C Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
15	Pre-existing Made Ground		25.00	0.00	19.00	9.50	8.00
16	Culvert		41.50	0.00	2.40	0.00	25.00
17	Granular Backfill to Culvert		41.50	0.00	18.00	8.00	16.00
18	Class 6N Selected Backfill to Structures		41.50	0.00	22.50	13.00	16.60
19	Redcued Level 78 - 77 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
20	Redcued Level 77 - 76 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
21	Redcued Level 76 - 75 m OD - MMG IVB		25.00	2.00	19.50	10.50	8.30
22	Redcued Level 75 - 74 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
23	Redcued Level 74 - 73 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70

No.	Name	Pattern	$\chi\pi_{ef}$ [°]	c_{ef} [kPa]	ψ [kN/m^3]	ψ_{su} [kN/m^3]	0 [°]
24	Redcued Level 73 - 72 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
25	Redcued Level 72 - 71 m OD - MMG IVA		32.00	4.00	20.50	11.00	10.70
26	Redcued Level 71 - 70 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
27	Redcued Level 70 - 69 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
28	Redcued Level 69 - 68 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
29	Redcued Level 68 - 67 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
30	Redcued Level 67 - 66 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
31	Redcued Level 66 - 65 m OD - MMG III		32.00	10.00	22.00	12.00	10.70
32	Redcued Level 65 - 64 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
33	Redcued Level 64 - 63 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
34	Redcued Level 63 - 62 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
35	Redcued Level 62 - 61 m OD - MMG II		42.00	16.00	22.50	12.50	14.00
36	Redcued Level 61 - 60 m OD - MMG II		42.00	16.00	22.50	12.50	14.00

Basic soil parameters - (total stress-state)

No.	Name	Pattern	c_u [kPa]	a [kPa]	ψ [kN/m^3]
1	Topsoil/Subsoil		35.00	28.00	16.50
11	Landscape Fill - Class 4		50.00	20.00	20.00
37	Redcued Level 60 - 59 m OD - MMG I		1097.00	116.00	23.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	$\chi\pi_{ef}$ [°]	ς [–]	OCR [–]	K_r [–]
1	Topsoil/Subsoil		cohesionless	0.00	-	-	-
2	Firm to stiff red brown silty CLAY - MMG IVB		cohesive	-	0.40	-	-

No.	Name	Pattern	Type calculation	$\chi\pi_{ef}$ [°]	ς [–]	OCR [–]	K_r [–]
3	Stiff red brown silty CLAY - MMG IVA		cohesive	-	0.40	-	-
4	Weathered Mudstone - MMG III		overconsolidated	-	-	2.00	-
5	Weathered Mudstone - MMG II		overconsolidated	-	-	3.00	-
6	Intact Mudstone - MMG I		overconsolidated	-	-	6.00	-
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		cohesionless	40.00	-	-	-
8	Existing Highway General Fill		cohesive	-	0.35	-	-
9	Class 2 Fill (Site Won MMG IV)		cohesive	-	0.35	-	-
10	Class 6F Capping/Subbase/Surfacing		cohesionless	35.00	-	-	-
11	Landscape Fill - Class 4		cohesive	-	0.40	-	-
12	Terrace Sands & Gravels		cohesionless	35.00	-	-	-
13	Class 7A Selected Cohesive Fill		cohesive	-	0.40	-	-
14	Class 7C Selected Cohesive Fill		cohesive	-	0.40	-	-
15	Pre-existing Made Ground		cohesive	-	0.35	-	-
16	Culvert		cohesionless	41.50	-	-	-
17	Granular Backfill to Culvert		cohesionless	41.50	-	-	-
18	Class 6N Selected Backfill to Structures		cohesionless	41.50	-	-	-
19	Redcued Level 78 - 77 m OD - MMG IVB		cohesive	-	0.40	-	-
20	Redcued Level 77 - 76 m OD - MMG IVB		cohesive	-	0.40	-	-
21	Redcued Level 76 - 75 m OD - MMG IVB		cohesive	-	0.40	-	-
22	Redcued Level 75 - 74 m OD - MMG IVA		cohesive	-	0.40	-	-
23	Redcued Level 74 - 73 m OD - MMG IVA		cohesive	-	0.40	-	-
24	Redcued Level 73 - 72 m OD - MMG IVA		cohesive	-	0.40	-	-

No.	Name	Pattern	Type calculation	$\chi\pi_{ef}$ [°]	ς [–]	OCR [–]	K_r [–]
25	Redcued Level 72 - 71 m OD - MMG IVA		cohesive	-	0.40	-	-
26	Redcued Level 71 - 70 m OD - MMG III		overconsolidated	-	-	2.00	-
27	Redcued Level 70 - 69 m OD - MMG III		overconsolidated	-	-	2.00	-
28	Redcued Level 69 - 68 m OD - MMG III		overconsolidated	-	-	2.00	-
29	Redcued Level 68 - 67 m OD - MMG III		overconsolidated	-	-	2.00	-
30	Redcued Level 67 - 66 m OD - MMG III		overconsolidated	-	-	2.00	-
31	Redcued Level 66 - 65 m OD - MMG III		overconsolidated	-	-	2.00	-
32	Redcued Level 65 - 64 m OD - MMG II		overconsolidated	-	-	2.00	-
33	Redcued Level 64 - 63 m OD - MMG II		overconsolidated	-	-	2.00	-
34	Redcued Level 63 - 62 m OD - MMG II		overconsolidated	-	-	2.00	-
35	Redcued Level 62 - 61 m OD - MMG II		overconsolidated	-	-	2.00	-
36	Redcued Level 61 - 60 m OD - MMG II		overconsolidated	-	-	2.00	-
37	Redcued Level 60 - 59 m OD - MMG I		overconsolidated	-	-	2.00	-

Soil parameters

Topsoil/Subsoil

Unit weight :	ψ	=	16.50 kN/m3
Angle of internal friction :	$\chi\pi_{ef}$	=	24.50 °
Cohesion of soil :	c_{ef}	=	14.00 kPa
Oedometric modulus :	E_{oed}	=	2.50 MPa
Saturated unit weight :	ψ_{sat}	=	18.50 kN/m3

Firm to stiff red brown silty CLAY - MMG IVB

Unit weight :	ψ	=	19.50 kN/m3
Angle of internal friction :	$\chi\pi_{ef}$	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Oedometric modulus :	E_{oed}	=	44.00 MPa
Saturated unit weight :	ψ_{sat}	=	20.50 kN/m3

Stiff red brown silty CLAY - MMG IVA

Unit weight :	ψ	=	20.50 kN/m3
Angle of internal friction :	$\chi\pi_{ef}$	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa
Oedometric modulus :	E_{oed}	=	68.00 MPa

Saturated unit weight : γ_{sat} = 21.00 kN/m³

Weathered Mudstone - MMG III

Unit weight :	γ =	22.00 kN/m^3
Angle of internal friction :	φ_{ef} =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Oedometric modulus :	E_{oed} =	120.00 MPa
Saturated unit weight :	γ_{sat} =	22.00 kN/m^3

Weathered Mudstone - MMG II

Unit weight :	γ =	22.50 kN/m^3
Angle of internal friction :	φ_{ef} =	42.00 °
Cohesion of soil :	c_{ef} =	16.00 kPa
Oedometric modulus :	E_{oed} =	200.00 MPa
Saturated unit weight :	γ_{sat} =	22.50 kN/m^3

Intact Mudstone - MMG I

Unit weight :	γ =	23.00 kN/m^3
Angle of internal friction :	φ_{ef} =	42.00 °
Cohesion of soil :	c_{ef} =	25.00 kPa
Oedometric modulus :	E_{oed} =	400.00 MPa
Saturated unit weight :	γ_{sat} =	23.00 kN/m^3

Bromsgrove Sandstone - Interbedded Mudstone & Sandstone

Unit weight :	γ =	22.50 kN/m^3
Angle of internal friction :	φ_{ef} =	40.00 °
Cohesion of soil :	c_{ef} =	8.00 kPa
Oedometric modulus :	E_{oed} =	250.00 MPa
Saturated unit weight :	γ_{sat} =	23.00 kN/m^3

Existing Highway General Fill

Unit weight :	γ =	19.50 kN/m^3
Angle of internal friction :	φ_{ef} =	25.00 °
Cohesion of soil :	c_{ef} =	2.00 kPa
Oedometric modulus :	E_{oed} =	17.50 MPa
Saturated unit weight :	γ_{sat} =	20.50 kN/m^3

Class 2 Fill (Site Won MMG IV)

Unit weight :	γ =	19.50 kN/m^3
Angle of internal friction :	φ_{ef} =	25.00 °
Cohesion of soil :	c_{ef} =	2.00 kPa
Oedometric modulus :	E_{oed} =	8.50 MPa
Saturated unit weight :	γ_{sat} =	20.50 kN/m^3

Class 6F Capping/Subbase/Surfacing

Unit weight :	γ =	21.00 kN/m^3
Angle of internal friction :	φ_{ef} =	35.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Oedometric modulus :	E_{oed} =	478.00 MPa
Saturated unit weight :	γ_{sat} =	21.50 kN/m^3

Landscape Fill - Class 4

Unit weight :	γ =	20.00 kN/m^3

Angle of internal friction :	$\chi\pi_{ef}$ =	25.00 °
Cohesion of soil :	c_{ef} =	1.00 kPa
Oedometric modulus :	E_{oed} =	8.50 MPa
Saturated unit weight :	ψ_{sat} =	20.50 kN/m^3

Terrace Sands & Gravels

Unit weight :	ψ =	22.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	35.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Oedometric modulus :	E_{oed} =	65.00 MPa
Saturated unit weight :	ψ_{sat} =	22.50 kN/m^3

Class 7A Selected Cohesive Fill

Unit weight :	ψ =	20.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	25.00 °
Cohesion of soil :	c_{ef} =	2.00 kPa
Oedometric modulus :	E_{oed} =	20.00 MPa
Saturated unit weight :	ψ_{sat} =	21.00 kN/m^3

Class 7C Selected Cohesive Fill

Unit weight :	ψ =	20.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	25.00 °
Cohesion of soil :	c_{ef} =	2.00 kPa
Oedometric modulus :	E_{oed} =	20.00 MPa
Saturated unit weight :	ψ_{sat} =	21.00 kN/m^3

Pre-existing Made Ground

Unit weight :	ψ =	19.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	25.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Oedometric modulus :	E_{oed} =	17.50 MPa
Saturated unit weight :	ψ_{sat} =	19.50 kN/m^3

Culvert

Unit weight :	ψ =	2.40 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	41.50 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Oedometric modulus :	E_{oed} =	478.00 MPa
Saturated unit weight :	ψ_{sat} =	2.40 kN/m^3

Granular Backfill to Culvert

Unit weight :	ψ =	18.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	41.50 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Oedometric modulus :	E_{oed} =	478.00 MPa
Saturated unit weight :	ψ_{sat} =	18.00 kN/m^3

Class 6N Selected Backfill to Structures

Unit weight :	ψ =	22.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	41.50 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Oedometric modulus :	E_{oed} =	478.00 MPa
Saturated unit weight :	ψ_{sat} =	23.00 kN/m^3

Redcued Level 78 - 77 m OD - MMG IVB

Unit weight :	ψ	=	19.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Deformation modulus :	E_{def}	=	10.00 MPa
Poisson's ratio :	ς	=	0.40
Saturated unit weight :	ψ_{sat}	=	20.50 kN/m^3

Redcued Level 77 - 76 m OD - MMG IVB

Unit weight :	ψ	=	19.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Deformation modulus :	E_{def}	=	20.00 MPa
Poisson's ratio :	ς	=	0.40
Saturated unit weight :	ψ_{sat}	=	20.50 kN/m^3

Redcued Level 76 - 75 m OD - MMG IVB

Unit weight :	ψ	=	19.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Deformation modulus :	E_{def}	=	30.00 MPa
Poisson's ratio :	ς	=	0.40
Saturated unit weight :	ψ_{sat}	=	20.50 kN/m^3

Redcued Level 75 - 74 m OD - MMG IVA

Unit weight :	ψ	=	20.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa
Deformation modulus :	E_{def}	=	40.00 MPa
Poisson's ratio :	ς	=	0.40
Saturated unit weight :	ψ_{sat}	=	21.00 kN/m^3

Redcued Level 74 - 73 m OD - MMG IVA

Unit weight :	ψ	=	20.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa
Deformation modulus :	E_{def}	=	50.00 MPa
Poisson's ratio :	ς	=	0.40
Saturated unit weight :	ψ_{sat}	=	21.00 kN/m^3

Redcued Level 73 - 72 m OD - MMG IVA

Unit weight :	ψ	=	20.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa
Deformation modulus :	E_{def}	=	60.00 MPa
Poisson's ratio :	ς	=	0.40
Saturated unit weight :	ψ_{sat}	=	21.00 kN/m^3

Redcued Level 72 - 71 m OD - MMG IVA

Unit weight :	ψ	=	20.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa

Deformation modulus :	E_{def} =	70.00 MPa
Poisson's ratio :	ς =	0.40
Saturated unit weight :	ψ_{sat} =	21.00 kN/m^3

Redcued Level 71 - 70 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Deformation modulus :	E_{def} =	80.00 MPa
Poisson's ratio :	ς =	0.30
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 70 - 69 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Deformation modulus :	E_{def} =	90.00 MPa
Poisson's ratio :	ς =	0.30
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 69 - 68 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Deformation modulus :	E_{def} =	100.00 MPa
Poisson's ratio :	ς =	0.30
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 68 - 67 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Deformation modulus :	E_{def} =	110.00 MPa
Poisson's ratio :	ς =	0.30
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 67 - 66 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Deformation modulus :	E_{def} =	120.00 MPa
Poisson's ratio :	ς =	0.30
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 66 - 65 m OD - MMG III

Unit weight :	ψ =	22.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$ =	32.00 °
Cohesion of soil :	c_{ef} =	10.00 kPa
Deformation modulus :	E_{def} =	130.00 MPa
Poisson's ratio :	ς =	0.30
Saturated unit weight :	ψ_{sat} =	22.00 kN/m^3

Redcued Level 65 - 64 m OD - MMG II

Unit weight :	ψ	=	22.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Deformation modulus :	E_{def}	=	151.50 MPa
Poisson's ratio :	ς	=	0.25
Saturated unit weight :	ψ_{sat}	=	22.50 kN/m^3

Redcued Level 64 - 63 m OD - MMG II

Unit weight :	ψ	=	22.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Deformation modulus :	E_{def}	=	184.50 MPa
Poisson's ratio :	ς	=	0.25
Saturated unit weight :	ψ_{sat}	=	22.50 kN/m^3

Redcued Level 63 - 62 m OD - MMG II

Unit weight :	ψ	=	22.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Deformation modulus :	E_{def}	=	217.50 MPa
Poisson's ratio :	ς	=	0.25
Saturated unit weight :	ψ_{sat}	=	22.50 kN/m^3

Redcued Level 62 - 61 m OD - MMG II

Unit weight :	ψ	=	22.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Deformation modulus :	E_{def}	=	250.50 MPa
Poisson's ratio :	ς	=	0.25
Saturated unit weight :	ψ_{sat}	=	22.50 kN/m^3

Redcued Level 61 - 60 m OD - MMG II

Unit weight :	ψ	=	22.50 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Deformation modulus :	E_{def}	=	283.50 MPa
Poisson's ratio :	ς	=	0.25
Saturated unit weight :	ψ_{sat}	=	22.50 kN/m^3

Redcued Level 60 - 59 m OD - MMG I

Unit weight :	ψ	=	23.00 kN/m^3
Angle of internal friction :	$\chi\pi_{ef}$	=	42.00 °
Cohesion of soil :	c_{ef}	=	25.00 kPa
Deformation modulus :	E_{def}	=	329.17 MPa
Poisson's ratio :	ς	=	0.25
Saturated unit weight :	ψ_{sat}	=	23.00 kN/m^3

Foundation

Foundation type: strip footing

Depth from original ground surface	h_z	=	6.00	m
Depth of footing bottom	d	=	1.00	m
Foundation thickness	t	=	1.00	m
Incl. of finished grade	s_1	=	0.00	°

Incl. of footing bottom s_2 = 0.00 °

Unit weight of soil above foundation = 20.50 kN/m^3

Geometry of structure

Foundation type: strip footing

Overall strip footing length	= 5.25	m
Strip footing width (x)	= 5.00	m
Column width in the direction of x	= 0.10	m
Volume of strip footing	= 5.00	m^3/m

Inserted loading is considered per unit length of continuous footing span.

Material of structure

Unit weight ψ = 23.00 kN/m^3
Analysis of concrete structures carried out according to the standard EN 1992-1-1 (EC2).

Concrete : C 20/25

Cylinder compressive strength	f_{ck} =	20.00	MPa
Tensile strength	f_{ctm} =	2.20	MPa
Elasticity modulus	E_{cm} =	30000.00	MPa

Longitudinal steel : B500

Yield strength f_{yk} = 500.00 MPa

Transverse steel: B500

Yield strength f_{yk} = 500.00 MPa

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	1.00	Redcued Level 77 - 76 m OD - MMG IVB	
2	1.00	Redcued Level 76 - 75 m OD - MMG IVB	
3	1.00	Redcued Level 75 - 74 m OD - MMG IVA	
4	1.00	Redcued Level 74 - 73 m OD - MMG IVA	
5	1.00	Redcued Level 73 - 72 m OD - MMG IVA	
6	1.00	Redcued Level 72 - 71 m OD - MMG IVA	
7	0.50	Class 6N Selected Backfill to Structures	
8	0.50	Redcued Level 71 - 70 m OD - MMG III	
9	1.00	Redcued Level 70 - 69 m OD - MMG III	
10	1.00	Redcued Level 69 - 68 m OD - MMG III	
11	1.00	Redcued Level 68 - 67 m OD - MMG III	

No.	Layer [m]	Assigned soil	Pattern
12	1.00	Redcued Level 67 - 66 m OD - MMG III	
13	1.00	Redcued Level 66 - 65 m OD - MMG III	
14	1.00	Redcued Level 65 - 64 m OD - MMG II	
15	1.00	Redcued Level 64 - 63 m OD - MMG II	
16	1.00	Redcued Level 63 - 62 m OD - MMG II	
17	1.00	Redcued Level 62 - 61 m OD - MMG II	
18	1.00	Redcued Level 61 - 60 m OD - MMG II	
19	1.00	Redcued Level 60 - 59 m OD - MMG I	
20	-	Redcued Level 60 - 59 m OD - MMG I	

Load

No.	Load new	Load change	Name	Type	N [kN/m]	M_y [kNm/m]	H_x [kN/m]
1	Yes		LC 1	Design	921.38	108.28	-135.53
2	Yes		LC 2	Design	668.83	83.75	-99.41
3	Yes		LC 3	Design	654.54	118.98	-131.03
4	Yes		LC 4	Design	654.54	118.98	-131.03
5	Yes		LC 5	Service	652.69	80.86	-99.41

Ground water table

The ground water table is at a depth of 11.00 m from the original terrain.

Global settings

Type of analysis : analysis for drained conditions

Settings of the stage of construction

Design situation : permanent

No. 1

Load case verification

Name	Self w. in favor	e_x [m]	e_y [m]	α [kPa]	R_d [kPa]	Utilization [%]	Is satisfied
LC 1	Yes	-0.24	0.00	228.81	3430.76	6.67	Yes
LC 1	No	-0.24	0.00	228.81	3430.76	6.67	Yes
LC 2	Yes	-0.23	0.00	172.93	3479.88	4.97	Yes
LC 2	No	-0.23	0.00	172.93	3479.88	4.97	Yes
LC 3	Yes	-0.32	0.00	176.90	3109.75	5.69	Yes
LC 3	No	-0.32	0.00	176.90	3109.75	5.69	Yes

Name	Self w. in favor	e_x [m]	e_y [m]	α [kPa]	R_d [kPa]	Utilization [%]	Is satisfied
LC 4	Yes	-0.32	0.00	176.90	3109.75	5.69	Yes
LC 4	No	-0.32	0.00	176.90	3109.75	5.69	Yes
LC 5	Yes	-0.23	0.00	169.46	1466.24	11.56	Yes
LC 5	No	-0.23	0.00	169.46	1466.24	11.56	Yes

Analysis carried out with automatic selection of the most unfavourable load cases.

Computed self weight of strip foundation G = 115.00 kN/m
Computed weight of overburden Z = 0.00 kN/m

Vertical bearing capacity check

Shape of contact stress : rectangle
Most severe load case No. 5. (LC 5)

Parameters of slip surface below foundation:
Depth of slip surface z_{sp} = 9.51 m
Length of slip surface l_{sp} = 31.29 m

Design bearing capacity of found.soil R_d = 1466.24 kPa
Extreme contact stress α = 169.46 kPa

Bearing capacity in the vertical direction is SATISFACTORY

Verification of load eccentricity

Max. eccentricity in direction of base length e_x = 0.065<0.333
Max. eccentricity in direction of base width e_y = 0.000<0.333
Max. overall eccentricity e_t = 0.065<0.333

Eccentricity of load is SATISFACTORY

Horizontal bearing capacity check

Most severe load case No. 3. (LC 3)

Earth resistance: not considered

Horizontal bearing capacity R_{dh} = 680.83 kN
Extreme horizontal force H = 131.03 kN

Bearing capacity in the horizontal direction is SATISFACTORY

Bearing capacity of foundation is SATISFACTORY

No. 1

Settlement and rotation of foundation - input data

Analysis carried out with automatic selection of the most unfavourable load cases.
Analysis carried out with accounting for coefficient K_1 (influence of foundation depth).
Stress at the footing bottom considered from the finished grade.

Computed self weight of strip foundation G = 115.00 kN/m
Computed weight of overburden Z = 0.00 kN/m

Settlement of mid point of longitudinal edge = 1.8 mm
Settlement of mid point of transverse edge 1 = 2.1 mm
Settlement of mid point of transverse edge 2 = 1.5 mm

(1-max.compressed edge; 2-min.compressed edge)

Settlement and rotation of foundation - results

Foundation stiffness:
Computed weighted average modulus of deformation E_{def} = 148.49 MPa
Foundation in the longitudinal direction is rigid (k=1.62)
Foundation in the direction of width is rigid (k=202.03)

Verification of load eccentricity

Max. eccentricity in direction of base length	e_x	=	0.047<0.333
Max. eccentricity in direction of base width	e_y	=	0.000<0.333
Max. overall eccentricity	e_t	=	0.047<0.333

Eccentricity of load is SATISFACTORY

Overall settlement and rotation of foundation:
Foundation settlement = 2.0 mm
Depth of influence zone = 5.85 m
Rotation in direction of width = 0.129 (tan*1000); (7.4E-03 °)

ANNEX B.6 EMG-HYD-C4-M1OB-CA-GE-0664

Earth pressure on structure analysis

Input data

Project

Task : EAST MIDLANDS GATEWAY - STRATEGIC RAIL FREIGHT INTERCHANGE
Part : M1 OVERBRIDGE, ELEMENT 11, WORKS COMPONENTS 5, HIGHWAY VII & VIII
Description : M1 OVERBRIDGE ABUTMENT ASSESSMENT
Customer : ROXHILL KEGWORTH LTD
Author : Ian Gardner
Date : 08/07/2017
Project ID : C14792
Project number : EMG-HYD-M1OB-GD-CA-GE-0664-S4-P2

Settings

United Kingdom - EN 1997

Pressure analysis

Active earth pressure calculation : Coulomb
Passive earth pressure calculation : Caquot-Kerisel
Earthquake analysis : Mononobe-Okabe
Shape of earth wedge : Calculate as skew
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)									
Permanent design situation									
		Combination 1				Combination 2			
		Unfavourable		Favourable		Unfavourable		Favourable	
Permanent actions :	$\psi_G =$	1.35	[–]	1.00	[–]	1.00	[–]	1.00	[–]
Variable actions :	$\psi_Q =$	1.50	[–]	0.00	[–]	1.30	[–]	0.00	[–]
Water load :	$\psi_w =$	1.35	[–]			1.00	[–]		

Partial factors for soil parameters (M)					
Permanent design situation					
		Combination 1		Combination 2	
Partial factor on internal friction :	$\psi_\phi =$	1.00	[–]	1.25	[–]
Partial factor on effective cohesion :	$\psi_c =$	1.00	[–]	1.25	[–]
Partial factor on undrained shear strength :	$\psi_{cu} =$	1.00	[–]	1.40	[–]
Partial factor on Poisson's ratio :	$\psi_v =$	1.00	[–]	1.00	[–]

Partial factors for variable actions			
Permanent design situation			
Factor for combination value :	$\psi_0 =$	0.70	[–]
Factor for frequent value :	$\psi_1 =$	0.50	[–]
Factor for quasi-permanent value :	$\psi_2 =$	0.30	[–]

Geometry of structure

No.	Coordinate X [m]	Depth Z [m]
1	0.00	0.00
2	0.00	10.50
3	0.00	0.00

The origin [0,0] is located at the most upper point of the structure.

Basic soil parameters - (effective stress-state)

No.	Name	Pattern	$\chi\pi_{ef}$ [°]	c_{ef} [kPa]	ψ [kN/m^3]	ψ_{su} [kN/m^3]	0 [°]
2	Firm to stiff red brown silty CLAY - MMG IVB		25.00	2.00	19.50	10.50	7.50
3	Stiff red brown silty CLAY - MMG IVA		32.00	4.00	20.50	11.00	10.00
4	Weathered Mudstone - MMG III		32.00	10.00	22.00	12.00	10.00
5	Weathered Mudstone - MMG II		42.00	16.00	22.50	12.50	14.00
6	Intact Mudstone - MMG I		42.00	25.00	23.00	13.00	14.00
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		40.00	8.00	22.50	13.00	12.00
8	Existing Highway General Fill		25.00	2.00	19.50	10.50	10.00
9	Class 2 Fill (Site Won MMG IV)		25.00	2.00	19.50	10.50	10.00
10	Class 6F Capping/Subbase/Surfacing		35.00	0.00	21.00	11.50	15.00
12	Terrace Sands & Gravels		35.00	0.00	22.00	12.50	15.00
13	Class 7A Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
14	Class 7C Selected Cohesive Fill		25.00	2.00	20.50	11.00	12.00
15	Pre-existing Made Ground		25.00	0.00	19.00	9.50	8.00
16	Culvert		41.50	0.00	2.40	0.00	25.00
17	Granular Backfill to Culvert		41.50	0.00	18.00	8.00	16.00
18	Class 6N Selected Backfill to Structures		41.50	0.00	22.50	13.00	16.60

Basic soil parameters - (total stress-state)

No.	Name	Pattern	c_u [kPa]	a [kPa]	ψ [kN/m^3]
1	Topsoil/Subsoil		35.00	28.00	16.50
11	Landscape Fill - Class 4		50.00	20.00	20.00

Soil parameters to compute pressure at rest

No.	Name	Pattern	Type calculation	$\chi\pi_{ef}$ [°]	ς [–]	OCR [–]	K_r [–]
1	Topsoil/Subsoil		cohesionless	0.00	-	-	-
2	Firm to stiff red brown silty CLAY - MMG IVB		cohesive	-	0.40	-	-
3	Stiff red brown silty CLAY - MMG IVA		cohesive	-	0.40	-	-
4	Weathered Mudstone - MMG III		overconsolidated	-	-	2.00	-
5	Weathered Mudstone - MMG II		overconsolidated	-	-	3.00	-
6	Intact Mudstone - MMG I		overconsolidated	-	-	6.00	-
7	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone		cohesionless	40.00	-	-	-
8	Existing Highway General Fill		cohesive	-	0.35	-	-
9	Class 2 Fill (Site Won MMG IV)		cohesive	-	0.35	-	-
10	Class 6F Capping/Subbase/Surfacing		cohesionless	35.00	-	-	-
11	Landscape Fill - Class 4		cohesive	-	0.40	-	-
12	Terrace Sands & Gravels		cohesionless	35.00	-	-	-
13	Class 7A Selected Cohesive Fill		cohesive	-	0.40	-	-
14	Class 7C Selected Cohesive Fill		cohesive	-	0.40	-	-
15	Pre-existing Made Ground		cohesive	-	0.35	-	-
16	Culvert		cohesionless	41.50	-	-	-
17	Granular Backfill to Culvert		cohesionless	41.50	-	-	-
18	Class 6N Selected Backfill to Structures		cohesionless	41.50	-	-	-

Soil parameters

Topsoil/Subsoil

Unit weight :	ψ = 16.50 kN/m^3
Stress-state :	total
Cohesion of soil :	c_u = 35.00 kPa
Adhesion struc.-soil :	a = 28.00 kPa
Soil :	cohesionless

Firm to stiff red brown silty CLAY - MMG IVB

Unit weight :	ψ	=	19.50 kN/m^3
Stress-state :	effective		
Angle of internal friction :	$\chi\pi_{ef}$	=	25.00 °
Cohesion of soil :	c_{ef}	=	2.00 kPa
Angle of friction struc.-soil :	0	=	7.50 °
Soil :	cohesive		
Poisson's ratio :	ς	=	0.40
Saturated unit weight :	ψ_{sat}	=	20.50 kN/m^3

Stiff red brown silty CLAY - MMG IVA

Unit weight :	ψ	=	20.50 kN/m^3
Stress-state :	effective		
Angle of internal friction :	$\chi\pi_{ef}$	=	32.00 °
Cohesion of soil :	c_{ef}	=	4.00 kPa
Angle of friction struc.-soil :	0	=	10.00 °
Soil :	cohesive		
Poisson's ratio :	ς	=	0.40
Saturated unit weight :	ψ_{sat}	=	21.00 kN/m^3

Weathered Mudstone - MMG III

Unit weight :	ψ	=	22.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	$\chi\pi_{ef}$	=	32.00 °
Cohesion of soil :	c_{ef}	=	10.00 kPa
Angle of friction struc.-soil :	0	=	10.00 °
Soil :	overconsolidated		
Overconsolidation ratio :	OCR	=	2.00
Saturated unit weight :	ψ_{sat}	=	22.00 kN/m^3

Weathered Mudstone - MMG II

Unit weight :	ψ	=	22.50 kN/m^3
Stress-state :	effective		
Angle of internal friction :	$\chi\pi_{ef}$	=	42.00 °
Cohesion of soil :	c_{ef}	=	16.00 kPa
Angle of friction struc.-soil :	0	=	14.00 °
Soil :	overconsolidated		
Overconsolidation ratio :	OCR	=	3.00
Saturated unit weight :	ψ_{sat}	=	22.50 kN/m^3

Intact Mudstone - MMG I

Unit weight :	ψ	=	23.00 kN/m^3
Stress-state :	effective		
Angle of internal friction :	$\chi\pi_{ef}$	=	42.00 °
Cohesion of soil :	c_{ef}	=	25.00 kPa
Angle of friction struc.-soil :	0	=	14.00 °
Soil :	overconsolidated		
Overconsolidation ratio :	OCR	=	6.00
Saturated unit weight :	ψ_{sat}	=	23.00 kN/m^3

Bromsgrove Sandstone - Interbedded Mudstone & Sandstone

Unit weight :	ψ	=	22.50 kN/m^3
Stress-state :	effective		
Angle of internal friction :	$\chi\pi_{ef}$	=	40.00 °
Cohesion of soil :	c_{ef}	=	8.00 kPa
Angle of friction struc.-soil :	0	=	12.00 °

Soil :	cohesionless
Saturated unit weight :	ψ_{sat} = 23.00 kN/m^3

Existing Highway General Fill

Unit weight :	ψ = 19.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 25.00 °
Cohesion of soil :	c_{ef} = 2.00 kPa
Angle of friction struc.-soil :	0 = 10.00 °
Soil :	cohesive
Poisson's ratio :	ς = 0.35
Saturated unit weight :	ψ_{sat} = 20.50 kN/m^3

Class 2 Fill (Site Won MMG IV)

Unit weight :	ψ = 19.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 25.00 °
Cohesion of soil :	c_{ef} = 2.00 kPa
Angle of friction struc.-soil :	0 = 10.00 °
Soil :	cohesive
Poisson's ratio :	ς = 0.35
Saturated unit weight :	ψ_{sat} = 20.50 kN/m^3

Class 6F Capping/Subbase/Surfacing

Unit weight :	ψ = 21.00 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 35.00 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	0 = 15.00 °
Soil :	cohesionless
Saturated unit weight :	ψ_{sat} = 21.50 kN/m^3

Landscape Fill - Class 4

Unit weight :	ψ = 20.00 kN/m^3
Stress-state :	total
Cohesion of soil :	c_u = 50.00 kPa
Adhesion struc.-soil :	a = 20.00 kPa
Soil :	cohesive
Poisson's ratio :	ς = 0.40

Terrace Sands & Gravels

Unit weight :	ψ = 22.00 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 35.00 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	0 = 15.00 °
Soil :	cohesionless
Saturated unit weight :	ψ_{sat} = 22.50 kN/m^3

Class 7A Selected Cohesive Fill

Unit weight :	ψ = 20.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 25.00 °
Cohesion of soil :	c_{ef} = 2.00 kPa
Angle of friction struc.-soil :	0 = 12.00 °

Soil :	cohesive
Poisson's ratio :	ς = 0.40
Saturated unit weight :	ψ_{sat} = 21.00 kN/m^3

Class 7C Selected Cohesive Fill

Unit weight :	ψ = 20.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 25.00 °
Cohesion of soil :	c_{ef} = 2.00 kPa
Angle of friction struc.-soil :	$()$ = 12.00 °
Soil :	cohesive
Poisson's ratio :	ς = 0.40
Saturated unit weight :	ψ_{sat} = 21.00 kN/m^3

Pre-existing Made Ground

Unit weight :	ψ = 19.00 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 25.00 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	$()$ = 8.00 °
Soil :	cohesive
Poisson's ratio :	ς = 0.35
Saturated unit weight :	ψ_{sat} = 19.50 kN/m^3

Culvert

Unit weight :	ψ = 2.40 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 41.50 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	$()$ = 25.00 °
Soil :	cohesionless
Saturated unit weight :	ψ_{sat} = 2.40 kN/m^3

Granular Backfill to Culvert

Unit weight :	ψ = 18.00 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 41.50 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	$()$ = 16.00 °
Soil :	cohesionless
Saturated unit weight :	ψ_{sat} = 18.00 kN/m^3

Class 6N Selected Backfill to Structures

Unit weight :	ψ = 22.50 kN/m^3
Stress-state :	effective
Angle of internal friction :	$\chi\pi_{ef}$ = 41.50 °
Cohesion of soil :	c_{ef} = 0.00 kPa
Angle of friction struc.-soil :	$()$ = 16.60 °
Soil :	cohesionless
Saturated unit weight :	ψ_{sat} = 23.00 kN/m^3

Geological profile and assigned soils

No.	Layer [m]	Assigned soil	Pattern
1	6.50	Class 6N Selected Backfill to Structures	
2	4.00	Class 6N Selected Backfill to Structures	
3	2.00	Weathered Mudstone - MMG II	
4	1.50	Weathered Mudstone - MMG II	
5	4.00	Intact Mudstone - MMG I	
6	-	Bromsgrove Sandstone - Interbedded Mudstone & Sandstone	

Terrain profile

Terrain behind the structure is flat.

Water influence

GWT behind the structure lies at a depth of 11.00 m

Input surface surcharges

No.	Surcharge new	Surcharge change	Action	Mag.1 [kN/m2]	Mag.2 [kN/m2]	Ord.x x [m]	Length l [m]	Depth z [m]
1	Yes		permanent	20.00				on terrain

No.	Name
1	TYPICAL HIGHWAY UDL

Settings of the stage of construction

Design situation : permanent

Analysis No. 1

Overall pressure acting on the structure

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	4.86	1.45
2	1.00	10.32	3.08
3	6.50	40.36	12.03
4	10.50	62.21	18.55

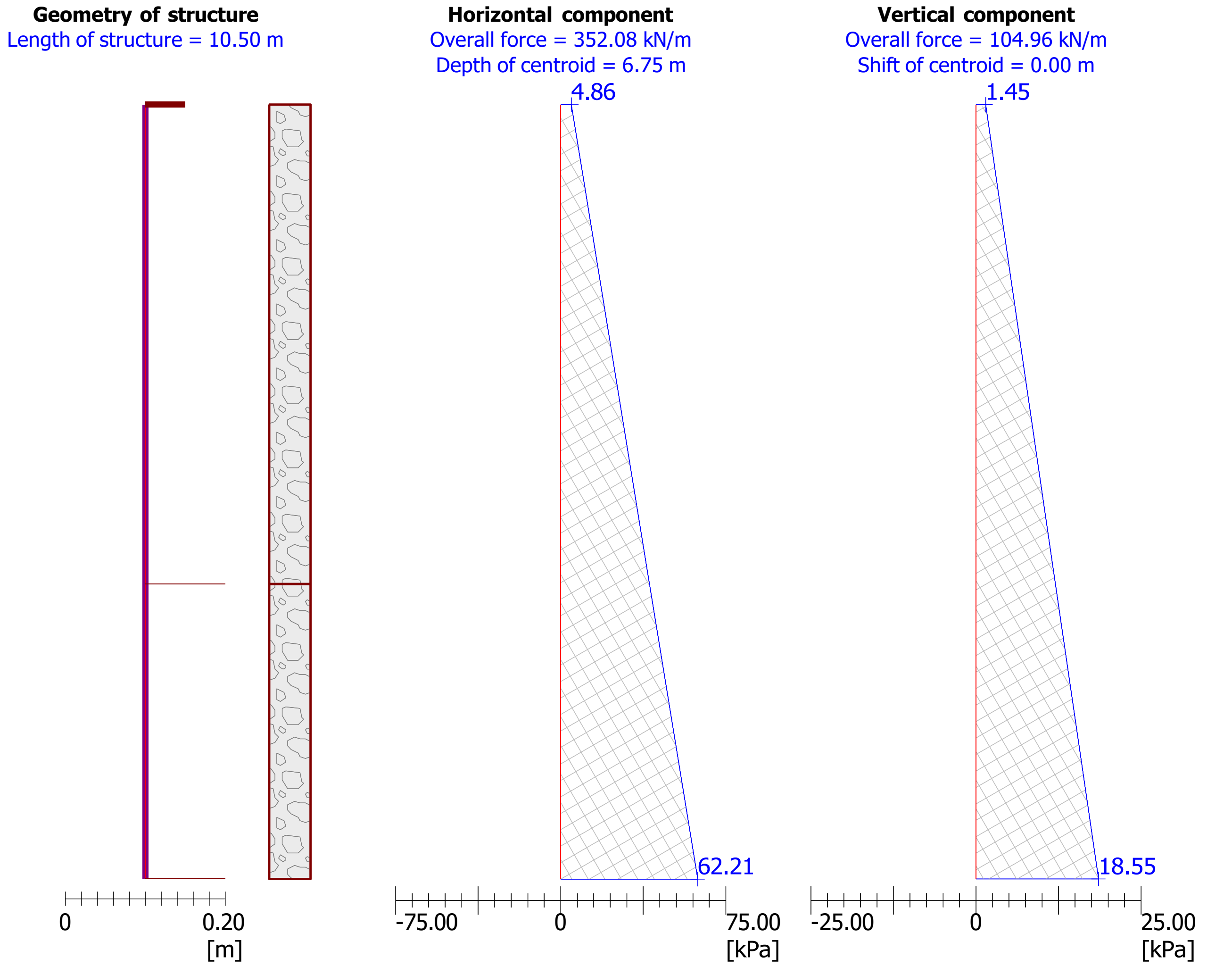
Resultant forces

Cohesion of soils has not been subtracted from pressures caused by a surcharge.

Total horizontal pressure acting on construction = 352.08 kN/m
Application point of horiz. comp. lies in depth = 6.75 m
Total vertical pressure acting on construction = 104.96 kN/m
Dist. of vertical comp. from top of constr. = 0.00 m

Analysis carried out for combination 1.

Name : Analysis | **Stage - analysis : 1 - 1**



Analysis No. 2

Overall pressure acting on the structure

Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	4.76	1.20
2	1.00	10.12	2.55
3	6.50	39.59	9.96
4	10.50	61.03	15.35

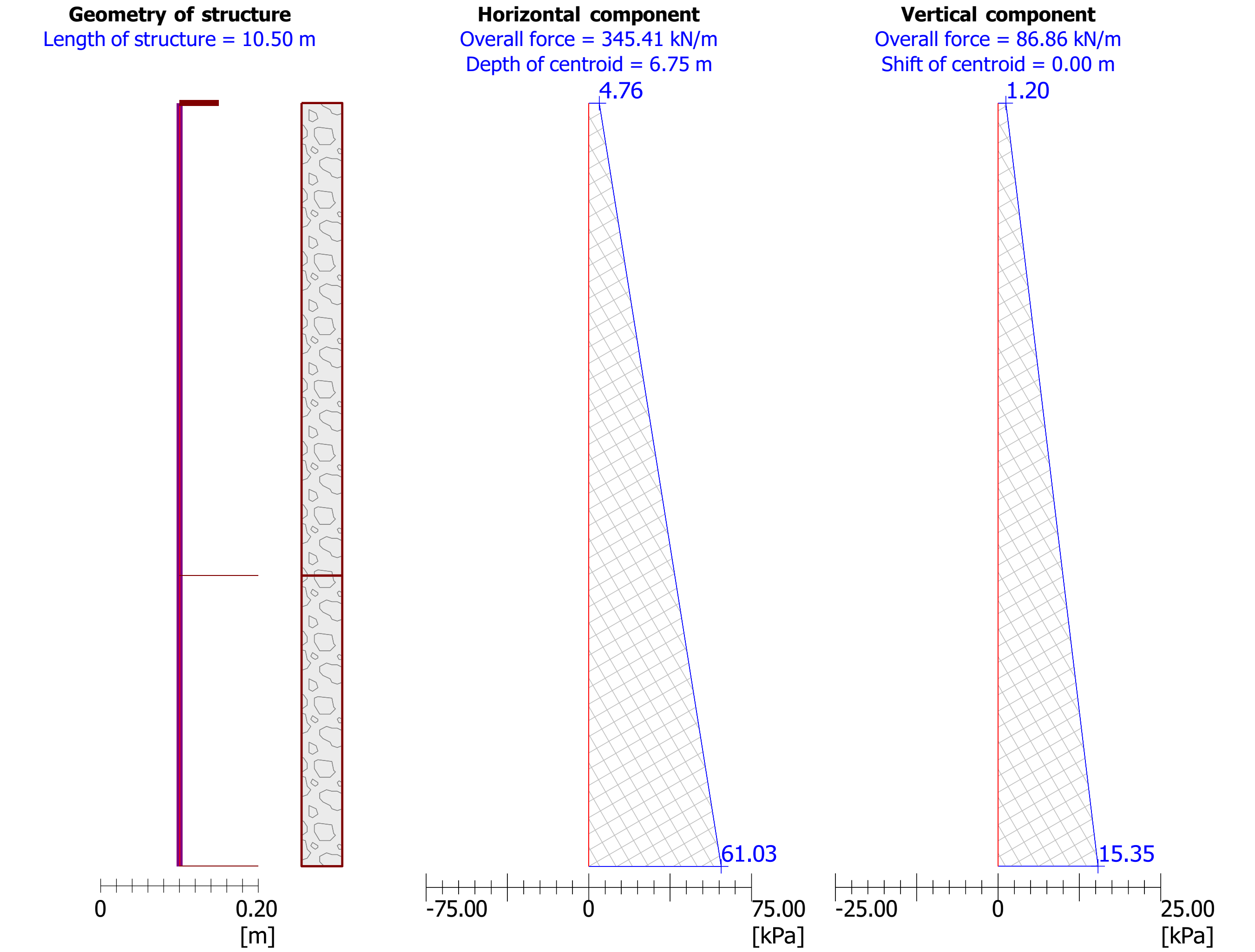
Resultant forces

Cohesion of soils has not been subtracted from pressures caused by a surcharge.

Total horizontal pressure acting on construction	**=**	**345.41**	**kN/m**
Application point of horiz. comp. lies in depth	**=**	**6.75**	**m**
Total vertical pressure acting on construction	**=**	**86.86**	**kN/m**
Dist. of vertical comp. from top of constr.	**=**	**0.00**	**m**

Analysis carried out for combination 2.

Name : Analysis **Stage - analysis : 1 - 2**



Analysis No. 3

Overall pressure acting on the structure

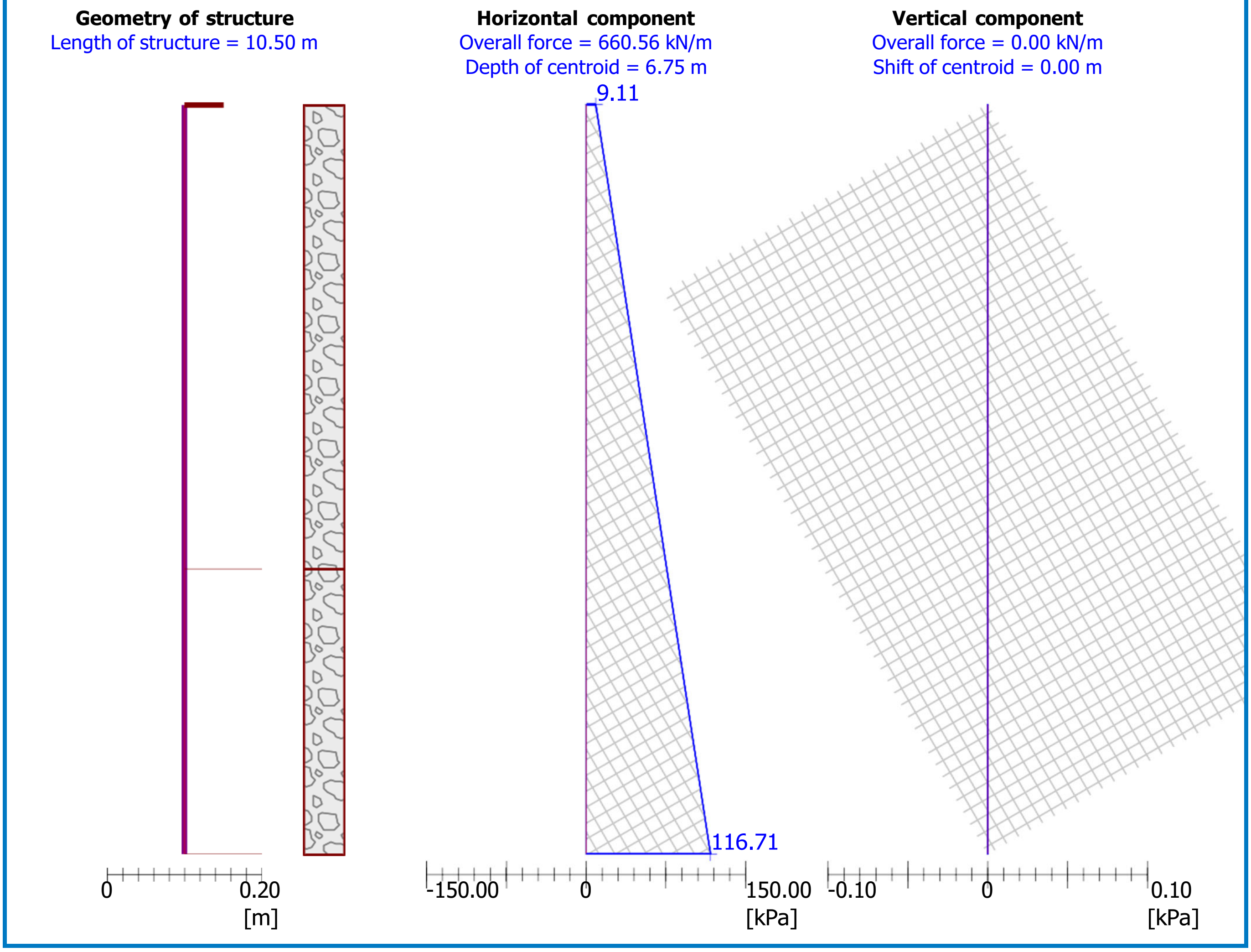
Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	9.11	0.00
2	1.00	19.36	0.00
3	6.50	75.72	0.00
4	10.50	116.71	0.00

Resultant forces

Total horizontal pressure acting on construction = 660.56 kN/m
Application point of horiz. comp. lies in depth = 6.75 m
Total vertical pressure acting on construction = 0.00 kN/m
Dist. of vertical comp. from top of constr. = 0.00 m

Analysis carried out for combination 1.

Name : Analysis | **Stage - analysis : 1 - 3**



Analysis No. 4

Overall pressure acting on the structure

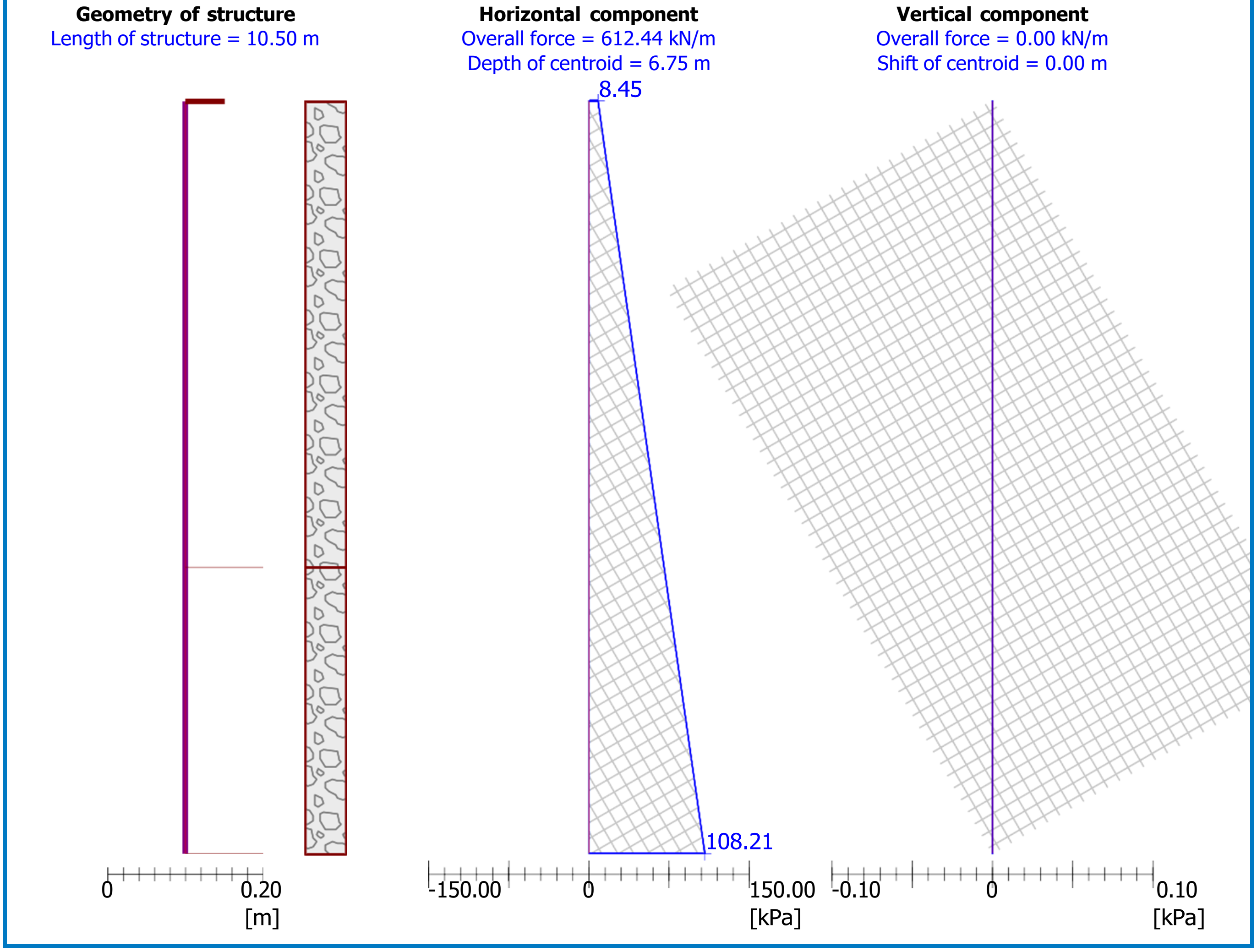
Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	8.45	0.00
2	1.00	17.95	0.00
3	6.50	70.20	0.00
4	10.50	108.21	0.00

Resultant forces

Total horizontal pressure acting on construction = 612.44 kN/m
Application point of horiz. comp. lies in depth = 6.75 m
Total vertical pressure acting on construction = 0.00 kN/m
Dist. of vertical comp. from top of constr. = 0.00 m

Analysis carried out for combination 2.

Name : Analysis **Stage - analysis : 1 - 4**



Analysis No. 5

Overall pressure acting on the structure

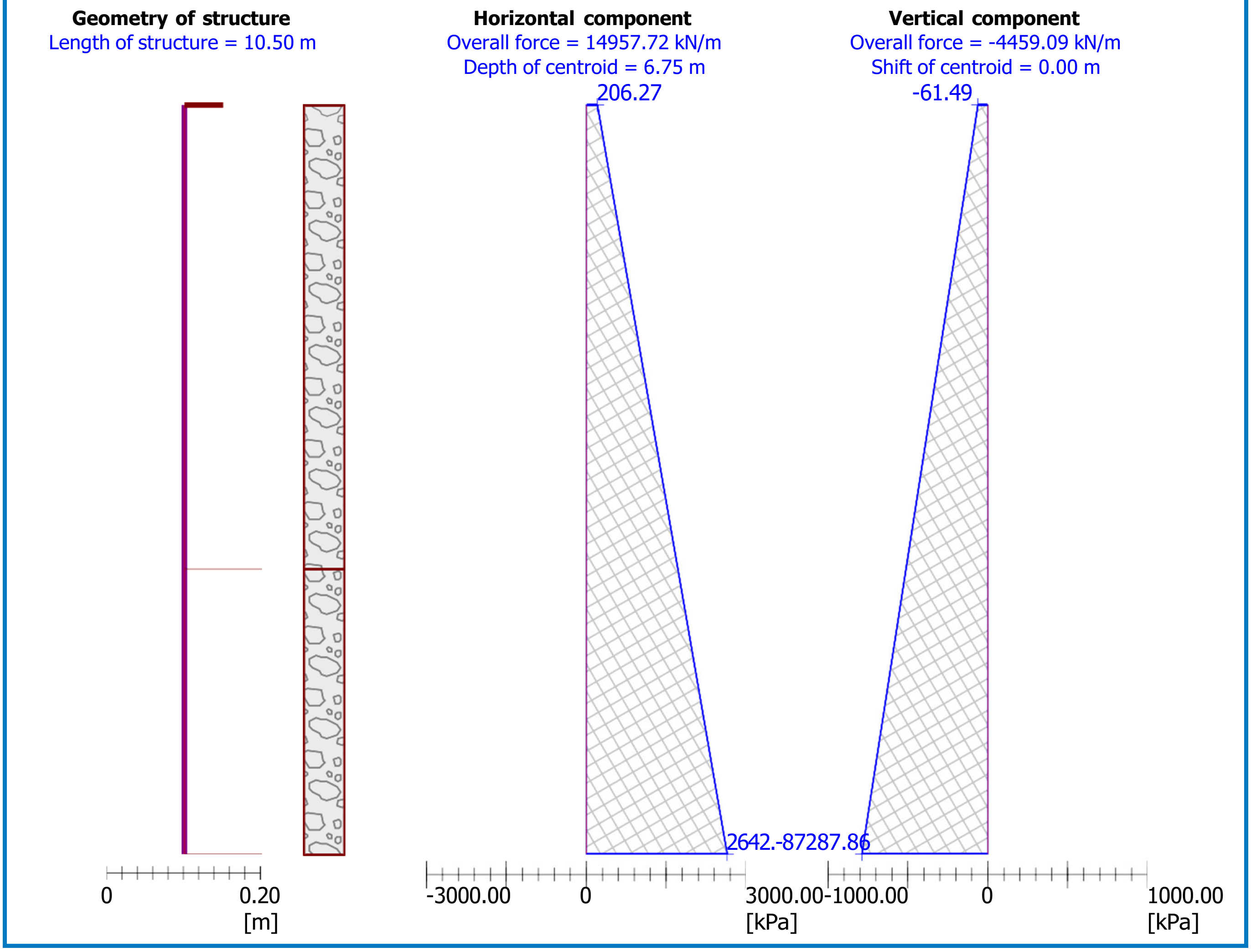
Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	206.27	-61.49
2	1.00	438.32	-130.67
3	6.50	1714.61	-511.15
4	10.50	2642.82	-787.86

Resultant forces

Total horizontal pressure acting on construction = 14957.72 kN/m
Application point of horiz. comp. lies in depth = 6.75 m
Total vertical pressure acting on construction = -4459.09 kN/m
Dist. of vertical comp. from top of constr. = 0.00 m

Analysis carried out for combination 1.

Name : Analysis **Stage - analysis : 1 - 5**



Analysis No. 6

Overall pressure acting on the structure

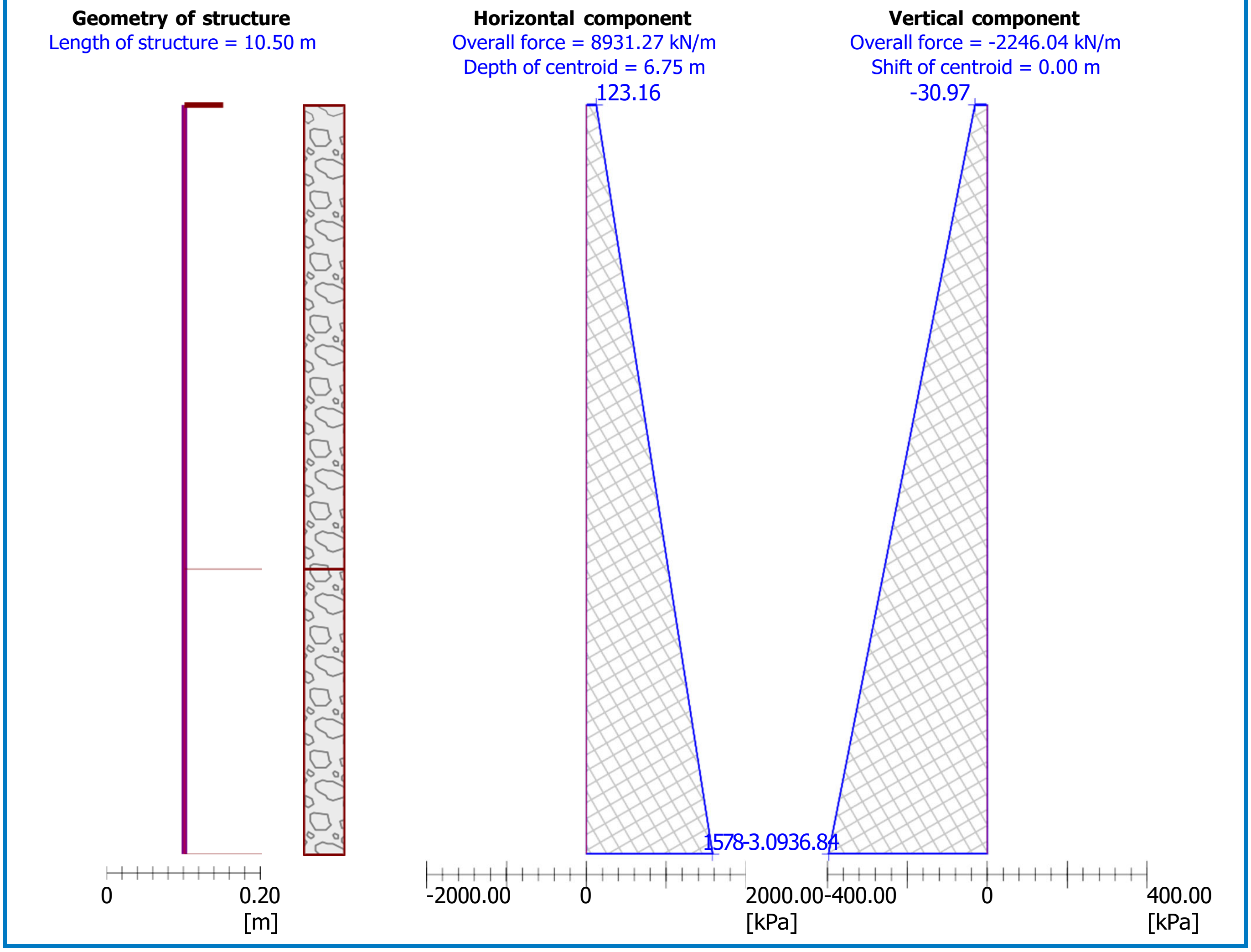
Point No.	Depth [m]	Hor. comp. [kPa]	Vert. comp. [kPa]
1	0.00	123.16	-30.97
2	1.00	261.72	-65.82
3	6.50	1023.80	-257.46
4	10.50	1578.03	-396.84

Resultant forces

Total horizontal pressure acting on construction	=	**8931.27**	**kN/m**
Application point of horiz. comp. lies in depth	=	**6.75**	**m**
Total vertical pressure acting on construction	=	**-2246.04**	**kN/m**
Dist. of vertical comp. from top of constr.	=	**0.00**	**m**

Analysis carried out for combination 2.

Name : Analysis **Stage - analysis : 1 - 6**



ANNEX C

METHODS OF BEARING PRESSURE DISTRIBUTION AND SETTLEMENT ANALYSIS

Technical Description of Methodologies Used

The assessment of the settlement characteristics of the ground and the associated net increase in bearing pressure below a loaded area is discussed in detail within the following sections.

The ground is represented as a series of soil profiles, which have been determined using CPT soundings which will provide a continuous assessment of the cone resistance and sleeve friction. The use of the CPT equipment is able to provide a measurement of the corrected cone resistance q_t (Mpa), friction ratio R_f (%) and inclination (º) at intervals depth of 0.01m.

The results of the CPT soundings have been used as both direct and indirect assessment of the soil stiffness profile, using measured data, industry accepted correlations and experience of similar materials.

The loading conditions used in this assessment are based on Hydrock's current understanding of the proposed development; however once final loading conditions are known the assessment of settlement and displacement should be reviewed and revised accordingly.

Vertical displacements have been calculated using a combination of equations, based upon Bousinesq theory and modified as discussed within the following sections, The Bousinesq method of determining the stress distribution is correct for a uniform isotropic, elastic material having a constant Poisson's ratio. Vertical strains are derived from this stress distribution using elastic constants appropriate to that strain level for each soil layer and then summed to give displacements. Where the Bousinesq equations have been modified (Janbu *et al*, Osterberg etc) then this is stated within the following relevant sections.

The Bousinesq method allows the assessment of non-linear soil properties and the accuracy of this has been increased by treating each 0.01m measurement of q_t and R_f as a separate, individual layer.

Settlement assessed using Coefficient of Volume Compressibility

To calculate the settlement caused by consolidation, the modulus of volume compressibility (m_v) can be used once it has been determined. The use of this method to assess consolidation settlements is covered by BS EN 1997-2: 2004 Annex F.4, and typically the value of m_v is determined from one dimensional (oedometer) laboratory testing or it can be estimated from correlations with other tests such as SPT '*N*' values or CPT q_t values.

The general equation to calculate the oedometer settlement of a soil layer is given in many soil mechanics text books, including Tomlinson, and is shown below:

ρ_{eod} = $m_v \times \sigma_z \times H$

Where:

ρ_{eod} = Settlement due to consolidation

m_v = average coefficient of volume compressibility for the effective pressure increment for the soil layer under assessment;

σ_z = average effective vertical stress imposed on the soil layer under assessment; and

H = thickness of soil layer under consideration.

The results for various layers can be summed together in order to provide a comprehensive assessment of the total predicted settlement for a soil profile, however it is noted that the addition of settlements in the undrained and consolidation state can often lead to an overestimate of the total settlement. Therefore it has become common practice to use empirical corrections applied to the results to provide a more realistic estimate of settlement for the type of soil under assessment and to account for their 3 dimensional consolidation properties (typically referenced as μ and μ_g correction factors). This gives the following additional equation for the assessment of total settlement:

ρ_c = $\mu_g \times \rho_{eod}$

Where:

μ_g = a geological factor coefficient, which will depend on the type of clay and for which there are industry accepted values recorded in soil mechanics text books.

The assessment of consolidation settlement using this method does not provide a direct value for immediate or consolidation settlement for normally or over consolidated soils. However there are a number of references which can be used to assess the proportion of immediate, consolidation and total settlement as indicated below:

For stiff over consolidated clays;

Immediate	ρ_i	$=0.5$ to $0.6\ \rho_{eod}$
Consolidation	ρ_c	$=0.5$ to $0.4\ \rho_{eod}$
Total	ρ_{eod}	$=1 \times \rho_{eod}$

For soft, normally consolidated clays;

Immediate	ρ_i	$=0.1\ \rho_{eod}$
Consolidation	ρ_c	$=1.0\ \rho_{eod}$
Total	ρ_{eod}	$=1.1 \times \rho_{eod}$

Therefore for the purposes of this assessment the reported total predicted settlement is based upon the calculated values of either ρ_{eod} for stiff consolidated soils, or 1.1 x ρ_{eod} where the soils have been deemed to be soft, normally consolidated.

The options for the estimation and calculation of the average vertical stress for a particular soil layer under assessment are discussed in more detail within the following sections.

Assessment of Secondary Consolidation

Where ground improvement using surcharge is to be undertaken, then as part of the overall prediction of settlement it is necessary to undertake an assessment on the secondary settlement of the ground. In general, it is the aspiration of ground improvement using surcharge to instigate all the primary settlement and sufficient secondary settlement of the ground, so that the long-term settlement performance will be within acceptable levels. Without a clear understanding of the secondary settlement characteristics, it will be difficult to decide when sufficient settlement has occurred during the ground improvement phase to permit the removal of the surcharge load.

Secondary consolidation is the compression of soil that takes place after the primary consolidation phase. The shape of the secondary settlement curve differs from the primary consolidation in that it forms a slope which can be expressed as a logarithmic function, whereas the primary consolidation generally forms a polynomial curve. Even after the reduction of hydrostatic pressure some compression of soil takes place at slow rate and this is known as secondary consolidation.

Secondary consolidation is caused by creep, viscous behaviour of the clay-water system, compression of organic matter, and other processes. In sand, settlement caused by secondary compression is negligible, but in peat, it is very significant. The equations and methodology used in the assessment of the secondary consolidation of peat are detailed in the following sections, however for cohesive soils the following equation has been used in this assessment.

Secondary consolidation is given by either of the following formulas:

$$\rho_s = [c_\alpha / (1 + e_0)] \times H_o \log (t_2 / t_1)$$

or

$$\rho_s = c_{\alpha\varepsilon} / \times H_o \log (t_2 / t_1)$$

Where:

ρ_s	=	Total settlement
H_0	=	Thickness of compressible layer under consideration
e_0	=	the void ratio at the end of the primary consolidation

c_α = is the secondary compression index (where not determined from laboratory analysis an assessment is made on the basis that $c_\alpha \simeq 0.04 \times c_c$ unless otherwise stated)

$c_{\alpha\varepsilon}$ = modified secondary compression index or re-compression index (after Mesri 1973)

t_1 = time at end of the primary consolidation / ground improvement period

t_2 = time at end of design period for structure under consideration.

For the purposes of secondary settlement calculations, secondary settlement is assumed to start when primary settlement is substantially complete. Thus, if primary settlements were substantially complete in 12 years, the value t_1 would be 12. The value of t_2 depends upon the lifespan of the structure under consideration.

Values of c_α are obtained from the e vs. log ρ or Δh vs. log ρ plots. C_α is usually assumed to be related to C_c with values of c_α / C_c typically in the range of 0.025 to 0.006 for inorganic soils and 0.035 to 0.085 for organic soils. Some typical values are presented in Table C.1 and Figure C.1.

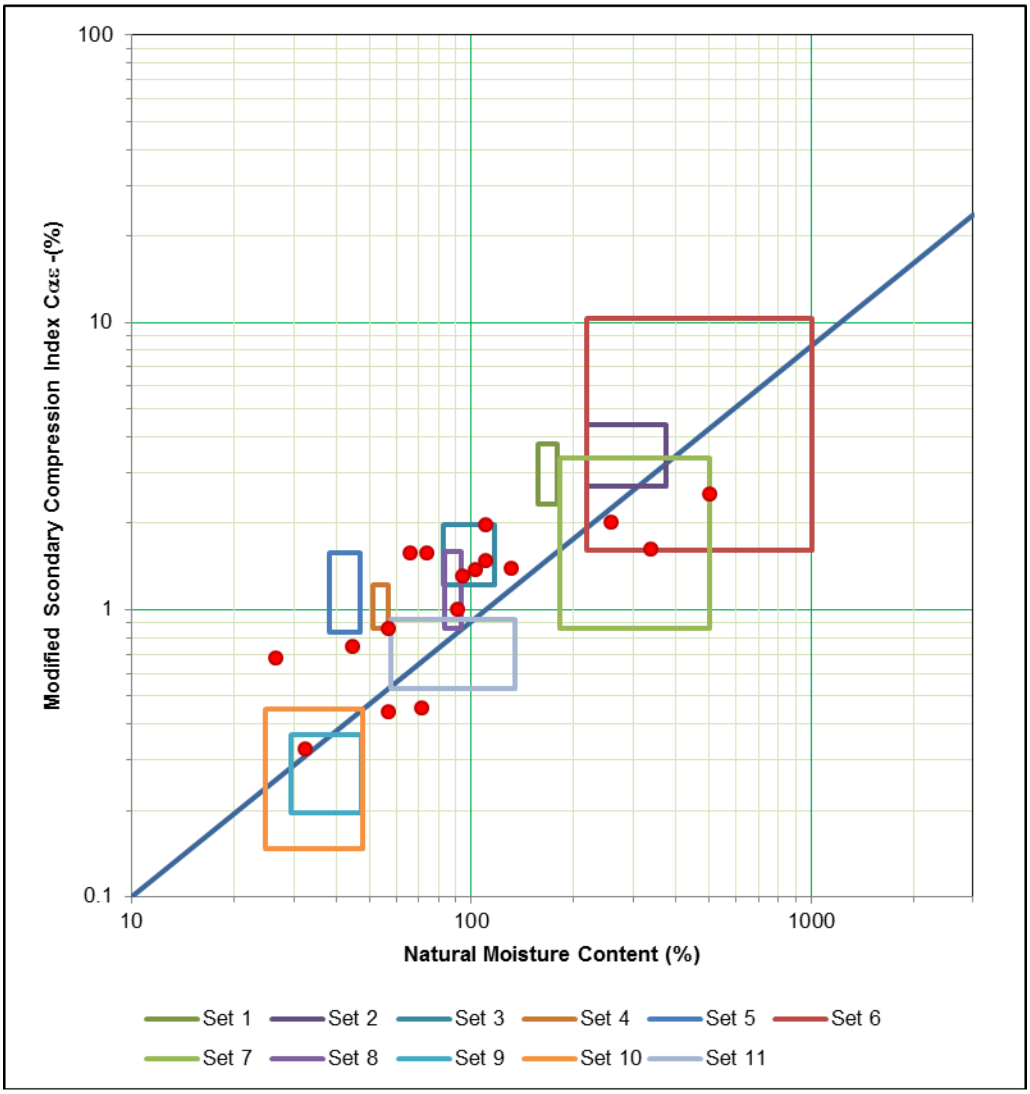
Table C.1: Typical Values of Compressibility Index and Secondary Compression (Carter *et al*)

Soil Type	Compressibility Index Typical C_c	Compressibility to Secondary Typical C_α / C_c	Secondary Compression Expected C_α
Normally consolidated medium sensitivity clays	0.20 to 0.50	0.025 to 0.055	0.005 to 0.025
Silty clay (CL)	0.15 to 0.30	0.030 to 0.060	0.004 to 0.018
Boston blue clay (CL)	0.30 to 0.50	0.030 to 0.060	0.009 to 0.030
Clay of high plasticity (CH)	0.50 to 0.60	0.050 to 0.070	0.025 to 0.042
Medium sensitivity clay (CL to CH)	1.0 to 3.0	0.050 to 0.070	0.050 to 0.210
Organic clays	Greater than 4	0.040 to 0.075	0.160 to 0.750
Peats	10 to 15	0.035 to 0.085	0.350 to 1.275
Organic silts	1.5 to 4.0	0.035 to 0.060	0.052 to 0.240
Alluvial silts and clays	0.40 to 1.2	0.040 to 0.060	0.016 to 0.072

As can be seen from Table C.1, there is a significant variation in the expected values of secondary compression and as such wherever possible the laboratory analysis will be used to determine an appropriate value.

Figure C.1 presents the correlation between the modified secondary compression index ($C_{\alpha\varepsilon}$) and the natural moisture content developed by Mesri.

Figure C.1: Correlation between Secondary Compression and Moisture Content



The relationship suggested by Mesri can be simplified to:

$C_{\alpha\varepsilon}$ = $0.0111 \times (NMC^{0.9572})$

Where:

$C_{\alpha\varepsilon}$ = Modified secondary compression index

NMC = Natural Moisture Content

Settlement assessed using Static Cone Penetrometer Test (CPT)

For the assessment of the settlement of the cohesionless soil, Schmertmann *et al* have provided the following equation, using the results from static CPT results:

ρ = $C_1 \times C_2 \times \Delta_p \times \Sigma\ {}^{2}{}_{0}{}^{B}\ (I_z/E_s) \times \Delta_z$

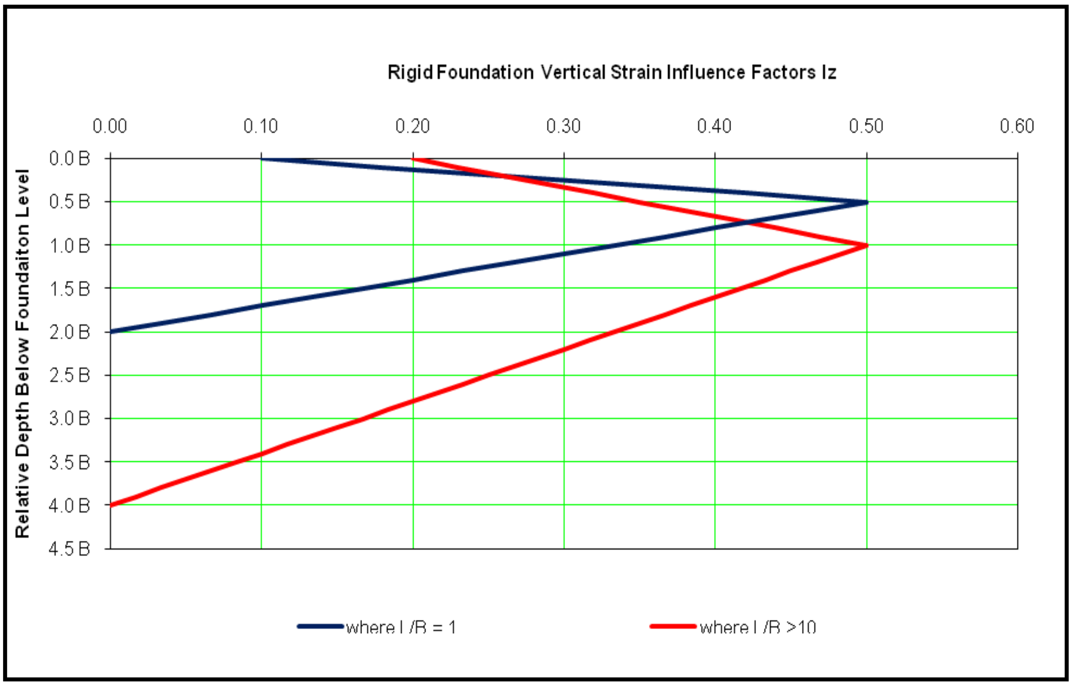
Where:

ρ	=	Total settlement			
C_1	=	Depth correction factor	=	$1 - 0.5\ (\sigma'_{vo} / \Delta_p)$	
C_2	=	Creep factor	=	$1 + 0.2\ \log_{10}(\text{time}_{years}/0.1)$	
Δ_p	=	net increase of load on soil at foundation level			
B	=	Width of loaded area			
I_z	=	vertical strain influence factor	=	interpreted from Figure F.1	
		and peak I_z	=	$0.5 + 0.1\ (\Delta_p / \sigma'_{vo})$	
E_s	=	Deformation modulus	=	where L/B =1	$E_s = 2.5\ q_c$
				where L/B > 10	$E_s = 3.5\ q_c$
Δ_z	=	thickness of soil layer			
σ'_{vo}	=	effective overburden pressure at foundation level			

The values for assessing the deformation modulus for granular soils that are based upon the results of CPT investigations are in accordance with current national practice, however there are a number of different correlations relating E to q_c. Of particular note is the 2007 paper, entitled 'Settlements of shallow foundations on granular soil, an overview', by Braja M.das and Nagaratnam Sivakugan and published in the International Journal of Geotechnical Engineering. Reference has been made to these alternative methodologies and a sensitivity assessment completed within the spread sheet assessment of the CPT data.

However it should be noted that this method was developed for cohesionless soils and as such this method is not used where the soil type is considered to be cohesive.

Figure C.2 Vertical strain influence factor diagram (after Schmertmann et al) Tomlinson Fig 2.28



Settlement analysis using Compression Index

A similar process to assessing the consolidation settlement using the coefficient of volume compressibility value m_v is to use the compression index C_c, which can also be obtained from oedometer testing. The general equation to determine the consolidation settlement using the compression index is shown below:

ρ_{eod} = $[H / (1 + e_1)] \times C_c \text{ Log10} [(\sigma'_{vo} + \sigma_z) / \sigma'_{vo}]$

and

ρ_c = $\mu_g \times \rho_{eod}$

Where:

C_c = Compression index as determined from oedometer testing

e_1 = initial voids ratio

A similar process for assessing the combination of immediate and primary settlement to that used when considering consolidation settlement using mv has also been completed where the compression index method of calculation was employed.

Settlement analysis using Adjusted Elasticity Method

The total settlement of a foundation on cohesive or non-cohesive soil may be evaluated using the adjusted elasticity method as defined in BS EN 1997-1: Annex F.2 with the general equation shown below:

s = $p \times b \times (f / E_m)$

Where:

s = total settlement

E_m = the design value of the modulus of elasticity

p = bearing pressure linearly distributed on the base of the foundation

b = width of the foundation

f = factor which depends upon:

the shape and dimensions of the foundation area;

the variation of stiffness with depth;

the thickness of the compressible formation;

the Poisson's ratio ; and

the point for which the settlement is calculated

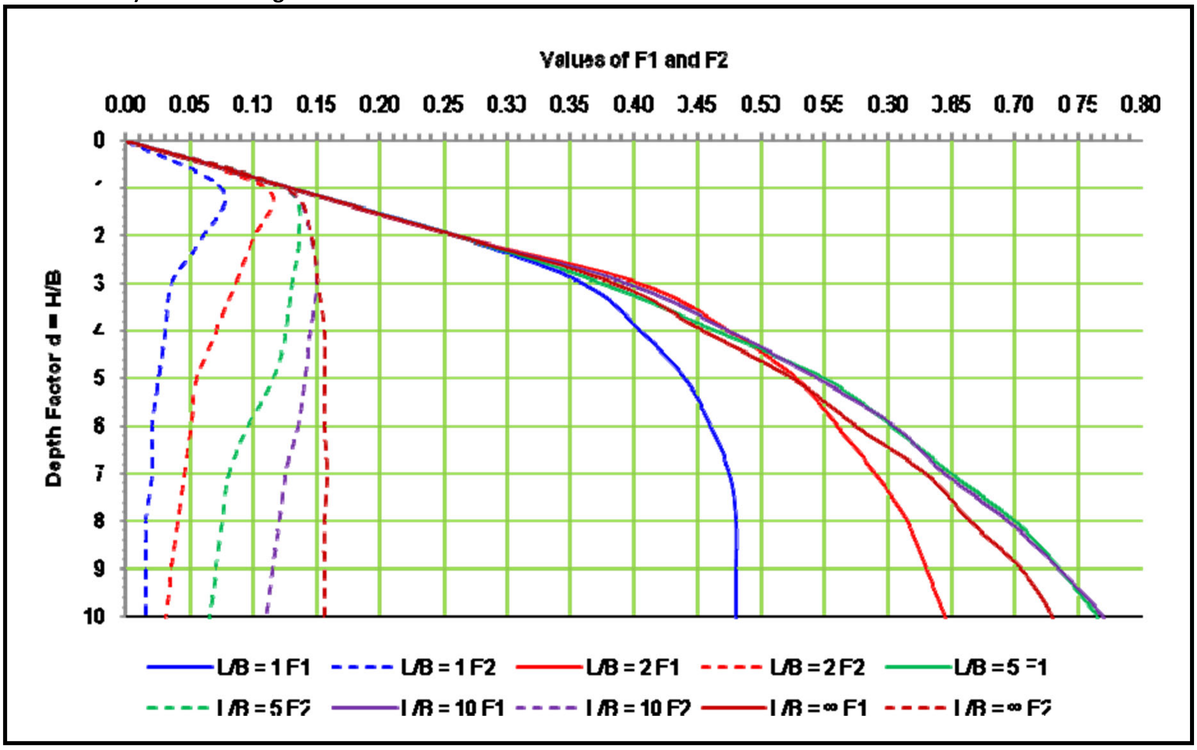
As this is a relatively non-specific and general equation, with a significant number of variables encapsulated in the factor f, the above equation can be expanded as shown below:

ρ = $q_n \times B \times ((1- \upsilon^2)/E'_d) \times I_p$

Where:

ρ	=	the total settlement (immediate and consolidation)
q_n	=	net foundation pressure
B	=	width of foundation
υ	=	Poisson's ratio
E'_d	=	deformation modulus for the soil in a drained condition
I_p	=	Influence factor, which is a function of the length to breadth ratio, the layer thickness and the Poisson's ratio which can be obtained from curves developed by Steinbrenner, reproduced as Figure C.3.

Figure C.3 Calculation of settlements due to flexible loaded area on the surface of an elastic layer (after Steinbrenner) Tomlinson Fig 2.35.



Note. When using this diagram to calculate at the centre of a rectangular area, take B as half foundation width to obtain H/B and L/B

When using Figure C.3, the assessment of the influence factor I_p is determined by using the following general equation:

For Poisson's ratio of 0.5: $I_p = F_1$; and

For Poisson's ratio of zero: $I_p=F_1 + F_2$.

Where the Poisson's ratio is between zero and 0.5, I_p is determined from interpreted values from Figure B.2.

In order to assess the drained modulus, and in the absence of drained triaxial tests, E'_d can be taken as the reciprocal of m_v, and in accordance with guidance provided by Tomlinson (and others) this allows for another method of assessment and interpretation of geotechnical test data. This approach is supported by BS EN 1997-1: 2004 Annex F.2 note 3, where the designed drained modulus E_m may be estimated from the results of laboratory or in-situ tests

As noted in BS EN 1997-1 Annex F, this method should only be used if the stresses in the ground are such that no significant yielding occurs and the stress strain behaviour of the ground may be considered linear. In consideration of this, where the adjusted elasticity method has been used to assess the settlement of the ground, it has been completed on multiple thin layers as recorded by the CPT equipment so as to limit the effect of variations in stress strain behaviour between different soil layers.

Assessment of Primary and Secondary Settlement of Organic Soils

The accurate assessment of the settlement of these complex deposits is vital in the overall assessment of the ground conditions and will influence the geotechnical options for the redevelopment of a site.

Peat and other similar organic alluvial deposits are subject to settlement when loaded with additional weight or when groundwater levels are lowered. However, unlike other non-organic soils, the level of secondary settlement can be both significant and occur over a long period of time. For this reason it is important to assess both the primary and secondary settlements using separate equations.

As for other calculation methods, there are a number of different equations which can be used, however for the purposes of this assessment, the following methodologies have been adopted.

The general equation to calculate the primary settlement of Peat and organic alluvium is given by the following equation:

s_t = Expected Total Settlement

$s_t = s_i + s_c + s_s$

Where:

s_i = immediate settlement

s_c = primary consolidation

s_s = secondary compression.

The level of immediate settlement is only of concern with these types of soils during the initial loading of them as they will respond quickly to any change ion load, typically during the physical application. Therefore estimates of the level of immediate settlement are both differ cult to estimate and in the case of earthworks land raising difficult to quantify without having a datum placed below the earthworks fill level.

For estimation and assessment of the primary consolidation settlement, the following equation has been used:

s_c = $\{C_r \times [\ H/(1 + e_0)\ ] \times \text{Log}\ (P'_p/P'_o)\} + \{C_c \times [\ H/(1 + e_0)\ ] \times \text{Log}\ (P'_f/P'_p)\ \}$

Where:

C_r = recompression index

C_c = compression index

H = thickness of layer (peat or organic soil)

e_0 = initial voids ratio

P'_o = initial effective stress on layer

P'_p = maximum past pressure on the layer

P'_f = final effective stress on the layer

The secondary compression of these soils is a continuation of the volume change that starts during the primary consolidation, but occurs at a much slower rate. In this respect, the characteristics of this type of settlement for this ground do differ from the secondary and creep settlement of other non-organic soils, although they are still termed as secondary compression.

The general equation which has been used for the assessment for this site is as follows:

s_s = $C_\alpha \times [\ H/(1 + e_p)\ ] \times [\Delta\text{Log}\ (t)]$

Where:

C_α = secondary compression index

e_p = void ratio at end of primary consolidation

t = time period being considered for design

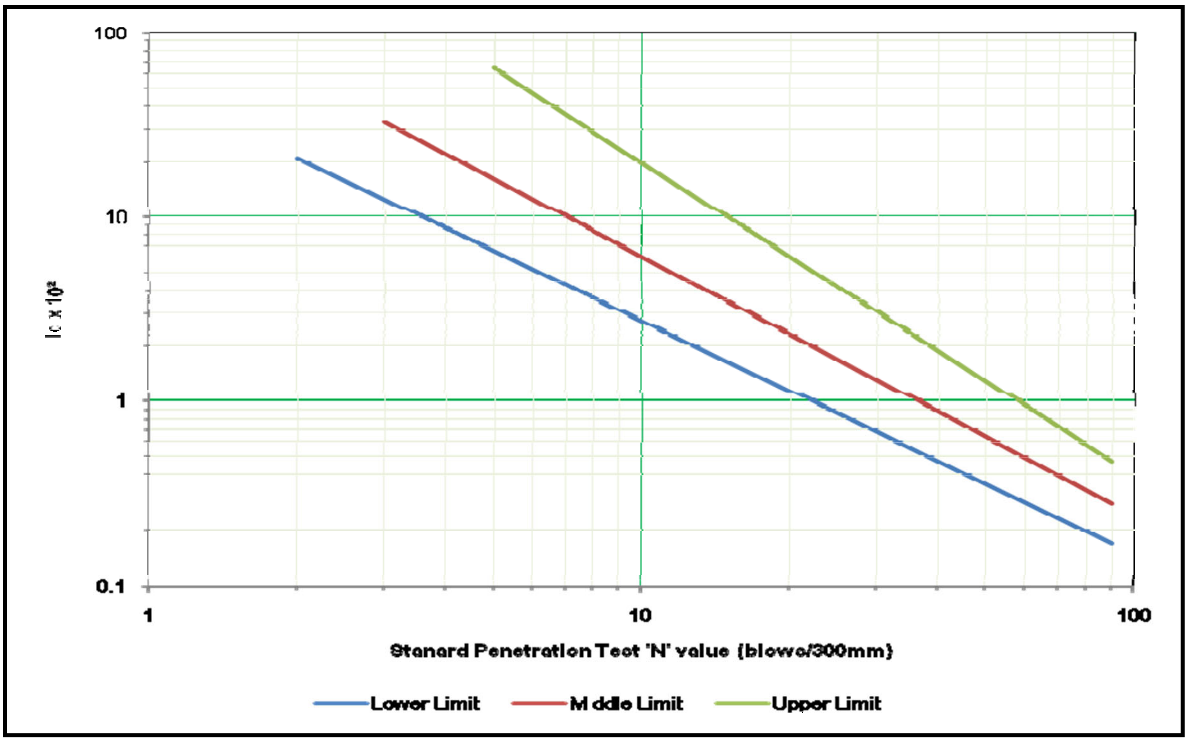
In addition to the assessment of settlement for these soils, there are also a number of other characteristics which would need to be accounted for in the development of the overall ground improvement and foundation strategy. Of particular note for this project are the problems with the construction of roads over peat, and in consideration of this detailed reference has been made to the Roadex II project.

It is worth noting that any change in load will induce a new phase of settlement. Given the high level of settlement predicted for these types of soil, with relatively small increases in effective stress, the simple action of overlying a road on the peat soil with new surfacing without first removing material from the road construction will induce reflective settlement in the final profile after a very short period of time. Therefore, if re-surfacing of the roads are required in the future, then a corresponding depth of material should first be removed to prevent a supplementary phase of primary and secondary settlement.

Assessment of Settlement from Standard Penetration Tests ‘N’ Values SPT

There are a number of calculation techniques which can be used to assess the settlement directly from SPT ‘N’ results, with the most widely used of these being the methodology proposed by Burland and Burbidge. However, it should be noted that these methods are invariable used to assess the settlements of sands and gravels and that the use of these equations is not suitable for cohesive soils (which make up the greater part of the near surface soils in the UK).

Figure C.4 Values of the compressibility index for sands and gravels (after Burland and Burbridge) Tomlinson Fig 2.26.



The general equation proposed by Burland and Burbidge for the assessment of settlement of sands and gravels from SPT 'N' values is as follows:

ρ = $f_s \times f_l \times f_t\,[(q'_n - {}^2/_3 \times p'_o) \times B^{0.7} \times I_c]$

Where:

ρ = the total settlement in mm

f_s = shape correction factor of the foundation, and

f_s = $[(1.25 \times L/B)/(L/B + 0.25)]^2$

f_l = depth correction factor of the sand or gravel layer, and

f_l = ρ_t / ρ_i = $H/z_i\,[2 - (H/z_i)]$

f_t = time correction factor, and

f_t = $[1 + R_3 + R\log(t/3)]$

R = creep ratio expressed as a proportion of the immediate settlement (ρ_i) that takes place per log cycle of time

R_3 = time-dependant settlement expressed as a proportion of the immediate settlement (ρ_i) that takes place during the first three years after construction

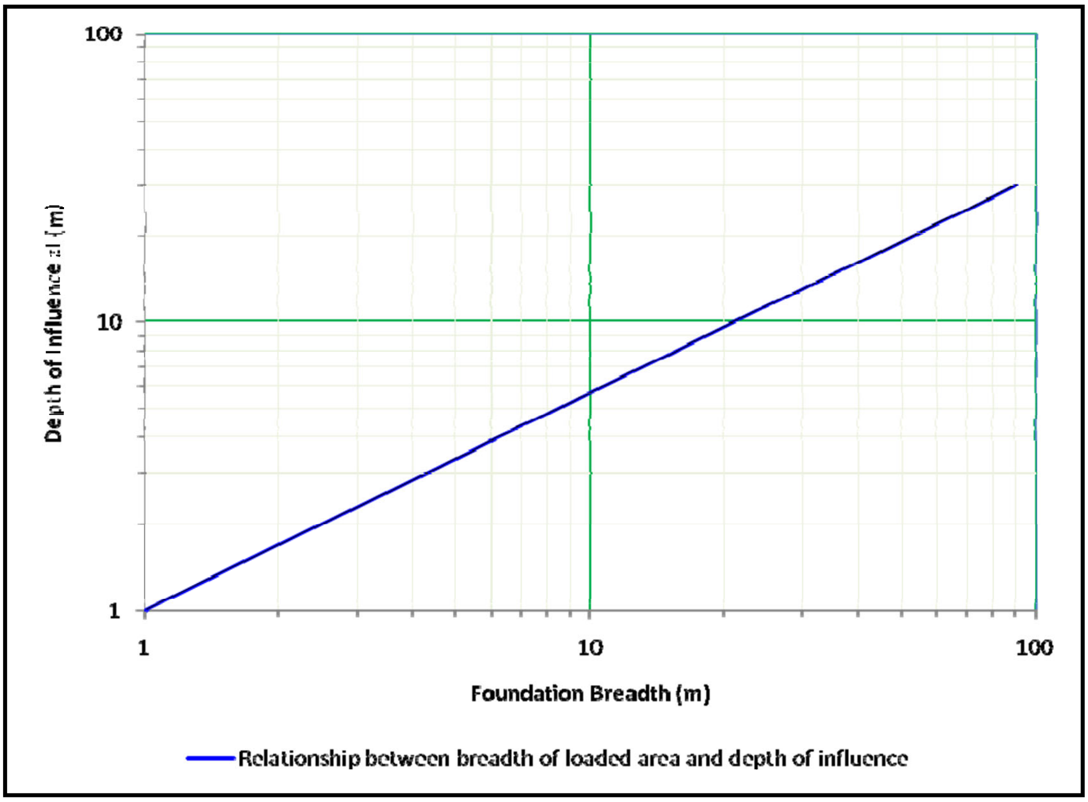
q'_n = average net applied pressure in KN/m²

p'_o	=	maximum previous effective overburden pressure in KN/m²
B	=	width of foundation in metres
L	=	length of foundation in metres
I_c	=	compressibility index, from Figure C.4
z_i	=	depth of influence for sands and gravels, from Figure C.5

The compressibility index I_c for sands and gravels, as determined by Burland and Burbidge, can be extrapolated from Figure C.4, which has been reproduced from Tomlinson.

The depth of influence z_i for sands and gravels, as determined by Burland and Burbidge, can be extrapolated from Figure C.5, which has been reproduced from Tomlinson.

Figure C.5 Relationship between the breadth of loaded area and the depth of influence z_i for sands and gravels (after Burland and Burbidge) Tomlinson Fig 2.27.



Assessment of Settlement using Propriety Software (Oasys Vdisp Version 17.8.4)

To supplement the modelling of the settlement characteristics using in-house spreadsheets, propriety software in the form of Oasys Vdsip. The modelling of the ground conditions and the determination of the resultant settlement characteristics follows the same methodology discussed above.

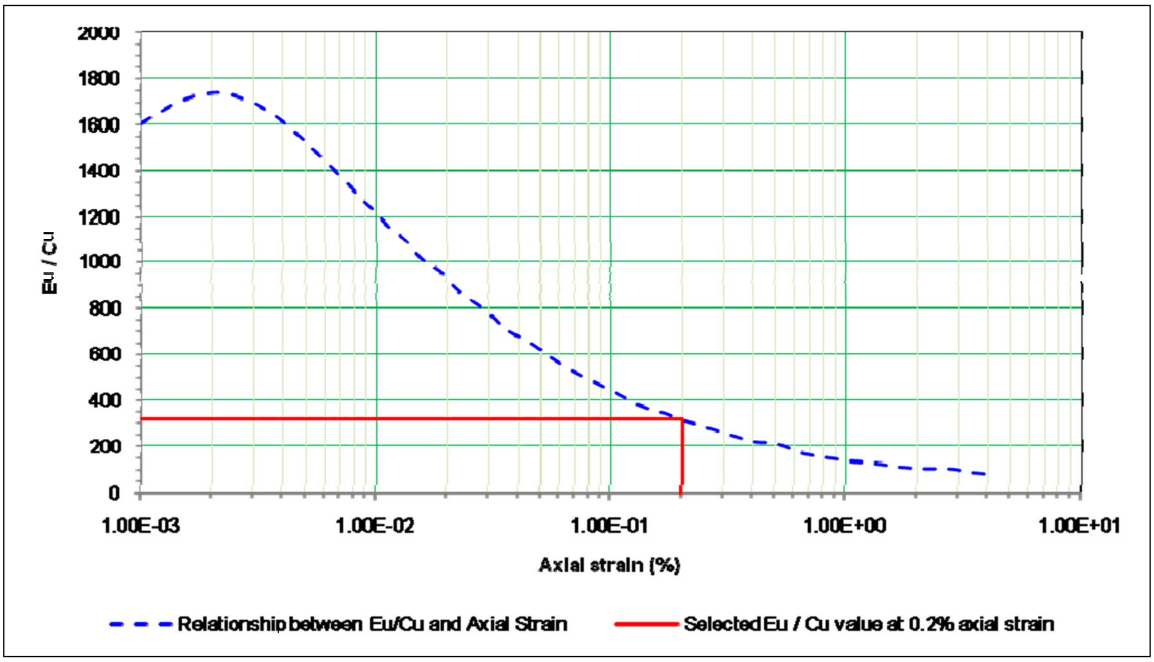
Where CPT soundings or effective stress parameters are not available for the correlation of the stiffness characteristics of the soil layers, then an additional series of industry recognise correlations are carried out.

For the purposes of the settlement assessment, the relationship between the undrained modulus (E_u) and the undrained shear strength (C_u) is used in conjunction with the axial strain (as reported by Tomlinson 2001) based upon the work by Jardine *et al* (1986).

Figure C.6 has been extracted from the paper by Jardine *et al* (1986), and this has been used in the assessment of the undrained modulus, once the undrained shear strength parameters have been determined by traditional methods. In order to complete the assessment of the undrained modulus, it is necessary to assess the axial strain which the soil will be subjected to. In accordance with the recommendations made by Tomlinson (2001), the strain applicable to normal foundations is in the range of 0.01 to 0.1%, confirming the relationship E_u/C_u = 400 which is frequently used for intact blue London Clay.

As the change in axial strain will directly influence the resultant stiffness of the soil, and in turn the stiffness will influence the strain exhibited, a range of axial strains are selected (typically in the range of 0.01% to 0.5%) so that a sensitivity analysis can be completed and an appropriate level of strain adopted.

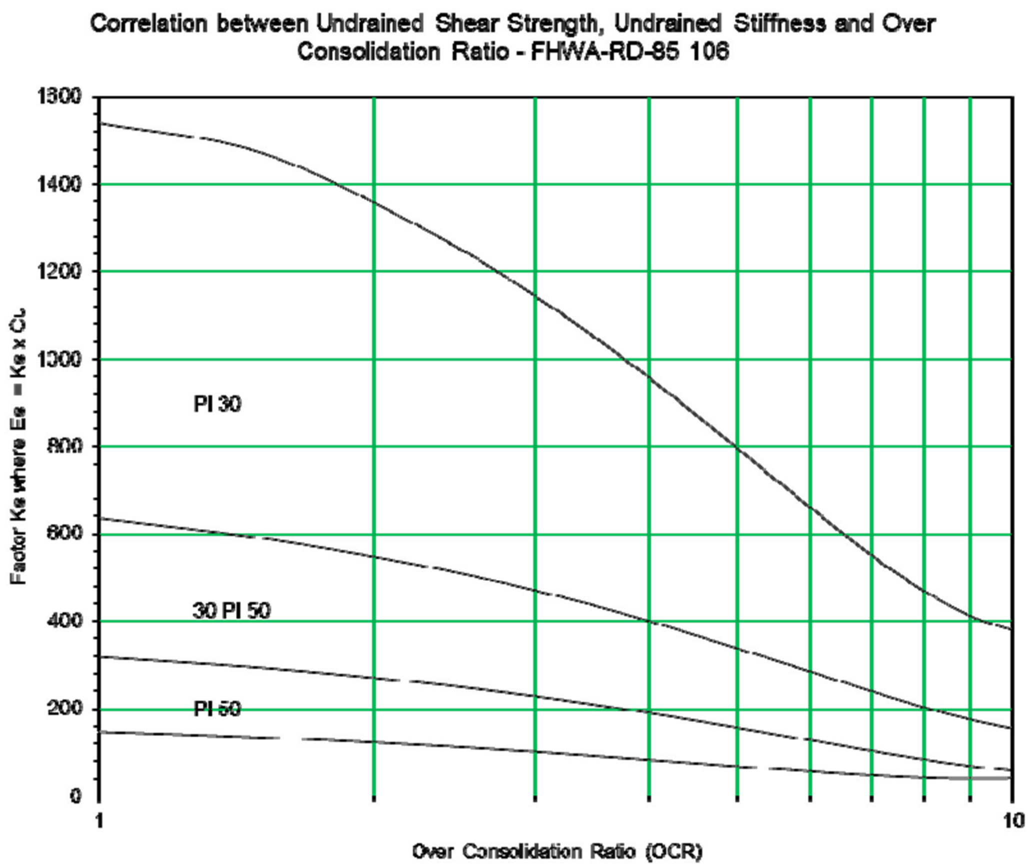
Figure C.6 Relationship between E_u/Cu and axial strain (after Jardine *et al*, 1986).



Once each soil layer and / or undrained shear strength (C_u) result has been converted to an equivalent undrained modulus (E_u), a further correlation is required in order to return a value for E'_d which can then be used for the determination of the settlement characteristics. Where the results of drained triaxial or equivalent effective stress parameters are not available to aid in the correlation between E_u and E'_d, the Tomlinson (2001) then the drained modulus may be obtained approximately from the relationship $E'_d = 0.6\ E_u$. Alternatively if m_v values are available from oedometer tests, then E'_d is the reciprocal of m_v.

Further to the general correlation based upon London Clay presented as Figure C.6, Figure C.7 presents the data for the comparison between the Over Consolidation Ratio (OCR), the undrained shear strength (Cu), the undrained stiffness (E_s) and the plasticity index (PI).

Figure C.7 Relationship between E_s/C_u and OCR (FHWA-RD-85- 106, "Behaviour of Piles and Pile Groups Under Lateral Load.").



The same principal relating the drained (E_d) to undrained stiffness (E_s) applies, with a value typically in the order of 60% adopted.

Assessment of Rate of Consolidation

In addition to the determination of how much settlement may be induced under a given load, it is also important to be able to assess the rate at which this settlement could occur. The settlement of a foundation in a cohesionless soil and the elastic settlement of a foundation in clay can be assumed to occur as soon as the load is applied (Smith 2006).

For cohesive soils, the rate of consolidation settlement is governed by the rate at which excess water can leave the soil, which in turn is a function of the soils permeability. The rate of consolidation of a cohesive soil is expressed as the coefficient of consolidation (c_v), typically expressed as m^2/year. This property can be determined from oedometer test results and from piezocone dissipation tests where these are undertaken as part of the CPT assessment.

For the estimation of the rate of settlement of a soil mass, the horizontal (c_h) and vertical (c_v) coefficients are used, however it can prove to be complex to assess the c_h from piezocone testing as often non-standard dissipation curves are derived from the in situ tests. The results from the dissipation testing are used to determine the time for 50%, identified as t_{50} and from this determine the c_h value to be used in the assessment of rate of settlement

Where piezocone dissipation tests have been completed, the empirical relationship proposed by Houlsby *et al* (1988 & 1991) and Chai *et al* (2004) is employed, where:

t_{50m} = t_{50} / [1 + 18.5 x $(t_{umax} / t_{50})^{0.67}$ $(I_r / 200)^{0.3}$]

Where

t_{50m} = corrected time for 50% excess pore pressure dissipation.

T_{umax} = time for measured excess pore pressure to reach its maximum value.

T_{50} = time difference between the maximum and 50% of the maximum excess pore pressure.

I_r = Rigidity Index, typically in the range of 50 to 500, with a value of 100 employed unless otherwise stated.

Using the corrected t_{50m} value, the horizontal coefficient of consolidation (c_h) is determined from the following equation:

c_h = [c_p x r_0^2 x √ I_r] / t_{50m}

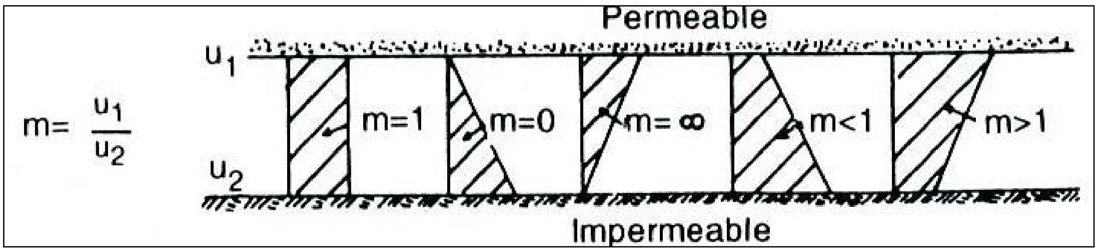
Where:

c_p = filter element correction factor, for a 10cm² cone with a shoulder element (as used in the dissipation testing unless otherwise stated) a value of 0.245 is adopted.

R_0^2 = radius of the cavity, the cone radius

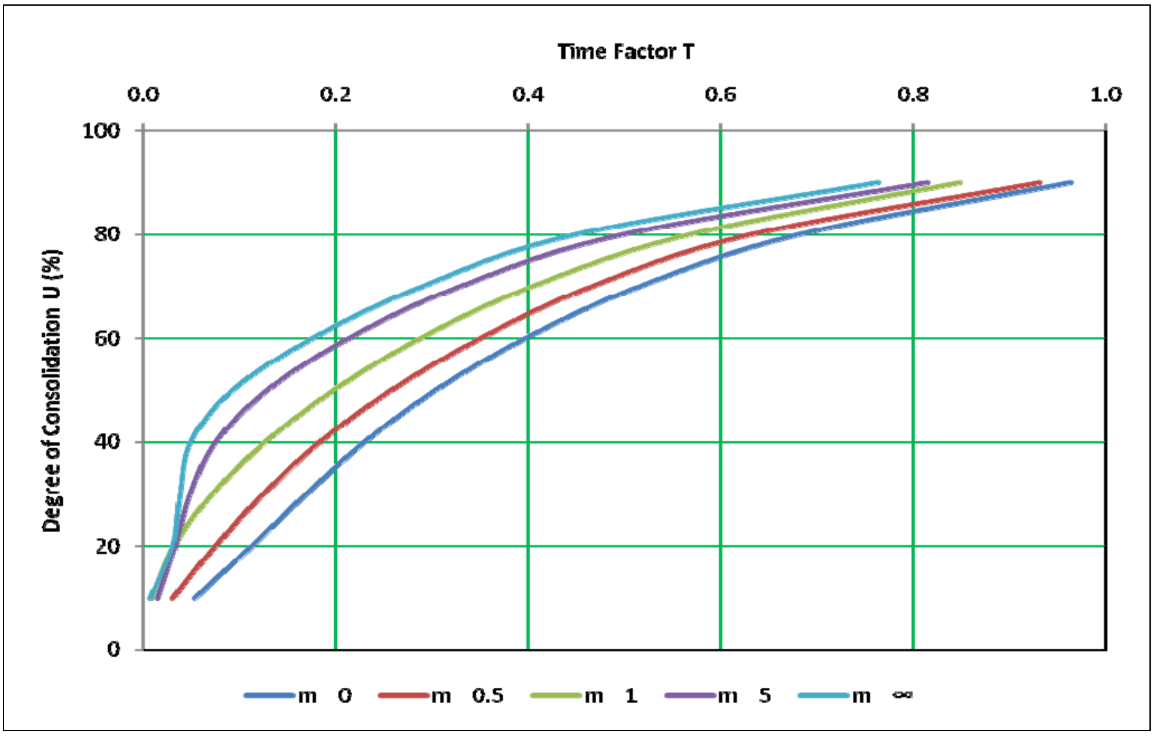
Using the values determined for c_v and c_h a series of soils profiles are constructed, with appropriate values allocated to each soil layer.

For each soil layer, the drainage path characteristics is also selected based upon the drainage characteristics of the surrounding material, and identified by the value m, where:



This is used in conjunction with a series of theoretical curves of consolidation, in order to determine the degree of consolidation at specific time intervals for each soil layer. Figure C.7 presents the theoretical curves derived for ‘m’ which are then used in the assessment of the degree of consolidation (U).

Figure C.7 Theoretical Consolidation Curves (Smith, 2006).



The average degree of consolidation is then can then be determined for each soil layer using the following equation:

T = $[(c_h \text{ or } c_v) \times t] / H^2$

Where

T = Time factor

t = Time period, in the same units as either c_h or c_v.

H = thickness of soil layer

Once the time factor (T) has been determined then a value for U is selected for each layer in the soil profile and the results summed to provide a value for the degree of consolidation at that time period. Therefore, for each soil profile assessed, and as each time interval, a comprehensive assessment of the degree of consolidation can be made.

In addition to using the theoretical consolidation curves listed in Figure B.6, it is possible to calculate U for general situations where m = 1 using the following equation:

U%/100= $[\sqrt{(4T/p)}] / \{[1 + (4T/p)^{\wedge 2.8}]^{\wedge 0.179}\}$

Where :

U% = Degree of consolidation as a percentage

T = Time factor

Conversely and by transposition of the above formula, the time factor T can be calculated using the following equation:

T = $[(\pi / 4)(U\%/100)]^2 / \{[1 - (U\%/100)^{\wedge 5.6}]^{\wedge 0.357}\}$

Where:

T = Time factor

U% = Degree of consolidation as a percentage

Using the general equations detailed above, it has been possible to derive a further relationship between the degree of consolidation and time using polynomial regression derived in the following form:

$$U\% = T \times \{a_0 + (a_1 * t) + (a_2 * t^2) + (a_3 * t^3) + (a_4 * t^4) + (a_5 * t^5) + (a_6 * t^6)\}$$

Where:

U% = Degree of consolidation as a percentage

t = duration in days

T = Time Factor, derived for each soil layer

a_0, a_1, a_2, a_3 & a_4 are factors derived from solving the polynomial regression equation where:

$$\begin{bmatrix} s_{c1} \\ s_{c2} \\ . \\ . \\ s_{cn} \end{bmatrix} = \begin{bmatrix} 1 & x_1 & x_1^2 & . & . & . & x_1^m \\ 1 & x_2 & x_2^2 & . & . & . & x_2^m \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ 1 & x_n & x_n^2 & . & . & . & x_n^m \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ . \\ . \\ a_m \end{bmatrix}$$

Using the general equation for a soil corresponding to m = 1, T = 1 and achieving a U of 90% at 205 days the following factors have been derived.

A_0 = 0.000726047

a_1 = 0.011528752

a_2 = -6.28547×10^{-05}

a_3 = 1.95221×10^{-07}

a_4 = -3.48469×10^{-10}

a_5 = 3.30418×10^{-13}

a_6 = -1.28501×10^{-16}

The above equation can then be used to derive any curve of settlement by first determining the time to achieve 90% consolidation, and deriving a Time Factor T for each soil layer.

Additional assessment methods

In addition to the methods for assessing settlement discussed previously, there are a number of other techniques which can be used, but these have not been adopted as part of the current geotechnical assessment process.

The range of calculation techniques listed in this Appendix represent the range of methodologies which have been employed in the current settlement assessment. It is noted that not only are there other general equations which can be used, but also there are a large number of additional correlations which can be employed to refine the settlement model. However, as stated above, the methodologies which have been used in this assessment are as detailed within this Appendix.

Assessment of Net Bearing Pressure

In addition to a range of methods for assessing the settlement of a soil layer, there are also a number of industry accepted methods for calculating the bearing pressure distribution below a foundation.

Bousinesq's original equation allows the calculation of the vertical stress ($_z$) at any point N below a loaded foundation, and is given by the following general equation:

σ_z = $(3Q / 2\pi z^2) \times [\,1 / (\{1 + (r/z)^2\}^{5/2})]$

Where:

σ_z = vertical stress at the point under consideration

Q = concentrated vertical load

z = vertical distance between N and the underside of the foundation

r = the horizontal distance from N to the line of action of the load.

The basic Bousinesq equation presented above is based on the assumption that the loaded material is elastic, homogenous and isotropic, which although not strictly true for soils in general, has been deemed to provide a suitably accurate method for the assessment of the pressure distribution below structures.

The original Bousinesq equations have been subsequently developed to allow for the calculation of stress below other types of foundation, including embankments and circular features. These expanded series of equations have been used in the assessment of pressure distribution below the proposed structures and embankments (using the Osterberg modified method).

For the purposes of this assessment, the following additional equations which expand upon the original Bousinesq equation have been used:

For Strip Foundations (Bousinesq):

$\Delta\sigma_z$ = $q / \pi \times [\alpha + \sin\alpha \cos(\alpha + 2\beta)]$

Where:

$\Delta\sigma_z$ = change in vertical stress

q = contact pressure, applied load from foundation

α = $\tan^{-1}[(x + b) / z] - \beta$ (in radians)

β = $\tan^{-1}[(x - b) / z]$

B = Width of foundation

b = effective breadth of foundation = foundation width B/2

x = horizontal distance from centre of foundation to point under assessment

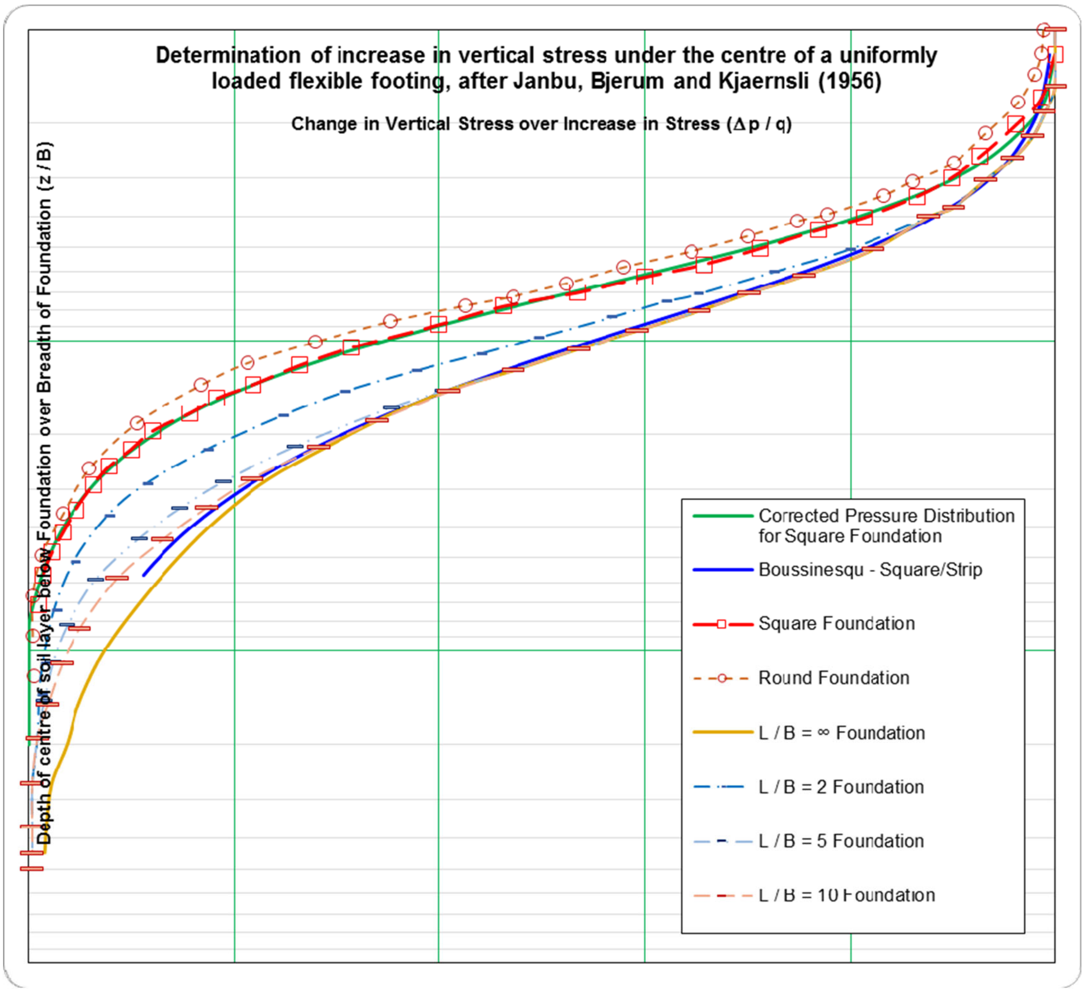
z = vertical distance from base of foundation to point under assessment.

For Strip Foundations (After Janbu, Bjerrum and Kjaernsli (1956))

The work completed by Janbu et al (1956) revised the general equation derived by Bousinesq for a range of foundations dimensions. Figure B5 presents the findings of the assessment completed by Janbu et al (1956) and includes the pressure distribution for a strip footing using the Bousinesq equation detailed previously.

Figure C.8 demonstrates that the assessment of vertical stress using the Bousinesq equation is directly comparable to the Janbu et al assessment for a rectangular footing of infinite length.

Figure C.8 Determination of increase in vertical stress under the center of a uniformly loaded flexible footing, after Janbu, Bjerum and Kjaernsli (1956).



Therefore, in order to correlate the relationship between the net increase in applied stress derived from the Bousinesq equation and that determined by Janbu et al, a polynomial relationship was determined for each foundation dimension.

The general equation used to derive the relationship between the Bousinesq and a strip footing is:

$\Delta\sigma_z$ = $a_0 + (a_1 * x) + (a_2 * x^2) + (a_3 * x^3) + (a_4 * x^4)$

where

s_c = Primary Settlement/Consolidation

x = change in vertical stress determined using the Bousinesq equation for strip footings

a_0, a_1, a_2, a_3 & a_4 are factors derived from solving the polynomial linear equation where:

$$\begin{bmatrix} s_{c1} \\ s_{c2} \\ . \\ . \\ s_{cn} \end{bmatrix} = \begin{bmatrix} 1 & x_1 & x_1^2 & . & . & . & x_1^m \\ 1 & x_2 & x_2^2 & . & . & . & x_2^m \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ 1 & x_n & x_n^2 & . & . & . & x_n^m \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ . \\ . \\ a_n \end{bmatrix}$$

The relationship determined for the correlation for a square foundation returned the following factors:

a_0 = -0.02278

a_1 = 0.22649

a_2 = 0.81125

a_3 = 0.00000

a_4 = 0.00000

A similar process is carried out where the foundation is not square, with the factors derived individually for the actual foundation dimensions under assessment.

The selection of the method of determining the pressure below a square or rectangular foundation is set as default to use the corrected pressure distribution equation corresponding to the Janbu et al methodology; however the user has the ability to switch between the Bousinesq, Newmark, Janbu and Steinbrenner as appropriate. Unless otherwise stated in the report, the Janbu et al methodology has been adopted for the assessment of vertical stress below a square or rectangular foundation.

For Area (point under centre of circular area):

$\Delta\sigma_z$ = $qr^2 [(s^2 + 2z^2) / 2S^4]$

Where:

$\Delta\sigma_z$ = change in vertical stress

q = contact pressure, applied load from foundation

S^2 = $r^2 + z^2$

r = radius of foundation

z = vertical distance from centre of base of foundation to point under assessment.

The selection of the method of determining the pressure below a circular foundation is set as default to use the Bousinesq methodology as the resultant pressure distribution curve is identical to the

Janbu et al result; however the use has the ability to switch between the Bousinesq, Newmark, Janbu and Steinbrenner as appropriate. Unless otherwise stated in the report, the Janbu et al methodology has been adopted for the assessment of vertical stress below a circular foundation.

For Embankment Loads (Osterberg):

$\Delta\sigma_z$ = I q

Where

$\Delta\sigma_z$ = change in vertical stress

q = applied load from embankment above the point of assessment, and

q = γH

γ = unit weight of embankment material

H = height of embankment material

I = influence factor

Where:

I = $1/\pi \times [\{(a + b)/a\} \{\alpha_1 + \alpha_2\} – \{(b/a)/\alpha_2\}]$

a = the horizontal length of the slope portion of the trapezium (embankment) to the point of assessment

b = the horizontal length of the flat portion of the trapezium (embankment) to the point of the assessment

α_1 = $\mathrm{Tan}^{-1} [(a + b)/z] – \mathrm{Tan}^{-1}(a/z)$ (in radians)

α_2 = $\mathrm{Tan}^{-1}(a/z)$ (in radians)

z = the depth to the point at which the stress is to be etermine.

The selection of the method of determining the pressure below a loaded area is set as default to use the Osterberg methodology.

For Floor Slabs (Hobbs):

In consideration of the stress distribution beneath a floor slab and similarly loaded areas, the following additional equation, proposed by Hobbs has also been employed in combination with those listed above:

P_z = $B \times L \times P_0 \times [1 / \{(B + 1.2z) \times (L + 1.2z)\}]$

Where:

P_z = stress at depth below the floor slab

P_0 = imposed load from foundation

B = width of slab area

L = length of slab area

z = depth below foundation

As for the previous assessment of pressure distribution, the settlement beneath the floor slab is only considered to a depth where the applied stress is greater than 20% of the previous overburden pressure, or where the ground is considered to be incompressible (BS EN 1997-1). The selection of the method of determining the pressure below a loaded area is set as default to use the Hobbs methodology.

Presentation of Assessment Data

Where the results of CPT soundings are used in the assessment of the settlement characteristics of the ground, the findings will be presented as a series of figures associated with each soil strength profile. The table below summarises the various mathematical equations that may be used in the electronic spreadsheet assessment of the settlement.

Table C.3: Assessment Method and Equations

Settlement Method	General Equation
Settlement based upon SPT	Total Settlement $\rho_t = f_s \times f_l \times f_t \times q'_n \times B^{0.7} \times I_c$
Consolidation based on m_v	Consolidation Settlement per layer $\rho_{oed} = M_v \times \sigma_z \times H \times \mu_g$
Settlement inc. Creep based on CPT	Settlement from CPT $\rho = C_1 \times C_2 \times q_n \times (I_z/E_s) \times t$
Adjusted Elasticity Method E'd	Total Settlement $\rho = \sigma_z \times H \times ((1-\upsilon^2)/E'd)$
Consolidation based on Cc	Consolidation settlement from fill $\rho_c = Cc/\ 1 + e_0 \times \log(p_2/p_1) \times H$
Primary Settlement of Peat	Primary settlement of Peat $s_c = [\{(Cr \times H)/\ (1 + e_0)\} \times \{LOG(p'_p/p'_o)\}] + [\{(Cc \times H)/(1 + e_0)\} \times \{LOG(p'_f/p'_p)\}]$
Secondary Settlement of Peat	Secondary settlement of Peat $s_s = ((C_\alpha \times H)/(1 + e_p)) \times LOG(\text{Design Life of Structure})$

ANNEX D

GEOTECHNICAL RISK REGISTER

Introduction

A Geotechnical Risk Register has been complied in accordance with the general requirements of HD 22/08 to assist in the management of the risks and hazards. The following pages set out the identified geotechnical risks and hazards which associated with the proposed development and establish the approach which is to be taken to manage the risks including the geotechnical input and analysis.

The purpose of the Geotechnical Risk Register is to provide and outline a description of the hazards, identify the likely cause, describe the potential impact of the hazard and identify the design construction controls to be implemented in order to minimise the geotechnical risk.

The Geotechnical Risk Register will be actively used during the design and construction stage of the project as a guide to address geotechnical issues. The risk register will be up-dated, as necessary, to reflect additional information, data and experience as it is gained through the construction process.

Whilst the probability and impact of the hazard occurring can be reduced to a minimum by geotechnical design, the impact cannot be reduced below very low. The probability and impact of a hazard have been judged on a qualitative scale as set out in Table D.1

Table D.1: Qualitative Assessment of Hazards and Risks

P = Probability		
1	Very unlikely	(VU)
2	Unlikely	(U)
3	Plausible	(P)
4	Likely	(Lk)
5	Very Likely	(VLk)

I = Impact		
1	Very Low	(VLw)
2	Low	(Lw)
3	Medium	(M)
4	High	(H)
5	Very High	(VH)

R = Risk Rating (P x I)		
1 – 4	None / negligible	(N)
5 – 9	Minor	(Mn)
10 – 14	Moderate	(Md)
15 – 19	Substantial	(Sb)
20 – 25	Severe	(Sv)

Project Name:	East Midlands Gateway M1 Overbridge	Project Number:	C14792	Date:	08/07/2017

Hazard	Location	Who is at Risk	Consequence	Risk Before Mitigation			Mitigation Measures			Residual Risk		
				S	L	R	Preliminary Design	Detailed Design	Construction Team	S	L	R
Slope Stability – New highway embankments	Refer to BWB drawing series	Construction staff, vehicles and plant operators. Pavement construction and long-term durability of new carriageway	Embankment failure	4	3	12	Hydrock GDR reference R/14792/008 which includes the detailed slope stability assessment identifying acceptable slope profiles. Engineered fill requirements defined at outline design stage.	Minimum engineering performance defined in slope stability included in Earthworks Specification. Minimum testing frequencies in Appendix 1/5 required demonstrate compliance.	Earthworks testing in accordance with the Specification to comply with Appendix 6/1 and 6/3, at the frequencies defined in Appendix 1/5. Site records to be provided in accordance with Appendix 1/24	2	1	2
Slope Stability – Re-profiled embankments	Refer to BWB drawing series	Construction staff, vehicles and plant operators. Pavement construction and long-term durability of new carriageway	Embankment failure	4	3	12	Hydrock GDR reference R/14792/008 which includes the detailed slope stability assessment identifying acceptable slope profiles. Engineered fill requirements defined at outline design stage. Granular fill required to form re-profiled slope form.	Minimum engineering performance defined in slope stability included in Earthworks Specification. Minimum testing frequencies in Appendix 1/5 required demonstrate compliance. Contractor to source appropriate granular material which will meet the minimum requirements. All fill to be benched in to slope and include additional drainage.	Importation of an appropriate granular fill material. Earthworks testing in accordance with the Specification to comply with Appendix 6/1 and 6/3, at the frequencies defined in Appendix 1/5. Site records to be provided in accordance with Appendix 1/24. Benches to be formed by Contractor	2	1	2
Excessive settlement of foundations (poor stiffness of underlying soils and engineered fill)	Refer to BWB drawing series	Carriageway including roundabout	Service limit state failure highway	3	3	9	Determination of minimum stiffness of engineered fill to provide sufficient support to foundations and floor slab. Details provided in GDR, Hydrock reference R/14792/014	Determination of compliance values to be met by engineered fill to meet the long-term stiffness. Values added to Appendix 6/1.	Site inspection, careful selection of fill and testing at the frequency defined in Appendix 1/5, to demonstrate compliance with Appendix 6/1 and 6/3 with Contractor to provide records in	3	1	3

Hazard	Location	Who is at Risk	Consequence	Risk Before Mitigation			Mitigation Measures			Residual Risk		
				S	L	R	Preliminary Design	Detailed Design	Construction Team	S	L	R
									compliance with Appendix 1/24. Hydrock to undertake routine site inspections to ensure Contractor is in compliance with the Specification.			
Excavations	Site wide	Construction staff	Risk of collapse of excavation. Falling debris in excavation. Slips, trips and falls.	4	2	8	Temporary works design to be completed by appointed contractor.	Temporary works design to be completed by appointed contractor.	Contactor to determine safe method of work	4	1	4
Working adjacent to live traffic during earthworks operation	Refer to BWB drawing series	General Public Construction staff	Rick of obstruction, striking passing vehicles. Risk of construction site staff being struck by plant.	4	3	12	Design team to consider the construction sequence to mitigate risk.	Discussion with HE and LA regarding temporary works and their residual risks	Contractors safe method of working. Implementation of signing and traffic control measures in accordance with Chapter 8. Contractor to provide appropriate protection barriers. Workers to wear high visibility clothing.	4	1	4
Limited geotechnical data and SI coverage	M1 bridge abutment location	Unexpected ground conditions, long-term embankment stability	Service limit state failure highway	3	3	9	Conservative lower bound values used in design. Adoption of published values. Review of historical sources of data.	Additional boreholes to be drilled, once access given by HE	Sub-formation to be inspected and approved by Hydrock Contractor to inform Hydrock before filling commences to ensure sub-formation is acceptable. Allowance for removal of upper superficial soils.	3	1	3

Hazard	Location	Who is at Risk	Consequence	Risk Before Mitigation			Mitigation Measures			Residual Risk		
				S	L	R	Preliminary Design	Detailed Design	Construction Team	S	L	R
Structural assessment for whole life cycle of bridge, including demolition	M1 Overbridge	Inspectors and contractors including demolition contractors	Risk to workers, and members of the public	5	2	10	Included in geotechnical risk register	Confirmation from the bridge designer that this is included in their design and DRA.	Reference to the bridge designers DRA	5	1	5
General Public/Children trespassing on site during earthworks operation	Whole Site	General Public Children	Risk of public injury on site from trips, slips, falls, falling from height, falling into excavations, open water.	4	2	8	Consideration of Public Right of Way	Construction sequences assessed to minimize the duration of any obstruction/severance to the public right of way. Closure of Town Lane. Possible diversions identified and assessed for the safety of the public.	Ensure the site is properly secure and inform the surrounding public of site locations and boundaries. Identified diversions for public right of way established and clearly signed.	4	1	4

Prepared By:	Ian Gardner	Signature:	[redacted]

See Bookmarks for contents of this report.

Smart Motorways Programme

M1 Junction 23a to 25

Geotechnical Feedback Report

HAGDMS Report No. 30523

June 2021

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.

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LIST OF TABLES

Glossary of Terms

Acronym	Description
ACEC	Aggressive Chemical Environment for Concrete
ADS	Advance Direction Sign
AIP	Approval In Principle
AMAR	Amey Arup Joint Venture
BRE	British Research Establishment
CCTV	Closed Circuit Television
CGT	Principal Contractor: Costain-Galliford Try Joint Venture
DF5	Design Fix 5: Detailed Design
DVA	Derwent Valley Aqueduct
DMRB	Design Manual of Roads and Bridges
EAV	External Automatic Verification Camera
ERA	Emergency Refuge Area
GDR	Geotechnical Design Report
GFR	Geotechnical Feedback Report
GIR	Ground Investigation Report
HAGDMS	Highway Agency Geotechnical Management Data System
KSP	King Sheet Pile Wall
LiDAR	Light Detection and Ranging
MS3 Cantilever	Message Sign 3 Cantilever
MS4 Cantilever	Message Sign 4 Cantilever
PSSR	Preliminary Sources Study Report
ROTTM	Remotely Operated Temporally Traffic Management
SHW	Specification for Highway Works
SMP	Smart Motorways Programme

Limitations

This report is presented to Highways England in respect of the M1 junction 23a-25 Smart Motorway Programme project and may not be used or relied on by any other person or by the client in relation to any other matters not covered specifically by the scope of this report. Notwithstanding anything to the contrary contained in the report, Amey–Arup Joint Venture (AMAR) is obliged to exercise reasonable skill, care and diligence in the performance of the services required by Highways England.

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The information upon which the content of this report is based is supplied by the construction delivery partner and AMAR can accept no responsibility of inaccuracies or omissions in that data. New information changed practices or new legislation may also necessitate revised interpretation of the report after the date of its submission.

Executive Summary

This Geotechnical Feedback Report (GFR) relates to the Smart Motorway scheme on the M1 motorway between junctions 23a (East Midlands Airport) and 25 (A52 Nottingham). Highways structures and earthworks for this scheme include:

- Gantry foundations (major structures);
- CCTV masts, large traffic signs, environmental barriers, radar masts, EAV poles and remotely operable temporary traffic management sign (ROTTMS) foundations (minor structures);
- Emergency Refuge Areas including retaining walls and local widening;
- Cross Carriageway Ducts; and
- Mainline verge widening to accommodate new drainage and technology ducting.

Generalised soil properties and parameters were derived in the AMAR Ground Investigation Report (GIR) [1]. These parameters were refined based on local data for major structures and earthwork widening locations. These parameters were presented in Geotechnical Summary Sheets appended to the Geotechnical Design Report [2].

AMAR used the Smart Motorway Programme Design Guide [3] to determine the preferred widening/retaining solutions for each location, based on its topography. These solutions can be summarised as follows:

1. Where a slope regrade was required, a numerical model using the slope stability modelling software program SLOPE/W [4] was used.

2. 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 [5].

Five different types of gantries were proposed for the scheme: MS3 cantilever, MS4 cantilever, ADS cantilever, super cantilever and super-span portal. All gantries were constructed on pile caps and pile group foundations. Foundations for minor structures were either planted foundations, bored piles or pad foundations, depending on structure type and associated loadings.

During construction, the Amey-Arup site team (Lead Designer) assisted the contractor in the delivery of construction phase by developing ongoing design changes during construction, due to changes and issues encountered in the construction phase. This report highlights these design changes from the designs documented in the GDR.

This GFR describes the construction problems that arose and the associated solutions. The appendices of this report contain details of the earthworks and other geotechnical features throughout the scheme, as well as the As-built Drawings. This report is a summary of the geotechnical aspects of the scheme and contains suggested improvements for similar future schemes.

This GFR has been prepared by AMAR in accordance with the guidance set out in HD22/08 [6] for a GFR and the design for the scheme was undertaken in accordance with Eurocode 7 [7]. This GFR shall be read in conjunction with the Ground Investigation Report (GIR) [1]; HAGDMS ref: 28929 dated February 2016 and the Geotechnical Design Report (GDR) [2]; HAGMDS ref: 29152 dated June 2017.

1. Introduction

1.1. Scope and objectives of the report

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

The M1 J23a-25 scheme was delivered by the Principal Designer, Amey-Arup (AMAR) jv and the Delivery Partner, Costain Galliford Try jv (CGT). The site works started in April 2017 and the scheme opened for traffic in December 2018. The scheme included the following elements:

- Smart Motorway infrastructure to enable hard shoulder running
- Mainline verge widening to accommodate drainage and communication ducting
- 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 Segro Logistics Park East Midlands Gateway strategic rail freight terminal between Junctions 24 and 24a.

The AMAR site team (Lead Designer) assisted in the delivery of construction phase by developing ongoing design changes during construction. This report highlights these design changes from DF5 due to construction phase problems encountered and reasoning behind changes.

This Geotechnical Feedback Report (GFR) provides feedback on the following geotechnical aspects of the scheme construction:

- Earthworks solutions including full and partial height cutting and embankment re-grades to accommodate verge widening and ERAs
- Retaining wall solutions including continuous sheet pile walls, king sheet pile walls and gabion walls to accommodate verge widening, ERAs and build-out areas for major and minor structures
- Various shallow and deep foundation solutions for gantry foundations, minor structures, environmental barriers, ROTTMs and EAV Poles
- “Just in Time” ground investigation and gantry foundation design verification
- Localised “slab on edge” solutions
- Cross Carriageway Ducting

A confirmatory ‘Just in Time’ Ground investigation (GI) [8] was carried out during the construction phase by the contractor, to confirm the assumptions of ground conditions and parameters used in pile design at proposed gantry locations. The results of the ‘Just in Time’ GI are included in Appendix G.

This report has produced by AMAR in accordance with the requirements of HD22/08 [6] .

1.2. Limits of the area covered by the report

This GFR refers to the construction work carried out for the implementation of the SMP scheme for M1 junctions 23a to 25. The scheme comprises a 12km long section of motorway. The construction has been divided into six links corresponding to the chainages shown in Table 1.

Table 1: M1 J23A TO J25 chainage and national grid reference

Construction Link	Chainage	Marker Post	Grid Reference Start		Grid Reference End	
			E	N	E	N
1	181500-182000	181/5-182/0	446867.290	323972.546	446855.524	324471.685
2	182000-185000	182/0-185/0	446855.524	324471.685	447539.281	327381.512
3	185000-187000	185/0-187/0	447539.281	327381.512	447111.775	329322.668
4a	187000-190000	187/0-190/0	447111.775	329322.668	446655.234	332203.407
4b	190000-193050	190/0-193/0	446655.234	332203.407	447171.361	335084.696
5	193050-193800	193/0-193/8	447171.361	335084.696	447184.558	335833.676

1.3. Bibliography of scheme specific geotechnical reports

Table 2: List of M1 J23a to J25 AMAR geotechnical reports

Author	Document Title	HA Reference	HAGDMS Pin	Document Date	Ref
AMAR	M1 J23a-J25, Statement of Intent Rev P01	HA549342-AMAR-HGT-SWI-RP-CE-000001	28704	October 2015	[9]
AMAR	M1 J23a-J25, Ground Investigation Report Volume 1 Rev P01	HA549342-AMAR-HGT-SWI-RP-CE-000002	28929	February 2016	[1]
	M1 J23a-J25, Ground Investigation Report Volume 2 Rev P01				
	M1 J23a-J25, Ground Investigation Report Volume 3 Rev P01				
	M1 J23a-J25, Ground Investigation Report Volume 4 Rev P01				
AMAR	M1 J23a-J25, Geotechnical Design Report Rev P02	HA549342-AMAR-HGT-SWI-RP-CE-000003	29152	June 2017	[10]
AMAR	M1 J23a-J25, Geotechnical Design Report Directional Drilling Rev P01	HA549342-AMAR-HGT-SWI-RP-SWI-RP-CE-000006	29378	May 2017	[2]

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 and 30 [11] and minor updates incorporated in the GIR.

1.4. Other relevant information

The construction works were undertaken within the existing highways boundary in permanent traffic management hard shoulder closures, with further lane closures as required during day and night shifts.

As-built drawings showing the details of work done in the scheme are included in Appendix C. A selection of photographs, showing the works in progress and completed, is presented in Appendix I.

As part of the handover process, Highways England (Operations Directorate) carried out inspections of the geotechnical assets. This inspection was carried out in multiple site visits accompanied by AMAR and CGT. Table 3 shows the site inspection visits.

Table 3: Summary of HAGDMS inspection visits

Site visit	Chainage From	Chainage to	Link	Date
1	184+000	185+600	Link 2 and Link 3	17-04-2018
2	184+000	185+600	Link 2 and Link 3	19-04-2018
3	187+000 to	192+800	4A, 4B and 5 expect last 1km	17-07-2018
4	Remaining Assets in Link 3*		Link 3	29-10-2018
5	Remaining Assets in Link 5*		Link 5.	19-03-2019

**some assets were not accessible during the site visits 1-3 because of traffic management issues, therefore these assets were inspected in site visits 4 and 5.*

In these site visits, Highways England raised early comments about the geotechnical assets including matters of maintenance and interface with drainage assets. These comments have been actioned and closed out as per CGT Defect and Outstanding Work List (DOWL).

To update the HAGDMS database with details of the scheme, AMAR prepared a detailed list of the geotechnical assets along M1 J 23a-25, including widened verge, gabion walls, regraded earthworks and sheet pile wall. These were imported to HAGDMS as “observations” on the relevant earthworks' asset. The POPI (Pre-Opening Principal Inspection) has been completed by Area 7 and all observation were closed out.

2. Earthworks

2.1. General description of earthworks

This section presents design changes made since the GDR [2] (DF5) regarding widening of earthworks in both cuttings and embankments.

Earthwork widening solutions were initially selected using the “SMP Preferred Widening Solutions Decision Flow Chart” and the methodology can be found in the GDR [2]. Alternative design solutions were used on embankments crossing floodplains, to minimise the loss of flood storage volume. Full and partial height cutting and embankment slope re-grades were used to widen the existing verge to accommodate the smart motorway infrastructure.

For areas of major verge widening, at gantry and ERA locations (i.e. major structures), site-specific design parameters were chosen by using a combination of historical GI data and considering the indicative design parameters given in the AMAR Ground Investigation Report (GIR) [1]. This was then confirmed within the ‘Just in Time’ GI [8], which was conducted at the site of each major structure prior to construction to confirm the ground model and parameters used in design.

During development of DF5, ground profiles were modelled based on LiDAR survey information. However, the coverage and quality of this survey was limited, particularly at large embankments with restricted sightlines to the scanning vehicle. This was considered as a risk to the overall design and it was included in the risk register within the GDR [2].

Typical slopes of 1V:2H for embankments and 1V:3H or 1V:2H for cuttings were proposed in the GDR.

Earthworks were constructed working from south to north. The earthworks subcontractor was Collins Ltd. During construction, various retaining solutions were reviewed using more accurate topographic surveys and changed to earthwork regrade solutions. The changes resulted in cost savings during construction and more sustainable options being implemented on site. Occasionally, the temporary piling platforms were found suitable to be used as permanent earthwork solutions. This was achieved when the constructed temporary platforms complied with earthwork requirements specified by AMAR in Volume 2 Works Information; Specification Appendices Series 600 Earthworks.

The design of all earthworks was performed in accordance with BS EN 1997-1:2004+A1:2013 (Eurocode 7) [7] and NA+A1:2014 to BS EN 1997-1:2004+A1:2013 [12]. Where a slope regrade was proposed, it was checked in a numerical model using the slope stability modelling software program SLOPE/W [4] . The Morgenstern-Price method of analysis was used with both the Piezometric Line and Ru options being run in separate models for pore-water pressure conditions, and using the Eurocode 7 Design Approach 1, Combination 1 and 2 set of partial factors [12]. The Grid and Radius slip surface option was used with a minimum slip surface depth geometry set at 1.

Appendix A includes lists of major structures (Gantries, Radar masts, CCTV), ERAs, and verge widening earthworks schedules.

Appendix C includes as-built drawings nos. HA549342-AMAR-HGT-E1A1-DR-CE-000001 to HA549342-AMAR-HGT-E1A1-DR-CE-000017, which present typical details of the above solutions.

2.2. Problems not envisaged in the GDR and their solutions

2.2.1. Changes in topography from original LiDAR survey

During development of the verge widening design, ground profile cross sections were derived from the LiDAR survey, where the information was captured using a vehicle mounted scanner. This LiDAR survey was taken from carriageway level and prior to vegetation clearance. Therefore, coverage of this survey was limited especially at the following areas:

- Soft areas (particularly merges and diverges), where vegetation obstructed the LiDAR; and
- Large embankments, where the slope was not visible from road level.

As a result, the design ground profile lacked detail of the ground surface as distinct from the vegetation cover, and details such as ditches, existing features and boundaries. These limitations resulted in inaccuracies in the topographical model used for design of verges, slopes, and retaining solutions. After vegetation clearance, the contractor carried out full topographic surveys which in many cases led to redesign of different geotechnical elements.

A flooding risk was identified based on the historical data but there was no flooding recorded during the construction phase of the scheme.

2.3. Weather conditions

The construction of embankment earthworks widening was carried out from April 2017 to April 2018. Construction activities were undertaken in a variety of different weather conditions. There was a particularly cold spell between January 2018 to February 2018 and heavy rain from March to May 2018. In general, the weather did not have a significant impact on the construction works.

As the scheme does not involve large bulk earthworks/mass haul, the works were not significantly weather dependent. Detailed weather records have not provided by the contractor. There are no records of any locations of excessive drying or shrinkage.

2.4. Application of acceptability criteria of earthworks materials

The suitability of materials on the project were assessed in accordance with the testing and specifications outlined in Appendix 1/5 [13] and Table 6/1 [14] of the specification, which was prepared base on the defined in the HE Specification for Highways works [15]. Table 4 presents the imported material used. Also, the Health and Safety File includes test results and certificates of these imported materials.

Table 4: List of imported materials

Class	Material
6N*	6N for the backfill behind the gabion\ sheet pile wall and embankment widening.
6G	Gabion basket fill
Geotextile	Geotextile Separator layer

*N. B: Class 6N imported material, which also met the specification for Class 1, was used for both fill to structures and embankment widening to give flexibility in material handling (rather than using a separate Class 1 fill).

All these materials were delivered to site by CGT after submitting Material Approval Requests (MARs). Table 5 shows list of MARs used for earthworks.

Table 5: List of MARs used for earthworks and retaining walls

MAR	Series	Product
0009	600: 6N Material	6N Crushed Limestone
0010	600: 6N Material	Tarmac Ballidon Quarry - 6N
0130	600: 6N Material	20mm down granite- 6N
0090	600: 6N Material	6N Crushed Granite
0079	600: 6N Material	6N Crushed Granite
0122	600; Drainage Geocomposite	Deckdrain drainage geocomposite
0061	600: Geotextile	Non-woven Geotextile
0227	600: Geotextile	Non-woven Geotextile
0226	600: Gabion Wall	Enviromesh welded mesh gabion basket
0143	600: Gabion Wall	Enviromesh woven mesh gabion basket wire
0148	600: Gabion Wall	6G Gabion stone 100mm to 150mm
0300	600: Gabion Wall	6G Gabion stone 100mm to 150mm

2.5. Haul conditions and types of plant used

Bulk earthworks were not used on the scheme because the excavation works were limited to localised small cut and fills, accessed from the hard shoulder in traffic management. Table 6 shows a summary of the plant used.

Table 6: Types of plant used

Category	Plant Type	Activity
Excavators	Tracked 20 tonne & 22 tonne	Topsoil Stripping, forming benches, loading/ filling materials.
	Rubber Tyre 10 tonne & 14 tonne	
Dumpers	6 Tonne Dumpers	Taking away suitable/unsuitable materials from the site to stockpile and bringing the fill material to the site
Rollers	Various	Compaction of 6N material
Bulldozer	CAT D6	Used for general site clearance work
Tipper Trucks	8 wheelers	To transport imported material and haul unsuitable materials to tip

2.6. Comparison between predicted and actual quantities of acceptable and unacceptable material

The earthworks solutions proposed for the scheme required imported Class 6N granular fill; the mixed and variable materials anticipated from cutting excavations were not expected to be suitable for re-use in the widened embankments and could not be transferred directly to fill locations as there was no provision for stockpiling. In addition, as the majority of the site comprises embankments rather than cuttings, it was anticipated that there would not be large volumes of ‘site won’ materials through excavation of existing cuttings. Therefore, bulk earthworks and re-use of fill material was not envisaged in the design.

During construction, it was confirmed that the cohesive materials from the excavations were not suitable for re-use as backfill to regraded earthworks and structures, where a granular material of higher shear strength was required by the design. Due to the similar specification of Class 1 (general granular fill) and Class 6N (fill to structures), it was found to be efficient to source a single combined imported material to satisfy both specifications, for greater efficiency in delivering material along the worksite.

The site-won materials from excavation of existing earthworks were classified as 2A and 2B and were removed from the site.

2.7. Topsoil and planting

Topsoil was generally stockpiled for reuse in the landscaping. Surplus topsoil was removed from site. Topsoil was reinstated on the new earthworks slopes at a thickness of 150mm to 300mm along the project. Appendix I includes detailed photographs showing the site won topsoil material.

2.8. Validation of site remediation strategy

Not used.

3. Cuttings

3.1. Location of materials excavated and subsequent destination in the works

Several gantry structures, ERAs and drainage/technology ducts are in cuttings. Where widening was required, cutting slopes were graded to 1V:2.5H.

Appendix A shows the modification of earthworks schedule, and Appendix C includes the as-built drawings.

No major earthworks modifications were required at the cutting sections; however, space problems did occur at the shallow cutting locations to accommodate some of the gantry foundations. Retaining structures were used to create additional space at the toe of the cuttings. Details of retaining structures are presented in Section 5.

As explained in section 2.4, the small quantity of material excavated from the widened cuttings did not meet acceptability criteria for re use and was removed from site.

Figure 3-1 Typical minor regrade to cutting slope around existing gantry G111 SB

3.2. Plant used

A summary of plant used for earthworks are listed in Table 6.

3.3. Details of any problems encountered

None encountered.

3.4. Instability problems and unusual ground conditions

The ground conditions and materials encountered during construction were similar to the anticipated ground model in the GIR [1] . All excavated material was classed as 2A and 2B (unsuitable for regrading or fill to structures) and removed from the site. No ground instability problems were encountered during the construction.

3.5. Ground water conditions and problems and drainage measures to overcome them

No major groundwater problems were encountered during regrading of the cutting slopes.

3.6. Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

No contamination or hazardous materials were encountered at cutting locations across the scheme.

4. Embankments

4.1. Source and location of materials placed

The northern part of the scheme between Junction 24a and 25 includes a number of large embankments crossing the River Trent flood plain. Several gantry structures, ERAs and drainage/technology ducts were constructed on embankment sections. The earthworks modifications consisted of re-graded slopes at final gradients typically between 1V:2H and 1V:3.5H. However, only one embankment section was re-designed and checked for a slope of 1V:1.6H. This section located at the following chainages:

- From 188+720 to 188+750: Slope at 32º and full height embankment widening 1V:1.6H; and
- From 188+840 to 188+980: Slope of 32º and full height embankment widening 1V:1.6H.

After topsoil strip and benching of the existing slopes, Class 1 (procured as Class 6N) imported fill was used for regrading embankments. Details of the imported fill are in Appendix D.

The sections of embankment widening are listed in the earthworks modification schedule in Appendix A and as-built drawings are shown in Appendix C.

Figure 4-1 Typical embankment widening construction at CH 183100 SB

4.2. Plant used

A summary of plant used for earthworks is presented in Table 6.

4.3. Details of any problems encountered

No particular embankment construction problems were encountered.

4.4. Instability problems and unusual ground conditions

The materials encountered during construction were broadly similar to the reported ground conditions in the GIR [1]/ GDR [2]. All excavated material was classed as 2A and 2B (unsuitable for embankment widening) and removed from site. No ground instability problems were encountered during the construction.

4.5. Ground water conditions and problems and drainage measures to overcome them

No major drainage or groundwater problems were encountered during widening of the embankments.

4.6. Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

No contamination or hazardous materials were encountered at cutting locations across the scheme.

4.7. Foundation treatment, including drainage measures and treatment of soft areas

No areas of soft foundations were encountered, as the embankment widening did not generally extend into the flood plain areas. New fill was benched into the existing embankment to maintain the integrity of the new slope.

4.8. Settlement of foundation and fill material

The works comprised only localised small scale widening of existing embankments. No new embankments that would be subject to foundation or internal settlement were constructed as part of the works.

5. Retaining Structures

Retaining structures were constructed at the locations where there was insufficient space for verge widening with an earthworks solution, due to the restrictions of the HE boundary, other infrastructure or on embankments crossing flood plains.

The types of retaining walls constructed on the scheme were conventional sheet pile and King Sheet Pile (KSP) walls, gabion walls and slab on edge walls.

5.1. Sheet pile and king sheet pile walls

Locations of sheet pile and KSP wall structures along with the as-built details are shown in Appendix B. The locations of construction phase design changes are summarised in Table 8 and Table 9. The sheet piling subcontractor was Sheet Piling (UK) Ltd.

5.1.1. Record of soil and groundwater conditions encountered

The encountered ground conditions were broadly as expected in the design as described in the GIR [1] and GDR [2]. No significant groundwater seepages were encountered in the temporary excavations or through the sheet pile walls.

5.1.2. Temporary works required

The piling works were carried out from temporary piling platforms designed and constructed by the contractor. Due to the size of the piling rigs, the width of the piling platforms in cuttings was in some cases greater than the available space in the traffic management. In these locations the piling platform was extended past the line of the sheet pile wall, in a temporary cutting, which was subsequently backfilled with Class 6N material with a geotextile drainage layer (Deckdrain) behind the sheet piles.

Figure 5-1 Sheet piling at ERA E1 showing temporary excavation

Figure 5-2 Deckdrain layer behind backfilled sheet piles in cuttings

On embankments, an extended piling platform was constructed that also formed the widened fill platform behind the sheet piles.

Figure 5-3 Sheet piling on embankment at ERA E3-B1

Pre-boring along the centre line of each sheet pile wall was carried out to ease installation through the Mercia Mudstone.

5.1.3. Details of any problems and changes encountered

5.1.3.1. Construction and procurement efficiencies

The designed sheet pile wall section AZ24 was replaced with ZZ26. This change was raised by the contractor to make use of a quantity of ZZ26 stocked sheet pile sections.

Table 3 presents the locations where the cross section of the sheet pile wall was changed in this way.

Table 7: Change of sheet pile section to make use of stocked materials

No.	Location (NB)/(SB)	From	To	Sheet Pile wall size reported in C01 drawings and Schedule	Installed
1	SB	188+500	188+550	AZ24	ZZ26
2	SB	188+740	188+790	AZ24	ZZ26
3	SB	188+925	188+960	AZ12	AZ18
4	SB	189+270	189+310	ZZ24	ZZ26
5	SB	189+745	189+790	ZZ24	ZZ26
6	SB	192+090	192+520	AZ70	ZZ70
7	SB	193+320	193+350	AZ24	ZZ26

5.1.3.2. Topographic survey changes and minor clashes

As explained in 2.2.1, the final topographic surveys in some cases differed from the LIDAR profiles used in the original design. Localised obstructions and constraints also became apparent on site. In some cases, this led to change in the extent and retained height of retaining walls, as listed in Table 8 and Table 9.

5.1.3.3. Derwent Valley Aqueduct

The Derwent Valley Aqueduct (DVA) is an existing 19th century large diameter water supply pipeline that crosses the M1 embankment diagonally between about NB:185+893 to 186+360 and SB:186+390 to 186+443. CGT raised an RFI (584) regarding driving a sheet pile wall in these sections of the verge, as the asset owner Severn Trent required the vibration near the DVA to be limited to 1.5 mm/sec.

CGT performed vibration monitoring at another sheet pile wall near to the DVA. These results showed that an exclusion zone of 25 m was required to keep the vibration level caused by the sheet piling below 1.5 mm/sec. The contractor asked AMAR to review alternative solutions that would not subject the DVA to excessive vibration inside the exclusion zone. After a multidisciplinary workshop, it was decided to omit driving of the sheet pile wall at this section subject to the following checks:

- Whether the new SMP technology items can be accommodated in the existing verge or not; and
- Whether the storage capacity of the flood plain would be reduced by using an earthworks solution.

The proposed sheet pile wall cross section was checked for gain or loss of flood storage capacity for each 10m interval. The conclusion was that the short section adjacent to the DVA could be converted to earthworks and compensated by lowering the ground level in front of the sheet pile wall nearby between NB:186+100 and 186+200.

Figure 5-4 Derwent Valley Aqueduct (Warren Farm Culvert) SB with earthworks widening under construction

5.1.3.4. 400kV overhead power lines

This change took place as a result of RFI 243. This change took place because of local site constraints recognised during construction. The original sheet pile wall design between CH188+720 and 188+980 was located underneath 400kV overhead cables on pylons. The piling rig operating height was 15m, whereas the cable height was approximately 10m. Between NB 188+720 to 188+980, the retaining solutions were modified as follows:

- From 188+720 to 188+750: Slope at 32º and full height embankment widening 1V:1.6H;
- From 188+750 to 188+840: Sheet pile wall; and
- From 188+840 to 188+980: Slope of 32º and full height embankment widening 1V:1.6H.

5.1.3.5. J24 southbound on slip

This change took place as a result of RFI 210, The DF5 design proposed a sheet pile wall solution to construct the required widening. However, during construction, an updated field survey showed enough room to the site boundary to use a regrade option. An embankment regrade at 1V: 2.5H was designed, providing a cost and programme saving by eliminating the sheet piling works including traffic management and temporary works.

5.1.3.6. Lockington Brook West culvert

This change took place as result of RFI 271.The sheet pile wall was deleted at this section to avoid a clash with Lockington Brook West Culvert (CH185892 to 186360). An earthwork regrade solution was designed after review of the actual topographical survey at this location.

5.1.3.7. Sheet pile clash at Gantry 318 (NB :191770 to 191830)

At DF5 stage, the designed earth works between CH191765 to 191830 was an earthwork embankment. After site clearing and detailed topographical survey, the designed earthwork embankment clashed with the with the drainage system which included the following elements:

- Existing ditch;
- Existing headwall of 1100mm dia. inlet pipe at CH191791; and
- Existing filter drain.

Therefore, it was necessary to redesign a retaining solution which included installation of a sheet pile wall along the clash line to retain the embankment and to keep the functionality of drainage system. The retaining solution was a cantilever sheet pile wall of maximum retained height of 1.75m and total pile length 6.0m.

5.1.4. Pile logs summary, pile test results and other relevant information

CGT provided installation records of sheet pile wall in both northbound and southbound. These installation records show the following:

- Consistent ground conditions with the GDR
- Installation of sheet pile with agrees with the specified tolerance
- Sheet pile wall sections agrees with the specified section

Installation records of the sheet pile walls are presented in the Health and Safety File.

5.1.5. Settlement records with dates of each major stage including backfill

Not applicable.

5.1.6. As-built details

As-built drawings of the sheet pile walls are provided in Appendix C.

5.1.7. Chemical attack

According to GIR [1] and GDR [2], sacrificial thickness on each relevant surface (i.e. front and back surface) of the sheet pile was designed in accordance with BD 42/00 [16]. The assumed maximum corrosion rate used was 0.0015mm/side/year. This was in accordance with BS 8002 [17] and clause 3.2 of the ArcelorMittal Piling Handbook [18], refer to AIP, Design of Sheet Pile Retaining Wall (HA549342-AMAR-HGT-SWI-RP-CE-000004) [19]. There was no change in the design assumption during construction.

Table 8: Summary of design changes of sheet pile walls

Earthwork Type	DF5								As-built				Reason for Change
	Chainage Start	Chainage End	Total Structure Length (m)	Max. Retained Height (m)	Sheet Pile Wall				Sheet Pile Wall				
					Max. Embedment Depth (m)	Total Pile Length (m)	Section	Steel Grade	Max. Embedment Depth (m)	Total Pile Length (m)	Section	Steel Grade	
Cutting (NB)	182880	182890	10	0.4	1.1	1.5	AZ 50	S 390 GP	-	-		-	Actual topographical survey on site offered enough space for regrade solution.

Table 9 : Summary of design changes of king sheet pile walls

Earthwork Type	DF5											As-built												Reason for Change
	Chainage Start	Chainage End	Total Structure Length (m)	Max. Retained Height (m)	King Sheet Pile Wall (700mm Sections)				Intermediate KSP Sections (770mm)			Chainage Start	Chainage End	Total Structure Length (m)	Max. Retained Height (m)	King Sheet Pile Wall (700mm Sections)				Intermediate KSP Sections (770mm)				
					Max. Embedment Depth (m)	Total Pile Length (m)	Section	Steel Grade	Min. Embedment	Section	Steel Grade					Max. Embedment Depth	Total Pile Length (m)	Section	Steel Grade	Min. Embed-ment (mbgl)	Total Length (m)	Section	Steel Grade	
Cutting (SB)	183798	183950	152	1.4	4.1	5.5	AZ 12	S 390 GP	1.0	S 270 GP	AZ 12	Deleted												Actual levels on site offered enough space for regrade solution.
												183860	183950	90	1.4	4.1	5.5	ZZ 18	S 355 GP	1.0	2.4	ZZ 18	S 355 GP	
Embankment (SB)	189155	189171	16	2.5	5.3	8.0	AZ 24	S 390 GP	1.0	S 270 GP	AZ 12	Deleted												Actual levels on site offered enough space for regrade solution.
Embankment (SB)	-	-	-	-	-	-	-	-	-	-	-	189163	189184	21	2.5	5.3	8.0	ZZ 26	S 355 GP	1.0	3.7	ZZ 18	S 355 GP	Reduced Wall length
Cutting (SB)	193680	193691	11	1.5	5.5	7.0	AZ 24	S 390 GP	1.0	S 270 GP	AZ 12	Deleted												Actual levels on site offered enough space for regrade solution.
Cutting (NB)	182880	182890	10	0.40	-	-	-	-	-	-	-	Deleted												Actual levels on site offered enough space for regrade solution.
Cutting (NB)	184071	184140	69	1.0	3.5	4.5	AZ 12	S 390 GP	1.0	S 270 GP	AZ 12	Deleted												Actual levels on site offered enough space for regrade solution.
Cutting (NB)	184140	184430	290	1.8	4.2	6.0	AZ 12	S 390 GP	1.0	S 270 GP	AZ 12	Deleted												Actual levels on site offered enough space for regrade solution.
Cutting (NB)	184430	184453	23	1.0	3.5	4.5	AZ 12	S 390 GP	1.0	S 270 GP	AZ 12	Deleted												Actual levels on site offered enough space for regrade solution.
Embankment (NB)	188522	188549	27	2.7	8.3	11.0	AZ 24	S 390 GP	1.0	S 270 GP	AZ 12	Deleted												Actual levels on site offered enough space for regrade solution.
Embankment (NB)	188721	188740	19	2.0	6.0	8.0	AZ 24	S 390 GP	1.0	S 270 GP	AZ 12	Deleted												Actual levels on site offered enough space for regrade solution.
Embankment (NB)	188850	188865	15	2.0	7.0	9.0	AZ 24	S 390 GP	1.0	S 270 GP	AZ 12	Deleted												Actual levels on site offered enough space for regrade solution.
Embankment (NB)	188865	188893	28	2.0	6.0	8.0	AZ 24	S 390 GP	1.0	S 270 GP	AZ 12	Deleted												Actual levels on site offered enough space for regrade solution.
Cutting (NB)	191557	191582	25	0.9	3.8	4.7	AZ 12	S 390 GP	1.0	S 270 GP	AZ 12	Deleted												Actual levels on site offered enough space for regrade solution.

5.2. Gabion walls

The location of gabion walls along with the as-built details are shown in Appendix A. In addition, the locations of design changes (Post DF5) are summarised in Table 11. The materials used are recorded in Appendix D.

5.2.1. Record of soil and groundwater conditions encountered

Material encountered during construction were similar to the reported ground conditions in the GIR [1]. Also, all excavated material was classified as 2A and 2B (unsuitable) and removed from site. No ground instability problems were encountered during the construction of the gabion walls.

Figure 5-5 Gabion wall construction at CH 182800

Figure 5-6 Gabion wall construction CH 182800 - detail

5.2.2. Temporary works

All gabion walls were constructed in temporary excavations, with the slopes benched for effective backfilling.

5.2.3. Details of any problems and changes encountered

5.2.3.1. East Midlands Airport landing light ducts

At Link 2 Southbound, the contractor raised RFI no 192and asked AMAR to revise the design of the sheet pile wall from CH 183+950 to 183+800, because of the contractor located the whereabouts of the East Midland's Airport landing lights duct from the central reserve to the south bound verge. Therefore, the contractor could not drive sheet pile wall through the ducts. However, between Ch 183+790 to 183+850, the sheet pile wall was replaced by a gabion wall.

It is necessary to highlight that part of gabion wall demolished and rebuilt because of defective workmanship. Also, within this stretch, the gabion wall has wall height greater than 1.50m. Therefore, it was classified as a structure.

AMAR redesigned the retaining solution at this area and replaced the sheet pile wall with a gabion wall to avoid any clash with the relocated East Midland's Airport landing lights duct.

5.2.3.2. SMP- East Midlands Gateway interface

At the interface between SMP M1 J23a-25 and East Midland Gateway project (EMG) at SB 185+764 to 185+770, AMAR used a gabion wall to provide a flat verge between the new entry slip and the mainline carriageway. This flat verge was required to accommodate the technology items (A chamber and communications ducting).

5.2.3.3. Localised gabion walls to accommodate lighting columns

The DF5 design assumed lighting columns to be installed in flat verges. At certain locations, the verge width was such that a localised retaining solution of about 1m in height was needed to provide a flat area for the lighting column.

Therefore, the contractor requested approval to construct gabion walls of typical length 4m and cross section 1.5m high x 1.5m wide (including the embedment). Locations of these gabion walls are listed in Table 10.

Table 10: Locations of gabion walls to accommodate lighting columns

Link	Location	Chainage	Lighting Column
Link 2	SB	183610	PC 100
Link 2	SB	183640	PC 102
Link 2	SB	183700	PC 106
Link 2	SB	183740	PC108 and A071
Link 2	SB	183770	PC110
Link 2	SB	184150	A079

Figure 5-7 Small gabion wall behind lighting column

5.2.4. Sub formation test results and other relevant information

According to typical gabion wall details presented in drawing no HA549342-AMAR-HGT-SWI-DR-CE-000602, a layer of 6N was used below the wall to provide a level platform for construction.

5.2.5. Settlement records with dates of each major stage including backfill behind the wall

Not applicable.

5.2.6. Details of as-built foundations

As-built drawings are shown in Appendix C.

5.2.7. Chemical attack

Not applicable.

Table 11: Summary of design changes of gabion walls

Earthwork Type	DF5				As-Built				Reason for Change
	Chainage Start	Chainage End	Length (m)	Max. Retained Height (m)	Chainage Start	Chainage End	Length (m)	Max. Retained Height (m)	
Cutting (NB)	182800	182880	80	1	182800	182890	90	--	Actual levels on site offers enough space for regrade solution.
Cutting (NB)	182880	182890	10	0.4					
Cutting (NB)	183710	183780	70	0.9	-	-	-		Actual levels on site offered enough space for regrade solution.
Cutting (NB)	184000	184020	20	0.9	-	-	-		Actual levels on site offered enough space for regrade solution.
Cutting (SB)	193320	193490	170	0.8	-	-	-		Actual levels on site offered enough space for regrade solution.
Cutting (SB)	-	-	-	-	183790	183850	60	2	The sheet pile wall original proposed in this stretch couldn't be driven because of the cable ducts, therefore a gabion wall of 2m height was introduced as an alternative to the original sheet pile wall.
Cutting (SB)	-	-	-	-	185764	185770	6	1.0	Actual topographical survey of the site offered a small space for regrade solution. Therefore, gabion wall required.
Cutting (SB)	-	-	-	-	193320	193490	170	1.5	Actual topographical survey at site offered a small space for regrade solution. Therefore, gabion wall required.

5.3. Slab-on-edge walls

Slab-on-edge solutions were included (Post DF5) to provide up to 0.5m high retaining walls behind minor structure locations. Locations of slab-on-edge wall structures along with the as-built details are summarised in Appendix B.

Figure 5-8 Typical slab-on-edge wall at minor structure location

5.3.1. Record of soil and groundwater conditions encountered

No water seepage was observed along the slab-on-edge walls.

5.3.2. Temporary works required

No benching was required for the install of slab-on-edge walls.

5.3.3. Details of any problems encountered

No problems were encountered during construction.

5.3.4. Sub formation test results and other relevant information

Not applicable.

5.3.5. Settlement records with dates of each major stage including backfill behind the wall

Not applicable.

5.3.6. Details of as-built foundations

As-built drawings are shown in Appendix C.

5.3.7. Chemical attack

In DF5 stage, the concrete has been classified according to BRE Special Digest 1 (2005) [20]. Because all foundations are in SMP M1 J23a-25 are in contact with either:

- Mercia Mudstone; or
- Embankment fill, which is comprised of reworked Mercia Mudstone.

The concrete classification was based on the Mercia Mudstone which is a stratum that is known to have high sulphate concentrations as noted within the BRE Special Digest 1 [20], Design sulphate class DS-3 and Aggressive Chemical Environment for Concrete (ACEC) class AC-3 was required.

No modification occurred to concrete classification during construction stage.

6. Subgrade and capping

6.1. Method of subgrade preparation, details of capping materials used, and details of any problems encountered

Generally, no problems were encountered during preparation of the subgrade, capping and pavement.

Formation testing was carried out in the central reserve using plate bearing tests and areas of widened verge using the Mexe probe to determine the equivalent CBR. All CBR values exceeded the minimum 2.5% for the pavement design and therefore no additional pavement thickness was required.

The sub-grade was prepared using excavators up to 22T and vibratory rollers of various sizes. The formation was prepared in accordance to Table 6/4 in Specification for Highways Works.

Refer to MARs 0041, 0042, 0073 CGT – Type 1 Sub base.

7. Drainage

7.1. Details of temporary drainage and its effectiveness

Not applicable.

7.2. Methods of installing permanent drainage and details of any problems encountered

The drainage strategy for the SMP J23a-25 outlined in the GDR [2] and it was developed in accordance with the requirements of the followings design manuals:

- IAN 161/15 – Smart Motorways [21];and
- Design Manual for Roads and Bridges (Volume 4, Section 2) [22].

In 2016, AMAR issued the Drainage Strategy Report [23], which outlined the general principles of design development of drainage works, scheme specific assumptions and risks.

The SMP works had a significant impact on the existing drainage network. The proposed drainage design was designed to interface with existing earthworks drainage. This interface included the following:

- The ditches were diverted, where widening of existing earthworks was proposed.
- The existing ditches were cleared of any debris and overgrown vegetation was removed as part of the site clearance works. This to ensure that the ditches are returned to their original capacity.
- Existing outfalls from the mainline drainage system, which discharged directly into these ditches, were retained as part of the drainage design and the existing headwalls were also retained.
- Replacing the drainage pipes identified within the drainage survey as having a Grade 4 or Grade 5 defect, i.e. pipes classified as either ‘not fit for purpose or unsafe’ or ‘blocked or in unsafe condition’.

However, in some areas, the scheme had a lower impact on the existing drainage pipe networks. For example, cross-carriageway drainage was retained and re-used wherever possible to minimise the requirement to construct new drainage, subject to the existing pipes being in acceptable condition.

8. Imported Materials

8.1. Types of imported materials and their Use

8.2. Sources of imported materials and their location in the works

The source of the following imported materials and their location used on site are shown in Table12.

Table12: Sources of imported materials

Material	Source	Location in works
6N (Structural and earthworks fill)	Breedon – Cloud Hill Quarry Breedon- Cliffe Hill Quarry MQP – Cliffe Hill Quarry Aggregate Industries; Bardon Hill Quarry	Embankment fill. Backfill behind the retaining structures & foundation.
Class 6G (Gabion Stone fill)	Aggregate Industries; Bardon Hill Quarry	Gabion filling
Gabion Baskets	Burdens- Gabions baskets (3x1x1m, 2x1x1m and 1x1x1m units)	Refer to Section 10
Geotextile (Separator Layer)		Between new & existing earthworks
Pre-cast Concrete block used for Slab on Edge	Keyline/Marshalls	Install up 0.5m height retaining wall
Deck drain	ABG	Behind Sheet pile wall
Concrete mixed	Varies	Concrete piles
Sheet pile Mill Certificates	Anshan Zizhu Heavy Casting Co. , Ltd.	Sheet pile wall

8.3. Acceptability and performance of imported materials

The imported materials were deemed acceptable and performed as expected; in accordance with Table 6/1 of the specification for Highway Works [24] and Series 600 specification appendixes [14].

CGT provided AMAR with results of 1797 tests of 6N material. These tests were carried out between 28/04/2017 and 26/01/2018. A summary of these test results is presented in Table 13.

Table 13: Summary of 6N test results

Link	Average Moisture Content [%]	Average passing from sieve 0.067mm [%]	Average Uniformity Coefficient	Average OMC [1]	Average MDD [2]	Average Oxidizable Sulphides	Average Water Soluble Sulphate
2	3.66	8.57	86.90	5.35	2.37	0.66	683.33
3	3.66	8.51	83.20	5.52	2.36	0.66	235.00
4A	3.56	7.80	75.14	5.57	2.35	NA[3]	NA[3]
4B	3.84	7.61	65.08	5.93	2.33	NA[3]	NA[3]

[1] MDD: Maximum Dry Density.

[2] OMC: Optimum moisture content.

[3] NA: Not Available.

Summary results of the tests carried out on each imported material type and approval forms are presented in the Health and Safety File [25].

9. Strengthened Earthworks

9.1. Description of strengthened earthworks types and locations

Not applicable.

9.2. Fill material used

Not applicable.

9.3. Records of soils and groundwater conditions encountered, and drainage measures required

Not applicable.

9.4. Inspection and maintenance requirements

Not applicable.

9.5. Details of any in-situ testing

Not applicable.

9.6. Details of any problems encountered

Not applicable.

10. Structure Foundations

10.1. Confirmatory Ground Investigation

In line with the SMP design approach, no ground investigation was carried out during the design phase as a recent ground investigation had been carried out for a previous widening scheme. The ground investigations reviewed in the Ground Investigation Report [1] were supplemented at key locations by a confirmatory ("Just in time" or JIT) ground investigation. The GI was procured and supervised by Costain Galliford Try jv and carried out by Nicholls Colton Group during the siteworks period between April 2017 and November 2017. The drilling works were generally carried out in night shifts to avoid blocking the site for the main works and were attended by an AMAR engineer for geotechnical design oversight.

The scope was as shown in Table 14:

Table 14 Confirmatory (JIT) ground investigation

Exploratory hole type	Number
Dynamic sample/rotary core	48
Dynamic sample/rotary core (slope climbing rig)	4
Cone penetration test	4

Of these 52 exploratory holes, 32 were to confirm design of gantries (including both carriageways of portal gantries) and the remainder for large sign, technology and ROTTM foundations.

Figure 10-1 Dynamic sampling rig Link 4b NB ch 192900 (pulled onto verge during day shift)

Factual borehole logs from the JIT ground investigation are attached in Appendix G.

10.2. Gantries

10.2.1. General

Pile foundations were constructed to support the gantry structures, comprising 750mm and 900mm diameter bored piles in four-pile groups. Locations of gantry structures along with the as-built details are shown in Appendix B. In addition, the locations of design changes (Post DF5) are summarised in Table 17.

Table 15: Summary of gantries.

Gantry Type	Number
MS3 cantilever	2
MS4 cantilever	12
ADS cantilever	7
Super cantilever	3
Super span portal	3
TOTAL	28

10.2.2. Design validation

During the construction phase, each gantry pile foundation design base was validated using the results of the confirmatory (JIT) ground investigation. The design validation and checking by the AMAR site team included the following steps:

- Check and return comments on the confirmatory borehole logs.
- Compare the ground conditions encountered in the confirmatory borehole with the ground model used for DF5 design;
- Ensure that the minimum pile socket length in Mercia Mudstone is 2m (if encountered);
- Review the SPT results and shear strength parameters of each stratum
- Obtain the latest loading combinations (Serviceability Limit State SLS and Ultimate Limit State ULS) from AMAR structures team and determine initial pile length and diameter
- Perform pile group analysis using PIGLET software to obtain the axial load, lateral load and moment distribution along the pile shaft as well as the pile cap deflection.
- Perform sensitivity checks to evaluate both maximum lateral deflection and axial loads.

The design validation revealed that in all cases the DF5 design was adequate and no more adverse conditions were revealed. The pile design for DF5 was relatively conservative and the foundations could have been optimised using the results of JIT investigation. However, there was not enough time to accommodate this design change in the construction programme.

10.2.3. Construction

Piles for gantry foundations were constructed in accordance with the Works Information. The piling subcontractor was Van Elle Ltd. The piles were installed using Soilmec SR-75 and Hutte 207 piling rigs for the 900mm and 750mm diameter piles respectively. CFA, SFA (Sectional Flight Auger) and rotary open hole boring methods were employed with temporary casing as required by the ground conditions

Figure 10-2 900mm diameter pile installation using Soilmec SR-75 rig

Figure 10-3 Completed 2x2 pile cap Gantry G203

Figure 10-4 750mm pile installation with Hutte rig (Gantry 318)

10.3. Record of soil and groundwater conditions encountered

No adverse or unexpected groundwater conditions were encountered as each pile group had a JIT borehole within a few metres of its location.

10.4. Temporary works required and their effectiveness

Temporary piling platforms were designed and installed by CGT. The piling platforms were certified by CGT in accordance with FPS guidance as part of the temporary works design.

10.5. Details of any problems encountered

No significant problems were encountered.

10.6. Pile logs summary, pile test results and other relevant information

10.6.1. Installation

For gantries, CGT provided installation records of the concrete piles. These installation records show the following:

- Consistent ground conditions with the GDR
- Installation of piles agrees with the specified tolerance
- Drilled pile diameter agrees with the specified diameter

Concrete and steel reinforcement were delivered to site by CGT after submitting Material Approval Requests (MARs). Table 5 shows the MARs relevant to the foundation piling works,

Table 16: List of MARs used for piling works

MAR No.	Series and Element	Brief Description/ Product
0059	1600: Concrete Piles	C35/45 Mix 3 C32/40 Mix 4 C32/40 Mix 5
0093	1600: Concrete Piles	Rebar
0114	1600: Concrete Piles	Rebar Couplers
0139	1600: Concrete Piles	Mix 3: C35/45 Mix 5: C32/40
0218	1600: Concrete Piles	Concrete mix Design C35/45

Full installation records of gantries and MARs used for piling works are presented in the Health and Safety File.

Refer to Section 12 for details of pile testing.

10.7. Details of as-built foundations

As-built drawings of the pile foundations are attached in Appendix C.

10.8. Chemical attack on concrete

The concrete was classified according to BRE Special Digest 1 [20] during design, but there was a lack of site-specific information. All foundations were in contact with Mercia Mudstone or Embankment fill, (reworked Mercia Mudstone), which is noted to have high sulphate concentrations in BRE Special Digest 1 [20], therefore design sulphate class DS-3 and Aggressive Chemical Environment for Concrete (ACEC) class AC-3 was required. This was verified by the Confirmatory Ground Investigation. The concrete classification was not modified during construction stage.

Table 17: Locations and Piled Foundations Details of Gantries

Asset	Chainage (m)	Carriageway	DF5			As Built				
			Number of Piles	Pile Diameter (mm)	Design Pile Length (m)	Number of Piles	Pile Diameter (mm)	Re-design Pile Length (m)	Installation method	Static load test Y/N
Gantry 101 (MS4)	181950	NB	4 (2 x 2)	0.75	11	4 (2 x 2)	0.75	11	Bored	N
Gantry 112 (Super Cantilever)	185180	SB	4 (2 x 2)	0.9	28	4 (2 x 2)	0.9	20	Bored	Y
Gantry 202 (Super-span Portal)	186240	NB	3 (1 x 3)	0.9	15.5	3 (1 x 3)	0.9	16	Bored	N
Gantry 202 (Super-span Portal)	186240	SB	3 (1 x 3)	0.9	15.5	3 (1 x 3)	0.9	16	Bored	Y
Gantry 203 (ADS)	186390	SB	4 (2 x 2)	0.9	25	4 (2 x 2)	0.9	25	Bored	N
Gantry 204 (Super Cantilever)	186526	NB	4 (2 x 2)	0.9	19	4 (2 x 2)	0.9	19	Bored	N
Gantry 301 (Super-span Portal)	186847	NB	4 (2 x 2)	0.9	13	4 (2 x 2)	0.9	16	Bored	Y
Gantry 301 (Super-span Portal)	186847	SB	4 (2 x 2)	0.9	13	4 (2 x 2)	0.9	16	Bored	Y
Gantry 302 (ADS)	187073	SB	4 (2 x 2)	0.9	21	4 (2 x 2)	0.9	21	Bored	N
Gantry 326 (MS4)	187300	SB	4 (2 x 2)	0.75	17	4 (2 x 2)	0.75	17	Bored	Y
Gantry 303 (ADS)	187608	SB	4 (2 x 2)	0.9	20	4 (2 x 2)	0.9	21	Bored	Y
Gantry 304 (Super Cantilever)	187650	NB	4 (2 x 2)	0.9	12.5	4 (2 x 2)	0.9	12.5	Bored	Y
Gantry 305 (MS4)	187818	SB	4 (2 x 2)	0.75	9	4 (2 x 2)	0.75	12.5	Bored	Y
Gantry 307 (MS4)	188529	NB	4 (2 x 2)	0.75	15	4 (2 x 2)	0.75	15	Bored	N
Gantry 308 (ADS)	188760	SB	4 (2 x 2)	0.9	26	4 (2 x 2)	0.9	26	Bored	Y
Gantry 309 (MS3)	188947	SB	4 (2 x 2)	0.75	12	4 (2 x 2)	0.75	14	Bored	Y
Gantry 310 (MS4)	189172	SB	4 (2 x 2)	0.75	6	4 (2 x 2)	0.75	14	Bored	N
Gantry 311 (Super-span Portal)	189780	NB	4 (2 x 2)	0.9	15.5	4 (2 x 2)	0.9	16	Bored	Y
Gantry 311 (Super-span Portal)	189780	SB	4 (2 x 2)	0.9	15.5	4 (2 x 2)	0.9	16	Bored	N
Gantry 312 (MS4)	190605	SB	4 (2 x 2)	0.75	16	4 (2 x 2)	0.75	16	Bored	N
Gantry 313 (MS3)	190771	NB	4 (2 x 2)	0.75	8	4 (2 x 2)	0.75	14	Bored	Y
Gantry314 (MS4)	191096	NB	4 (2 x 2)	0.75	11	4 (2 x 2)	0.75	11	Bored	Y
Gantry 315 (ADS)	191296	NB	4 (2 x 2)	0.9	25	4 (2 x 2)	0.9	26	Bored	Y
Gantry 316 (MS4)	191430	SB	4 (2 x 2)	0.75	10.5	4 (2 x 2)	0.75	10.5	Bored	N
Gantry 318 (MS4)	191801	NB	4 (2 x 2)	0.75	13	4 (2 x 2)	0.75	13	Bored	N
Gantry 319 (ADS)	192101	NB	4 (2 x 2)	0.9	25	4 (2 x 2)	0.9	25	Bored	N
Gantry 320 (Super Cantilever)	192290	SB	4 (2 x 2)	0.9	12.5	4 (2 x 2)	0.9	12.5	Bored	N
Gantry 321 (MS4)	192476	NB	4 (2 x 2)	0.75	15	4 (2 x 2)	0.75	15	Bored	Y
Gantry 322 (ADS)	192906	NB	4 (2 x 2)	0.9	15	4 (2 x 2)	0.9	15	Bored	Y
Gantry 323 (MS4)	193300	SB	4 (2 x 2)	0.75	6	4 (2 x 2)	0.75	6	Bored	Y
Gantry 324 (MS4)	193331	NB	4 (2 x 2)	0.75	7	4 (2 x 2)	0.75	7	Bored	Y

10.9. Remote Operated Temporary Traffic Management Signs (ROTTMS)

Remote Operated Temporary Traffic Management Sign (ROTTMS) were installed with planted foundations. The typical foundation diameters were 450mm and 750mm, and the planted depth varied from 3.5m to 4.50m, except for FTP_SB5_800y which was constructed with two 450mm diameter piles 3.5m long. Locations of the ROTTMS structures along with the as-built details are shown in Appendix B. In addition, the locations of design changes (Post DF5) are summarised in Table18.

10.9.1. Record of soil and groundwater conditions encountered

Encountered ground conditions were broadly similar to the anticipated materials encountered during ground investigations works. No groundwater was recorded during the installation of the foundations.

10.9.2. Temporary works required and their effectiveness

No temporary works were required as the piles were installed from the existing hard shoulder using small plant.

10.9.3. Details of any problems encountered

No problems in installation of ROTTMS foundations were encountered.

10.9.4. Pile Logs summary, pile test results and other relevant information

For ROTTMS, CGT provided installation records of the concrete piles. These installation records show the following:

- Consistent ground conditions with the GDR,
- Installation of ROTTMS piles agrees with the specified tolerance; and
- Sheet pile wall sections agrees with the specified section.

Installation records are presented in the Health and Safety File.

10.9.5. Details of as-built foundations

As-built drawings are shown in Appendix C.

10.10. Chemical attack on concrete

The concrete was classified according to BRE Special Digest 1 [20] during design, but there was a lack of site-specific information. All foundations were in contact with Mercia Mudstone or Embankment fill, (reworked Mercia Mudstone), which is noted to have high sulphate concentrations in BRE Special Digest 1 [20], therefore design sulphate class DS-3 and Aggressive Chemical Environment for Concrete (ACEC) class AC-3 was required. The concrete classification was not modified during construction stage.

Table18: Summary of design changes of foundations of ROTTMS

Asset	Chainage (m)	Carriageway	DF5				As built				Reason for Change
			Foundation type	Planted / Pile Diameter (mm)	Design Planted / Pile Length (m)	Bored Pile Length (m)	Foundation Type	Planted / Pile Diameter (mm)	Design Planted / Pile Length (m)	Bored Planted / Pile Length (m)	
RAD_02	182222	NB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_04	182812	NB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_05	183240	NB	Planted	Foundation Design not issued in DF5			Single Pile	450	5.0	4.08	
RAD_07	183781	NB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_08	183850	SB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_09	184350	NB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_10	184420	SB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_11	184867	NB	Planted	Foundation Design not issued in DF5			Single Pile	750	5.0	3.98	
RAD_12	184921	SB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_15	186265	SB	Planted	Foundation Design not issued in DF5			Single Pile	450	5.0	3.98	
RAD_17	186873	NB	Planted	Foundation Design not issued in DF5			Single Pile	450	5.0	3.98	
RAD_18	187290	SB	Planted	Foundation Design not issued in DF5			Single Pile	750	5.0	3.98	
RAD_25	189769	NB	Planted	Foundation Design not issued in DF5			Single Pile	450	5.0	3.98	
RAD_28	191085	NB	Planted	Foundation Design not issued in DF5			Single Pile	450	5.0	3.98	
RAD_29	191440	SB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_32	192313	SB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_35	193290	SB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_37	193970	SB	Single Pile	450	3.0	1.98	~~Single Pile~~	~~750~~	~~5.0~~	3.98	Removed from Schedule

10.11. Environmental Barriers

Environmental Barriers were installed at 25 locations. At 12 locations revised foundations were used, which consisted of 450mm diameter planted foundations. This foundation type was selected because of implementing BD94/17. Whilst BD 94/17 does not explicitly cover Environmental Barriers, the design method was adopted following discussions and approval from Highways England.

Where the foundations were converted from bored to planted, the pile caps were omitted. Therefore, this solution provided benefits to the scheme by reducing the construction time. Also, the planted foundation design was applied to a small number of foundations found on site where modifications were required due to topography inconsistencies relative to the LIDAR survey, or other on-site issues.

Locations of Environmental barriers along with the as-built details are shown in Appendix B. In addition, the locations of design changes (Post DF5) are summarised in Table19.

10.11.1. Record of soil and groundwater conditions encountered

The encountered ground conditions were similar to the reported ground conditions in the GIR. No groundwater was encountered in the foundation works.

10.11.2. Temporary works required and their effectiveness

Where possible, the piling works were carried out from the existing hard shoulder. Where used, the temporary piling platforms were certified by CGT in accordance with FPS guidance.

10.11.3. Details of any problems encountered

None encountered.

10.11.4. Pile test results and other relevant information

A summary of test results is included in Appendix F.

10.11.5. Details of as-built foundations

As-built drawings are shown in Appendix C.

10.11.6. Chemical attack on concrete

The concrete was classified according to BRE Special Digest 1 [20] during design, but there was a lack of site-specific information. All foundations were in contact with Mercia Mudstone or Embankment fill, (reworked Mercia Mudstone), which is noted to have high sulphate concentrations in BRE Special Digest 1 [20], therefore design sulphate class DS-3 and Aggressive Chemical Environment for Concrete (ACEC) class AC-3 was required. The concrete classification was not modified during construction stage.

Table19: Summary of design changes of foundations of environmental barriers

Asset	Chainage Start (m)	Chainage End (m)	Length (m)	DF5 Noise Barrier Height (m)	DF5 Pile Type	DF5 Pile Diameter (mm)	DF5 Design Pile Length (m)	As Built Noise Barrier Height (m)	As Built Pile Type	Normal Section Dia (mm)	Normal Section Planted Depth (m)	End Section Dia (mm)	End Section Planted Depth (m)	Next Section Dia (mm)	Next Section Planted Depth (m)	Reason for Change
NB7_2 (NB)	187870	187945	75	3	Bored	450	9.0	3	Planted	450	3.0	600	3.3	600	3.0	Implementation of BD 94/17
NB7_4 (NB)	188000	188195	195	3	Bored	450	9.0	3	Planted	450	3.0	600	3.3	600	3.0	Implementation of BD 94/17
ENS2_2 (SB)	189550	189690	140	4	Bored	750	8.0	4	Planted	600	2.5	600	3.0	600	2.8	Implementation of BD 94/17
ENS2_3 (SB)	189690	189730	40	3	Bored	450	7.0	3	Planted	450	3.0	600	3.3	600	3.0	Implementation of BD 94/17
	189730	189750	20						Planted	450	3.4	600	3.8	600	3.6	
	189750	189792	42						Planted	450	1.7	600	2.0	450	1.8	
	189792	189820	28						Planted	450	3.0	600	3.3	600	3.0	
	189820	189840	20						Planted	450	3.4	600	3.8	600	3.6	
	189840	189915	75						Planted	450	3.0	600	3.3	600	3.0	
	189915	189935	20						Planted	450	3.4	600	3.8	600	3.6	
ENS2_5 (SB)	189950	190115	165	3	Bored	450	9.0	3	Planted	450	3.0	600	3.3	600	3.0	Implementation of BD 94/17
	190115	190125	10			750	7.0		Planted	450	3.3	600	3.6	600	3.4	
	190125	190245	120			450	9.0		Planted	450	3.0	600	3.3	600	3.0	
	190245	190265	20			750	7.0		Planted	450	3.4	600	3.8	600	3.5	
	190265	190375	110			450	9.0		Planted	450	3.0	600	3.3	600	3.0	
ENS3_1 (SB)	190395	190655	260	3	Bored	450	9.0	3	Planted	450	3.1	600	3.4	600	3.2	Implementation of BD 94/17
ENS3_3 (SB)	190660	191030	370	3	Bored	450	6.0	3	Planted	450	3.1	600	3.4	600	3.2	Implementation of BD 94/17
ENS3_6 (SB)	191400	191455	55	4	Bored	750	6.0	4	Planted	600	2.8	600	3.3	600	3.0	Implementation of BD 94/17
ENS4_1 (NB)	190835	190945	110	2	Bored	450	4.0	2	Planted	450	3.0	600	3.3	450	3.3	Implementation of BD 94/17
	190945	191025	80							450	2.5	600	2.8	450	2.8	
ENS4_2 (NB)	191025	191060	35	2	Bored	450	4.0	2	Planted	450	2.2	600	2.5	450	2.5	Implementation of BD 94/17
	191060	191080	20				5.0			450	2.8	600	3.1	450	3.0	
	191080	191310	230				4.0			450	2.9	600	3.2	450	3.0	
	191310	191360	50				4.0			450	2.8	600	3.1	450	3.0	
ENS4_4 (NB)	191365	191480	115	2	Bored	450	6.0	2	Planted	450	1.6	600	1.9	450	1.9	Implementation of BD 94/17
ENS5_2 (SB)	192000	192020	20	4	Bored	750	4.0	4	Planted	600	2.5	600	3.0	600	2.8	Implementation of BD 94/17
	192020	192138	118				6.0			600	2.5	600	3.0	600	2.8	
	192138	192165	27				6.0			600	1.6	600	2.0	600	1.8	
ENS5_3 (SB)	192165	192240	75	3	Bored	450	8.0	3	Planted	450	1.7	600	2.0	600	1.8	Implementation of BD 94/17
	192240	192260	20						Planted	450	1.7	600	2.0	600	1.8	
	192260	192401	141				7.0		Planted	450	1.7	600	2.0	600	1.8	
	192401	192530	129						Planted	450	1.7	600	2.0	600	1.8	

10.12. CCTV

Closed Circuit Television (CCTV) camera posts were installed at 34 locations. At eight locations, the existing foundations were used. At 26 locations, new foundations were installed on either single 450mm or 750mm diameter bored piles.

Location of CCTV structures along with the as-built details are shown in Appendix B. In addition, the summary of design changes of CCTVs foundation (Post DF5) are presented in Table20.

10.12.1. Record of soil and groundwater conditions encountered

The encountered ground conditions were similar to the reported ground conditions in the GIR. No groundwater was encountered in the foundation works.

10.12.2. Temporary works required and their effectiveness

Where possible, the piling works were carried out from the existing hard shoulder. Where used, the temporary piling platforms were certified by CGT in accordance with FPS guidance.

10.12.3. Details of any problems encountered

None encountered

10.12.4. Pile test results and other relevant information

CGT provided installation records of CCTV concrete piles. These installation records show the following:

- Consistent ground conditions with the GDR;
- Installation of CCTV concrete piles agrees with the specified tolerance; and

Installation records of 450mm piles installed for CCTV 02, CCTV 05, CCTV 07, CCTV 08 are presented in the Health and Safety File.

10.12.5. Details of as-built foundations

As-built drawings are shown in Appendix C.

10.12.6. Chemical attack on concrete

The concrete was classified according to BRE Special Digest 1 [20] during design, but there was a lack of site-specific information. All foundations were in contact with Mercia Mudstone or Embankment fill, (reworked Mercia Mudstone), which is noted to have high sulphate concentrations in BRE Special Digest 1 [20], therefore design sulphate class DS-3 and Aggressive Chemical Environment for Concrete (ACEC) class AC-3 was required. The concrete classification was not modified during construction stage.

Table20: Summary of design changes of foundations of CCTVs

Asset	Chainage (m)	Carriageway	Foundation type	DF5			As-Built			Reason for change
				Pile Diameter (mm)	Design Pile Length (m)	Bored Pile Length (m)	Pile Diameter (mm)	Design Pile Length (m)	Bored Pile Length (m)	
CCTV_04	182496	SB	Single Pile	750.0	7.0	6.0	750	5.0	3.975	Design standardisation
CCTV_05	183283	NB	Single Pile	450.0	5.0	4.0	450	7.0	5.975	Design standardisation
CCTV_10	185379	K	Single Pile	750.0	7.0	6.0	750	7.0	5.975	Design standardisation
CCTV_23	190983	SB	Single Pile	750.0	7.0	6.0	750	7.0	5.975	Design standardisation
CCTV_25	192272	SB	Single Pile	450.0	5.0	4.0	750	5.0	3.975	Design standardisation
CCTV_30	182766	L	Single Pile	450.0	3.0	2.0	750	7.0	5.975	Design standardisation
CCTV_33	184373	NB	Pad Foundation				L=2.0m	W=3.2m	D=1.5m	New location added
CCTV_34	191419	SB	Single Pile	-	-	-	750	5.0	3.975	New location added

10.13. RADARs

The RADAR foundations were either planted or bored piles of 450mm and 750mm diameter.

Appendix B includes the locations of RADARs structures along with as-built details. Table21 includes a summary of design changes of RADAR foundations.

10.13.1. Record of soil and groundwater conditions encountered

The encountered ground conditions were similar to the reported ground conditions in the GIR. No groundwater was encountered in the foundation works.

10.13.2. Temporary works required and their effectiveness

Where possible, the piling works were carried out from the existing hard shoulder. Where used, the temporary piling platforms were certified by CGT in accordance with FPS guidance.

10.13.3. Details of any problems encountered

None encountered.

10.13.4. Pile logs summary, pile test results and other relevant information

For RADAR foundation, CGT provided installation records of the concrete piles. These installation records show the following:

- Consistent ground conditions with the GDR; and
- Installation of RADAR piles agrees with the specified tolerance.

Installation records of RADAR piles RAD 01, RAD 03, RAD 05, RAD 06, RAD 13, RAD 14, RAD 15, RAD 16, RAD 17, RAD 19, RAD 21, RAD 22, RAD 23, RAD 25, RAD 26, RAD 11, RAD 18, RAD 20, RAD24, RAD 27 are presented in the Health and Safety File.

10.13.5. Settlement records with dates of each major stage including backfill of abutments and approach fills

Not applicable.

10.13.6. Details of as-built foundations

As-built drawings are shown on the drawings in Appendix C.

10.13.7. Chemical attack on concrete

The concrete was classified according to BRE Special Digest 1 [20] during design, but there was a lack of site-specific information. All foundations were in contact with Mercia Mudstone or Embankment fill, (reworked Mercia Mudstone), which is noted to have high sulphate concentrations in BRE Special Digest 1 [20], therefore design sulphate class DS-3 and Aggressive Chemical Environment for Concrete (ACEC) class AC-3 was required. The concrete classification was not modified during construction stage.

Table21: Summary of design changes of foundations of Radars

Asset	Chainage (m)	Carriageway	DF5				As-Built				Reason for Change
			Foundation type	Planted / Pile Diameter (mm)	Design Planted / Pile Length (m)	Bored Pile Length (m)	Foundation Type	Planted / Pile Diameter (mm)	Design Planted / Pile Length (m)	Bored Planted / Pile Length (m)	
RAD_02	182222	NB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_04	182812	NB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_05	183240	NB	Planted	Foundation Design not issued in DF5			Planted	450	2.5	2.5	Standard conservative design used for efficient construction.
RAD_07	183781	NB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_08	183850	SB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_09	184350	NB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_10	184420	SB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_11	184867	NB	Planted	Foundation Design not issued in DF5			Single Pile	750	5.0	3.98	Standard conservative design used for efficient construction.
RAD_12	184921	SB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_15	186265	SB	Planted	Foundation Design not issued in DF5			Single Pile	450	5.0	3.98	Standard conservative design used for efficient construction.
RAD_17	186873	NB	Planted	Foundation Design not issued in DF5			Single Pile	450	5.0	3.98	Standard conservative design used for efficient construction.
RAD_18	187290	SB	Planted	Foundation Design not issued in DF5			Single Pile	750	5.0	3.98	Standard conservative design used for efficient construction.
RAD_25	189769	NB	Planted	Foundation Design not issued in DF5			Single Pile	450	5.0	3.98	Standard conservative design used for efficient construction.
RAD_28	191085	NB	Planted	Foundation Design not issued in DF5			Single Pile	450	5.0	3.98	Standard conservative design used for efficient construction.
RAD_29	191440	SB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_32	192313	SB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_35	193290	SB	Planted	Foundation Design not issued in DF5			Planted			-	Implementation of BD 94/17
RAD_37	193970	SB	Single Pile	450	3.0	1.98	Single Pile	750	5.0	3.98	Removed from Schedule

10.14. External Aspect Verification (EAV) Poles

EAV poles foundations consisted 450mm diameter bored piles. Location of the EAV Poles structures along with the As-built details are shown in Appendix B. In addition, the locations of design changes (Post DF5) are summarised in Table22.

10.14.1. Record of soil and groundwater conditions encountered

The encountered ground conditions were similar to the reported ground conditions in the GIR. No groundwater was encountered in the foundation works.

10.14.2. Temporary works required and their effectiveness

Where possible, the piling works were carried out from the existing hard shoulder. Where used, the temporary piling platforms were certified by CGT in accordance with FPS guidance.

10.14.3. Details of any problems encountered

None encountered.

10.14.4. Pile logs summary, pile test results and other relevant Information

For EAV poles, CGT provided installation records of concrete piles. These installation records show the following:

- Consistent ground conditions with the GDR;
- Installation of concrete pile with agrees with the specified tolerance; and
- Pile diameter agrees with the specified diameter.

Piling records of EAV01, EAV02, EA03, EA06 are presented in the Health and Safety File.

10.14.5. Details of as-built foundations

As-built drawings are presented in Appendix C.

10.14.6. Chemical attack on concrete

The concrete was classified according to BRE Special Digest 1 [20] during design, but there was a lack of site-specific information. All foundations were in contact with Mercia Mudstone or Embankment fill, (reworked Mercia Mudstone), which is noted to have high sulphate concentrations in BRE Special Digest 1 [20], therefore design sulphate class DS-3 and Aggressive Chemical Environment for Concrete (ACEC) class AC-3 was required. The concrete classification was not modified during construction stage.

Table22: Summary of design changes of foundations of EAV poles

Asset	Chainage	Pile Cap Depth (m)	DF5			As- Built			Reason for Change
			Pile Diameter (mm)	Design Pile Length (m)	Pile length from cut off to toe level (m)	Pile Diameter (mm)	Design Pile Length (m)	Pile length from cut off to toe level (m)	
EAV_03	187914 (SB)	1.1	-	-	-	450	3.0	1.975	Replaced by EAV_05-3M
EAV_05-3M	187933 (SB)	-	450	7	7.075	-	-	-	Removed from design; due to HADECS Cameras location changes
EAV_06	189958 (SB)	1.1	-	-	-	450	3.0	1.975	Replaced by EAV_04-3
EAV_04-3	192490 (SB)	-	450	10	10.075	-	-	-	Removed from design; due to HADECS Cameras location changes

10.15. Large traffic signs

Large Traffic signs foundations consisted of pad, planted or bored piles, and location of structures along with the As-built details are shown in Appendix B. In addition, the locations of design changes (Post DF5) are summarised in Table 23.

10.15.1. Record of soil and groundwater conditions encountered

The encountered ground conditions were similar to the reported ground conditions in the GIR. No groundwater was encountered in the foundation works.

10.15.2. Temporary works required and their effectiveness

Where possible, the piling works were carried out from the existing hard shoulder. Where used, the temporary piling platforms were certified by CGT in accordance with FPS guidance.

10.15.3. Details of any problems encountered

None encountered

10.15.4. Pile logs summary, pile test results and other relevant Information

For large traffic signs, CGT provided installation records of the concrete piles. These installation records show the following:

- Consistent ground conditions with the GDR;
- Installation of concrete piles agrees with the specified tolerance; and
- Concrete pile diameter agrees with the specified diameter.

Installation records of the large traffic signs TS1, TS2, TS3, TS4 piles are presented in the Health and Safety File.

10.15.5. Using planted foundation for minor structures to improve efficiency

During DF5 stage, AMAR assumed that the maximum planted foundation depth would be 1.5m and any minor structure foundation requiring over 1.5m planted depth would be designed as a pile, based on the available construction information at the time.

During construction, it was proposed to construct deeper planted foundations which would reduce the time for construction. Some large traffic signs were therefore designed with a planted foundation based on BD94/17 and IHE Sign Structures Guide. The knowledge was approved by Highways England SES and then shared to other designers through the structures Peer to Peer (P2P) Group.

10.15.6. Details of as-built foundations

As-built drawings are shown on the drawings in Appendix C.

10.15.7. Chemical attack on concrete

The concrete was classified according to BRE Special Digest 1 [20] during design, but there was a lack of site-specific information. All foundations were in contact with Mercia Mudstone or Embankment fill, (reworked Mercia Mudstone), which is noted to have high sulphate concentrations in BRE Special Digest 1 [20], therefore design sulphate class DS-3 and Aggressive Chemical Environment for Concrete (ACEC) class AC-3 was required. The concrete classification was not modified during construction stage.

Table 23: Summary of design change of foundations of large traffic signs

Asset	Chainage	Carriageway	DF5		AS built	Reason for change
			Pad or Pile	Pad Size (w x l x d) (m)	Pad or pile	
NB03	182109	NB	Pad	2.6 x 4.0 x 2.0	N/A	Not required

10.16. Single post traffic signs

Single Post Traffic Signs foundations consisted of Pad, planted or bored piles, Location of the structures along with the As-built details are shown in Appendix B. In addition, locations of design changes (Post DF5) are summarised in **Table24.**

10.16.1. Record of soil and groundwater conditions encountered

Ground conditions were as expected from the GIR and assumed in the design.

10.16.2. Temporary works required and their effectiveness

Where possible, the piling works were carried out from the existing hard shoulder. Where used, the temporary piling platforms were certified by CGT in accordance with FPS guidance.

10.16.3. Details of any problems encountered

None encountered.

10.16.4. Pile logs summary, pile test results and other relevant Information

For large traffic signs, CGT provided installation records of concrete piles. These installation records show the following:

- Consistent ground conditions with the GDR
- Installation of concrete piles with agrees with the specified tolerance
- Installed pile diameter agrees with the designed pile diameter.

Installation records of single post traffic sign SB28, SB37, SB 40, SB 48, SB 50, SB 54, SB55, SB 69, SB 72, SB 92, NB30, NB 31, NB 40, NB 41, NB 42, NB46, NB 52, NB 56, NBS05, NBS12 are presented in the Health and Safety File.

10.16.5. Settlement records with dates of each major stage including backfill of abutments and approach fills

Not applicable.

10.16.6. Details of as-built foundations

As-built drawings are shown in Appendix C.

10.16.7. Chemical attack on concrete

The concrete was classified according to BRE Special Digest 1 [20] during design, but there was a lack of site-specific information. All foundations were in contact with Mercia Mudstone or Embankment fill, (reworked Mercia Mudstone), which is noted to have high sulphate concentrations in BRE Special Digest 1 [20], therefore design sulphate class DS-3 and Aggressive Chemical Environment for Concrete (ACEC) class AC-3 was required. The concrete classification was not modified during construction stage.

.

Table24: Summary of design changes of foundations of single post traffic signs

Asset	Chainage	Carriageway	DF5						As-Built					
			Pad or Pile	Pad Size (w x l x d) (m)	Pile Dia (mm)	Nos of Sign post legs (Nos of Piles)	Design Pile Length (m)	Bored Pile Length (m)	Pad, Pile, or Planted	Pile Dia (mm)	Nos of Sign post legs (Nos of Piles)	Design Pile Length (m)	Bored Pile Length (m)	Reason for Change
NB27	185595	NB	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	Pile	750	1	4.5		Standard conservative design used for efficient construction.
NB77	193171	NB	Pad	1.0 x 1.2 x 1.0	N/A	N/A	N/A	N/A	Pad	N/A	N/A	N/A	N/A	Sign No longer Required
SB08	193450	SB	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	Pile	750	1	4.5		Standard conservative design used for efficient construction.
SB10	192684	SB	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	Pile	750	1	4.5		Standard conservative design used for efficient construction.
SB36	189540	SB	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	Pile	750	1	4.5		Standard conservative design used for efficient construction.
NBS09	0 + 192	24a Entry Slip	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	Pile	750	1	4.5		Standard conservative design used for efficient construction.
NBS13	0 + 243	24a Entry Slip	-	-	-	-	-	-	Pad	N/A	N/A	N/A	N/A	Site and program constraints
SBS03	0 - 8	25 Entry Slip	Pad	2.0 x 3.2 x 1.5	N/A	N/A	N/A	N/A	Pile	750	1	4.5		Standard conservative design used for efficient construction.
SBS17	0 - 23	24 Entry Slip	Pad	2.0 x 3.2 x 1.5	N/A	N/A		N/A	Pile (if pad is not already constructed)	750	1	4.5		Standard conservative design used for efficient construction.

10.18. Cross-carriageway ducts

Locations of cross-carriageway ducts and as-built details are shown in Appendix H.

10.18.1. Record of soil and groundwater conditions encountered

Ground conditions were as expected from the GIR and assumed in the design.

10.18.2. Temporary works required and their effectiveness

No temporary works

10.18.3. Details of any problems encountered

None encountered

10.18.4. Settlement records with dates of each major stage including backfill of abutments and approach fills

The GDR assumed a very conservative 100% volume loss and predicted settlement up to 40mm. The predicted **settlements** for a more typical ground loss of up to 4**% (**Mair 1996) predict ground settlements of <5mm. Monitoring during the directional drilling was the responsibility of the contractor under self-certification. No non-conformances were reported.

10.18.5. Details of as-built foundations

Refer to Appendix H.

10.18.6. Chemical attack

Not applicable.

11. Earthworks Testing

11.1. Summary of site testing

Different types of testing and their corresponding specifications are summarised in the Table25 below.

Table25: List of Laboratory Tests

Material	Test	Specification
6G (Imported)	Determination of Particle Size Distribution	BS EN 933 – 2 (Imported onto site)
	Los Angeles coefficient	BS EN 13242 & Clause 635
6N (Imported)	Determination of Particle Size Distribution	BS EN 1377: Part 2 (On-site) BS EN 933 – 2 (Imported onto site)
	Uniformity coefficient	Clause 635
	Los Angeles coefficient	Clause 635
	Effective angel of internal friction (ϕ°)	Clause 635
	Moisture Content (mc)	BS EN 1377: Part 2 (On-site)
	Compaction Requirements Clause 612	(End product 95% of maximum dry density of BS 1377: Part 4 (vibrating hammer method)
	Determination of Oxidisable Sulfides (OS)	TRL 447 Test 2 and 4
	Determination of Water Soluble Sulphate (WSS)	TRL 447 Test 1
	Determination of pH Value	BS 1377: Part 3: 1990
5A - Topsoil (existing on site)	Determination of Particle Size Distribution	Clause 618

11.2. Summary of test results

The following is a summary of the imported material testing presents in Appendix D. Compaction control testing was carried out as part of the ongoing works.

No problems were found during material testing and materials were found to be acceptable.

12. Pile Testing

12.1.1. Pile testing programme

The preliminary piles were constructed sufficiently in advance of the installation of the working piles to allow time for the test, the evaluation of the results and the adoption of modifications if these proved necessary. CGT allowed minimum 2 weeks between pile installation and testing to ensure adequate strength gain of the concrete. Cube test results of all test piles show that minimum 7 day strength was 20 MN/mm^2, while the maximum compressive stress in any test pile was 5 N/mm^2. These values show that the minimum cube strength is four times than maximum compressive stress in any test pile. This satisfies 1600 series (section 1609, clause 5), where the cube strength criteria defined is defined as:

"...*The pile test shall not be started until the strength of the cubes taken from the pile exceeds twice the average direct stress in any pile section under the maximum required test load, and the strength of the cubes taken from the cap exceeds twice the average stress at any point in the cap under the same load*".

CGT removed all temporary works following preliminary pile testing. The preliminary pile load tests were designed to achieve the following goals:

- Validate the pile design;
- Validate performance criteria; and
- Prove that piling method of construction can construct viable foundations in the local ground conditions encountered along M1 SMP J23a-25.

CGT also performed working piles load tests during the construction to verify the following:

- Construction method used has not changed to produce piles inferior to the preliminary piles
- Piles have satisfactory load-settlement performance.
- Ensure both structural and geotechnical soundness.

For both preliminary and working pile load test, construction detail and plant were the same as proposed for the main works. According to the drilling records, the reported ground conditions were as reported in GIR.

The testing procedures followed the requirements of HA549342-AMAR-HGT-SWI-SP-CE-000004 (Specification Schedules Series 1600). Each preliminary pile load tests included three cycles as follows:

- First cycle: Loading of test piles to 100 % working load;
- Second cycle: Loading the test pile to 150% working load; and
- Third cycle: Loading the pile to 200 % of the working load.

On the other hand, in the working pile load tests, the piles tested to 150% of the working load. The maximum test load, together with the test and reaction pile lengths are summarised in HA549342-AMAR-HGT-SWI-SP-CE-000004 (Specification Schedules Series 1600).

The pile testing arrangements are shown in Figure 12-1 and Figure 12-2.

Figure 12-1 Static load test on 0.75m diameter pile: Gantry 313 (Link 4b NB)

Figure 12-2 Static load test on 0.9m diameter pile: Gantry G311 Link 4b NB

12.2. Pile load test results

The contractor performed 3 No. preliminary pile tests (on non-working piles) at G101, G304, G112. Theses testes aimed to test the piles throughout the scheme in varying ground conditions. All tests for preliminary piles were carried out in three cycles for loading and unloading. Also, the contractor performed 13 working pile load tests at G202, G203, G301 NB, G301SB, G303, G311, G313, G315, G322, G322, G326, Rad 22, and G101.

Following each application of an increment of load, the load was maintained at the specified value for not less than the hold periods indicated in the specification above until the measured rate of settlement in a period of 30minutes was less than 0.5% of the current cumulative settlement which has occurred, subject to a minimum settlement rate of 0.05mm in 30minutes. The rate of settlement was calculated from the slope of the line obtained by plotting values of settlement versus time and drawing a smooth curve through the points.

For working pile load tests, adjacent working piles to the test pile were used as reaction piles. These reaction piles were monitored during static load testing. The movement was measured and recorded within an accuracy of 0.5mm.

All piles were installed primarily in Mercia Mudstone with two geologies as follows:

- Mercia Mudstone outcrops at the start/end of the scheme
- Embankment fill and flood plain deposits overlie the Mercia Mudstone along large section in the centre of the scheme (Ch 185+000 to Ch 191+300).

For both Mercia Mudstone settings, preliminary and working pile load test results suggested high level of consistency. This was achieved by close agreement in repeated results under the same conditions. Therefore, pile design and pile construction method showed high level of reliability.

Results of preliminary pile load tests showed that the maximum settlement was less than 8mm under 200% of the working loads, while results of working pile load tests showed settlement less than 2.5m under 150% of the working loads. Appendix F includes summary tables of pile test results.

It worth to mentioned that the recorded settlement during the pile load tests was relatively small. This could be attributed to the pile vertical capacity is not the governing factors of gantries, while the lateral capacity is the governing factor of the gantries.

Based on the above consistency and reliability, HE and AMAR agreed in December 2017 to reduce the remaining pile testing, since the further pile testing would add no further assurance to the design.

All Details of preliminary and working pile load tests are presented in Health and Safety File.

12.3. Pile integrity tests

12.3.1. General

The Pile Integrity Test (PIT) system performs a low strain integrity testing of piles. The test can be used for cast-in-place. It can detect potentially major defects such as cracks, necking, soil inclusions or voids and in some situations. Also, it can determine unknown lengths of piles.

The test consisted of attaching the accelerometer to the top of the test pile. The accelerometer acquired data resulted from the impact of a small hand-held hammer. If a defect was present along the shaft, its size and location could be estimated by back-analysing the propagation and reflection of the wave induced in the pile by the hammer impact

12.3.2. Details of pile integrity testing

CGT performed 214 Pile Integrity Tests (PIT) between 15/02/2017 and 25/09/2018. These test cover most of the pile foundations including gantries, radars, ROTTMs, traffic signs, etc. Results of PIT tests showed satisfactory shaft formation and they showed no obvious indication of any pile defects. Also, they indicated consistent workmanship and piling construction practice. All details of PIT are presented in Health and Safety File.

However, CGT did not provide results of Pile Integrity Test (PIT) of NBS05, RAD 23, RAD 26, CCTV10, CCTV12, CCTV30, G314, SB54, G301, G311, G319, G315, G303, G304.

Lack of PIT record for under 10% of piles was considered an acceptable non-conformance by AMAR and CGT on the basis that no defects were detected from any of the 214 PITs carried out and all PIT testing suggested good and consistent workmanship and piling construction practice.

12.4. Concrete test results

CGT provided AMAR with concrete test results of 13280 samples collected from 28-07-2017 to 23-02-2018. These samples were collected during construction of piles of different structures such as gantries, ROTTOMs, RADARs, ERA, small signs etc. The nominal concrete strength of concrete piles was 40 and 45 N/mm2.

Table 26: Summary concrete test results

Concrete Type	Age [days]	Average [N/mm2]	Max [N/mm2]	Min [N/mm2]	Standard Deviation [N/mm2]
C40	7	33	54.8	15.1	7.9
C40	28	50.3	140.1	18.4	9.5
C40	56	62.5	75.4	50.5	5.1
C45	7	40.8	55.3	19.7	7.1
C45	28	57.1	72.4	45.1	5.8

All Details of concrete test results are presented in the Health and Safety File.

13. Instrumentation

No instrumentation was installed to monitor geotechnical works as part of this scheme. The SMP design approach requires robust and standardised designs. There were no special risks on the site and therefore no instrumentation was proposed.

14. Summary of problems experienced and design changes

14.1. Summary of problems and details of design changes

As with any construction project, various minor issues and design changes arose during the siteworks which resulted in changes from the design presented in the GDR. These are discussed in the individual sections above and summarised below.

14.1.1. Programming of geotechnical design and construction

SMP schemes have a rapid design and procurement model compared to traditional highway improvements, with a relatively short period for delivery of the multidisciplinary design. The geotechnical widening solutions can only be finalised when the highway verge, drainage and technology layouts are complete, so that the appropriate retaining structures and earthworks can be designed and drawn up for the Works Information. Any late changes in these disciplines can delay the production of IFC geotechnical drawings and schedules. However, the earthworks contract is one of the early activities in the site programme, requiring the IFC geotechnical information at an early stage. Various last-minute design changes, together with the late changes of topographical information (see below), resulted in a large amount of geotechnical redesign being carried out in a short time, with a corresponding increase in the size of the geotechnical site team.

Similarly, delays in mobilisation of the Confirmatory Ground Investigation meant that some validation boreholes had insufficient time between drilling and the programmed start of piling works. The programme must allow enough time for the validation boreholes to be drilled, reported, laboratory testing received and then the design validation to be carried out and checked, which amounts to about two months. In some cases, the ground investigation delays then constrained the piling programme.

14.1.2. Topographical survey changes (Section 2.2.1)

In accordance with the SMP Survey Guide, no foot-based topographic survey or walkover survey was carried out during the design phase. The topographic model for design was generated from a LIDAR point cloud survey, mainly taken from vehicle mounted scanners. Once the contractor could gain access to the site, after vegetation clearance, and carry out a foot based traditional survey, the ground profile was found to be different to the design model. In many cases these changes were large enough that the retaining wall and slope calculations needed to be re-checked and revised by a site based geotechnical design team, and revised construction drawings produced.

This issue was substantially mitigated by having a integrated, multidisciplinary site-based design support team who could respond rapidly to changes and queries.

14.1.3. Implementation of new standards

As noted in Section 10, the implementation of BD94/17 “Design of Minor Structures” permitted a number of efficiencies in the foundation design of technology structures and signs.

14.2. How problems might be avoided in the future, including suggested revisions required to the SHW and DMRB

The issues noted above need to be considered in the overall planning and programming of schemes, which involves the Project Control Framework and procurement approach as well as design and specification.

15. Residual Health and Safety Risks

15.1. Locally over-steepened slope

As noted in 4.1, two short localised sections of 1 in 1.6 slope were constructed on the northbound side, from 188+720 to 188+750 and from 188+840 to 188+980. This solution was a consequence of the verge widening in conjunction with constraints of widening the embankment due to floodplain levels and was discussed during the construction phase with HE representatives. The imported fill material used for these slopes exceeded the specified shear strength such that the slope stability factor of safety was still maintained. There is a residual risk of potentially more challenging access for maintenance due to the steeper slope.

Maintenance access is also required for the noise barriers. The noise barriers adjacent to residential properties (on the southbound carriageway south of J25) are not new installations due to SMP but are replacement of existing barrier that was previously present. The existing access for maintenance has been kept as existing or improved by addition of gates within the barrier.

15.2. As-built details of cross-carriageway ducts

As-built profiles of the cross-carriageway duct runs have not been captured on the earthworks and general arrangement drawings. The CCDs were all constructed directly between the start and finish chambers listed in Appendix H. As-built schematic drawings showing the nominal location of the cross-carriageway connections were produced by the technology and lighting disciplines. Details of all construction materials and as-built records for all disciplines are contained in the Health and Safety File for the project which is held by Highways England.

Any future works in the vicinity of the CCDs should take account of the uncertainty as to the precise depth below the carriageway and include consultation with the appropriate technology/communications or lighting system maintenance provider.

16. References

[1] Amey Arup Joint Venture. SMP M1 J23a-25, “Ground Investigation Report- Report Ref. HA549342-AMAR-HGT- SWI-RP-CE-000002- Rev P01- HAGDMS Ref. 28929,” Amey International Design Hub, Birmingham, 2016.

[2] Amey Arup Joint Venture. SMP M1 J23a-25, “Geotechnical Design Report – Report Ref: HA549342-AMAR-HGT-SWI-RP-CE-000003, HAGDMS Ref: 29152,,” Amey Internation Design Hub, Birmingham, 2017.

[3] Highways England, “Smart Motorways Programme- Design Guide Version 3.01- Annex E3.04: Geotechnical Retaining Systems,” Highways England, Birmingham, 2016.

[4] Geo-Slope International, “SLOPE/W Slope Stability Analysis,” Geo Studio , 2012.

[5] Geosolve, *WALLAP Retaining Wall Analysis Program,* 2014.

[6] Highways England, “Design Manual for Roads and Bridges- Volume 4- Geotechnics and Drainage- Managing Geotechnical Risk (HD22/08),” Highways England, Birmingham, 2008.

[7] BSI Publications, “BS EN 1997-1:2004+A1:2013-Eurocode 7: Geotechnical Design - Part 1: General Rules,” BSI Publications, 2013.

[8] “Just in time GI......Ref missing”.

[9] Amey Arup Joint Venture M1 J23a - J25, “ Statement of Intent, Report Ref. HA549342-AMAR-HGT-SWI-RP-CE-000001, Rev P01, HAGDMS Ref. 28704.,” Amey International Design Hub, Birmingham, October 2015.

[10] Amey Arup joint Venture. SMP J23a-25, “ Geotechnical Design Report- Directional Drilling- Report Ref: HA549342-AMAR-HGT-SWI-RP-CE-000006- HAGDMS Ref: 29378,” Amey Internation Design Hub, Birmingham, 2017.

[11] “Ove Arup & Partners, M1 Widening: Junctions 21-30, Preliminary Sources Study Report, March 2005, Report Ref: 0017PSSR M1 J21-30 RevA;”.

[12] BSI Standard Publications, “UK National Annex to Eurocode 7: Geotechnical Design - Part 1: General Rules-NA+A1:2004 to BS EN 1997-1:2004+A1:2013,” BSI Standard Publications, 2013.

[13] Amey Arup joint Venture. SMP J23a-25, “Specification Schedules Series 100: 1/5-1 Testing to be Carried Out by the Contractor,” Amey Intrnation Design Hub, Birmingham, 2017.

[14] Amey Arup Joint Venture M1 J23a - J25, “Smart Motorways Programme- M1 J23a 25-Volume 2 Works Information- Specification Appendices series 600- EARTHWORKS,” Amey International Design Hub, Birmingham, 2017.

[15] Highways England , “Manual of Contact Document for Highways Works Volume 1-Series 600 EARTHWORKS,” Highways England , Birmingham, 2016.

[16] Higways Agency , “DMRB Volume 2 Section 1 Part 2 (BD 42/00) Highway structures- Design (substructures and special structures) material. Substructures-Design of embedded retaining walls and bridge abutments (Withdrawn),” Higways Agency , 2000.

[17] BSI Publications, “BS 8002:2015 – Code of Practice for Earth Retaining Structures,” BSI Publications, 2015.

[18] ArcelorMittal, “Piling Handbook 9th edidtion,” ArcelorMittal Commercial RPS, Luxembourg, 2016.

[19] Amey Arup Joint Venture. SMP J23a-25, “Design of Sheet Pile Retaining Wall (HA549342-AMAR-HGT-SWI-RP-CE-000004),” Amey Internation Design Hub, birmingham, 2017.

[20] BRE, “BRE Special Digest- Concrete in Aggressive Ground,” 2005.

[21] Highways England, “Smart Motorways- Interim Advice Note 161/15,” Highways England Company Limited, Birmingham, 2015.

[22] Highways England, “Design Manual for Roads and Bridges, Volume 4, Section 2, Drainage,” Highways England, Birmingham, 2008.

[23] Amey Arup Joint Venture. SMP M1 J23a-25, “Drainage Strategy Report- Report Ref. HA549342-AMAR- HDG- SWI-RP-CD-000001-Rev P02,” Amey International Design Hub, Birmingham, 2016.

[24] Highways England, “Manual of Contract Documents for Highways Works- Volume 1-Specification for Highways Works-Series 600 EARTHWORKS,” Highways England, 2016.

[25] A. Arup, “Health and Safety File”.

[26] “Randolf, M.F., Piglet: Analysis and Design of Pile Groups, Version 5.1, July 2006;”.

[27] “Berezantzev, V.G., Load bearing capacity and deformation of piled foundations, Proceedings of the 5th International Conference on Soil Mechanics. 1961;”.

[28] “Crown International, TALL Consulting Structural Engineers, CCTV Pole, Structural Calculations, Issue 01, March 2014;”.

[29] “Valmont Stainton, ‘6m, 8m, 10m & 12m Plain Top Tubular Columns c/w 1 No Cable Gland Hole & Plastic Pole Cap’, Drawing No. CC7942, Rev 00, December 2013;”.

[30] “Valmont Stainton, Appendix 13/2, Specification for Highways Works, Column and Bracket Data Sheet, 12M RADAR COLUMN (CC7942), April 2015;”.

[31] Environment Agency, “Groundwater protection: Principles and practice (GP3),” Environment Agency Bristol, Version 1.1, August 2013.

[32] A. Bond and A. Harris, Decoding Eurocode 7, Abingdon: Taylor & Francis, 2008.

[33] “King Sheet Piling – Technical Guidance, V 1.2/15.4.14, obtained from www.ksp-piling.co.uk.,” [Online].

[34] Highways England, “Interim Advice Note 73/06-Revision 1- Design Guidance for Road Pavement Foundation (Draft HD25),” Highways England, 2009.

[35] Highways England, “Design Manual for Roads and Bridges, Volume 4, Section 1, Part 2, HD22/08, Managing Geotechncial Risk;,” Highways England, Birmingham, 2008.

[36] Environment Agency., “ Guidance on the Classification and Assessment of Waste- Technical Guidance WM3 1st edition,” Environment Agency, Scottish Environment, Bristol, 2015.

[37] “Atkins, ATRISK Soil,” Atkins, 29 January January 2015. [Online]. Available: http://www.atrisksoil.co.uk/index.php/login.

[38] BSI Publications, “NA to BS EN 1990:2002+A1:2005, Eurocode – Basis of Structural Design,” BSI Publications, 2005.

[39] Department for Environment, Food and Rural Affairs (DEFRA), “ Category 4 Screening Levels (C4SLs) Screening Levels for Assessment of Land Affected by Contamination,” Department for Environment, Food and Rural Affairs (DEFRA), 2014.

[40] Amey Arup Joint Venture. SMP M1J23a-25, “Gantries and ERAs Lateral Solutions Options Report, Document Ref HA549342-AMAR-SGT-SWI-RP-CB-000001,” Amey International Design Hub, Birmingham, 2016.

[41] Highways England, “Design Manual for Roads and Bridges. Volume 2, Section 2, Part 1, Design of Minor Structures (BD95/07),” Highways England, Birmingham, 2007.

[42] Highways England, “Design Manual for Roads and Bridges- Volume 4 Geotechnics and Drainage- Section 1 Earthworks- Part 3 Maintenance of Highway Geotechnical Assets (HD 41/15),” Highways England, Birmingham, 2015.

[43] Highways England, “Design Manual for Roads and Bridges- Volume 4- Geotechnics and Drainage– Maintenance of Geotechnical Assets (HD41/03),” Highways England, Birmingham, 2003.

[44] BSI Publications, “BS 6031:2009-Code of Practice for Earthworks,” BSI Publications, 2009.

[45] Highways England, “Design Manual for Roads and Bridges- Volume 1, Section 1, Part 1, Technical Approval of Highway Structures (BD 2/12),” Highways England, 2012.

[46] BSI Publications, “BS 8004:2015 – Code of Practice for Foundations,” BSI Publications, 2015.

[47] BSI Publications, “BS EN 1993-5 2007: Eurocode 3: Design of Steel Structures Part 5: Piling,” BSI Publications, 2007.

[48] Highways England, “Design Manual for Roads and Bridges, Volume 1 (Highways Structures: Approval Procedures and General Design) Section 3 (General Design) Part 14 (Loads For Highway Bridges) (BD 37/01),” Highways England, 2001.

[49] Highways England , “Design Manual for raods and bridges-Volume 2-Section 2-part 1 BD97/17-Design of Minor Structures,” Highways England, Birmingham , 2017.

[50] Highways England , “Smart Motorways Programme- Design Guide Version 3.01- Annex E3.04-Geotechnical Retaining Systems,” Highways England, Birmingham, 2016.

Appendix A Earthworks Schedule (As-Built)

A.1: Major Structure – Geotechnical Schedule
A.2: Mainline Widening Solutions Schedule Northbound
A.3: Mainline Widening Solutions Schedules Southbound
A.4: Mainline Merge & Diverge Widening Schedule

A.1: Major Structures - Geotechnical Schedule

SMIS Structure Name	Asset	SMP Reference	Chainage	Carriageway	Marker Post	New/ Remaining	Asset Type	Widening Extents (Approx.)		Proposed Solution		
								Longitudinal Length (m)	Proposed Verge Widening (m)	Earthwork Retaining Solution	Max Proposed Retained Earthwork Height (m)	Comments
Sign Gantry Number 1	Gantry	N/A	180500	NB	180/5A+00	REMAINING	Sign/Signal Gantry	-	-	NO SOLUTION REQUIRED	**N/A**	
MS3 Cantilever Gantry 3805A	Gantry	N/A	180700	NB	180/7A+00	REMAINING	Sign/Signal Gantry	-	-	NO SOLUTION REQUIRED	**N/A**	
Sign Gantry Number 2	Gantry	N/A	181000	SB	181/0B+00	REMAINING	Sign/Signal Gantry	-	-	NO SOLUTION REQUIRED	**N/A**	
	Gantry	N/A	181200	NB	181/2A+00	REMAINING	Sign/Signal Gantry	-	-	NO SOLUTION REQUIRED	**N/A**	
Link 1												
	Gantry	101	181930	NB	181/9A+30	NEW	MS4 Cantilever	N/A	N/A	LOCAL REGRADE	**N/A**	
	Gantry	102	182244	NB	182/2AB+44	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
	Gantry	102	182244	SB	182/2AB+44	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
	Gantry	103	182786	Central	182/7B+86	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
	Gantry	103	182786	SB	182/7B+86	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
Sign Gantry Number 7	Gantry	104	183270	NB	183/2A+70	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
Sign Gantry Number 8	Gantry	105	183274	SB	183/2B+74	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
Sign Gantry Number 9	Gantry	106	183813	NB	183/8A+13	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
Sign Gantry Number 11	Gantry	107	183820	SB	183/8B+20	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
	Gantry	108	184180	SB	184/1B+80	REMAINING	MS3 Cantilever	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
Sign Gantry Number 12	Gantry	109	184390	NB	184/3A+90	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
Sign Gantry Number 14	Gantry	113	184390	SB	184/3B+90	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
	Gantry	110	184900	NB	184/9A+00	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
	Gantry	111	184900	SB	184/9B+00	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
Signals Mast Arm Gantry N/B Off-slip	Gantry	N/A	185100	Off Slip	185/1+00	REMAINING	Signals Mast Arm Gantry N/B Off-Slip	NA	-	NO SOLUTION REQUIRED	**N/A**	
Link 3												
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	201	185634	NB	185/6A+34	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**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**	
Link 4a												
	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	306	188034	SB	188/0B+34	REMAINING	MS3 Cantilever	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
	Gantry	307	188529	NB	188/5A+29	NEW	MS4 Cantilever	25.0	5.4	Full Height Embankment Widening 1:2.2	**N/A**	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	312	190610	SB	190/6B+10	REMAINING	MS4 Cantilever	NA	3.2	NO SOLUTION REQUIRED	**0.2**	
Link 4b												
	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**	

SMIS Structure Name	Asset	SMP Reference	Chainage	Carriageway	Marker Post	New/ Remaining	Asset Type	Widening Extents (Approx.)		Proposed Solution		
								Longitudinal Length (m)	Proposed Verge Widening (m)	Earthwork Retaining Solution	Max Proposed Retained Earthwork Height (m)	Comments
	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	317	191577	NB	191/5A+77	REMAINING	MS3 Cantilever	NA	N/A	NO SOLUTION REQUIRED	**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 1:3.5	**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**	
Link 5												
	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.
	Gantry	325	193950	SB	193/9B+50	REMAINING	Portal	NA	N/A	NO SOLUTION REQUIRED	**N/A**	
Link 3												
	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**	
Link 4a												
	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 and Granular Wedge	**2.4**	Sheet Pile is required to maintain existing vegetation. Regrade solution applied for Ch188720 to 188760 and from Ch188850 to 188890. The base benching width reduced to 3.1m.
Link 4b												
	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**	

A.2 - Mainline Widening Solutions Schedule Northbound

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
Link 2										
182000	182050	50	Embankment	G	None	No Solution Used	--	N/A	N/A	No solution required based on RFI 114
182060	182160	100	At Grade	G	None	No Solution Used	--	N/A	N/A	No solution required based on RFI 114
182170	182220	50	At Grade	G	None	No Solution Used	--	2.3	0.68	No solution required based on RFI 114
182230	182450	220	Cutting	G	None	No Solution Used	--	N/A	N/A	No solution required based on RFI 261
182460	182470	10	Cutting	G	None	No Solution Used	--	0.2	5.6	No solution required based on RFI 261
182480	182640	160	Cutting	G	None	No Solution Used		0.3	1	No solution required based on RFI 261
182650	182710	60	Cutting	G	None	No Solution Used	--	0.2	3.5	No solution required based on RFI 261
182720	182740	20	Cutting	G	None	No Solution Used		N/A	N/A	No solution required based on RFI 261
182750	182790	40	-	-	-	Overbridge	--	N/A	N/A	--
182800	182890	90	Cutting	G	None	Full Height Cutting Regrade 1:2.5	--	N/A	N/A	Refer to RFI 403, Gabion wall built and demolished
~~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	Additional regrade required RFI 403
182910	183000	90	Cutting	G	None	<500mm Fill	--	N/A	N/A	Additional regrade required RFI 403
183000	183070	70	At Grade	G	None	<500mm Cut	--	N/A	N/A	Additional regrade required RFI 403
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	No Solution Used	--	N/A	N/A	No solution required based on RFI 142
183580	183610	30	Cutting	G	None	No Solution Used	--	2.5	1.9	No solution required based on RFI 142
~~183620~~	~~183700~~	~~80~~	~~Cutting~~	~~G~~	~~None~~	~~Regrade Full Height 1:3~~	~~--~~	~~2~~	~~7.6~~	~~--~~
183620	183700	80	Cutting	G	None	No Solution Used	--	2	7.6	No solution required based on RFI 142
183710	183780	70	Cutting	G	None	No Solution Used	--	N/A	N/A	No solution required based on RFI 142
183790	183830	40	Cutting	G	None	No Solution Used	--	N/A	N/A	No solution required based on RFI 142
183840	183920	80	Cutting	G	None	No Solution Used	--	N/A	N/A	No solution required based on RFI 142
183930	183960	30	Cutting	G	None	No Solution Used	--	N/A	N/A	No solution required based on RFI 142
183960	184035	75	Cutting			Full Height regrade 1:2.5. kegworth Bypass (by others)				
~~183980~~	~~184000~~	~~20~~	~~Cutting~~	~~G~~	~~None~~	~~Regrade Full Height 1:3~~				
184000	184020	20	Cutting	G	None	No Solution Used	--	N/A	0.7	No solution required based on RFI 142
184030	184060	30	-	-	-	Overbridge	--	N/A	N/A	--
184040	184450	410	Cutting	G	None	Full Height Cutting Regrade1:2.5	--	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	--
184740	184920	180	Embankment	G	None	Full Height Embankment Widening 1:2	--	3.1	3.5	--
Link 3										
184910	185110	200	At Grade	G	None	No Solution Used	--	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~~	--
185140	185220	80	Cutting	G	None	Retaining Wall (Sheet Pile)	2.0	N/A	N/A	--
185220	185270	50	Cutting	G	None	Retaining Wall (Sheet Pile)	2.3	N/A	N/A	--
185270	185320	50	Cutting	G	None	Retaining 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	--
185880	185904	24	Embankment	A	32.30	<500mm Fill	--	0.6	--	1:2.5 Partial Re-grade
185904	185960	56	Embankment	A	32.30	Retaining Wall (Sheet Pile)	2.0	N/A	N/A	Sheet pile to start 1.0m north of exisiting culvert
185960	185990	30	Embankment	A	32.30	Retaining Wall (Sheet Pile)	2.1	N/A	N/A	--
185990	186040	50	Embankment	A	32.30	Retaining Wall (Sheet Pile)	2.0	N/A	N/A	--

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
186040	186090	50	Embankment	A	32.30	Retaining Wall (Sheet Pile)	2.3	N/A	N/A	--
186090	186230	140	Embankment	A	32.30	Retaining Wall (Sheet Pile)	2.0	N/A	N/A	--
186230	186270	40	Embankment	A	32.30	Retaining Wall (Sheet Pile)	2.5	N/A	N/A	
186270	186340	70	Embankment	A	32.30	Retaining Wall (Sheet Pile)	2.0	N/A	N/A	
186340	186370	30	Embankment	A	32.30	Full Height Embankment Widening 1:2	--	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	following RFI 685
186440	186450	10	Embankment	A	32.30	<500mm Fill	--	N/A	N/A	--
186460	186489	29	Embankment	A	32.30	No Solution Used	--	N/A	N/A	--
186489	186535	46	Embankment		32.30	Retaining 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	--	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	--
Link 4a										
187080	187090	10	-	-	-	Overbridge	--	N/A	N/A	--
187100	187180	80	Embankment	A	30.90	<500mm Fill	--	N/A	N/A	--
187190	187250	60	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	187510	160	Embankment	A	30.90	Granular Wedge at Embankment Crest 1:2	--	4.6	2.6	--
187510	187390	-120	Embankment	A		No Solution Used				
187390	187540	150	Embankment	A	30.90	No Solution Used	--	N/A	N/A	--
~~187550~~	~~187790~~	~~240~~	~~Embankment~~	~~A~~	~~31.30~~	~~Granular Wedge at Embankment Crest 1:2~~	~~--~~	~~4.3~~	~~2.6~~	--
187540	187800	260	Embankment	A	31.3	Granular Wedge at Embankment Crest 1:2	--			
187800	187865	65	Embankment	A	31.3	Granular Wedge at Embankment Crest 1:2	--			
187870	187880	10	-	-	-	Granular Wedge at Embankment Crest 1:2	--	N/A	N/A	--
187890	187920	30	Embankment	A	31.40	Granular Wedge at Embankment Crest 1:2	--	N/A	N/A	--
187930	187950	20	Embankment	A	32.40	Granular Wedge at Embankment Crest 1:2	--	2	1.3	--
187950	187990	40	-	-	-	River Trent Bridge	--	N/A	N/A	--
188000	188190	190	Embankment	R	31.70	Granular Wedge at Embankment Crest 1:2	--	N/A	N/A	--
~~188130~~	~~188190~~	~~60~~	~~Embankment~~	~~R~~	~~31.70~~	~~Granular Wedge at Embankment Crest 1:2~~		~~3.9~~	~~5.2~~	
188190	188460	270	Embankment	R	31.70	No Solution Used		N/A	N/A	
188460	188510	50	-	-	-	Granular Wedge at Embankment Crest 1:2	--	N/A	N/A	--
~~188290~~	~~188520~~	~~230~~	~~Embankment~~	~~R~~	~~31.90~~	~~No Solution Used~~	~~--~~	~~N/A~~	~~N/A~~	~~--~~
~~188490~~	~~188510~~	~~20~~	~~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~~	--
188510	188540	30	Embankment	R	31.90	Full Height Embankment Regrade 1 in 2.2	--	--	N/A	
188550	188570	20	Embankment	R	31.90	No Solution Used	--	N/A	N/A	
188570	188730	160	-	-	.	River Trent Bridge	--	N/A	N/A	--
188730	188760	30	Embankment	R	32.20	Full Height Embankment Widening 1:1.6	--	N/A	N/A	--
188760	188850	90	Embankment	R	32.20	Retaining Wall (Sheet Pile)	2.8	N/A	N/A	--
188850	188890	40	Embankment	R	32.20	Full Height Embankment Widening 1:1.6	--	N/A	N/A	
~~188900~~	~~188980~~	~~80~~	~~Embankment~~	~~R~~	~~32.20~~	~~Full Height Embankment Widening 1:1.6~~	~~--~~	~~N/A~~	~~N/A~~	~~--~~
188990	189150	160	-	-	-	River Trent Bridge	--	N/A	N/A	--

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
189160	189320	160	Embankment	A	32.20	No Solution Used	--	N/A	N/A	--
189320	189500	180	-	-	-	River Trent Bridge	--	N/A	N/A	--
189500	189520	20	Cutting	A	32.20	<500mm Cut	--	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	189760	90	Embankment	G	32.20	Granular Wedge at Embankment Crest 1:2	--	N/A	N/A	--
189760	189830	70	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	--
Link 4b										
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	--
190380	190390	10	-	-	-	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	190940	200	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	191490	30	Cutting	A	32.20	Regrade Full Height 1:3	--	3.7	1.6	--
191500	191550	50	Cutting	A	33.20	<500mm Cut	--	N/A	N/A	--
191560	191580	20	Cutting	R	None	Regrade Full Height 1:2.0	--	N/A	N/A	Replacement to sheet pile wall
191590	191640	50	Cutting	R	None	<500mm Cut	--	N/A	N/A	--
191650	191660	10	-	-	-	Overbridge	--	N/A	N/A	--
191670	191770	100	Cutting	G	None	No Solution Used	--	N/A	N/A	--
191762	191830	68	Sheet Pile Wall	G	None	Sheet Pile Wall	--	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 Fill	--	N/A	N/A	--
192090	192110	20	Embankment	G	None	Full Height Embankment Widening 1:2	--	--	1.1	--
192110	192160	50	Embankment	A	None	<500mm Fill	--	N/A	N/A	--
192160	192370	210	Embankment	A	None	Granular Wedge at Embankment Crest 1:2	--	N/A	N/A	--
192370	192460	90	Embankment	A	None	Granular Wedge at Embankment Crest 1:2	--	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~~	--
192460	192520	60	Embankment	A	None	Full Height Embankment Widening 1:2	--	4	6.2	--
~~192500~~	~~192510~~	~~10~~	~~Embankment~~	~~A~~	~~None~~	~~<500mm Fill~~	~~--~~	~~--~~	~~--~~	~~--~~
192520	192530	10	-	-	-	Underbridge	--	N/A	N/A	--
192540	192970	430	Embankment	A	None	<500mm Fill	--	N/A	N/A	--
192980	193010	30	Cutting	A	None	Full Height Cutting Regrade 1:2.5	--	N/A	N/A	The solution has changed from gabion wall to regrade
193010	193020	10	Cutting	A	None	Full Height Cutting Regrade 1:2.2	--	N/A	N/A	The solution has changed from gabion wall to regrade
Link 5										
193050	193060	10	-	-	-	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 Cut	--	N/A	N/A	--
193250	193320	70	Cutting	A	None	Gabion Wall	0.5	N/A	N/A	--

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
193320	193350	30	Cutting	A	None	Retaining 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	--
193560	193590	30	-	-	-	Overbridge	--	N/A	N/A	--
193600	193640	40	Cutting	G	None	No Solution Used	--	N/A	N/A	--
193650	193660	10	-	-	-	Overbridge	--	N/A	N/A	--
193670	193680	10	Cutting	G	None	No Solution Used	--	N/A	N/A	--
193690	193700	10	Cutting	G	None	<500mm Cut	--	N/A	N/A	--
193710	193730	20	Cutting	G	None	No Solution Used	--	N/A	N/A	--
193740	193780	40	Cutting	G	None	No Solution Used	--	N/A	N/A	
193790	193800	10	Cutting	G	None	No Solution Used	--	N/A	N/A	
193810	193830	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	--

A.3 - Mainline Widening Solutions Schedule Southbound

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
					Link 2					
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 1:3.0	--	2.8	5.5	--
182150	182680	460	Cutting	?	None	Regrade Full Height 1:3.0	--	2.9	7.3	
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	No Solution Used	--	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	183420	100	Embankment	A	None	Full Height Embankment Widening 1:2	--	3.9	5.2	--
183440	183460	20	At Grade	A	None	<500mm Cut	--	N/A	N/A	--
183460	183520	60	At Grade	G	None	No Solution Used	--	2.4	1	--
183520	183700	180	Cutting	G	None	Regrade Full Height 1:2.5	--	N/A	N/A	--
183700	183800	100	Cutting	G	None	No Solution Used	--	N/A	N/A	
~~183665~~	~~183780~~	~~115~~	~~Cutting~~	~~G~~	~~None~~	~~No Solution Used~~	--	N/A	N/A	RFI614
~~183780~~	~~183790~~	~~10~~	~~Cutting~~	~~G~~	~~None~~	~~No Solution Used~~	--	N/A	N/A	RFI614
183800	183860	60	Cutting	G	None	Gabion wall	--	N/A	N/A	
183860	183950	90	Cutting	G	None	Ret. Wall (Sheet Pile)	1.1	N/A	N/A	
183950	184065	115				NO WORKS REQUIRED				Works removed, refer to PMI 20.
~~183980~~	~~184020~~					~~NO WORKS REQUIRED~~				Full Height regrade 1:2.5. Kegworth Bypass bridgeby others.
~~184030~~	~~184060~~	~~30~~	~~Cutting~~	~~G~~	~~None~~	~~<500mm Cut~~	--	N/A	N/A	--
184065	184107	42	-	-	-	Overbridge	--	N/A	N/A	--
184107	184112	5	Cutting	G	None	Regrade Full Height 1:2	--	N/A	N/A	--
184112	184130	18	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	--
184470	184620	150	At Grade	A	None	<500mm Cut / No Solution	--	N/A	N/A	--
184620	184740	120	Embankment	A	None	Full Height Embankment Widening 1:2	--	5.2	2.6	--
184740	184840	100	Embankment	R	None	No Solution Used	--	N/A	N/A	--
					Link 3					
184840	185100	260	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	--
185160	185220	60	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	185380	10	Cutting	R	None	<500mm Fill	--	N/A	N/A	--
~~185380~~	~~185500~~	~~120~~	~~Cutting~~	~~R~~	~~None~~	~~<500mm Cut~~	--	N/A	N/A	
185380	185560	180	Cutting	G	None	Regrade Full Height 1:3	--	1.7	2.8	--
185560	185630	70	At Grade	G	None	<500mm Cut	--	N/A	N/A	Slope is approximately at-grade / shallow slope which is formed between the new EMG J24A SB on slip and the realigned EMG J24 SB off slip. Note this is predominantly "cutting" between the M1 and J24 SB off slip / new EMG J24A SB on slip
185630	185700	70	At Grade	G	None	<500mm Fill	--	N/A	N/A	Slope is approximately at-grade / shallow slope which is formed between the new EMG J24A SB on slip and the realigned EMG J24
185700	185770	70	At Grade	G	None	Gabion wall	1	N/A	N/A	Refer to PMI 150 and 166
185770	185860	90	At Grade	G	None	<500mm Fill	--	N/A	N/A	Slope is "cutting" and formed by new earthworks embankment for new EMG J24A SB on slip. Includes 2 small gabion retaining solutions at 2 chambers and 2 small slab on edge retaining solutions at 2 lighting
185860	185900	40	Embankment	A	30.6	Granular Wedge At Embankment Crest 1:2	--	1.9	2.3	Area between M1 and new EMG J24A SB on slip embankment has also been infilled / reprofiled to create an at-grade region.
185900	185940	40				Granular Wedge At Embankment Crest 1:2	--	N/A	N/A	Area between M1 and new EMG J24A SB on slip embankment has also been infilled / reprofiled to create an at-grade region
185940	186200	260	Embankment	A	30.6	Granular Wedge At Embankment Crest 1:2	--	1.9	3	--
186200	186330	130	Embankment	A	31.6	Full Height Embankment Widening 1:2	--	4.7	2.9	--
186330	186410	80	Embankment	A	None	<500mm Fill	--	N/A	N/A	--
186450	186520	70	At Grade	A	None	No Solution Used	--	N/A	N/A	--

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
186530	186560	30	-	-	-	Overbridge	--	N/A	N/A	--
186570	186770	200	Embankment	G	30.5	No Solution Used	--	N/A	N/A	RFI614
186770	186830	60	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	187090	200	Embankment	G	30.5	Full Height Embankment Widening 1:2	--	--	6.5	
						Link 4a				
187090	187140	50	-	-	-	Underbridge	--	N/A	N/A	--
187140	187260	120	Embankment	A	None	Granular Wedge At Embankment Crest 1:2	--	1	5.5	--
187260	187275	15	-	-	-	Culvert	--	N/A	N/A	--
187275	187330	55	Embankment	A	30.9	Full Height Embankment Widening 1:2	--	4.3	2	--
187330	187350	20	-	-	-	Culvert	--	N/A	N/A	--
187350	187450	100	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	RFI614
187800	187835	35	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	No Solution Used	--	N/A	N/A	RFI614
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	--
188220	188250	30	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	--
188408	188500	92	Embankment	R	31.1	Ret. Wall (Sheet Pile)	2.7	N/A	N/A	--
188500	188546	46	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
188930	188950	20	Embankment	R	32.2	Ret. Wall (Sheet Pile)	2.1	N/A	N/A	--
188950	188980	30	Embankment	R	32.2	<500mm Fill	--	N/A	N/A	--
188990	189150	160	-	-	-	Underbridge	--	N/A	N/A	--
189160	189180	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~~	--
189180	189190	10	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	189305	25	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	No Solution Used	--	N/A	N/A	RFI614
189520	189530	10	-	-	-	Overbridge	--	N/A	N/A	--
189540	189550	10	Cutting	A	32.2	No Solution Used	--	N/A	N/A	RFI614
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	--
189790	189930	140	Embankment	A	32.2	Granular Wedge At Embankment Crest 1:2	--	3.9	2.7	--
189940	189950	10	-	-	-	Underbridge	--	N/A	N/A	--
						Link 4b				
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	191050	370	Embankment	A	31.2	Granular Wedge At Embankment Crest 1:2	--	1	2.6	--
191050	191410	360	Embankment	A	31.2	No Solution Used	--	N/A	N/A	RFI614
191420	191450	30	Embankment	A	32.2	Granular Wedge At Embankment Crest 1:2	--	--	2.8	--
191450	191500	50	Embankment	A	None	No Solution Used	--	N/A	N/A	RFI614
191500	191530	30	At Grade	A	None	No Solution Used	--	N/A	N/A	RFI614

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
191530	191550	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	No Solution Used	--	N/A	N/A	RFI614
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	--	--
191990	192000	10	Embankment	R	None	<500mm Fill	--	N/A	N/A	--
192000	192090	90	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	--
192520	192560	40	-	-	-	Underbridge	--	N/A	N/A	--
192560	192710	150	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	192830	60	Embankment	A	None	Ret. Wall (Sheet Pile)	2.0	N/A	N/A	--
192830	192890	60	Embankment	A	None	No Solution Used	--	N/A	N/A	RFI614
192890	192940	50	Cutting	A	None	Regrade Full Height 1:2.5	--	N/A	N/A	--
Link 5										
192940	193040	100	Cutting	A	None	Full Height Embankment Widening 1:2	--	N/A	N/A	--
193230	193290	60	At Grade	A	None	Full Height Embankment Widening 1:2	--	N/A	N/A	--
193300	193320	20	Cutting	A	None	Ret. Wall (Sheet Pile)	1.1	N/A	N/A	Original Sheet pile solution to be used
193320	193470	150	Cutting	A	None	Ret. Wall (Gabion)	--	N/A	N/A	Original Gabion solution to be used
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	No Solution Used	--	N/A	N/A	Change of design from sheet pile to full height regrade
193695	193715	20	Cutting	A	None	No Solution Used	--	N/A	N/A	Change from no solution to earthwork solution, refer to RFI 1077 and PMI 193
193716	193730	14	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	No Solution Used	--	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	--

A.4 - Mainline Widening Solutions Schedule Merges & Diverges

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
									Link 2				
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	No Solution Used	--	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	No Solution Used	--	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	
181810	181860	50	23a	NB	A42-M1 (west)	Embankment			Granular Wedge At Embankment Crest 1:3	--	4.0	2.5	Limited topo data. Solution to be verified on-site follow removal of vegetation
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	No solution used	--	--	--	There are no changes to thecurrent highways model, therefore, no geotechnical solution will be required.
184860	184910	50	24	SB	A453/A50/A6-M1 Onslip (east)	Embankment	Red	None	Full Height Embankment Widening 1:2	--	4.9	3	Solution changed from sheet pile wall
184920	185040	120	24	SB	A453/A50/A6-M1 Onslip (east)	Embankment	Red	None	Full Height Embankment Widening 1:2.5	--	6.3	5	Refer to RFI 460 and drawing HA549342-AMAR-HGT-SWI-DR-CE-000620
~~184970~~	~~185000~~	~~30~~	~~24~~	~~SB~~	~~A453/A50/A6-M1 Onslip (east)~~	~~Embankment~~	~~Red~~	~~None~~	~~No solution used~~	~~--~~	--	--	~~There are no changes to the current highways model, therefore, no geotechnical solution will be required.~~
									Link 3				
185010	185100	90	24	SB	A453/A50/A6-M1 Onslip (east)	Embankment	Red	None	No solution used	--	--	--	~~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	No Solution Used	--	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 maininline 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	Local build out at Ch180 rquired for CCA chamber. Additional 1.2m wide 3m long build out required at this location. Refer to RFI 791.
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 maininline widening schedule	--	--	--	
									Link 5				
193110	193250	140	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	

Appendix B Retaining structures and structure foundation schedule (As-Built)

B.1 - Sheet Pile Wall Schedule Northbound
B.2 - Sheet Pile Wall Schedule Southbound
B.3 - Slab-on-edge Schedule
B.4 - Gantries Foundation Schedule
B.5 - ROTTOMS Foundation Schedule
B.6 - Environmental Barriers Foundation Schedule
B.7 - CCTVs Foundation Schedule
B.8 - Radar’s Foundation Schedule
B.9 - EAV Poles Foundation schedule
B.10 - Large Traffic Signs Foundation schedule
B.11 - Single Post Traffic Signs Foundation Schedule

B.1 - Sheet Piling Schedule Northbound

Chainage Start	Chainage End	Earthwork Type	Sheet Pile Type	Total Structure Length (m)	Max. Retained Height (m)	Sheet Pile Wall				King Sheet Pile Wall							
										KSP (700mm Sections)				Intermediate KSP Sections (700mm)			
						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)	Total Length (m)
Link2																	
Link 3																	
185140	185220	Cutting	Steel	80	2.0	-	-	-	-	6.0	8.0	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.0
185220	185270	Cutting	Steel	50	2.3	-	-	-	-	7.7	10.0	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.3
185270	185320	Cutting	Steel	50	2.0	-	-	-	-	6.0	8.0	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.0
185904	185950	Embankment	Steel	46	2.0	-	-	-	-	4.5	6.5	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.0
185950	185990	Embankment	Steel	40	2.1	-	-	-	-	4.4	6.5	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.1
185990	186040	Embankment	Steel	50	2.0	-	-	-	-	4.5	6.5	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.0
186040	186090	Embankment	Steel	50	2.3	-	-	-	-	5.2	7.5	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.3
186090	186230	Embankment	Steel	140	2.0	-	-	-	-	4.5	6.5	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.0
186230	186270	Embankment	Steel	40	2.5	-	-	-	-	5.0	7.5	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.5
186270	186340	Embankment	Steel	70	2.0	-	-	-	-	4.5	6.5	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.0
186500	186530	Embankment	Steel	30	1.9	-	-	-	-	4.1	6.0	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	2.9
~~188530~~	~~188550~~	~~Embankment~~	~~Steel~~	20	~~2.7~~	-	-	-	-	~~8.3~~	~~11.0~~	~~ZZ26~~	~~S 355 GP~~	~~ZZ18~~	~~S 355 GP~~	~~1.0~~	~~3.7~~
Link 4a																	
~~188720~~	~~188760~~	~~Embankment~~	~~Steel~~	~~40~~	~~2.0~~	-	-	-	-	~~6.0~~	~~8.0~~	~~ZZ26~~	~~S 355 GP~~	~~ZZ18~~	~~S 355 GP~~	~~1.0~~	~~3.0~~
188760	188850	Embankment	Steel	~~90~~	2.8	-	-	-	-	6.2	9.0	ZZ26	S 355 GP	ZZ18	S 355 GP	1.5	4.3
~~188850~~	~~188865~~	~~Embankment~~	~~Steel~~	~~15~~	~~2.0~~	-	-	-	-	~~7.0~~	~~9.0~~	~~ZZ26~~	~~S 355 GP~~	~~ZZ18~~	~~S 355 GP~~	~~1.0~~	~~3.0~~
~~188865~~	~~188890~~	~~Embankment~~	~~Steel~~	~~25~~	~~2.0~~	-	-	-	-	~~6.0~~	~~8.0~~	~~ZZ26~~	~~S 355 GP~~	~~ZZ18~~	~~S 355 GP~~	~~1.0~~	~~3.0~~
~~191557~~	~~191582~~	~~Cutting~~	~~Steel~~	~~25~~	~~0.9~~	-	-	-	-	~~3.8~~	~~4.7~~	~~ZZ18~~	~~S 355 GP~~	~~ZZ18~~	~~S 355 GP~~	~~1.0~~	~~1.9~~
Link 5																	
191770	191830	Embankment	Steel	60	1.8	-	-	-	-	4.3	6.0	ZZ26	S 355 GP	-	-	-	-
193320	193350	Cutting	Steel	30	2.3	-	-	-	-	7.7	10.0	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.3

B.2 - Sheet Piling Schedule Southbound

Chainage Start	Chainage End	Earthwork Type	Sheet Pile Type	Total Structure Length (m)	Max. Retained Height (m)	Sheet Pile Wall				King Sheet Pile Wall							
										KSP (700mm sections)				Intermediate KSP Sections (700mm)			
						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)	Total Length (m)
Link2																	
183860	183950	Cutting	Steel	90	1.4	-	-	-	-	4.1	5.5	ZZ18	S 355 GP	ZZ18	S 355 GP	1.0	2.4
Link 4a																	
187800	187830	Embankment	Steel	30	2.3	-	-	-	-	4.2	6.5	ZZ 26	S 355 GP	ZZ18	S 355 GP	1.0	3.3
187910	187930	Embankment	Steel	20	1.2	-	-	-	-	6.9	7.5	ZZ18	S 355 GP	ZZ18	S 355 GP	1.0	1.6
188100	188130	Embankment	Steel	30	1.4	-	-	-	-	5.6	7.0	ZZ18	S 355 GP	ZZ18	S 355 GP	1.0	2.4
188410	188500	Embankment	Steel	90	2.7	-	-	-	-	8.3	11.0	AZ46	S 390 GP	ZZ18	S 355 GP	1.0	3.7
188500	188540	Embankment	Steel	40	2.0	-	-	-	-	6.0	8.0	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.0
188750	188770	Embankment	Steel	20	2.3	-	-	-	-	5.2	7.5	ZZ26	S 355 GP	ZZ18	S 355 GP	2.5	4.8
188930	188950	Embankment	Steel	20	2.1	-	-	-	-	5.7	8.0	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.3
189160	189180	Embankment	Steel	20	2.5	-	-	-	-	5.3	8.0	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.7
189280	189305	Embankment	Steel	25	1.5	-	-	-	-	5.0	6.5	ZZ18	S 355 GP	ZZ18	S 355 GP	1.0	2.5
189750	189790	Embankment	Steel	40	2.9	-	-	-	-	6.1	9.0	ZZ26	S 355 GP	ZZ18	S 355 GP	1.0	3.9
Link 4b																	
192090	192140	Embankment	Steel	50	2.0	-	-	-	-	6.0	8.0	AZ36	S 390 GP	ZZ18	S 355 GP	1.0	3.0
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	ZZ18	S 355 GP	1.0	4.1
192240	192260	Embankment	Steel	20	2.0	-	-	-	-	6.0	8.0	AZ36	S 390 GP	ZZ18	S 355 GP	1.0	3.0
192260	192300	Embankment	Steel	40	3.1	-	-	-	-	7.9	11.0	AZ36	S 390 GP	ZZ18	S 355 GP	1.0	4.1
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	ZZ18	S 355 GP	1.0	4.1
192400	192480	Embankment	Steel	80	2.4	-	-	-	-	9.6	12.0	AZ36	S 390 GP	ZZ18	S 355 GP	1.0	3.4
192480	192519	Embankment	Steel	39	2.3	-	-	-	-	9.7	12.0	AZ36	S 390 GP	ZZ18	S 355 GP	1.0	3.3
192710	192747	Embankment	Steel	37	3.4	-	-	-	-	9.1	12.5	AZ50	S 390 GP	ZZ18	S 355 GP	1.0	4.4
~~192770~~	~~192832~~	~~Embankment~~	~~Steel~~	~~62~~	~~2.5~~	-	-	-	-	6.0	8.5	AZ36	S 390 GP	ZZ18	S 355 GP	1.0	3.5
193300	193320	Cutting	Steel	20	1.1	-	-	-	-	4.2	5.0	ZZ18	S 355 GP	ZZ18	S 355 GP	1.0	1.8
~~193680~~	~~193691~~	~~Cutting~~	~~Steel~~	~~11~~	~~1.5~~	-	-	-	-	~~5.5~~	~~7.0~~	~~ZZ26~~	~~S 355 GP~~	~~ZZ18~~	~~S 355 GP~~	~~1.0~~	~~2.5~~

B.3 - Slab-on-edge Schedule

Asset	Earthwork Type	Carriageway	Structure Location	As-built			Comments
				Chainage Start	Chainage End	Length (m)	
PC17	Cutting	NB	Lighting Column	182286	182292	6	Slab-on-Edge solution included (Post DF5) to provide up to 0.5m high retaining wall behind lighting column and A chambers locations.
PC19	Cutting	NB	Lighting Column	182313	182319	6	
PC21	Cutting	NB	Lighting Column	182340	182347	7	
PC23	Cutting	NB	Lighting Column	182366	182372	6	
PC25	Cutting	NB	Lighting Column	182393	182399	6	
PC27	Cutting	NB	Lighting Column	182420	182426	6	
PC29	Cutting	NB	Lighting Column	182447	182453	6	
PC31	Cutting	NB	Lighting Column	182474	182480	6	
PC33	Cutting	NB	Lighting Column	182500	182506	6	
PC35	Cutting	NB	Lighting Column	182538	182544	6	
PC37	Cutting	NB	Lighting Column	182576	182582	6	
PC39	Cutting	NB	Lighting Column	182614	182620	6	
PC41	Cutting	NB	Lighting Column	182653	182659	6	
PC43	Cutting	NB	Lighting Column	182691	182697	6	
PC46	Cutting	NB	Lighting Column	182730	182736	6	
PC57	Cutting	NB	Lighting Column	182895	182901	6	
PC59	Cutting	NB	Lighting Column	182928	182933	5	
PC61	Cutting	NB	Lighting Column	182960	182966	6	
PC63	Cutting	NB	Lighting Column	182992	182998	6	
PC38	Cutting	SB	Lighting Column	182578	182575	3	
PC40	Cutting	SB	Lighting Column	182617	182613	4	
PC92	Cutting	SB	Lighting Column	183492	183487	5	
PC94	Cutting	SB	Lighting Column	183524	183519	5	
PC96	Cutting	SB	Lighting Column	183554	183549	5	
PC98	Cutting	SB	Lighting Column	183585	183580	5	
PC104	Cutting	SB	Lighting Column	183678	183673	5	
A041	Cutting	SB	A Chamber	182491	182486	5	
A018	Cutting	SB	A Chamber	181965	181960	5	

B.4 - Gantries Foundation Schedule

Asset	SMP Reference	Chainage (m)	Carriageway	Foundation type	Pile Type (Construction Method)	Number of Piles	Pile Diameter (mm)	Pile Spacing (m)	As-built Pile Length (m)	Working Pile Test Details				Design Validation		
										Test	Representative Load (kN)	Max. Test Load (kN)	Permitted Settlement at 150% Representative Load (mm)	Geotech	Borehole No.	Static Load Test Y/N
Gantry (MS4)	101	181950	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	11						BH-G101	
Gantry (Super Cantilever)	112	185180	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	20	Y	1225	1838	13	Complete	BH-G112	Y
Gantry (Superspan Portal)	202	186240	NB	Pile Group	Bored	3 (1 x 3)	0.9	2.7	16		No test required			Complete	BH-G202	
Gantry (Superspan Portal)	202	186240	SB	Pile Group	Bored	3 (1 x 3)	0.9	2.7	16	Y	849	1274	14	Complete	BH-G202	Y
Gantry (ADS)	203	186390	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	25		No test required			Complete	BH-G203	
Gantry (Super Cantilever)	204	186526	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	19		No test required			Complete	BH-G204	
Gantry (Superspan Portal)	301	186847	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	16	Y	1539	2309	20	Complete	BH-G301A	Y
Gantry (Superspan Portal)	301	186847	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	16	Y	1539	2309	20	Complete	BH-G301B	Y
Gantry (ADS)	302	187073	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	21		No test required			Complete	BH-G302	N
Gantry (MS4)	326	187300	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	17	Y	576	864	8	Complete	BH-G326	Y
Gantry (ADS)	303	187608	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	21	Y	1040	1560	8	Complete	BH-G303	Y
Gantry (Super Cantilever)	304	187650	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	12.5	Y	1386	2079	8	Complete	BH-G304	Y
Gantry (MS4)	305	187818	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	12.5	Y	497	745	8	Complete	BH-G305	Y
Gantry (MS4)	307	188529	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	15		No test required			Complete	BH-G307	N
Gantry (ADS)	308	188760	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	26	Y	912	1369	8	Complete	BH-G308	Y
Gantry (MS3)	309	188947	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	14	Y	498	747	8	Complete	BH-G309	Y
Gantry (MS4)	310	189172	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	14		No test required			Complete	BH-G310	N
Gantry (Superspan Portal)	311	189780	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	16	Y	578	885	12	Complete	BH-G311A	Y
Gantry (Superspan Portal)	311	189780	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	16		No test required			Complete	BH-G311B	N
Gantry (MS4)	312	190605	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	16		No test required			Complete	BH-G312	N
Gantry (MS3)	313	190771	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	14	Y	412	618	8	Complete	BH-G313	Y
Gantry (MS4)	314	191096	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	11	Y	428	642	8	Complete	BH-G314	Y
Gantry (ADS)	315	191296	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	26	Y	937	1406	9	Complete	BH-G315	Y
Gantry (MS4)	316	191430	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	10.5		No test required			Complete	BH-G316	N
Gantry (MS4)	318	191801	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	13		No test required			Complete	BH-G318	N
Gantry (ADS)	319	192101	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	25		No test required			Complete	BH-G319	N
Gantry (Super Cantilever)	320	192290	SB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	12.5		No test required			Complete	BH-G320	N
Gantry (MS4)	321	192476	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	15	Y	498	748	8	Complete	BH-G321	Y
Gantry (ADS)	322	192906	NB	Pile Group	Bored	4 (2 x 2)	0.9	2.7	15	Y	799	1198	12	Complete	BH-G322	Y
Gantry (MS4)	323	193300	SB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	6	Y	318	478	10	Complete	BH-G322A	Y
Gantry (MS4)	324	193331	NB	Pile Group	Bored	4 (2 x 2)	0.75	2.25	7	Y	361	542	8	Complete	BH-G324	Y

B.5 - ROTTMS Foundation Schedule

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)	Total Pile Length (m)	Easting*	Northing*	Ground Level (m)	Pile length from cut off to toe level	Top of Pile Cap Level	Pile Toe Level	Pile Cap Depth	Pile Cut off Level	Comments
ROTTM	FTP_NB2_200y	187768	NB	Single Pile	N/A	Planted	1	450	N/A	4.0	446852.02	330045.46	33.570						
ROTTM	FTP_NB2_400y	187551	NB	Single Pile	N/A	Planted	1	450	N/A	4.0	446919.88	329840.19	33.780						
ROTTM	FTP_NB2_600y	187369	NB	Single Pile	N/A	Planted	1	450	N/A	4.0	446978.5	329667.06	35.900						
ROTTM	FTP_NB2_800y	187216	NB	Single Pile	N/A	Planted	1	450	N/A	4.0	447023.1	329520.47	37.900						
ROTTM	FTP_NB2_1m	186321	NB	Single Pile	N/A	Planted	1	450	N/A	4.0	447303.02	328670.64	33.300						
ROTTM	FTP_NB2_1m_2	186950	NB	Single Pile	N/A	Planted	1	450	N/A	4.0	447104.52	329257.25	37.630						
ROTTM	FTP_NB4_200y	191967	NB	Pad Foundation	2.3m x 2.0m x 1.5m	N/A	N/A	N/A	N/A	N/A	447246.87	334012.77	35.550						Easting and Northig are assumed at the centre of the pad
ROTTM	FTP_NB4_400y	191785	NB	Pad Foundation	2.3m x 2.0m x 1.5m	N/A	N/A	N/A	N/A	N/A	447266.74	333834.07	33.550						Easting and Northig are assumed at the centre of the pad
ROTTM	FTP_NB4_600y	191560	NB	Pad Foundation	2.3m x 2.0m x 1.5m	N/A	N/A	N/A	N/A	N/A	447264.69	333611.9	33.020						Easting and Northig are assumed at the centre of the pad
ROTTM	FTP_NB4_800y	191485	NB	Pad Foundation	2.3m x 2.0m x 1.5m	N/A	N/A	N/A	N/A	N/A	447257.35	333537.47	33.160						Easting and Northig are assumed at the centre of the pad
ROTTM	FTP_NB4_1m	190541	NB	Single Pile	N/A	Planted	1	450	N/A	4.0	446914.9	332678.85	37.860						
ROTTM	FTP_SB2_200y	192176	SB	Single Pile	N/A	Planted	1	450	N/A	4.0	447241.04	334224.37	40.080						
ROTTM	FTP_SB2_400y	192356	SB	Single Pile	N/A	Planted	1	450	N/A	4.0	447197.74	334398.33	43.430						
ROTTM	FTP_SB2_600y	192564	SB	Single Pile	N/A	Planted	1	450	N/A	4.0	447168.88	334602.34	45.520						
ROTTM	FTP_SB2_800y	192731	SB	Single Pile	N/A	Planted	1	450	N/A	4.0	447167.03	334766.11	45.450						
ROTTM	FTP_SB2_1m_1	193695	SB	Single Pile	N/A	Planted	1	750	N/A	4.5	447209.03	335729.76	50.947						~~Easting and Northig are assumed at the centre of the pad~~
ROTTM	FTP_SB2_1m_2	193439	M	Single Pile	N/A	Planted	1	750	N/A	4.5	447239.35	335472.64	53.673						Easting and Northig are assumed at the centre of the pad
ROTTM	FTP_SB3_200y	190368	SB	Single Pile	N/A	Planted	1	450	N/A	4.0	446853.84	332512.65	39.390						
ROTTM	FTP_SB3_400y	190640	SB	Single Pile	N/A	Planted	1	450	N/A	4.0	447000.72	332740.5	36.590						
ROTTM	FTP_SB3_600y	190749	SB	Single Pile	N/A	Planted	1	450	N/A	4.0	447060.01	332832.57	35.300						
ROTTM	FTP_SB3_800y	190931	SB	Single Pile	N/A	Planted	1	450	N/A	4.0	447146.11	332996.1	33.780						
ROTTM	FTP_SB3_1m	191812	SB	Pad Foundation	2.3m x 2.0m x 1.5m	N/A	N/A	N/A	N/A	N/A	447304.34	333864.86	34.630						Easting and Northig are assumed at the centre of the pad
ROTTM	FTP_SB4_200y	187922	SB	Single Pile	N/A	Planted	1	450	N/A	4.0	446841.07	330204.28	33.860						
ROTTM	FTP_SB4_400y	188116	SB	Single Pile	N/A	Planted	1	450	N/A	4.0	446780.95	330388.49	37.190						
ROTTM	FTP_SB4_600y	188238	SB	Single Pile	N/A	Planted	1	450	N/A	4.0	446742.36	330504.91	38.050						
ROTTM	FTP_SB4_800y	188395	SB	Single Pile	N/A	Planted	1	450	N/A	4.0	446694.55	330654.31	38.330						
ROTTM	FTP_SB4_1m	189299	SB	Single Pile	N/A	Planted	1	450	N/A	3.5	446511.66	331526.02	33.650						
ROTTM	FTP_SB5_200y	184115	SB	Pad Foundation	2.3m x 2.0m x 2.0m	N/A	N/A	N/A	N/A	N/A	447429.35	326502.17	66.380						Easting and Northig are assumed at the centre of the pad
ROTTM	FTP_SB5_400y	184307	SB	Pad Foundation	2.3m x 2.0m x 2.0m	N/A	N/A	N/A	N/A	N/A	447480.01	326690.2	66.680						Easting and Northig are assumed at the centre of the pad
ROTTM	FTP_SB5_600y	184475	SB	Pad Foundation	2.3m x 2.0m x 2.0m	N/A	N/A	N/A	N/A	N/A	447511.98	326855.27	56.280						Easting and Northig are assumed at the centre of the pad
ROTTM	FTP_SB5_800y	184672	SB	Pile Group	N/A	Bored	2	450	1.35	3.5	447540.69	327051.15	50.400	2.575	50.40	46.90	1.00	49.475	already built, as informed by Denis Shapley on 23/1/18
											447542.03	327051.02	50.400	2.575	50.40	46.90	1.00	49.475	
ROTTM	FTP_SB5_1m_2	184917	M	Pad Foundation	2.3m x 2.0m x 2.0m	N/A	N/A	N/A	N/A	N/A	447573.75	327303.87	43.030						Name changed from FTP_SB5_1m(b); Easting and Northig are assumed at the centre of the pad
ROTTM	FTP_SB5_1m	185389	SB	Pad Foundation	2.3m x 2.0m x 1.5m	N/A	N/A	N/A	N/A	N/A	447547.05	327772.11	34.780						Name changed from FTP_SB5_1m_2; Easting and Northig are assumed at the centre of the pad

* Easting and Northing for the planted foundations is the centre of the pile and for the pad foundations is the centre of the pad.

B.6 - Environmental Barriers Foundation Schedule

Asset	SMP Reference	Chainage Start (m)	Chainage End (m)	Length (m)	Carriageway	Marker Post Start	Marker Post End	Noise Barrier Height (m)	Pile Type	Normal Section		End Section		Next Section	
										Diameter (mm)	Planted Depth (m)	Diameter (mm)	Planted Depth (m)	Diameter (mm)	Planted Depth (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	Planted	450	3.0	600	3.3	600	3.0
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	Planted	450	3.0	600	3.3	600	3.0
Noise Barrier	ENS2_1	189535	189550	15	SB	189/5B+35	189/5B+60	3	Existing to be retained						
Noise Barrier	ENS2_2	189550	189690	140	SB	189/5B+60	189/6B+90	4	Planted	600	2.5	600	3.0	600	2.8
Noise Barrier	ENS2_3	189690	189730	40	SB	189/6B+90	189/9B+35	3	Planted	450	3.0	600	3.3	600	3.0
		189730	189750	20					Planted	450	3.4	600	3.8	600	3.6
		189750	189792	42					Planted	450	1.7	600	2.0	450	1.8
		189792	189820	28					Planted	450	3.0	600	3.3	600	3.0
		189820	189840	20					Planted	450	3.4	600	3.8	600	3.6
		189840	189915	75					Planted	450	3.0	600	3.3	600	3.0
		189915	189935	20					Planted	450	3.4	600	3.8	600	3.6
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	Planted	450	3.0	600	3.3	600	3.0
		190115	190125	10		190/1B+15	190/1B+25		Planted	450	3.3	600	3.6	600	3.4
		190125	190245	120		190/1B+25	190/2B+45		Planted	450	3.0	600	3.3	600	3.0
		190245	190265	20		190/2B+45	190/2B+65		Planted	450	3.4	600	3.8	600	3.5
		190265	190375	110		190/2B+65	190/3B+75		Planted	450	3.0	600	3.3	600	3.0
Noise Barrier	ENS3_1	190395	190655	260	SB	190/3B+95	190/6B+55	3	Planted	450	3.1	600	3.4	600	3.2
Noise Barrier	ENS3_2	190655	190660	5	SB	190/6B+55	190/6B+60	3	Fixed to existing parapet plinth						
Noise Barrier	ENS3_3	190660	191030	370	SB	190/6B+60	191/0B+30	3	Planted	450	3.1	600	3.4	600	3.2
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	Planted	600	2.8	600	3.3	600	3.0
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	190945	110	NB	190/8A+35	191/0A+25	2	Planted	450	3.0	600	3.3	450	3.3
		190945	191025	80						450	2.5	600	2.8	450	2.8
Noise Barrier	ENS4_2	191025	191060	35	NB	191/0A+25	191/0A+60	2	Planted	450	2.2	600	2.5	450	2.5
		191060	191080	20		191/0A+60	191/0A+80			450	2.8	600	3.1	450	3.0
		191080	191310	230		191/0A+80	191/3A+10			450	2.9	600	3.2	450	3.0
		191310	191360	50		191/3A+10	191/3A+60			450	2.8	600	3.1	450	3.0
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	Planted	450	1.6	600	1.9	450	1.9
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	Planted	600	2.5	600	3.0	600	2.8
		192020	192138	118		192/0B+20	192/1B+40			600	2.5	600	3.0	600	2.8
		192138	192165	27		192/1B+40	192/1B+65			600	1.6	600	2.0	600	1.8
Noise Barrier	ENS5_3	192165	192240	75	SB	192/1B+65	192/2B+65	3	Planted	450	1.7	600	2.0	600	1.8
		192240	192260	20					Planted	450	1.7	600	2.0	600	1.8
		192260	192401	141					Planted	450	1.7	600	2.0	600	1.8
		192401	192530	129					Planted	450	1.7	600	2.0	600	1.8
Visual Barrier	VB1	188720	188910	190	SB	188/7B+20	188/9B+10	*1.5	Planted	450	2.7	450	3.0	450	2.9

Notes
*1.5m above highway level

B.7 - CCTVs FoundationSchedule

Asset	SMP Reference	New or Modified Existing	Chainage (m)	Carriageway	Foundation type	Pile Type	Pile Diameter (mm)	Pile Length (m)	Eastings	Northings	Pile length from cut off to toe level (m)	Top of Pile Cap Level (mAOD)	Pile Toe Level (mAOD)	Pile Cap Depth (m)	Pile Cut off Level (mAOD)
CCTV	CCTV_01	Modified	182040	SB	Existing	Existing foundation to be reused									
CCTV	CCTV_02	New	182234	SB	Single Pile	Bored	450	3.0	446901.23	324700.89	1.975	66.33	63.330	1.1	65.305
CCTV	CCTV_03	Modified	182769	NB	Existing	Existing foundation to be reused									
CCTV	CCTV_04	New	182496	SB	Single Pile	Bored	750	5.0	446955.02	324954.89	3.975	71.465	66.465	1.1	70.44
CCTV	CCTV_05	New	183283	NB	Single Pile	Bored	450	7.0	447143.26	325719.86	5.975	76.87	69.870	1.1	75.845
CCTV	CCTV_06	New	183825	NB	Single Pile	Bored	450	3.0	447302.42	326237.85	1.975	71.53	68.530	1.1	70.505
CCTV	CCTV_07	New	184166	SB	Single Pile	Bored	450	3.0	447445.65	326556.68	1.975	65.25	62.250	1.1	64.225
CCTV	CCTV_08	New	184906	NB	Single Pile	Bored	450	5.0	447501.29	327296.25	3.975	42.63	37.630	1.1	41.605
CCTV	CCTV_09	Modified	185095	M	Existing	Existing foundation to be reused									
CCTV	CCTV_10	New	185371	K	Single Pile	Bored	750	7.0	447474.69	327748.70	5.975	40.74	33.740	1.1	39.715
CCTV	CCTV_11	New	186034	SB	Single Pile	Bored	750	7.0	447429.36	328409.59	5.975	33.98	26.980	1.1	32.955
CCTV	CCTV_12	New	186532	NB	Single Pile	Bored	450	5.0	447237.53	328871.12	3.975	33.33	28.330	1.1	32.305
CCTV	CCTV_13	Modified	186547	SB	Existing	Existing foundation to be reused									
CCTV	CCTV_14	New	186835	SB	Single Pile	Bored	750	5.0	447195.38	329177.07	3.975	36.08	31.080	1.1	35.055
CCTV	CCTV_15	New	187064	SB	Single Pile	Bored	750	5.0	447112.86	329390.68	3.975	38.27	33.270	1.1	37.245
CCTV	CCTV_16	New	187661	NB	Single Pile	Bored	750	5.0	446885.12	329943.85	3.975	33.44	28.440	1.1	32.415
CCTV	CCTV_17	New	187805	SB	Single Pile	Bored	750	5.0	446880.47	330094.27	3.975	33.70	28.700	1.1	32.675
CCTV	CCTV_18	New	188540	NB	Single Pile	Bored	750	7.0	446608.74	330777.97	5.975	38.55	31.550	1.1	37.525
CCTV	CCTV_19	New	188751	SB	Single Pile	Bored	750	5.0	446583.15	330991.99	3.975	35.89	30.890	1.1	34.865
CCTV	CCTV_20	Modified	189265	NB	Existing	Existing foundation to be reused									
CCTV	CCTV_21	New	189793	NB	Single Pile	Bored	750	5.0	446558.42	332017.29	3.975	36.40	31.400	1.1	35.375
CCTV	CCTV_22	New	190225	NB	Single Pile	Bored	750	5.0	446743.24	332411.35	3.975	40.62	35.620	1.1	39.595
CCTV	CCTV_23	New	190985	SB	Single Pile	Bored	750	7.0	447169.02	333048.15	5.975	33.67	26.670	1.1	32.645
CCTV	CCTV_24	New	191698	SB	Single Pile	Bored	750	5.0	447307.60	333750.24	3.975	33.86	28.860	1.1	32.835
CCTV	CCTV_25	New	192272	SB	Single Pile	Bored	750	5.0	447216.13	334317.83	3.975	41.98	36.980	1.1	40.955
CCTV	CCTV_26	New	192915	NB	Single Pile	Bored	750	5.0	447134.13	334952.78	3.975	45.76	40.760	1.1	44.735
CCTV	CCTV_27	New	193391	M	Single Pile	Bored	750	5.0	447238.16	335424.31	3.975	52.34	47.340	1.1	51.315
CCTV	CCTV_28	Modified	193497	NB	Existing	Existing foundation to be reused									
CCTV	CCTV_29	Modified	193602	NB	Existing	Existing foundation to be reused									
PTZ Camera	CCTV_30	New	182766	L	Single Pile	Bored	750	7.0	447042.21	325211.37	5.975	75.11	68.110	1.1	74.085
PTZ Camera	CCTV_31	New	192486	NB	Single Pile	Bored	750	5.0	447134.89	334520.34	3.975	44.60	39.600	1.1	44.575
CCTV	CCTV_32	Modified	193949	L	Existing	Existing foundation to be reused									
CCTV	CCTV_33	New	184373	NB	Pad Foundation	-	-	-	447446.4	326763.94	-	-	-	-	-
CCTV	CCTV_34	New	191421	SB	Single Pile	Bored	750	5.0	447289.30	333468.36	3.975	33.573	28.573	1.1	32.548

Notes
CCTV 33:Pad Foundation
Length [m] (Perpendicular to carriageway):2.0
Width [m] (paralleled to carriage way):3.2
Depth [m]: 1.5

B.8 - Radars Foundation Schedule

Asset	SMP Reference	Chainage (m)	Carriageway	Foundation type	Planted Depth (m)	Pile Type	Pile Diameter (mm)	Pile Length (m)	Eastings	Northings	Pile length from cut off to toe level (m)	Top of Pile Cap Level (mAOD)	Pile Toe Level (mAOD)	Pile Cap Depth (mAOD)	Pile Cut off Level (mAOD)	Working Pile Test Details		
																Representative Load (kN)	Max. Test Load (kN)	Permitted Settlement at 150% Representative Load (mm)
Radar	RAD_01	181914	NB	Single Pile	N/A	Bored	450	5.0	446830.06	324387.18	3.975	60.25	55.3	1.1	59.225			
Radar	RAD_02	182222	NB	Planted	1.5	N/A	N/A	N/A	446860.90	324695.00	N/A	N/A	N/A	N/A	N/A			
Radar	RAD_03	182275	SB	Single Pile	N/A	Bored	450	5.0	446909.93	324740.22	3.975	67.47	62.5	1.1	66.445			
Radar	RAD_04	182812	NB	Planted	1.5	N/A	N/A	N/A	447003.93	325270.42	N/A	N/A	N/A	N/A	N/A			
Radar	RAD_05	183240	NB	Planted	2.5	N/A	750	N/A	447130.61	325681.11	N/A	N/A	N/A	N/A	N/A			
Radar	RAD_06	183285	SB	Single Pile	N/A	Bored	450	5.0	447188.73	325708.17	3.975	75.98	71.0	1.1	N/A			
Radar	RAD_07	183781	NB	Planted	1.5	N/A	N/A	N/A	447289.59	326196.02	N/A	N/A	N/A	N/A	N/A			
Radar	RAD_08	183850	SB	Planted	1.5	N/A	N/A	N/A	447354.31	326247.85	N/A	N/A	N/A	N/A	N/A			
Radar	RAD_09	184350	NB	Planted	1.5	N/A	N/A	N/A	447441.66	326741.73	N/A	N/A	N/A	N/A	N/A			
Radar	RAD_10	184420	SB	Planted	1.5	N/A	N/A	N/A	447501.43	326800.70	N/A	N/A	N/A	N/A	N/A			
Radar	RAD_11	184867	NB	Single Pile	N/A	Bored	750	5.0	447501.90	327250.90	3.975	43.43	38.4	1.1	42.405			
Radar	RAD_12	184921	SB	Planted	1.5	N/A	N/A	N/A	447557.74	327301.40	N/A	N/A	N/A	N/A	N/A			
Radar	RAD_13	185210	SB	Single Pile	N/A	Bored	450	5.0	447558.16	327592.23	3.975	36.17	31.2	1.1	35.145			
Radar	RAD_14	185621	NB	Single Pile	N/A	Bored	450	5.0	447476.43	327997.09	3.975	33.624	28.624	1.1	32.599			
Radar	RAD_15	186265	SB	Single Pile	N/A	Bored	450	5.0	447364.08	328631.01	3.975	33.2	27.2	1.1	32.175			
Radar	RAD_16	186505	SB	Planted	1.5	N/A	450	N/A	447283.90	328862.42	N/A	N/A	N/A	N/A	N/A			
Radar	RAD_17	186873	NB	Planted	1.5	N/A	450	N/A	447129.33	329198.60	N/A	N/A	N/A	N/A	N/A			
Radar	RAD_18	187290	SB	Single Pile	N/A	Bored	750	5.0	447041.47	329604.87	3.975	35.92	30.9	1.1	34.895			
Radar	RAD_19	187619	NB	Single Pile	N/A	Bored	450	5.0	446897.41	329904.12	3.975	33.41	28.4	1.1	32.385			
Radar	RAD_20	187829	SB	Single Pile	N/A	Bored	450	5.0	446870.88	330115.87	3.975	33.92	28.9	1.1	32.895			
Radar	RAD_21	188156	SB	Single Pile	N/A	Bored	450	5.0	446768.88	330426.79	3.975	37.47	32.5	1.1	36.445			
Radar	RAD_22	188501	NB	Single Pile	N/A	Bored	450	7.0	446623.09	330741.01	5.975	38.66	31.7	1.1	37.635	120	180	8
Radar	RAD_23	188854	SB	Single Pile	N/A	Bored	450	5.0	446555.97	331090.10	3.975	34.92	29.9	1.1	33.895			
Radar	RAD_24	189190	SB	Single Pile	N/A	Bored	450	5.0	446510.83	331418.41	3.975	33.92	28.9	1.1	32.895			
Radar	RAD_25	189769	NB	Single Pile	N/A	Bored	450	5.0	446551.61	331994.35	3.975	35.30	30.3	1.1	34.275			
Radar	RAD_26	190205	NB	Single Pile	N/A	Bored	450	7.0	446732.30	332395.35	5.975	40.61	33.6	1.1	39.585			
Radar	RAD_27	190630	SB	Single Pile	N/A	Bored	450	5.0	446996.27	332730.56	3.975	36.71	31.7	1.1	35.685			
Radar	RAD_28	191085	NB	Single Pile	N/A	Bored	450	5.0	447166.78	333153.99	3.975	32.56	27.6	1.1	31.535			
Radar	RAD_29	191440	SB	Planted	1.5	N/A	N/A	N/A	447292.65	333487.62	N/A	N/A	N/A	N/A	N/A			
Radar	RAD_30	191775	NB	Single Pile	N/A	Bored	450	5.0	447266.10	333824.50	3.975	33.64	28.6	1.1	32.615			
Radar	RAD_31	192128	NB	Single Pile	N/A	Bored	450	5.0	447214.57	334168.61	3.975	38.43	33.4	1.1	37.405			
Radar	RAD_32	192313	SB	Planted	1.5	N/A	N/A	N/A	447207.94	334357.07	N/A	N/A	N/A	N/A	N/A			
Radar	RAD_33	192466	NB	Single Pile	N/A	Bored	450	5.0	447139.52	334499.06	3.975	45.44	40.4	1.1	44.415			
Radar	RAD_34	192834	NB	Single Pile	N/A	Bored	450	5.0	447127.79	334871.76	3.975	45.76	40.8	1.1	44.735			
Radar	RAD_35	193290	SB	Planted	1.5	N/A	N/A	N/A	447209.60	335322.30	N/A	N/A	N/A	N/A	N/A			
Radar	RAD_36	193732	NB	Single Pile	N/A	Bored	450	5.0	447167.24	335764.64	3.975	50.8	45.8	1.1	49.775			
~~Radar~~	~~RAD_37~~	~~193970~~	~~L~~	~~Single Pile~~	~~N/A~~	~~Bored~~	~~750~~	~~5.0~~	~~447203.77~~	~~336005.35~~	~~3.975~~	~~54.59~~	~~49.6~~	~~1.1~~	~~53.565~~			

B.9 - EAV Poles Foundation Schedule

Asset	SMP Reference	Chainage (m)	Carriageway	Foundation type	Pile Type	Pile Diameter (mm)	Pile Length (m)	Eastings	Northings	Pile length from cut off to toe level (m)	Top of Pile Cap Level (mAOD)	Pile Toe Level (mAOD)	Pile Cap Depth (m)	Pile Cut off Level (mAOD)
EAV Pole	EAV_01	183618	NB	Single Pile	Bored	450	3.0	447242.65	326039.75	1.975	74.42	71.42	1.1	73.395
EAV Pole	EAV_02	184590	SB	Single Pile	Bored	450	3.0	447530.16	326969.90	1.975	52.91	49.91	1.1	51.885
EAV Pole	EAV_03	187914	SB	Single Pile	Bored	450	3.0	446845.14	330195.01	1.975	34.73	31.73	1.1	33.705
EAV Pole	EAV_04	189630	NB	Single Pile	Bored	450	3.0	446517.50	331858.01	1.975	34.54	31.54	1.1	33.515
EAV Pole	EAV_06	189958	SB	Single Pile	Bored	450	3.0	446655.13	332158.04	1.975	38.10	35.10	1.1	37.075
EAV Pole	EAV_05	191702	NB	Single Pile	Bored	450	5.0	447269.74	333749.07	3.975	33.36	28.36	1.1	32.335
ERA SIGN	NB86	185062	NB	Planted Foundation	Planted	750*	2.5**	447520.79	327443.89	NA	NA	NA	NA	NA
ERA SIGN	NB88	188495	NB	Planted Foundation	Planted	750*	4.5**	446625.86	330736.90	NA	NA	NA	NA	NA
ERA SIGN	NB89	190589	NB	Planted Foundation	Planted	750*	4.5**	446941.56	332719.03	NA	NA	NA	NA	NA
ERA SIGN	NB87	186358	NB	Planted Foundation	Planted	750*	4.5**	447292.52	328706.83	NA	NA	NA	NA	NA
ERA SIGN	SB100	192153	SB	Planted Foundation	Planted	750*	4.5**	447246.91	334202.44	NA	NA	NA	NA	NA
ERA SIGN	SB101	1908333	SB	Planted Foundation	Planted	750*	4.5**	447101.49	332907.69	NA	NA	NA	NA	NA
ERA SIGN	EAV_04	~~192478~~	~~SB~~	~~Single Pile~~	Removed from scheme									

Notes
- * Planted Diamter im m
- ** Planted Depth in m

B.10 - Large Traffic Signs Foundation Schedule

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)	Pile Number	Easting	Northing	Ground level (mAOD)	Pile Cut off level (mAOD)
Large Traffic Sign	NB03	182109	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	NB04	182413	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	NB07	183411	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	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	Pad	2.6 x 2.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A					
Large Traffic Sign	NB21	185180	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	NB30	186490	NB	Pile	N/A	1	N/A	2	Bored	450	5.0	1	447250.00	328831.48	33.1280	32.103
												2	447251.73	328832.06	33.3450	32.320
Large Traffic Sign	NB31	186790	NB	Pile	N/A	2	1 x 2	4	Bored	450	5.0	1	447155.19	329117.26	34.8290	33.804
												2	447155.61	329115.98	34.8060	33.781
												3	447157.20	329117.92	35.5410	34.516
												4	447157.62	329116.64	35.5110	34.486
Large Traffic Sign	NB32	186630	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	NB41	187450	NB	Pile	N/A	1	N/A	2	Bored	450	5.0	1	446951.18	329743.55	34.7290	33.704
												2	446952.91	329744.13	34.7110	33.686
Large Traffic Sign	NB42	187630	NB	Pile	N/A	2	1 x 2	4	Bored	450	5.0	1	446893.76	329914.68	33.2530	32.228
												2	446894.18	329913.40	33.2560	32.231
												3	446895.60	329915.29	33.4340	32.409
												4	446896.02	329914.01	33.4380	32.413
Large Traffic Sign	NB46	188770	NB	Pile	N/A	1	N/A	2	Bored	450	10.0	1	446536.55	330998.24	36.6560	35.631
												2	446538.32	330998.79	36.7030	35.678
Large Traffic Sign	NB50	188556	NB	Pile	N/A	1	N/A	2	Bored	450	10.0	1	446606.23	330793.36	38.5300	37.505
												2	446607.98	330793.91	38.6600	37.635
Large Traffic Sign	NB58	190820	NB	Pile	N/A	1	N/A	2	Bored	450	5.0	1	447060.27	332915.18	33.7200	32.695
												2	447061.90	332914.30	33.7700	32.745
Large Traffic Sign	NB75	193186	NB	Pad	2.6 x 2.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A		447164.31	335221.9		
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	1	447208.71	334346.18	42.4800	41.455
												2	447209.02	334344.86	42.4550	41.430
												3	447.210.77	334346.65	42.5530	41.528
												4	447211.08	334345.34	42.5290	41.504
Large Traffic Sign	SB12	192430	SB	Pile	N/A	1	N/A	2	Bored	450	10.0	1	447183.96	334469.43	44.4490	43.424
												2	447185.80	334469.66	44.5140	43.489
Large Traffic Sign	SB14	191970	SB	Pad	2.6 x 4.0 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	1	446967.45	332687.28	37.3270	36.302
												2	446969.22	332686.13	37.2740	36.249
Large Traffic Sign	SB37	189200	SB	Pile	N/A	2	1 x 2	4	Bored	450	5.0	1	446509.20	331428.21	33.9120	32.887
												2	446509.23	331426.86	33.9160	32.891
												3	446511.31	331428.26	33.7210	32.696
												4	446511.34	331426.91	33.6780	32.653
Large Traffic Sign	SB40	188880	SB	Pile	N/A	1	N/A	2	Bored	450	5.0	1	446549.90	331114.60	34.6030	33.578
												2	446551.70	331115.00	33.8940	32.869
Large Traffic Sign	SB43	188522	SB	Pile	N/A	1	N/A	2	Bored	450	10.0	1	446654.80	330774.12	37.9580	36.933
												2	446656.80	330774.82	37.9050	36.880
Large Traffic Sign	SB48	188321	SB	Pile	N/A	2	1 x 2	6	Bored	450	9.0	1	446714.26	330586.28	38.3650	37.340
												2	446714.69	330585.00	38.3620	37.337
												3	446716.27	330586.94	38.3120	37.287
												4	446716.69	330585.66	38.3040	37.279
												5	446718.28	330587.60	37.6520	36.627
												6	446718.70	330586.32	37.6600	36.635
Large Traffic Sign	SB50	188180	SB	Pile	N/A	2	1 x 2	4	Bored	450	9.0	1	446760.72	330449.26	37.7120	36.687
												2	446761.14	330447.98	37.7020	36.677
												3	446762.73	330449.92	36.9910	35.966
												4	446763.15	330448.64	36.9720	35.947
Large Traffic Sign	SB54	187712	SB	Pile	N/A	2	1 x 2	4	Bored	450	5.0	1	446905.80	330004.92	33.3860	32.361
												2	446906.22	330003.64	33.3830	32.358
												3	446907.80	330005.58	33.0210	31.996
												4	446908.23	330004.30	33.0010	31.976
Large Traffic Sign	SB55	187520	SB	Pile	N/A	1	N/A	2	Bored	450	5.0	1	446966.51	329820.00	33.9560	32.931
												2	446968.25	329820.58	33.8670	32.842
Large Traffic Sign	SB69	186493	SB	Pile	N/A	2	1 x 2	4	Bored	450	5.0	1	447251.04	328953.15	33.3520	32.327
												2	447251.47	328951.87	33.3500	32.325
												3	447252.82	328953.73	33.3820	32.357
												4	447253.56		33.4520	32.427
Large Traffic Sign	SB72	186182	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	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	183876	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	SB89	183565	SB	Pad	2.6 x 4.0 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	1	447232.57	325852.27	76.1010	75.076
												2	447234.31	325851.73	75.6840	74.659
Large Traffic Sign	SB96	182544	SB	Pad	2.6 x 4.0 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	1	446851.51	324662.08	66.3940	65.369
												2	446853.31	324661.63	66.1450	65.120
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		447476.06	327937.62		
Slip Road Sign	NBS12	0 + 035	24a Entry Slip	Pile	N/A	1	N/A	2	Bored	450	7.0	1	447129.09	329190.84	36.8970	35.872
												2	447127.23	329190.86	36.8920	35.867
Slip Road Sign	NBS17	0+330	24a Entry Slip	Pad	2.6 x 2.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A		446966.90	328956.44		
Slip Road Sign	SBS04	0 + 60	25 Entry Slip	Pile	N/A	1	N/A	2	Bored	450	5.0	1	447219.38	335422.32	50.9720	49.947
												2	447221.23	335422.15	51.6430	50.618
Slip Road Sign	SBS07	0 + 310	24a Exit Slip	Pad	2.6 x 4.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A		447278.00	328933.00		
Slip Road Sign	SBS08	0 + 308	24a Exit Slip	Pile	N/A	1	N/A	2	Planted	750	4.5		447262.00	328930.00		

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)	Pile Number	Easting	Northing	Ground level (mAOD)	Pile Cut off level (mAOD)
Slip Road Sign	SBS12	0 + 30	24a Entry Slip	Pad	2.6 x 2.0 x 2.0 (With Duct opening) Refer to drawing HA549342-AMAR-SMN-SWI-DR-CB-160011	N/A	N/A	N/A	N/A	N/A	N/A		447508.82	328117.91	34.9250	
Slip Road Sign	SBS18	0 + 360	23a Exit Slip	Pad	2.6 x 4.0 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A		446996.00	324940.00		
Ghost Island Sign	TS1	183485	NB	Pile	N/A	2	1 x 2	8	Bored	450	5.0	1	447197.63	325916.46	77.2200	76.195
												2	447197.19	325915.18	77.1960	76.171
												3	447199.63	325915.77	76.9360	75.911
												4	447199.19	325914.49	76.9250	75.900
												5	447201.63	325915.08	76.3360	75.311
												6	447201.19	325913.80	76.5970	75.572
												7	447203.63	325914.39	75.8480	74.823
												8	447203.19	325913.11	75.8750	74.850
Ghost Island Sign	TS2	183890	NB	Pile	N/A	2	1 x 2	8	Bored	450	5.0	1	447316.84	326302.87	71.7190	70.694
												2	447316.44	326301.58	71.7050	70.680
												3	447318.86	326302.24	71.2000	70.175
												4	447318.46	326300.95	71.2250	70.200
												5	447320.87	326301.62	70.4990	69.474
												6	447320.48	326300.33	70.5210	69.496
												7	447322.89	326301.00	70.1670	69.142
												8	447322.50	326299.71	70.1920	69.167
Ghost Island Sign	TS3	184146	SB	Pile	N/A	2	1 x 2	6	Bored	450	3.0	1	447439.28	326532.95	65.5040	64.479
												2	447438.93	326531.65	65.5370	64.512
												3	447441.32	326532.39	65.5850	64.560
												4	447440.97	326531.09	65.6310	64.606
												5	447443.36	326531.83	66.4320	65.407
												6	447443.00	326530.53	66.4740	65.449
Ghost Island Sign	TS4	183748	SB	Pile	N/A	2	1 x 2	6	Bored	450	3.0	1	447323.79	326151.34	72.5900	71.565
												2	447323.39	326150.05	72.6100	71.585
												3	447325.81	326150.72	72.9390	71.914
												4	447325.41	326149.43	72.9590	71.934
												5	447327.83	326150.09	73.7860	72.761
												6	447327.43	326148.80	73.8060	72.781

B.11 - Signle Post Traffic Signs Foundation Schedule

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)	Easting	Northing	Ground Level (mAOD)	Pile Cut off level (mAOD)
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 3.5 x 2.0	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	184016	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 3.5 x 2.0	N/A	N/A	N/A	N/A	N/A	N/A				
Single Post Sign	NB16	184109	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	184202	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	Yes	4.5	Planted	2.0 x 3.5 x 2.0	1	N/A	1	Planted	750	4.5				
Single Post Sign	NB28	186112	NB	No	N/A	Pile	N/A	1	N/A	1	Bored	450	7.0	447364.900	328471.870	33.277	32.252
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	446936.370	329791.450	34.151	33.126
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	446728.380	330424.740	37.663	36.638
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	446471.440	331477.520	34.563	33.538
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	446665.320	332268.700	40.017	38.992
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	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	Yes	4.5	Planted	2.0 x 3.5 x 2.0	1	N/A	1	Planted	750	4.5				
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	Yes	4.5	Planted	2.0 x 3.5 x 2.0	1	N/A	1	Planted	750	4.5				
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	447302.990	333598.990	33.673	32.648
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	447222.090	333192.970	33.459	32.434
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	Yes	4.5	Planted	2.0 x 3.2 x 1.5	1	N/A	1	Planted	750	4.5				
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	188820	SB	No	N/A	Pile	N/A	1	N/A	1	Bored	450	7.0	446562.810	331057.03	35.875	34.185
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				

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)	Easting	Northing	Ground Level (mAOD)	Pile Cut off level (mAOD)
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	185450	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	185809	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	447480.700	328189.400		
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	446777.000	324495.000		
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	447475.000	327897.000		
Slip Road Sign	NBS09	0 + 192	24a Entry Slip	Yes	4.5	Planted	2.0 x 3.2 x 1.5	1	N/A	1	Planted	750	4.5	447125.000	329162.000		
Slip Road Sign	NBS13	0 + 243	24a Entry 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	447038.800	329008.280		
Slip Road Sign	SBS03	0 - 8	25 Entry Slip	Yes	4.5	Planted	2.0 x 3.2 x 1.5	1	N/A	1	Planted	750	4.5	447225.000	335490.000		
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	447236.000	329056.000		
Slip Road Sign	SBS10																
Slip Road Sign	SBS17	0 - 23	24 Entry Slip	Yes	4.5	Planted	2.0 x 3.2 x 1.5	1	N/A	1	Planted	750	4.5	447591.000	327407.000		
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	447252.000	329008.000		

Appendix C As-Built Drawings

C.1 - Series 1600 As-built Drawings
C.2 - Series 600 As-built Drawings
C.3 - ERA's and Gantries As-built Drawings
C.4 - Mainline General Arrangement As-built Drawings

C.1 - Mainline Drawings - As-Built

Title	Drawing Numbers
Earthworks - Legend / Notes	HA549342-AMAR-HGT-MLC-DR-CE-000001.
Earthworks Plan 1	HA549342-AMAR-HGT-MLC-DR-CE-000002.
Earthworks Plan 2	HA549342-AMAR-HGT-MLC-DR-CE-000003.
Earthworks Plan 3	HA549342-AMAR-HGT-MLC-DR-CE-000004.
Earthworks Plan 4	HA549342-AMAR-HGT-MLC-DR-CE-000005.
Earthworks Plan 5	HA549342-AMAR-HGT-MLC-DR-CE-000006.
Earthworks Plan 6	HA549342-AMAR-HGT-MLC-DR-CE-000007.
Earthworks Plan 7	HA549342-AMAR-HGT-MLC-DR-CE-000008.
Earthworks Plan 8	HA549342-AMAR-HGT-MLC-DR-CE-000009.
Earthworks Plan 9	HA549342-AMAR-HGT-MLC-DR-CE-000010.
Earthworks Plan 10	HA549342-AMAR-HGT-MLC-DR-CE-000011.
Earthworks Plan 11	HA549342-AMAR-HGT-MLC-DR-CE-000012.
Earthworks Plan 12	HA549342-AMAR-HGT-MLC-DR-CE-000013.

C.2 - List of Series 600 Drawings - As-Built

Title	Drawing Numbers
Typical Earthworks Solutions	HA549342-AMAR-HGT-SWI-DR-CE-000601.
Typical Retaining Solutions - Gabion Wall	HA549342-AMAR-HGT-SWI-DR-CE-000602.
Gabion Wall 193200-193321 & 193350 - 193475	HA549342-AMAR-HGT-SWI-DR-CE-000611.
Gabion Wall 193200-193321 & 193350 - 193475	HA549342-AMAR-HGT-SWI-DR-CE-000612.
Gabion Wall 193200-193311 & 193357 - 193475	HA549342-AMAR-HGT-SWI-DR-CE-000613.
Gabion Wall 193320 - 193497 SB Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-000614.
Gabion Wall 193320 - 193497 SB Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-000615.
Gabion Wall 193320 - 193497 SB Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-000616.
Benching required at regrade	HA549342-AMAR-HGT-SWI-DR-CE-000617.
Earthworks Solution Plan and Elevation ch 183800 - 183854 SB Sheet 1 of 2	HA549342-AMAR-HGT-SWI-DR-CE-000618.
Earthworks Solution Plan and Elevation ch 183800 - 183854 SB Sheet 2 of 2	HA549342-AMAR-HGT-SWI-DR-CE-000619.

C.3 - List of Series 1600 Drawings - As-Built

Title	Drawing Numbers
Retaining Solutions - Sheet pile	HA549342-AMAR-HGT-SWI-DR-CE-001601.
Typical Retaining Solutions - Low Height Walls	HA549342-AMAR-HGT-SWI-DR-CE-001602.
King Sheet Pile 185139-185321 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001613.
King Sheet Pile 185139-185321 Earthworks Design Solution - Cross section	HA549342-AMAR-HGT-SWI-DR-CE-001614.
King Sheet Pile 185139-185321 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001615.
King Sheet Pile 185893-186360 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001616.
King Sheet Pile 185893-186360 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001617.
King Sheet Pile 185893-186360 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001618.
King Sheet Pile 185893-186360 Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001619.
King Sheet Pile 186489-186535 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001622.
King Sheet Pile 186489-186535 Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001623.
King Sheet Pile 188721 - 188893 Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-001626.
King Sheet Pile 188721 - 188893 Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-001628.
King Sheet Pile Wall 193320-193350 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001634.
King Sheet Pile Wall 193320-193350 Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001637.
KSP Sheet Pile 183798- 183950 SB Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-001638.
KSP Sheet Pile 183798 - 183950 SB Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-001639.
King Sheet Pile 187800 - 187835 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001640.
King Sheet Pile 187800 - 187835 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001641.
King Sheet Pile 187910 - 187931 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001642.
King Sheet Pile 187910 - 187931 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001643.
King Sheet Pile 188100 - 188129 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001644.
King Sheet Pile 188100 - 188129 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001645.
King Sheet Pile 188408 - 188546 SB Earthworks Design Solution -Plan	HA549342-AMAR-HGT-SWI-DR-CE-001646.
King Sheet Pile 188408 - 188546 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001648.
King Sheet Pile 188746 - 188769 SB Earthworks Design Solution- Plan	HA549342-AMAR-HGT-SWI-DR-CE-001649.
King Sheet Pile 188746 - 188769 SB Earthworks Design Solution- Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001650.
King Sheet Pile 188934 - 188956 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001651.
King Sheet Pile 188934 - 188956 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001652.
King Sheet Pile 189167 - 189183 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001653.
King Sheet Pile 189167 - 189183 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001654.
King Sheet Pile 189280 - 189305 SB Earthworks Design Solution- Plan	HA549342-AMAR-HGT-SWI-DR-CE-001655.
King Sheet Pile 189280 - 189305 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001656.
King Sheet Pile 189750 - 189791 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001657.
King Sheet Pile 189750 - 189791 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001658.
King Sheet Pile 192085 - 192523 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001659.
King Sheet Pile 192085 - 192523 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001660.
King Sheet Pile 192085 - 192523 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001661.
King Sheet Pile 192085 - 192523 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001662.
King Sheet Pile 192709 - 192832 SB Earthworks Design Solution- Plan	HA549342-AMAR-HGT-SWI-DR-CE-001663.
King Sheet Pile 192709- 192832 SB Earthworks Design Solution - Cross section	HA549342-AMAR-HGT-SWI-DR-CE-001664.
King sheet Pile 193301 - 193320 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001665.
King Sheet Pile 193301 - 193320 SB Earthworks Design Solution - Cross section	HA549342-AMAR-HGT-SWI-DR-CE-001669.
Kingsheet pile Solution plan Ch191762 - ch191830 NB Sheet 1 of 2	HA549342-AMAR-HGT-SWI-DR-CE-001675.
Kingsheet pile Solution cross section Ch191762 - ch191830 NB Sheet 2 of 2	HA549342-AMAR-HGT-SWI-DR-CE-001676.

C.4 - ERA and Gantries Drawings - As-Built

Title	Drawing Numbers
Gantry 112 Earthworks Design Solution	HA549342-AMAR-HGT-G112-DR-CE-000001.
Gantry 202 NB Earthworks Design Solution	HA549342-AMAR-HGT-G202-DR-CE-000001.
Gantry 202 SB Earthworks Design Solution	HA549342-AMAR-HGT-G202-DR-CE-000002.
Gantry 203 Earthworks Design Solution	HA549342-AMAR-HGT-G203-DR-CE-000001.
Gantry 204 Earthworks Design Solution	HA549342-AMAR-HGT-G204-DR-CE-000001.
Gantry 301 NB Earthworks Design Solution	HA549342-AMAR-HGT-G301-DR-CE-000001.
Gantry 301 SB Earthworks Design Solution	HA549342-AMAR-HGT-G301-DR-CE-000002.
Gantry 302 Earthworks Design Solution	HA549342-AMAR-HGT-G302-DR-CE-000001.
Gantry 303 Earthworks Design Solution	HA549342-AMAR-HGT-G303-DR-CE-000001.
Gantry 304 Earthworks Design Solution	HA549342-AMAR-HGT-G304-DR-CE-000001.
Gantry 305 Earthworks Design Solution	HA549342-AMAR-HGT-G305-DR-CE-000001.
Gantry 307 Earthworks Design Solution	HA549342-AMAR-HGT-G307-DR-CE-000001.
Gantry 308 Earthworks Design Solution	HA549342-AMAR-HGT-G308-DR-CE-000001.
Gantry 309 Earthworks Design Solution	HA549342-AMAR-HGT-G309-DR-CE-000001.
Gantry 310 Earthworks Design Solution	HA549342-AMAR-HGT-G310-DR-CE-000001.
Gantry 311 NB Earthworks Design Solution	HA549342-AMAR-HGT-G311-DR-CE-000001.
Gantry 311 SB Earthworks Design Solution	HA549342-AMAR-HGT-G311-DR-CE-000002.
Gantry 312 Earthworks Design Solution	HA549342-AMAR-HGT-G312-DR-CE-000001.
Gantry 313 Earthworks Design Solution	HA549342-AMAR-HGT-G313-DR-CE-000001.
Gantry 314 Earthworks Design Solution	HA549342-AMAR-HGT-G314-DR-CE-000001.
Gantry 315 Earthworks Design Solution	HA549342-AMAR-HGT-G315-DR-CE-000001.
Gantry 316 Earthworks Design Solution	HA549342-AMAR-HGT-G316-DR-CE-000001.
Gantry 318 Earthworks Design Solution	HA549342-AMAR-HGT-G318-DR-CE-000001.
Gantry 319 Earthworks Design Solution	HA549342-AMAR-HGT-G319-DR-CE-000001.
Gantry 320 Earthworks Design Solution	HA549342-AMAR-HGT-G320-DR-CE-000001.
Gantry 321 Earthworks Design Solution	HA549342-AMAR-HGT-G321-DR-CE-000001.
Gantry 322 Earthworks Design Solution	HA549342-AMAR-HGT-G322-DR-CE-000001.
Gantry 324 Earthworks Design Solution	HA549342-AMAR-HGT-G324-DR-CE-000001.
Gantry 326 Earthworks Design Solution	HA549342-AMAR-HGT-G326-DR-CE-000001.

C.1 - Mainline Drawings - As-Built

Title	Drawing Numbers
Earthworks - Legend / Notes	HA549342-AMAR-HGT-MLC-DR-CE-000001.
Earthworks Plan 1	HA549342-AMAR-HGT-MLC-DR-CE-000002.
Earthworks Plan 2	HA549342-AMAR-HGT-MLC-DR-CE-000003.
Earthworks Plan 3	HA549342-AMAR-HGT-MLC-DR-CE-000004.
Earthworks Plan 4	HA549342-AMAR-HGT-MLC-DR-CE-000005.
Earthworks Plan 5	HA549342-AMAR-HGT-MLC-DR-CE-000006.
Earthworks Plan 6	HA549342-AMAR-HGT-MLC-DR-CE-000007.
Earthworks Plan 7	HA549342-AMAR-HGT-MLC-DR-CE-000008.
Earthworks Plan 8	HA549342-AMAR-HGT-MLC-DR-CE-000009.
Earthworks Plan 9	HA549342-AMAR-HGT-MLC-DR-CE-000010.
Earthworks Plan 10	HA549342-AMAR-HGT-MLC-DR-CE-000011.
Earthworks Plan 11	HA549342-AMAR-HGT-MLC-DR-CE-000012.
Earthworks Plan 12	HA549342-AMAR-HGT-MLC-DR-CE-000013.

C.2 - List of Series 600 Drawings - As-Built

Title	Drawing Numbers
Typical Earthworks Solutions	HA549342-AMAR-HGT-SWI-DR-CE-000601.
Typical Retaining Solutions - Gabion Wall	HA549342-AMAR-HGT-SWI-DR-CE-000602.
Gabion Wall 193200-193321 & 193350 - 193475	HA549342-AMAR-HGT-SWI-DR-CE-000611.
Gabion Wall 193200-193321 & 193350 - 193475	HA549342-AMAR-HGT-SWI-DR-CE-000612.
Gabion Wall 193200-193311 & 193357 - 193475	HA549342-AMAR-HGT-SWI-DR-CE-000613.
Gabion Wall 193320 - 193497 SB Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-000614.
Gabion Wall 193320 - 193497 SB Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-000615.
Gabion Wall 193320 - 193497 SB Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-000616.
Benching required at regrade	HA549342-AMAR-HGT-SWI-DR-CE-000617.
Earthworks Solution Plan and Elevation ch 183800 - 183854 SB Sheet 1 of 2	HA549342-AMAR-HGT-SWI-DR-CE-000618.
Earthworks Solution Plan and Elevation ch 183800 - 183854 SB Sheet 2 of 2	HA549342-AMAR-HGT-SWI-DR-CE-000619.

C.3 - List of Series 1600 Drawings - As-Built

Title	Drawing Numbers
Retaining Solutions - Sheet pile	HA549342-AMAR-HGT-SWI-DR-CE-001601.
Typical Retaining Solutions - Low Height Walls	HA549342-AMAR-HGT-SWI-DR-CE-001602.
King Sheet Pile 185139-185321 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001613.
King Sheet Pile 185139-185321 Earthworks Design Solution - Cross section	HA549342-AMAR-HGT-SWI-DR-CE-001614.
King Sheet Pile 185139-185321 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001615.
King Sheet Pile 185893-186360 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001616.
King Sheet Pile 185893-186360 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001617.
King Sheet Pile 185893-186360 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001618.
King Sheet Pile 185893-186360 Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001619.
King Sheet Pile 186489-186535 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001622.
King Sheet Pile 186489-186535 Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001623.
King Sheet Pile 188721 - 188893 Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-001626.
King Sheet Pile 188721 - 188893 Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-001628.
King Sheet Pile Wall 193320-193350 Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001634.
King Sheet Pile Wall 193320-193350 Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001637.
KSP Sheet Pile 183798- 183950 SB Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-001638.
KSP Sheet Pile 183798 - 183950 SB Earthworks Design Solution	HA549342-AMAR-HGT-SWI-DR-CE-001639.
King Sheet Pile 187800 - 187835 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001640.
King Sheet Pile 187800 - 187835 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001641.
King Sheet Pile 187910 - 187931 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001642.
King Sheet Pile 187910 - 187931 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001643.
King Sheet Pile 188100 - 188129 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001644.
King Sheet Pile 188100 - 188129 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001645.
King Sheet Pile 188408 - 188546 SB Earthworks Design Solution -Plan	HA549342-AMAR-HGT-SWI-DR-CE-001646.
King Sheet Pile 188408 - 188546 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001648.
King Sheet Pile 188746 - 188769 SB Earthworks Design Solution- Plan	HA549342-AMAR-HGT-SWI-DR-CE-001649.
King Sheet Pile 188746 - 188769 SB Earthworks Design Solution- Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001650.
King Sheet Pile 188934 - 188956 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001651.
King Sheet Pile 188934 - 188956 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001652.
King Sheet Pile 189167 - 189183 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001653.
King Sheet Pile 189167 - 189183 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001654.
King Sheet Pile 189280 - 189305 SB Earthworks Design Solution- Plan	HA549342-AMAR-HGT-SWI-DR-CE-001655.
King Sheet Pile 189280 - 189305 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001656.
King Sheet Pile 189750 - 189791 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001657.
King Sheet Pile 189750 - 189791 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001658.
King Sheet Pile 192085 - 192523 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001659.
King Sheet Pile 192085 - 192523 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001660.
King Sheet Pile 192085 - 192523 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001661.
King Sheet Pile 192085 - 192523 SB Earthworks Design Solution - Cross Section	HA549342-AMAR-HGT-SWI-DR-CE-001662.
King Sheet Pile 192709 - 192832 SB Earthworks Design Solution- Plan	HA549342-AMAR-HGT-SWI-DR-CE-001663.
King Sheet Pile 192709- 192832 SB Earthworks Design Solution - Cross section	HA549342-AMAR-HGT-SWI-DR-CE-001664.
King sheet Pile 193301 - 193320 SB Earthworks Design Solution - Plan	HA549342-AMAR-HGT-SWI-DR-CE-001665.
King Sheet Pile 193301 - 193320 SB Earthworks Design Solution - Cross section	HA549342-AMAR-HGT-SWI-DR-CE-001669.
Kingsheet pile Solution plan Ch191762 - ch191830 NB Sheet 1 of 2	HA549342-AMAR-HGT-SWI-DR-CE-001675.
Kingsheet pile Solution cross section Ch191762 - ch191830 NB Sheet 2 of 2	HA549342-AMAR-HGT-SWI-DR-CE-001676.

C.4 - ERA and Gantries Drawings - As-Built

Title	Drawing Numbers
Gantry 112 Earthworks Design Solution	HA549342-AMAR-HGT-G112-DR-CE-000001.
Gantry 202 NB Earthworks Design Solution	HA549342-AMAR-HGT-G202-DR-CE-000001.
Gantry 202 SB Earthworks Design Solution	HA549342-AMAR-HGT-G202-DR-CE-000002.
Gantry 203 Earthworks Design Solution	HA549342-AMAR-HGT-G203-DR-CE-000001.
Gantry 204 Earthworks Design Solution	HA549342-AMAR-HGT-G204-DR-CE-000001.
Gantry 301 NB Earthworks Design Solution	HA549342-AMAR-HGT-G301-DR-CE-000001.
Gantry 301 SB Earthworks Design Solution	HA549342-AMAR-HGT-G301-DR-CE-000002.
Gantry 302 Earthworks Design Solution	HA549342-AMAR-HGT-G302-DR-CE-000001.
Gantry 303 Earthworks Design Solution	HA549342-AMAR-HGT-G303-DR-CE-000001.
Gantry 304 Earthworks Design Solution	HA549342-AMAR-HGT-G304-DR-CE-000001.
Gantry 305 Earthworks Design Solution	HA549342-AMAR-HGT-G305-DR-CE-000001.
Gantry 307 Earthworks Design Solution	HA549342-AMAR-HGT-G307-DR-CE-000001.
Gantry 308 Earthworks Design Solution	HA549342-AMAR-HGT-G308-DR-CE-000001.
Gantry 309 Earthworks Design Solution	HA549342-AMAR-HGT-G309-DR-CE-000001.
Gantry 310 Earthworks Design Solution	HA549342-AMAR-HGT-G310-DR-CE-000001.
Gantry 311 NB Earthworks Design Solution	HA549342-AMAR-HGT-G311-DR-CE-000001.
Gantry 311 SB Earthworks Design Solution	HA549342-AMAR-HGT-G311-DR-CE-000002.
Gantry 312 Earthworks Design Solution	HA549342-AMAR-HGT-G312-DR-CE-000001.
Gantry 313 Earthworks Design Solution	HA549342-AMAR-HGT-G313-DR-CE-000001.
Gantry 314 Earthworks Design Solution	HA549342-AMAR-HGT-G314-DR-CE-000001.
Gantry 315 Earthworks Design Solution	HA549342-AMAR-HGT-G315-DR-CE-000001.
Gantry 316 Earthworks Design Solution	HA549342-AMAR-HGT-G316-DR-CE-000001.
Gantry 318 Earthworks Design Solution	HA549342-AMAR-HGT-G318-DR-CE-000001.
Gantry 319 Earthworks Design Solution	HA549342-AMAR-HGT-G319-DR-CE-000001.
Gantry 320 Earthworks Design Solution	HA549342-AMAR-HGT-G320-DR-CE-000001.
Gantry 321 Earthworks Design Solution	HA549342-AMAR-HGT-G321-DR-CE-000001.
Gantry 322 Earthworks Design Solution	HA549342-AMAR-HGT-G322-DR-CE-000001.
Gantry 324 Earthworks Design Solution	HA549342-AMAR-HGT-G324-DR-CE-000001.
Gantry 326 Earthworks Design Solution	HA549342-AMAR-HGT-G326-DR-CE-000001.

4. THE PROPOSED EARTHWORKS SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.

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The Colmore Building
20 Galmore Circus Queensway
Birmingham 84 6AT
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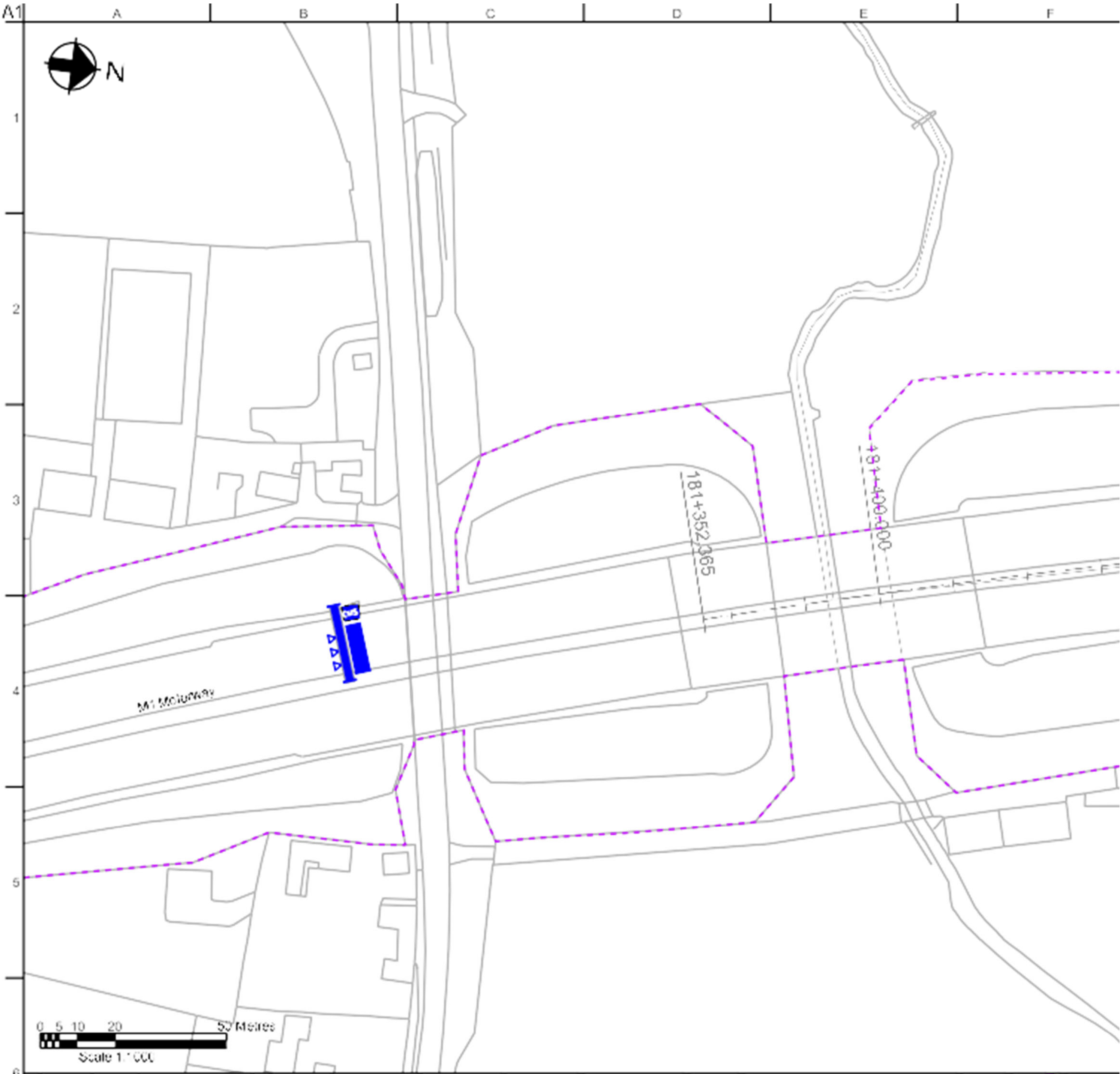
A1
A
B
C
D
E
F
N
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M1 Motorway
0 5 10 20 50 Metres
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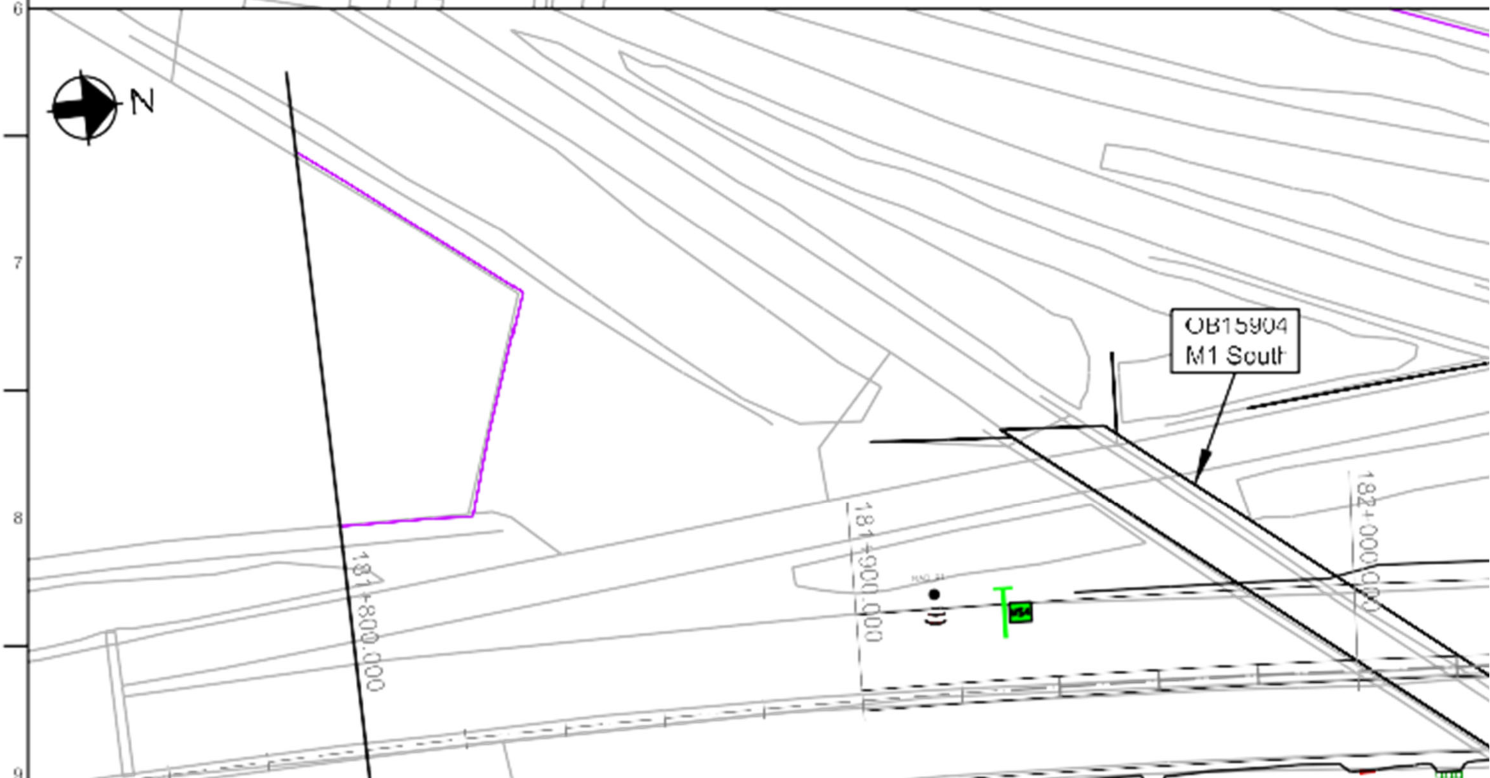
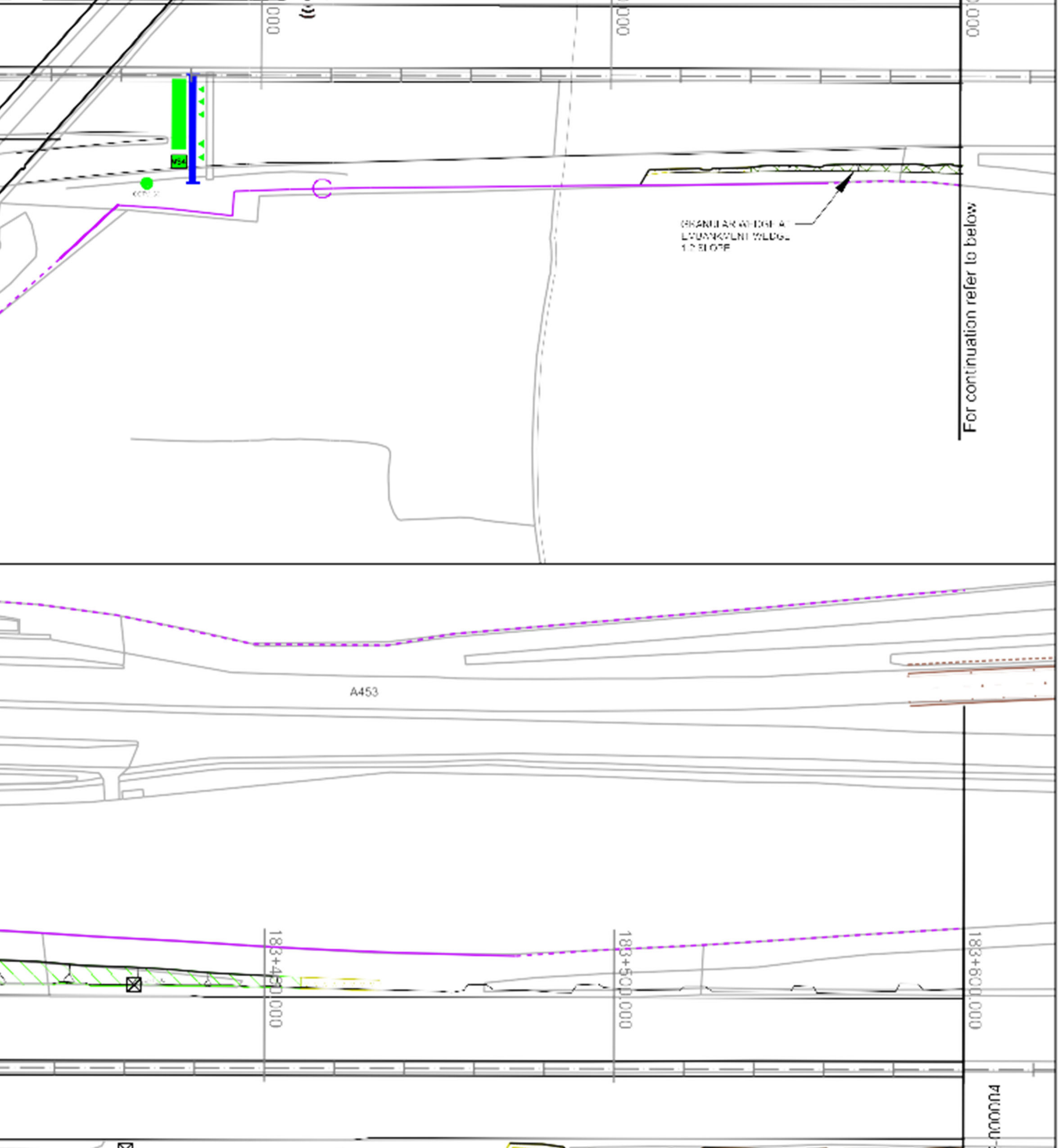

N
OB15904
M1 South
181+800.000
181+900.000
182+000.000



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. HA540342-AMAR-HGT-MLC-DR-CE-000001
3. WHERE HATCHING IS UNCLEAR DESCRIPTION BOX ADDED TO INDICATE SOLUTION FOR CLARITY.

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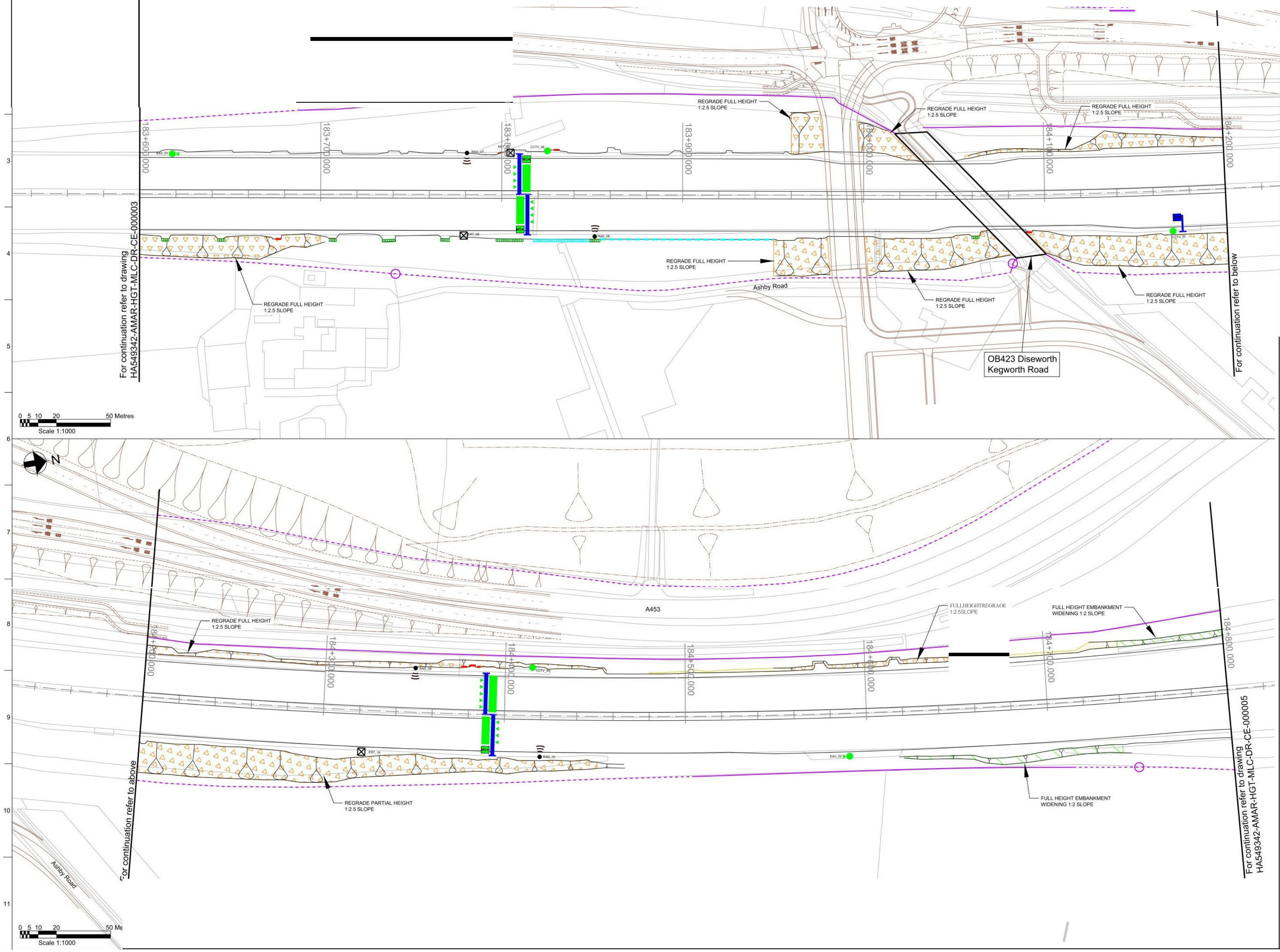

2. Risk of moving construction vehicles and
6. Risk of asbestos within structures
7. Redundant BT cable throughout scheme extents in Northbound verge and shown locations

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
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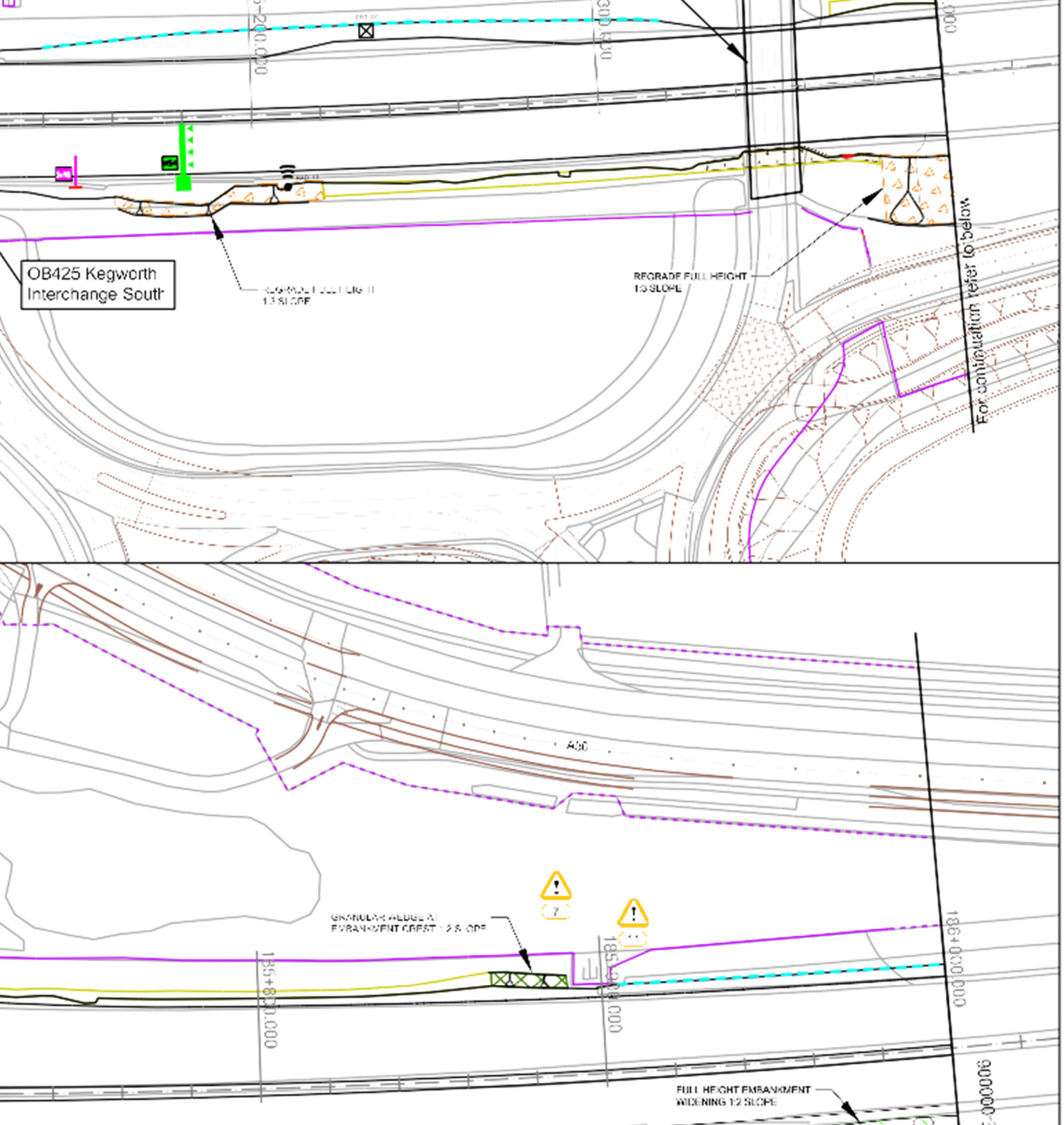
M1 Mainline
Earthworks General Arrangement
Chainage 183+600 - 184+800
Sheet 4 of 13

1:1000

AB-Asbuill

244508-00



present on site during works

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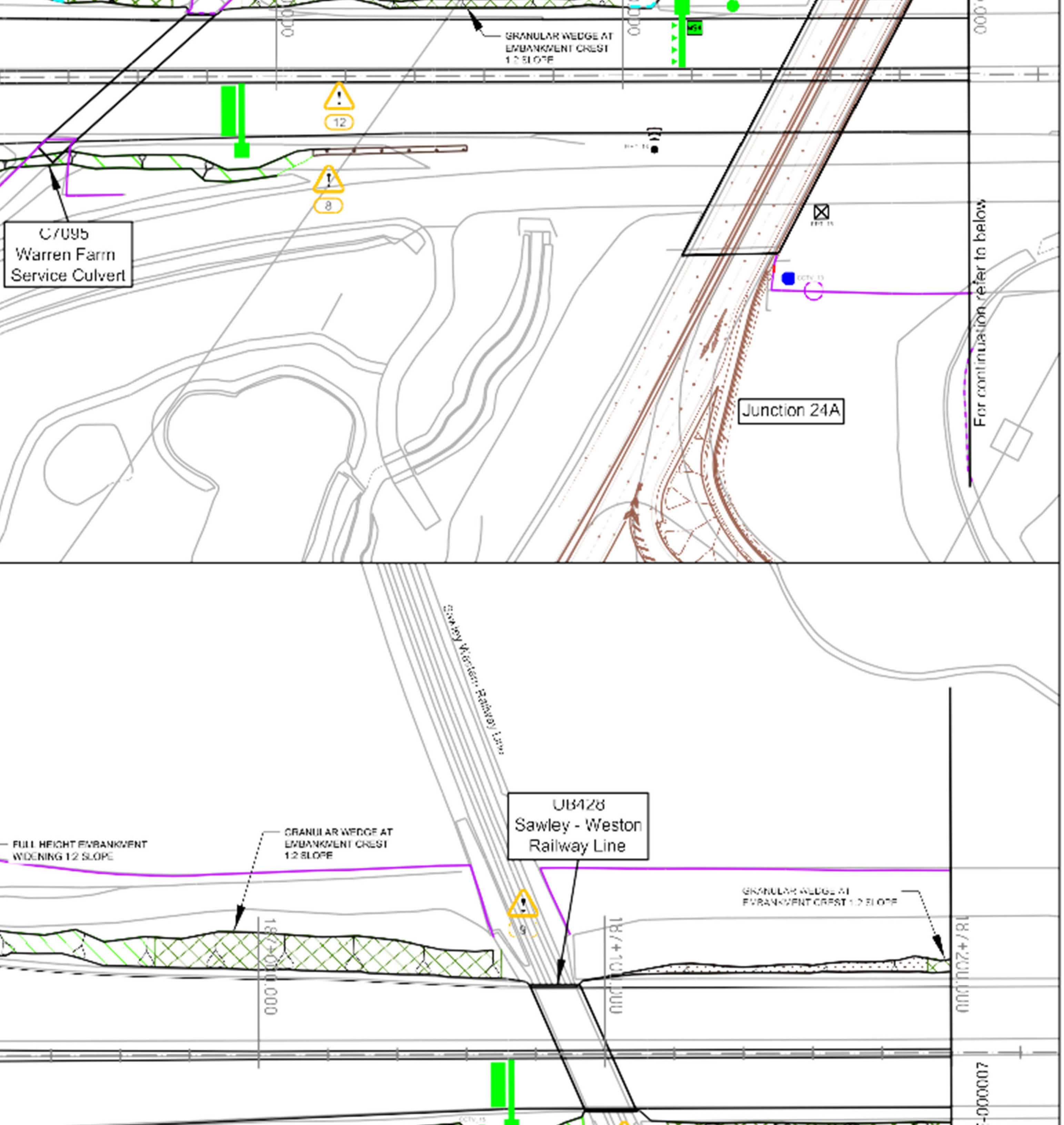
Junction 25



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present on site during works
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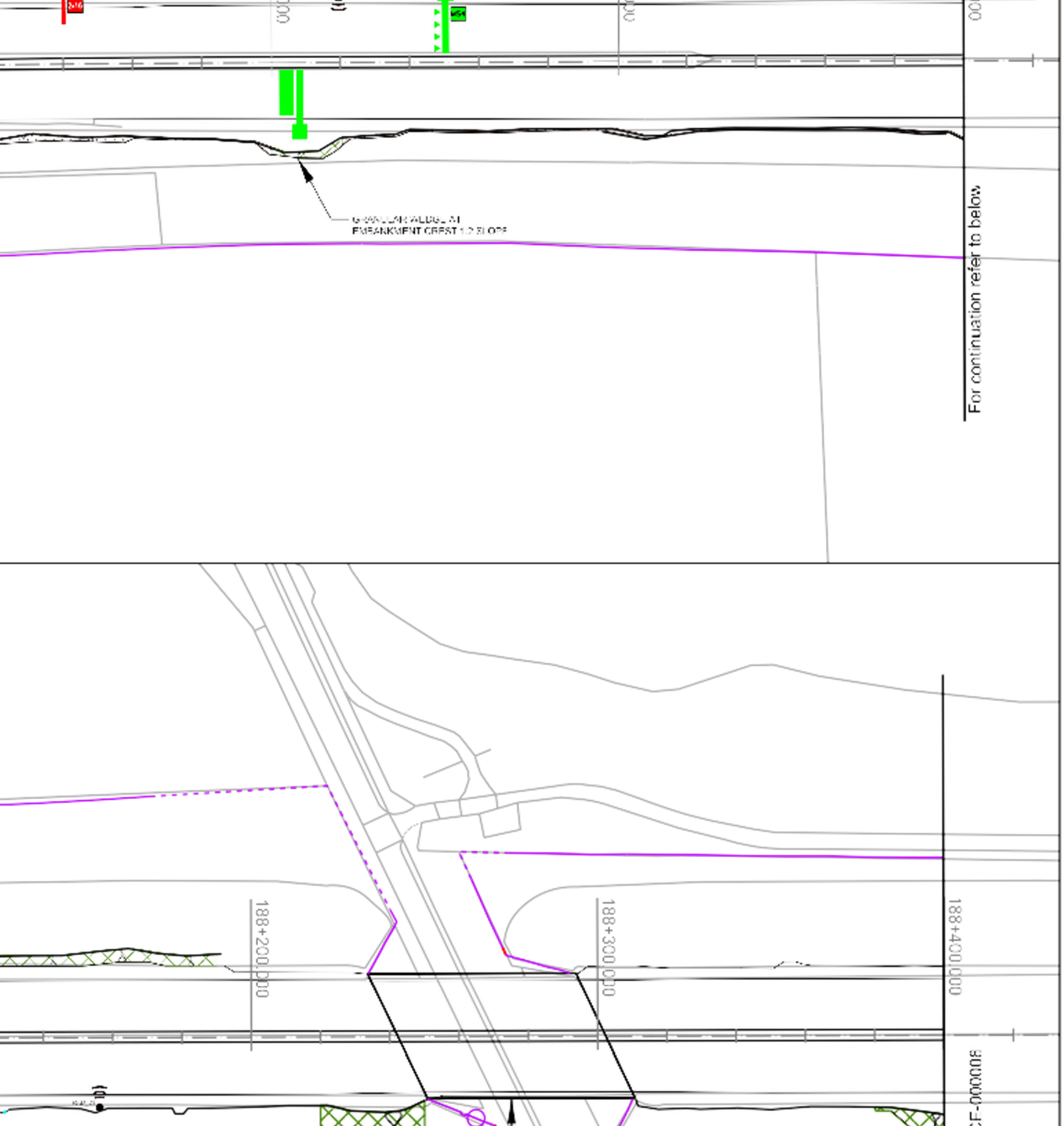

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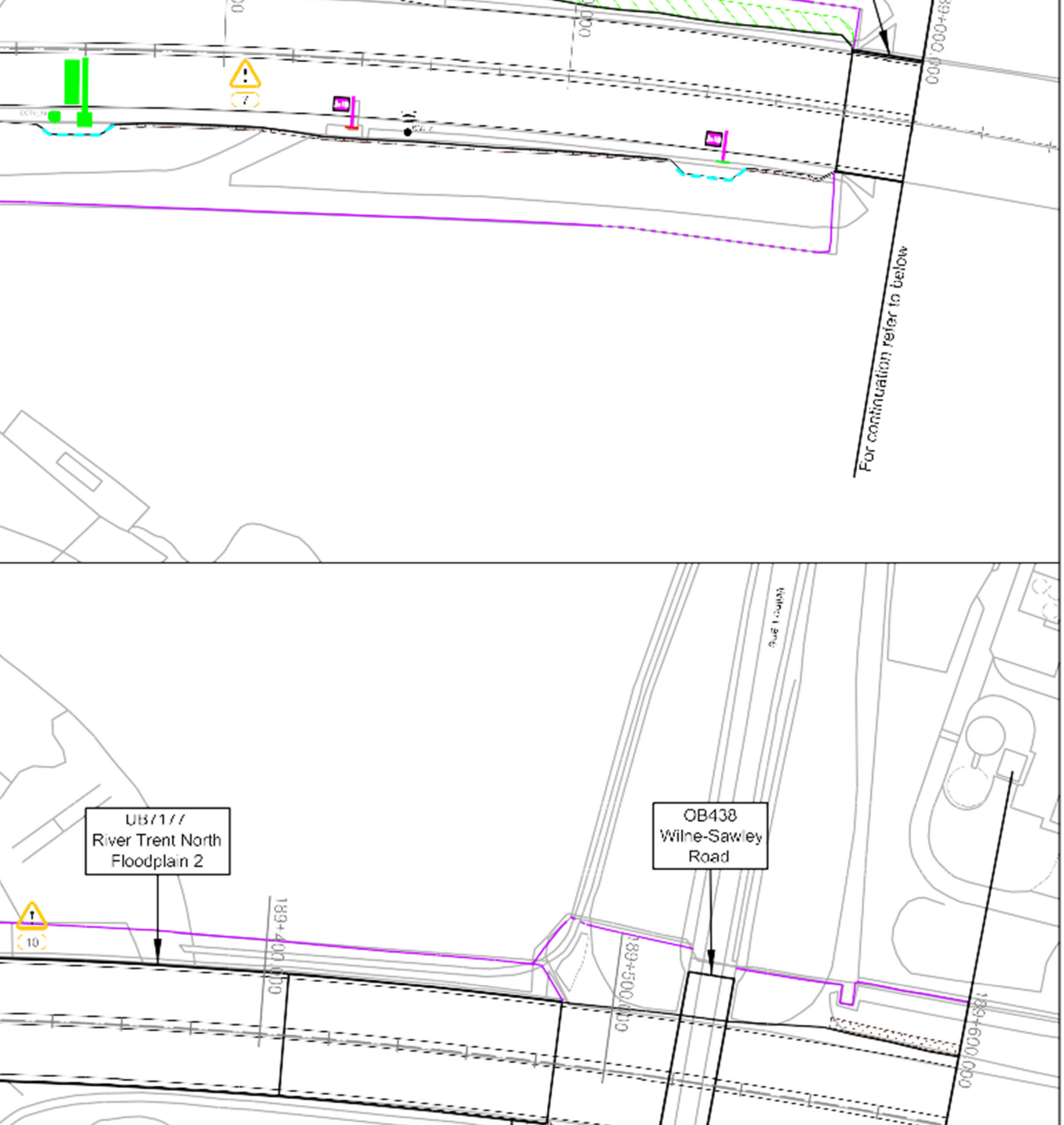

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As Built				
Rev	Date	By	Chkd	Appd

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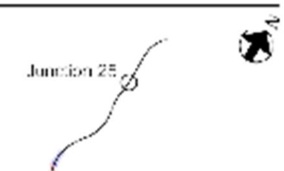

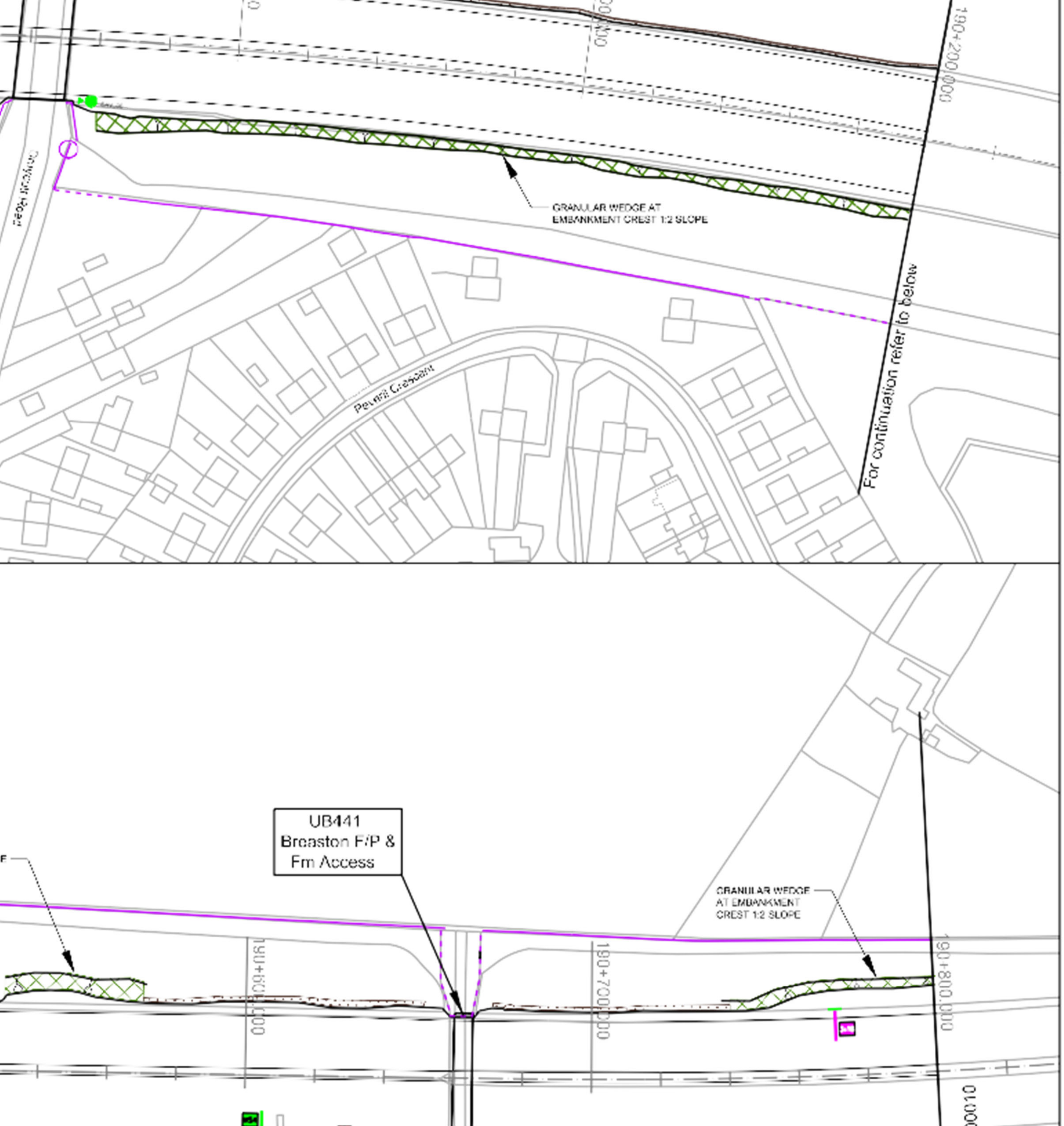

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C03	24/02/20	AT	MA	SV
As Built				
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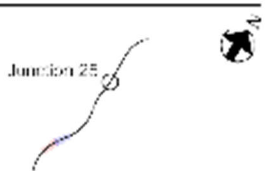

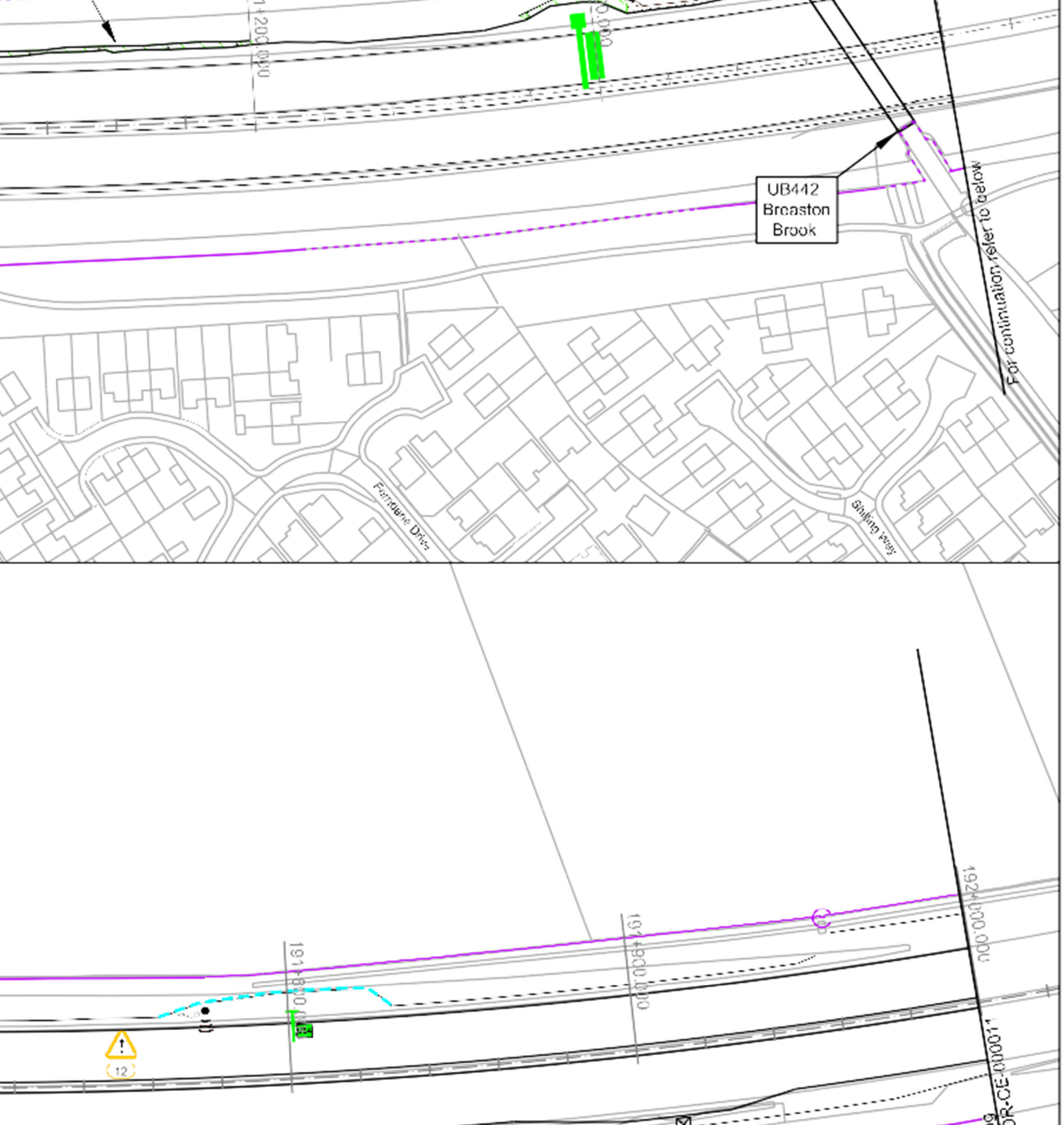

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C03	24/02/20	AT	MA	SV
As Built				
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Project Title
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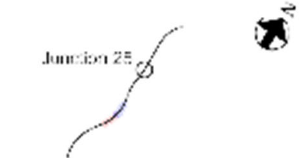
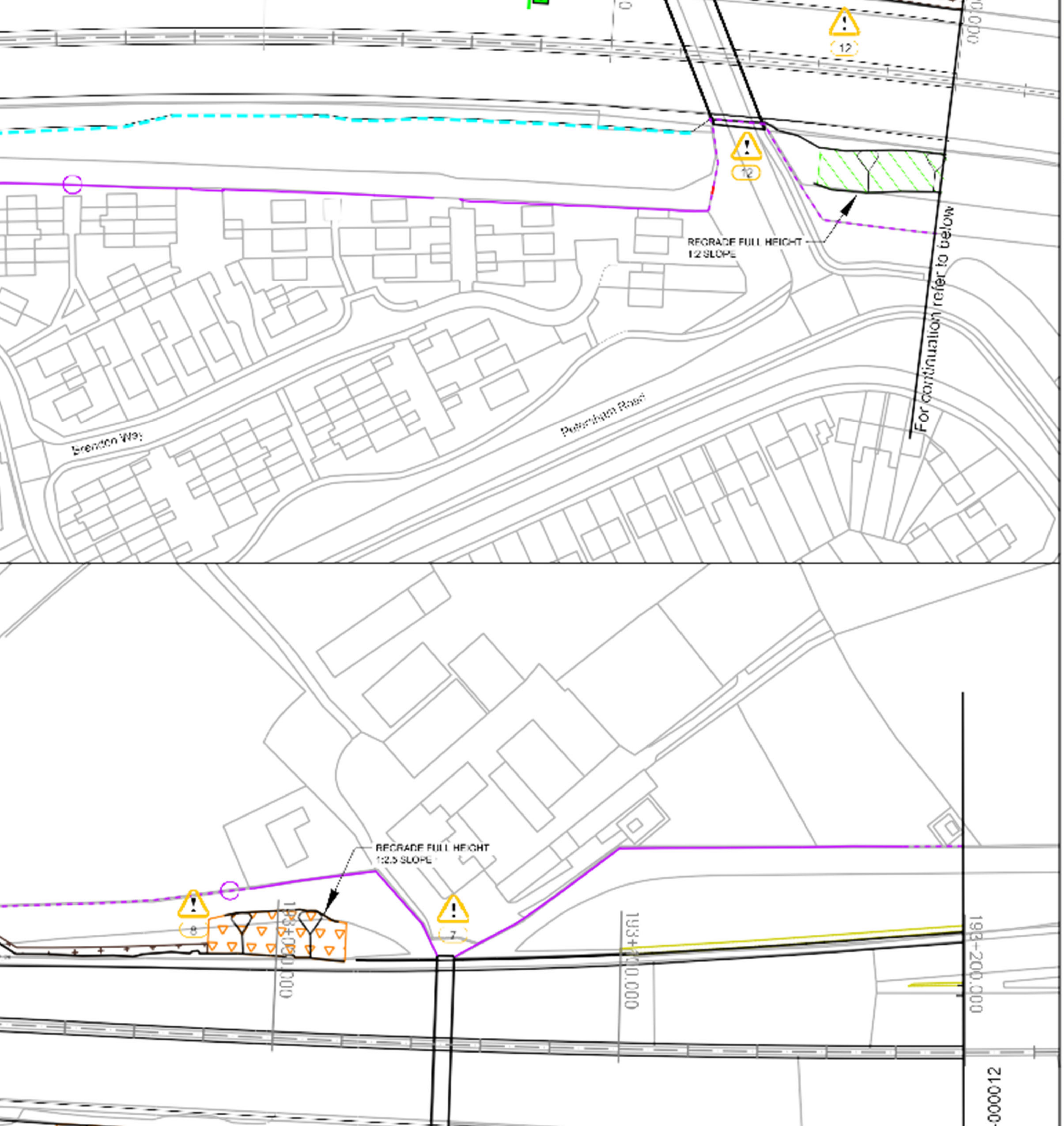
Key Plan




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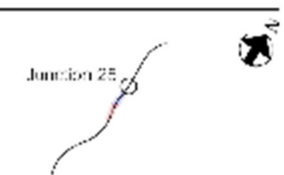
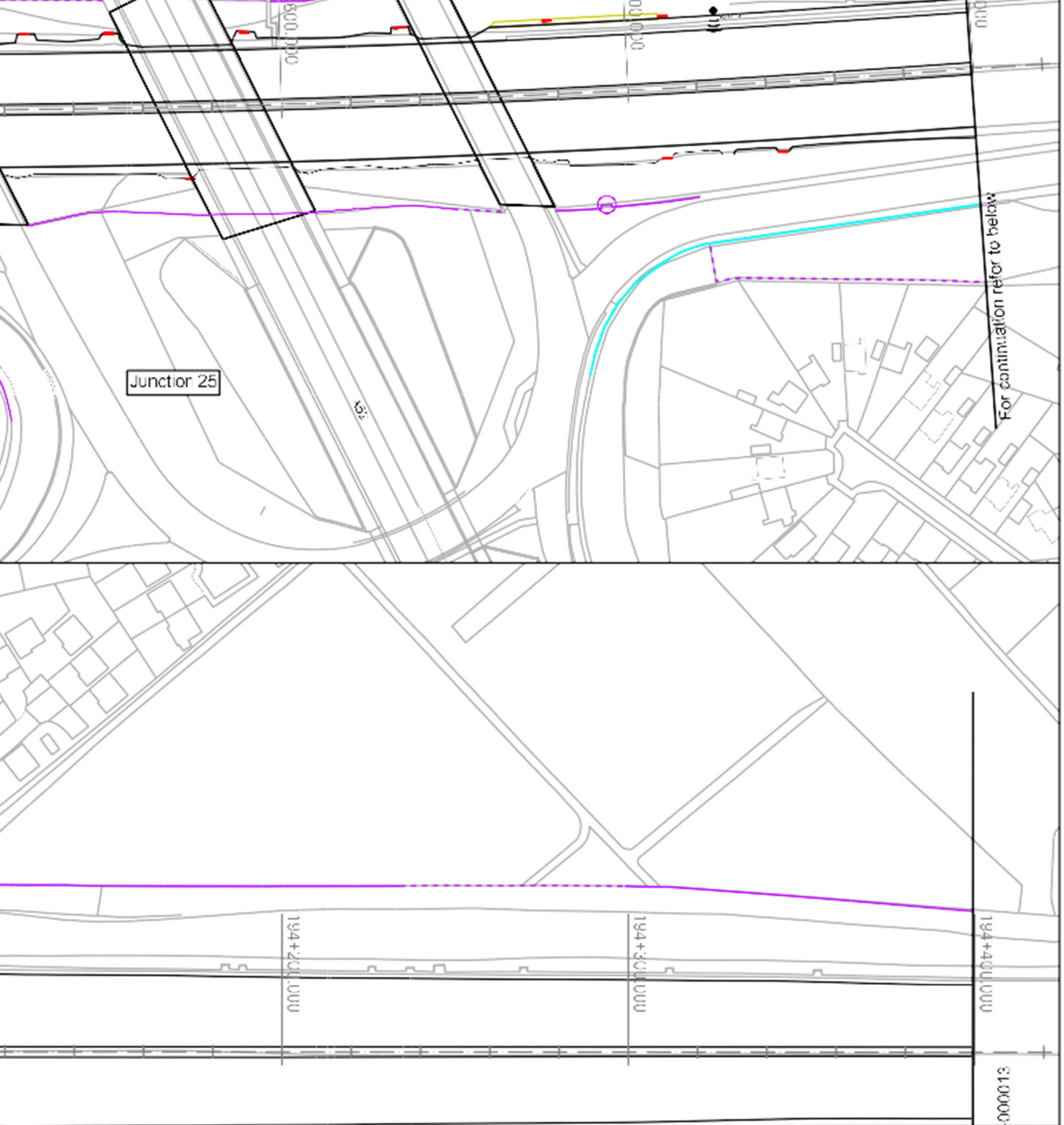
Rev	Date	By	Chkd	Appd
C03	24/02/20	AT	MA	SV
As Built				

Client

Project Title

SMP M1 J23a - J25





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Rev	Date	By	Chkd	Appd
C04	24/02/20	AT	MA	SV
As Built				

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The Colmore Building
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 212 3002

Client

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Project Title

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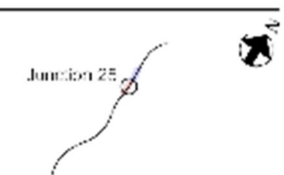
Key Plan



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C03	24/02/20	AT	MA	SV
As Built				

The Colmore Building
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 212 5002

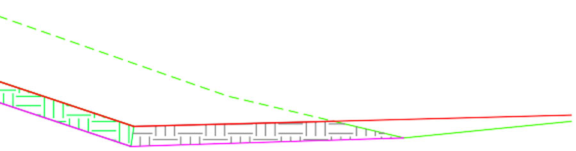
Client

Project Title
SMP M1 J23a - J25

FULL HEIGHT EMBANKMENT WIDENING

Scale 1:100 @A3

BE EXCAVATED
ED BACK TO PROVIDE
ROUND PROFILE [1:2.5 OR 1:3 GRADIENT,
HEDULE REFERENCE NO.
AR-HGT-SWI-SP-000002]



LOPE

ATED

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. FOR DETAILS OF BENCHING AT INDIVIDUAL LOCATIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000617.

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.

12. FOR TYPICAL DETAILS OF LOW HEIGHT RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001602

13. REFER TO TYPICAL VERGE DETAILS (HA549342-AMAR-HGN-SWI-DR-CH-000018 TO 23) FOR TYPICAL DETAILS OF ASSETS **IN** VERGE

LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SURVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

TOPSOIL

GRANULAR FILL [REFER TO SERIES 600 SPEC]

CO2	28/04/20	DR	**MA**	**SV**
As Built				
Rev	Date	By	Chkd	Appd

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Client

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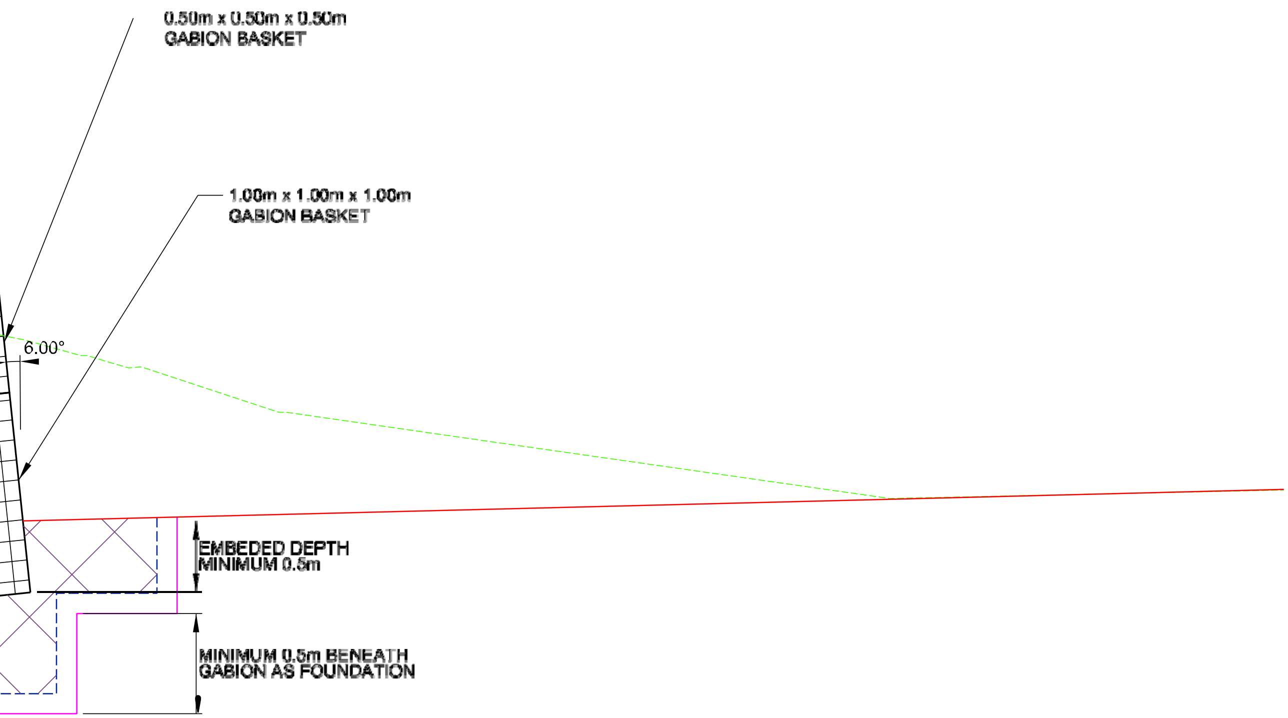

RETAINED HEIGHT)

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 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.

12. REFER TO TYPICAL VERGE DETAILS (HA549342-AMAR-HGN-SWI-DR-CH-000018 TO 23) FOR TYPICAL DETAILS OF ASSETS **IN** VERGE

LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE (LIDAR SURVEY)
- EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]
- GABIONWALL

Rev	Date	By	Chkd	Appd
CO2	28/04/20	DR	MA	SV
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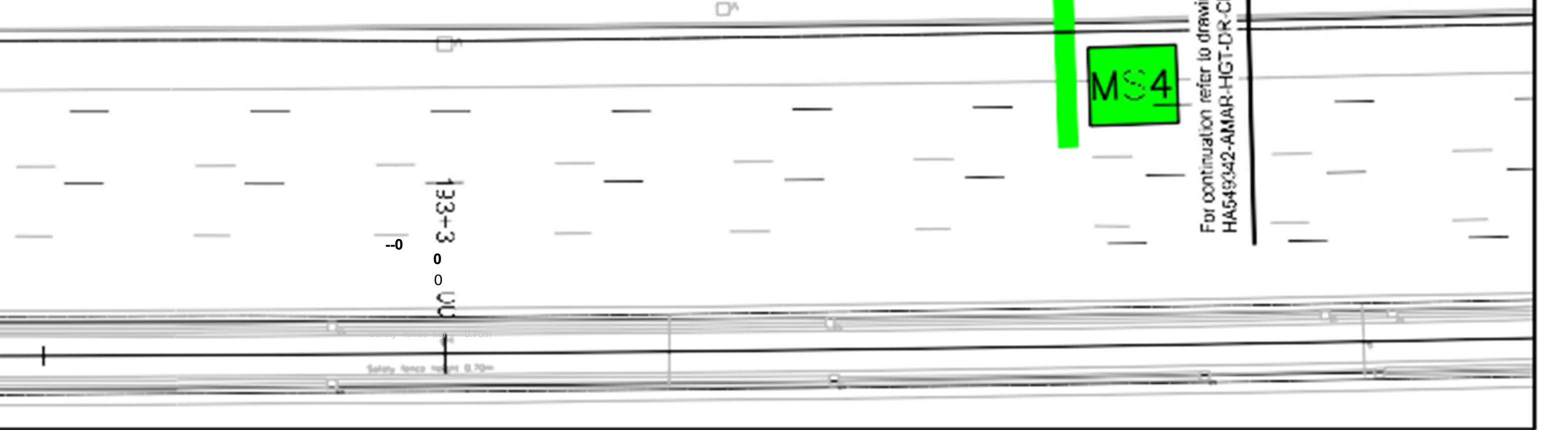


... SLOPES OF 1(V):2(H) OR STEEPER, OR 300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED ON SECTIONS.
9. ALL SHEET PILE SECTIONS SHALL BE Z SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

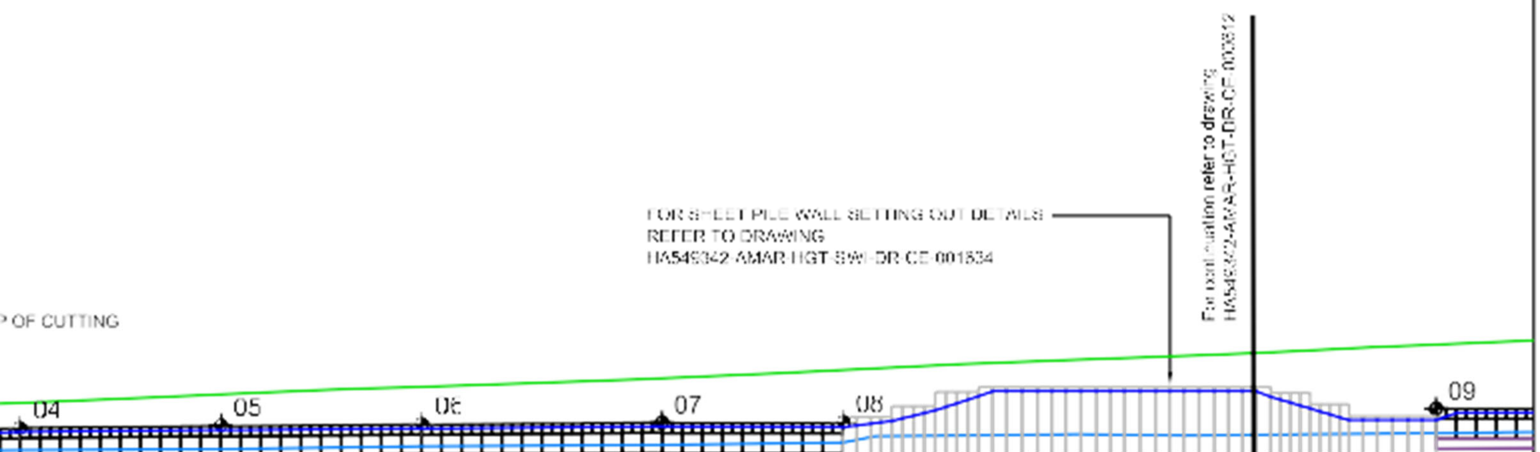
PLAN LEGEND

- EXISTING HIGHWAY FENCELINE
- TOPO SURVEY (BEFORE SMP)
- KING SHEET PILE LOCATION
- GABIONWALL
- SECTION LINE
- SETTING OUT POINT

		GABION WALL DETAILS	
...ACK OF BATTER [c]			
NORTHING	LEVEL (mAOD)	TOTAL RETAINED HEIGHT (m)	EMBEDMENT DEPTH (m)
335286.28	47.90	0.95	0.50
335296.26	47.80	0.95	0.50
335306.24	48.20	0.95	0.50
335316.23	48.50	0.95	0.50
335326.21	48.90	0.95	0.50
335336.22	49.15	0.95	0.50
335346.26	49.20	0.95	0.50
335355.26	49.30	0.95	0.50

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
- GABIONWALL
- GRANULAR FILL [SERIES 600 SPECIFICATION]



CO2	28/04/20	DR	MA	SV
As Built				
Re.	Date	By	Chkd	Appd

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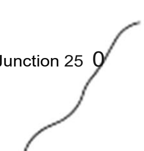
Project Title

SMP M1 J23a - J25

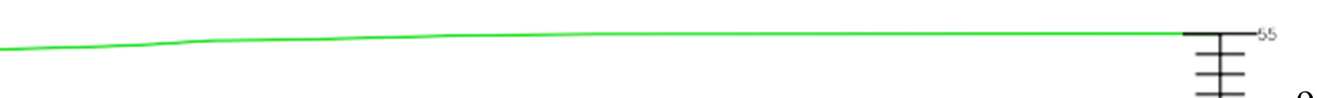
Key Plan



BACK OF BATTER [c]		GABION WALL DETAILS	
NORTHING	LEVEL (mAOD)	TOTAL RETAINED HEIGHT (m)	EMBEDMENT DEPTH (m)
335384.63	49.90	0.95	0.50
335391.79	49.90	0.95	0.50
335401.49	49.90	1.40	0.50
335421.52	50.10	1.40	0.50
335431.81	50.20	1.40	0.50
335442.11	50.30	1.40	0.50
335452.39	50.40	1.40	0.50
335462.79	50.90	1.40	0.50
335471.23	51.00	1.40	0.50
335492.16	51.30	1.40	0.50
335500.60	51.40	1.40	0.50
335509.81	51.50	1.40	0.50

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]



300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED ON SECTIONS.
9. ALL SHEET PILE SECTIONS SHALL BE Z SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- EXISTING HIGHWAY FENCELINE
- TOPO SURVEY (BEFORE SMP)
- KING SHEET PILE LOCATION
- GABIONWALL
- SECTION LINE
- SETTING OUT POINT

Re.	Date	By	Chkd	Appd
C03	28/04/20	DR	MA	SV
As Built				

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20 Colmore Circus Queensway
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Tel 0121 212 5000

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Project Title

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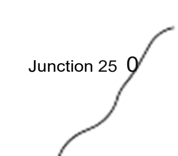

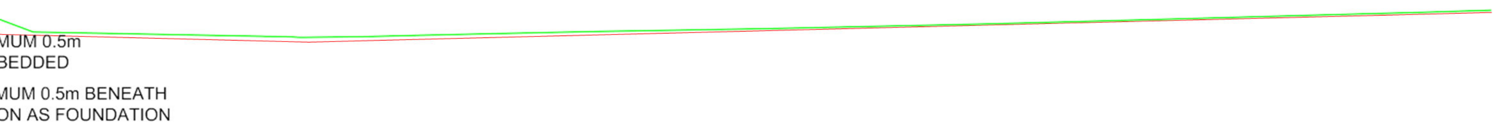

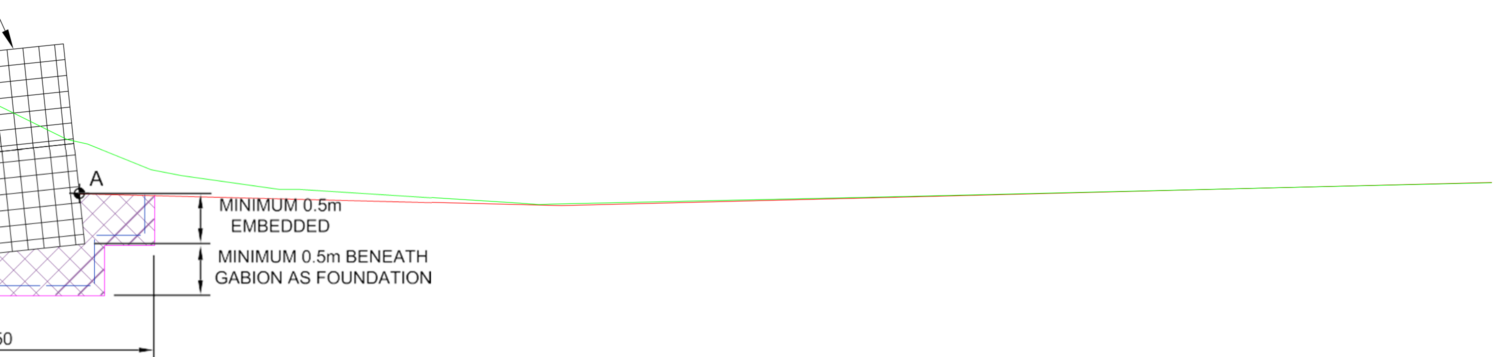

300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE (LIDAR SURVEY)
- EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]
- GABION BASKET
- SETTING OUT POINT

Rev	Date	By	Chkd	Appd
CO2	28104/20	DR	MA	SV
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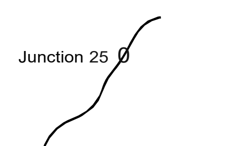
Key Plan



SLOPES OF 1(V):2(H) OR STEEPER, OR 300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOTTO EXCEED 0.5m IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED ON SECTIONS.
9. ALL SHEET PILE SECTIONS SHALL BEZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

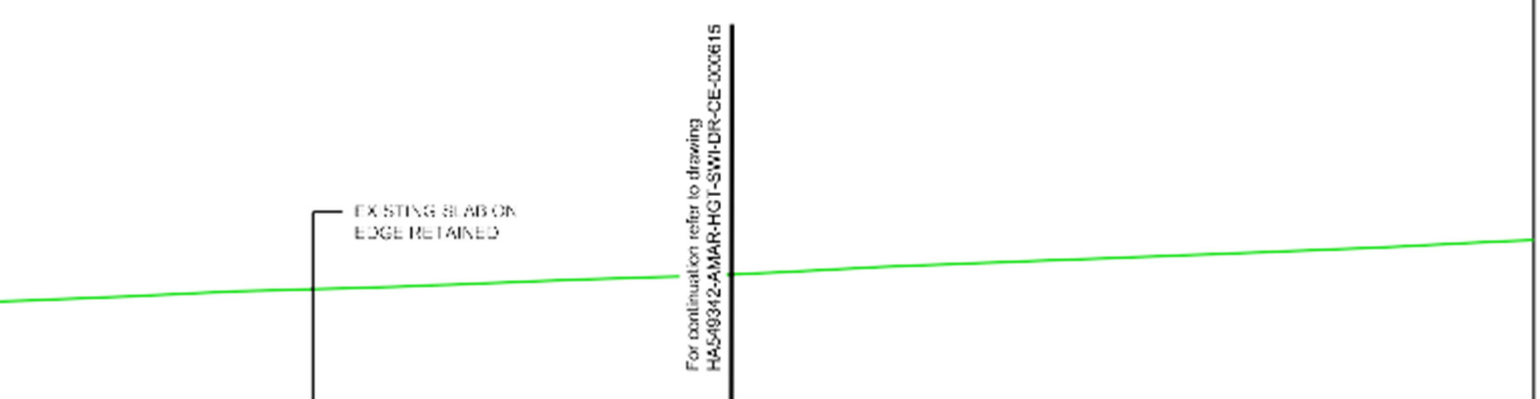
- EXISTING HIGHWAY FENCELINE
- TOPO SURVEY (BEFORE SMP)
- KING SHEET PILE LOCATION
- GABION WALL
- SECTION LINE
- SETTING OUT POINT

GABION WALL DETAILS

K OF BATTER [c]			
NORTHING	LEVEL (mAOD)	TOTAL RETAINED HEIGHT (m)	EMBEDMENT DEPTH (m)
335358.00	50.00	0.95	0.50
335367.70	50.00	0.95	0.50
335377.70	50.10	0.95	0.50
335387.70	50.40	0.95	0.50
335397.69	50.80	0.95	0.50
335407.74	51.20	0.95	0.50
335415.40	51.60	1.40	0.50
335417.73	51.60	1.40	0.50
335427.73	51.80	1.40	0.50
335437.72	51.80	1.40	0.50
335447.72	52.10	1.40	0.50
335457.72	52.20	1.40	0.50
335467.71	52.30	1.40	0.50

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)



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As Built				
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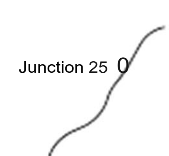
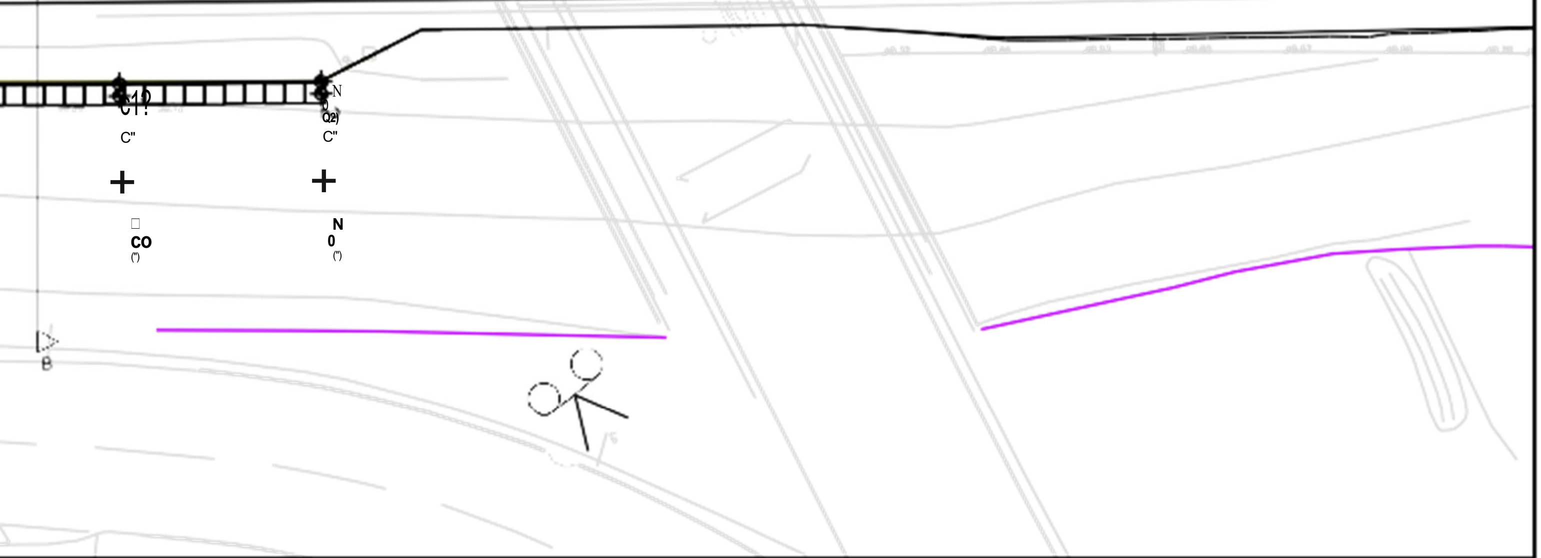


BUT NO THICKER THAN 150mm FOR SLOPES OF 1(V) :2(H) OR STEEPER, OR 300mm FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY. WORST CASE SCENARIOS INDICATED IN SECTION A-A.



PLAN LEGEND

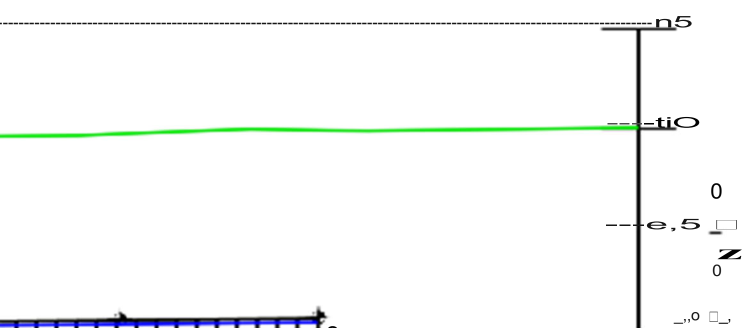
- EXISTING HIGHWAY FENCELINE
- TOPO SURVEY (BEFORE SMP)
- GABIONWALL
- +X SETTING OUT POINT
- SECTION LINE

ELEVATION LEGEND

- TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)
- BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)
- TOP OF CUTTING
- GABION WALL
- GRANULAR FILL [REFER SERIES 600 SPECIFICATION]

GABION WALL DETAILS

BACK OF BATTER [c]				
EASTING	NORTHING	LEVEL (mAOD)	TOTAL RETAINED HEIGHT (m)	EMBEDMENT DEPTH (m)
447221 6	335487.8	52.10	1.40	0.50
447221.71	335497.8	52.10	1.40	0.50
447221.82	335507.8	52.10	1.40	0.50
447221.85	335517.8	52.10	1.40	0.50
447221.85	335527.85	52.20	1.40	0.50
447220.4	335530.75	52.30	1.40	0.50



CO2	28/04/20	DR	MA	SV
As Built				
Re,	Date	By	Chkd	Appd

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Project Title

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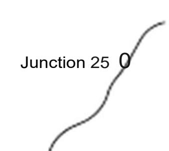
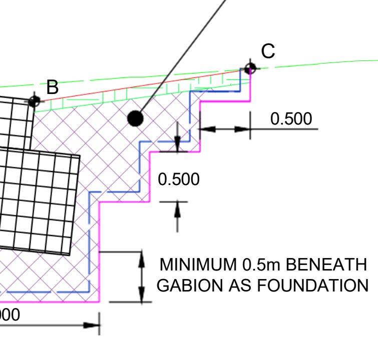


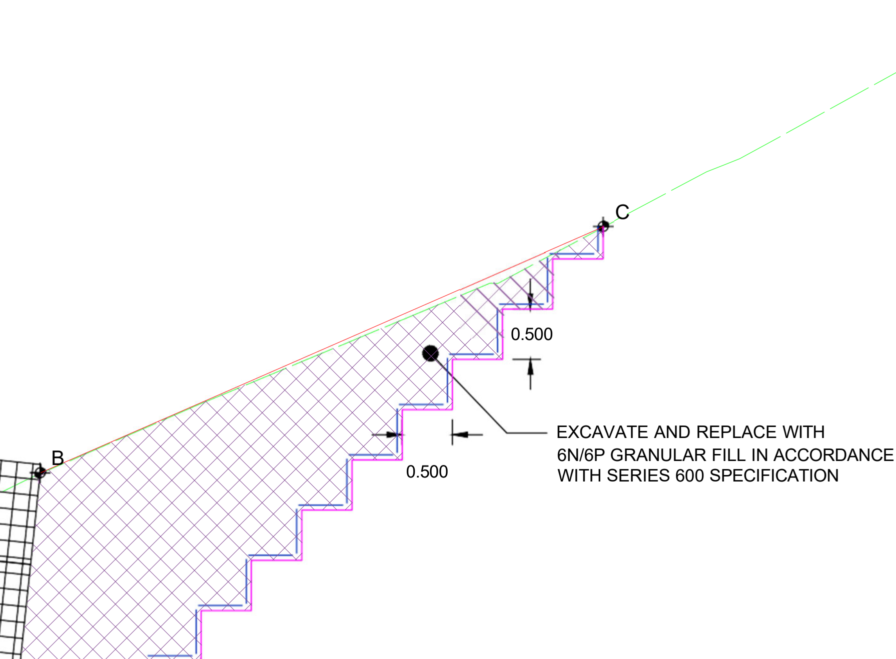


300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.

SECTION LEGEND

	PROPOSED GROUND PROFILE
	EXISTING GROUND PROFILE (LIDAR SURVEY)
	EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
	INDICATIVE EXCAVATION PROFILE
	GEOTEXTILE SEPARATOR LAYER
	TOPSOIL
	GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]
	GABION BASKET
X	SETTING OUT POINT



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Project Title

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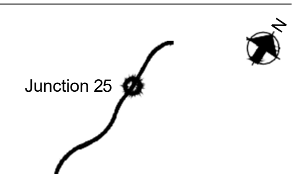
Key Plan



3.0	26.5
5.0	24.4
4.5	32.0
4.5	32.0
4.2	26.5
4.5	26.5
8.2	26.5
3.4	26.5
3.4	26.5
6.0	26.5

ching Details

	Benching Details	
	Base width (m)	Batter Angle (^{0})
	7.3	26.5
	4.5	26.5
	2.1	26.5
	2.0	26.5
	4.5	26.5
t	4.5	26.5
t	4.5	26.5
	4.5	26.5
	10.4	26.5
	10.4	26.5
	9.0	26.5
	6.6	26.5
	9.0	26.5
	6.1	26.5
	6.5	26.5
	4.0	26.5
	6.5	26.5
	6.5	26.5
	4.0	26.5
	6.2	26.5
	4.0	26.5
	4.5	26.5
	4.5	26.5
	3.5	26.5
	3.9	26.5
	3.8	26.5
	3.0	26.5

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C03	28/04/20	DR	MA	SV
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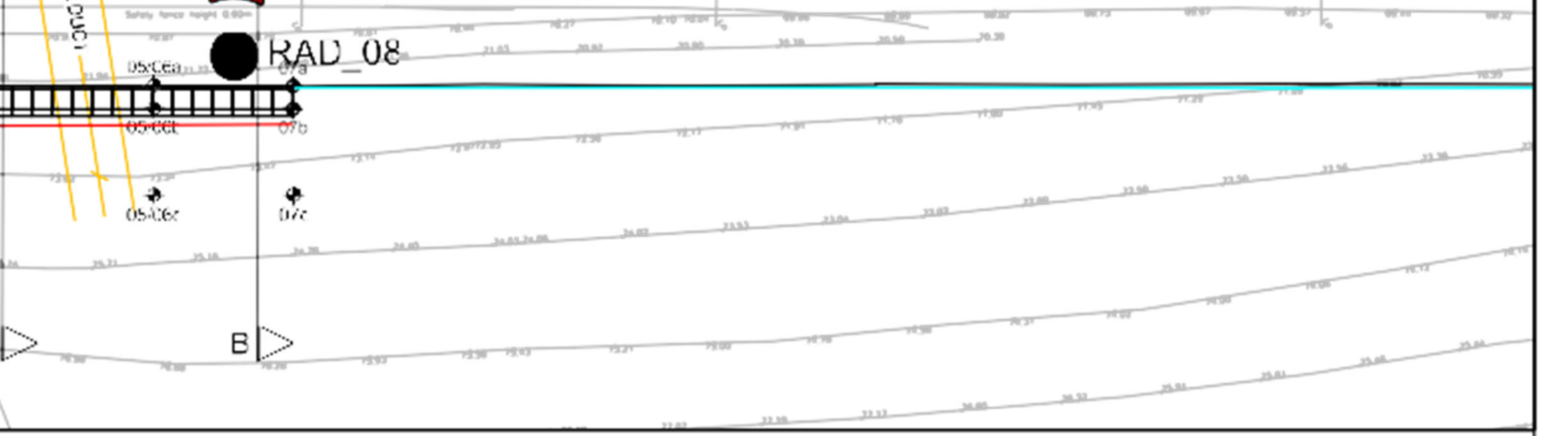
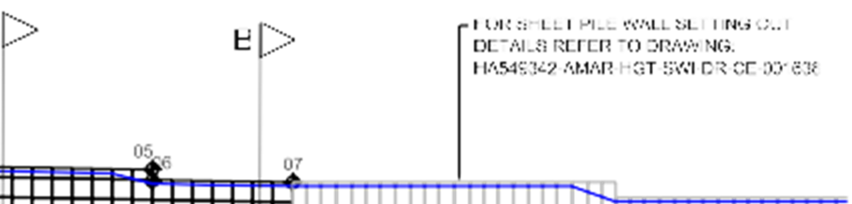


BACK OF BATTER [c]			GABION WALL DETAILS	
EASTING	NORTHING	LEVEL (mAOD)	TOTAL RETAINED HEIGHT (m)	EMBEDMENT DEPTH (m)
447345.57	326192.02	74.84	1.40	0.50
447349.82	326209.79	74.60	1.40	0.50
447351.43	326214.99	74.91	1.90	0.50
447355.26	326227.41	74.93	1.90	0.50
447360.17	326243.28	74.28	1.90	0.50
447360.17	326243.28	74.28	1.40	0.50
447362.35	326250.34	74.05	1.40	0.50



ELEVATION LEGEND

TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)

BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)

300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOTTO EXCEED 0.5m IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED ON SECTIONS.
9. ALL SHEET PILE SECTIONS SHALL BEZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

EXISTING HIGHWAY FENCELINE

TOPO SURVEY (BEFORE SMP)

KING SHEET PILE LOCATION

GABION WALL

SECTION LINE

PEDESTRIAN RESTRAINT SYSTEM

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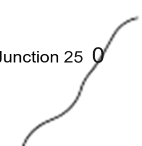
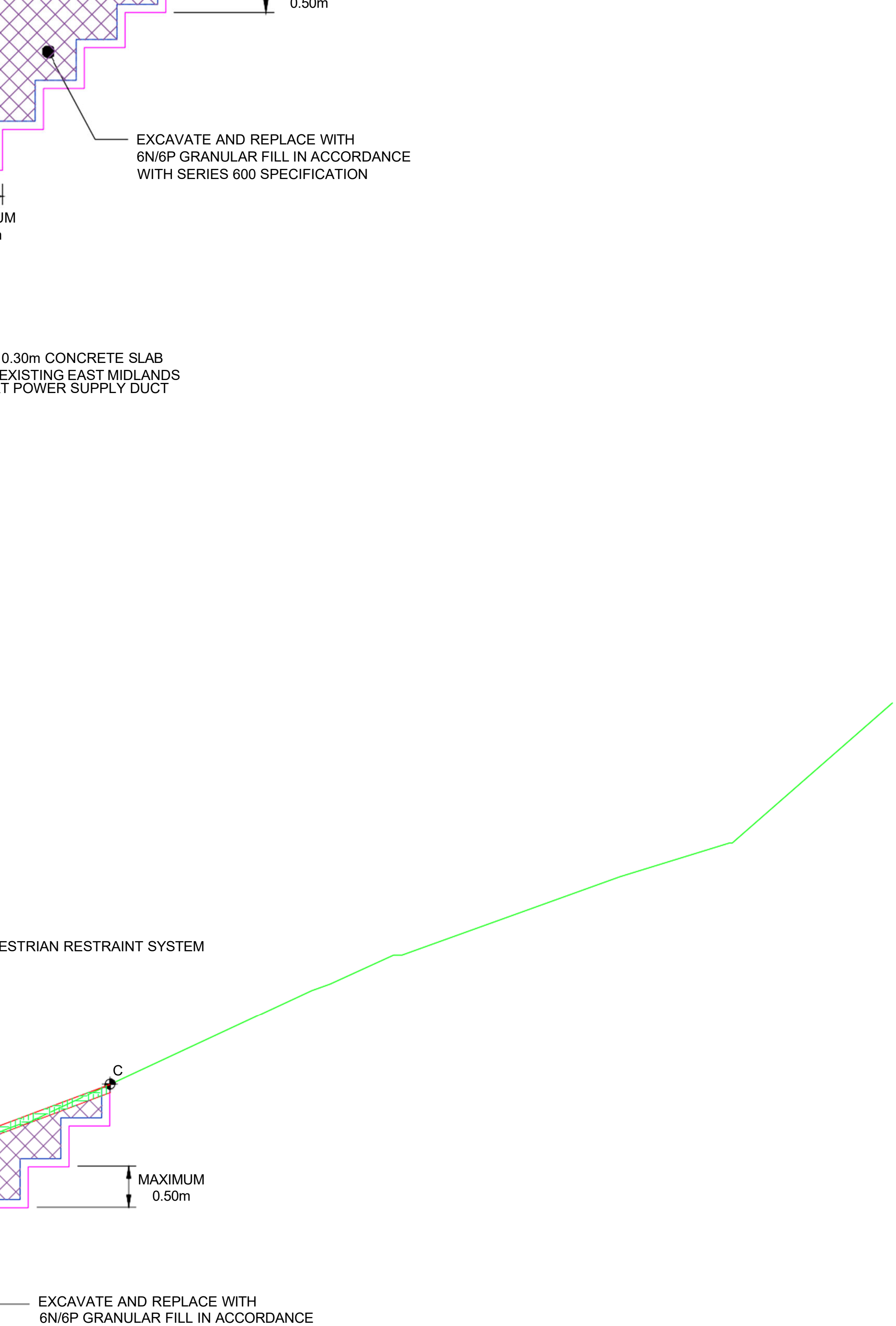
Project Title

SMP M1 J23a - J25

Key Plan





300mm FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE (LIDAR SURVEY)
- EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]
- GABION BASKET
- X SETTING OUT POINT

Rev	Date	By	Chkd	Appd
C03	28/04/20	DR	MA	SV
As Built				

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Key Plan

Junction 25

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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.

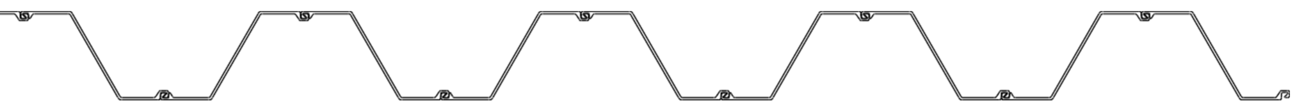
9. EXCAVATION PROFILES WILL VARY, DEPENDING ON GEOMETRY.

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.

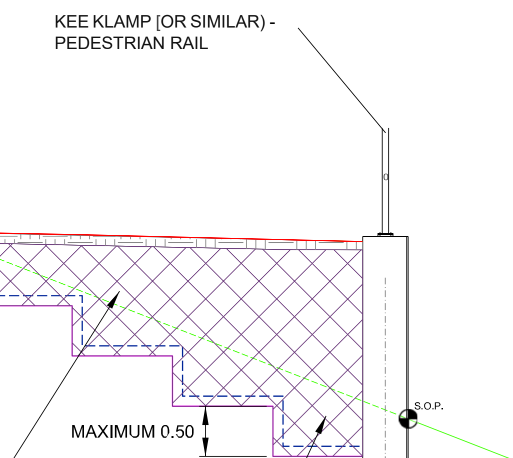
12. FOR TYPICAL DETAILS OF LOW HEIGHT RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-0001602.

TYPICAL SHEET PILE SECTION (VARIES, REFER TO SERIES 1600 SPECIFICATION AND SCHEDULE)



SHEET PILE PLAN DETAIL

Scale 1:20 @ A3



LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE (LIDAR SURVEY)
- EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]
- SOS SETTING OUT POINT

C03	15/05/20	DR	MA	SV
As Built				
Rev	Date	By	Chkd	Appd

amey ARUP

The Colmore Building
20 Galmore Circus Queensway
Birmingham 84 6AT
Tel 0121 212 5000

Client

highways england
driving forward

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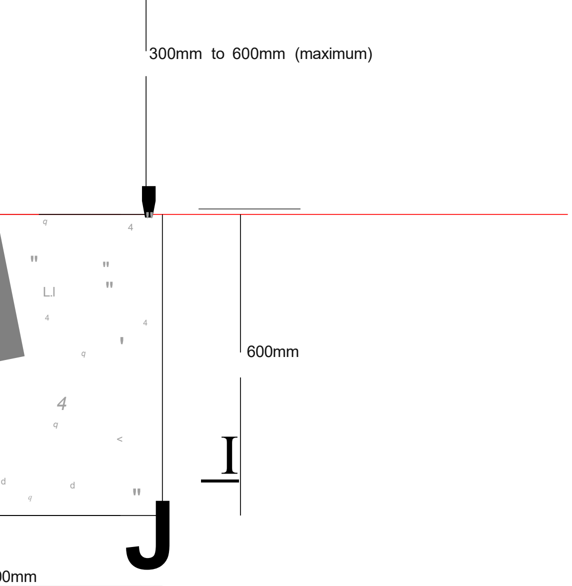

on Edge Detail

10

- Details as above

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.

LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SURVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

C35/45 CONCRETE FILL

Rev	Date	By	Chkd	Appd
CO2	15/05/20	DR	MA	SV
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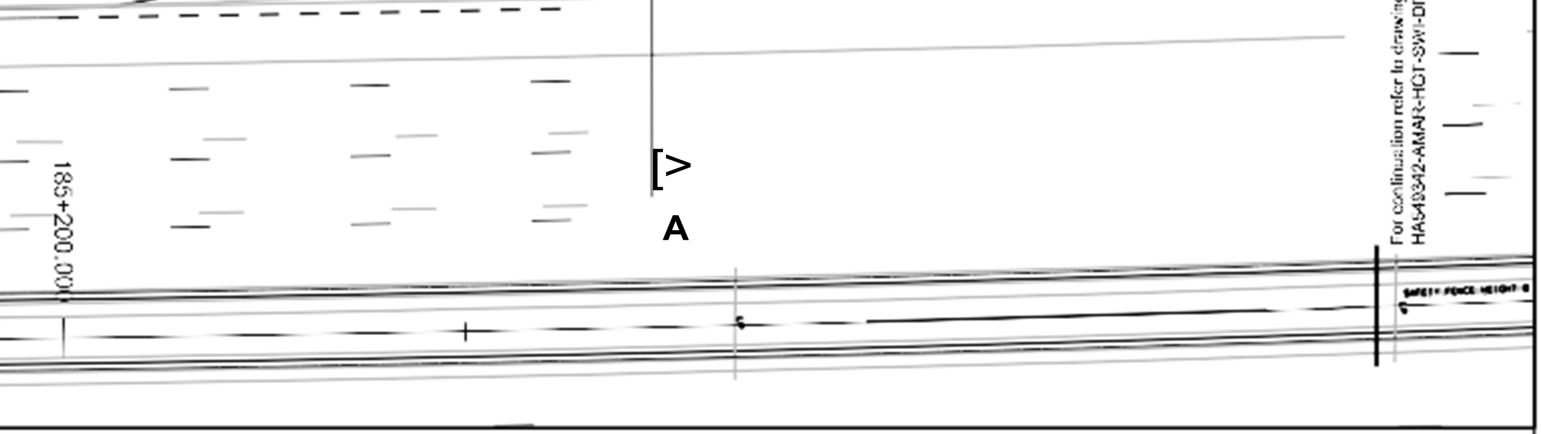


IN HEIGHT.

8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN IN SECTION A-A.
9. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
10. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

PLAN LEGEND

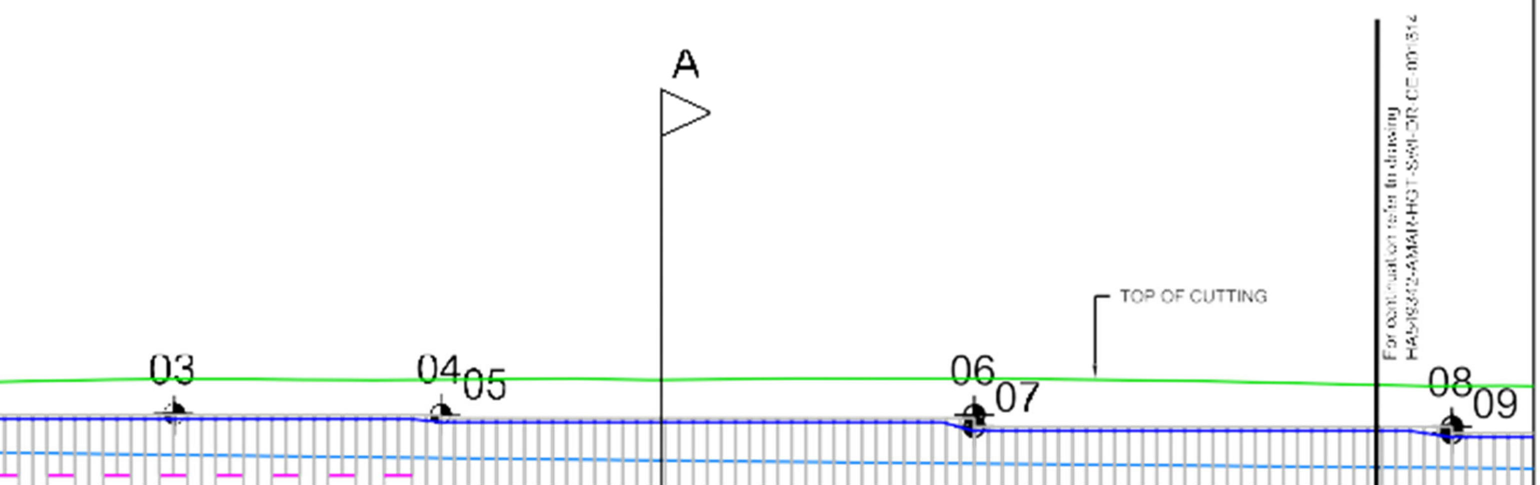
- EXISTING HIGHWAY FENCELINE
- TOPO SURVEY (BEFORE SMP)
- KING SHEET PILE LOCATION
- SETTING OUT POINT
- SECTION LINE

RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
0.85	8.00	3.00
1.45	8.00	3.00
1.75	8.00	3.00
1.90	8.00	3.00
1.75	10.00	3.50
1.90	10.00	3.50
1.50	10.00	3.50
1.90	10.00	3.50
1.55	8.00	3.00

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



C03	11/05/20	DR	MA	SV
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;w Galmore Circus Queensway
Birmingham 84 BAT
Tel 01212125000

Client

highways england
driv ng forward

Project Title

SMP M1 J23a - J25

Key Plan

Junction 25

IN HEIGHT.

8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN IN SECTION A-A.
9. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
10. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

PLAN LEGEND

EXISTING HIGHWAY FENCELINE

TOPO SURVEY (BEFORE SMP)

KING SHEET PILE LOCATION

SETTING OUT POINT

SECTION LINE

RET. WALL DETAILS

OTTOM OF RETAINED HEIGHT (C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
34.60	1.65	10.00	3.00
34.40	1.85	10.00	3.00
34.40	1.50	10.00	3.00
34.30	1.60	10.00	3.00

ELEVATION LEGEND

TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)

BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)

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20 Colmore Circus Queensway
Birmingham B4 6AT
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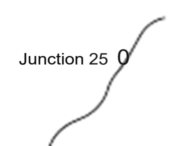
Project Title

SMP M1 J23a - J25

Key Plan



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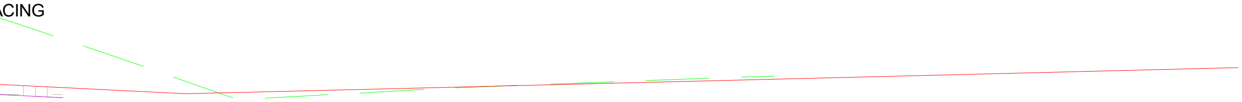

LS REFER TO SERIES
E.

300mm FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
9. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SURVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

CLASS 6N FILL

SHEET PILE

X

SETTING OUT POINT

EXCAVATED MATERIAL REINSTATED

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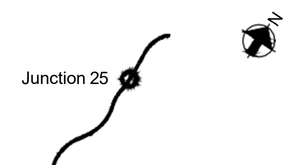
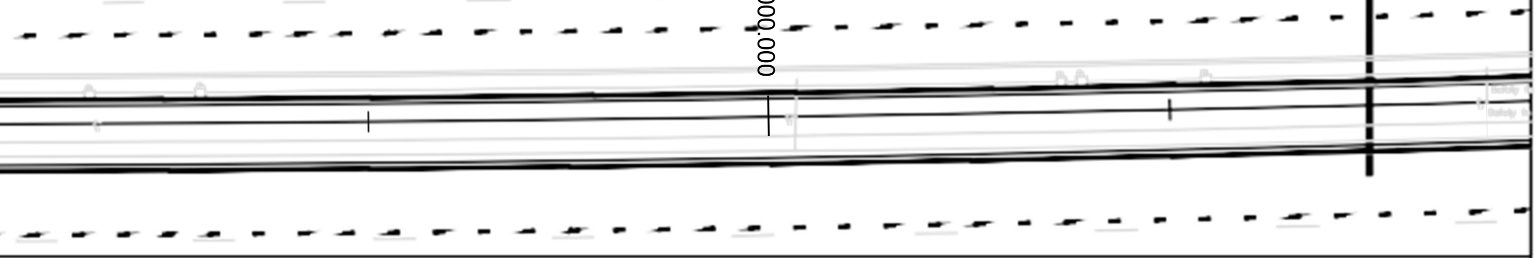
SMP M1 J23a - J25

Key Plan





8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN IN SECTION A-A.
9. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
10. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

PLAN LEGEND

- EXISTING HIGHWAY FENCELINE
- TOPO SURVEY (BEFORE SMP)
- KING SHEET PILE LOCATION
- X SETTING OUT POINTS
- SECTION LINE

RET. WALL DETAILS

C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
	1.20	6.50	3.00
	1.51	6.50	3.00
	1.53	6.50	3.00
	1.53	6.50	3.00
	1.84	6.50	3.00
	1.85	6.50	3.00
	1.55	6.50	3.00
	1.55	6.50	3.00

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
C04	07/05/20	DR	MA	SV
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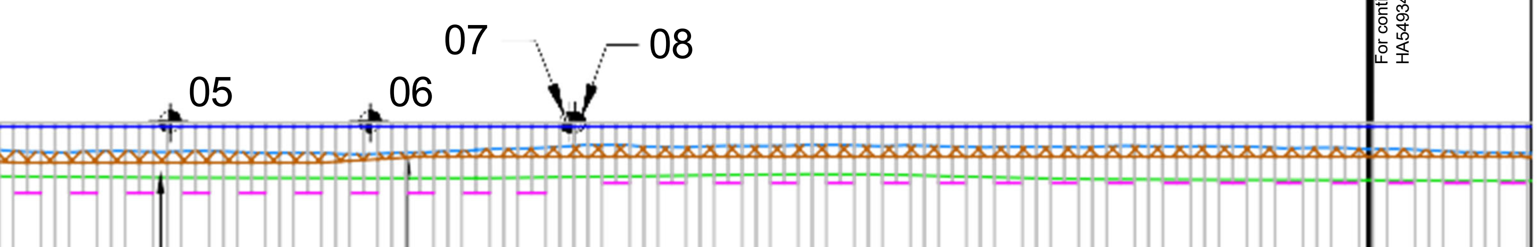
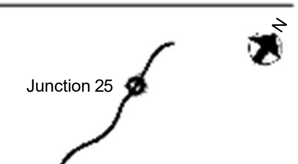
SMP M1 J23a - J25

For continuation refer to drawing
HA549342-AMAR-HGT-SWI-DR-CE-001617



Key Plan



For continuation HA549342-AMAF

IN HEIGHT.

8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN IN SECTION A-A.
9. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
10. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

PLAN LEGEND

EXISTING HIGHWAY FENCELINE

TOPO SURVEY (BEFORE SMP)

KING SHEET PILE LOCATION

X SETTING OUT POINTS

SECTION LINE

	RET. WALL DETAILS		
ASE OF EXCAVATION (C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
31.70	1.55	6.50	3.00
31.40	1.86	6.50	3.00
31.40	1.86	7.50	3.00
31.10	2.16	7.50	3.00
31.40	1.86	7.50	3.00
31.40	1.87	7.50	3.00
31.40	1.87	6.50	3.00

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)

For continuation refer to drawing HA549342-AMAR-HGT-SWI-DR-CE-001618

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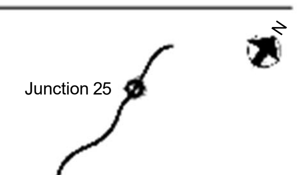
Key Plan



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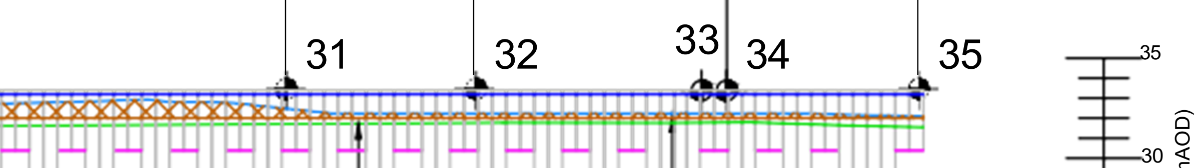
C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
	RET. WALL DETAILS		
	1.92	6.50	3.00
	1.92	6.50	3.00
	1.62	6.50	3.00
	1.92	6.50	3.00
	1.92	7.50	3.50
	2.23	7.50	3.50
	2.23	7.50	3.50
	2.23	7.50	3.50
	1.93	7.50	3.50
	1.93	7.50	3.50
	1.74	7.50	3.50
	1.64	7.50	3.50
	1.64	7.50	3.50
	1.64	6.50	3.00
	1.35	6.50	3.00
	1.36	6.50	3.00
	1.36	6.50	3.00
	1.21	6.50	3.00
	1.21	6.50	3.00
	1.26	6.50	3.00



8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN IN SECTION A-A.
9. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
10. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

PLAN LEGEND

- EXISTING HIGHWAY FENCELINE
- TOPO SURVEY (BEFORE SMP)
- KING SHEET PILE LOCATION
- X 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)

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C04	07/05/20	DR	MA	SV
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20 Colmore Circus Queensway
Birmingham B4 6AT
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Client

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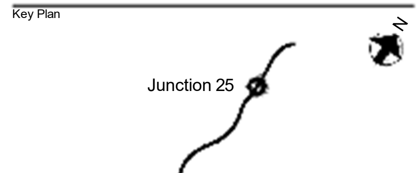
Project Title

SMP M1 J23a - J25

Key Plan



300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
9. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SURVEY)

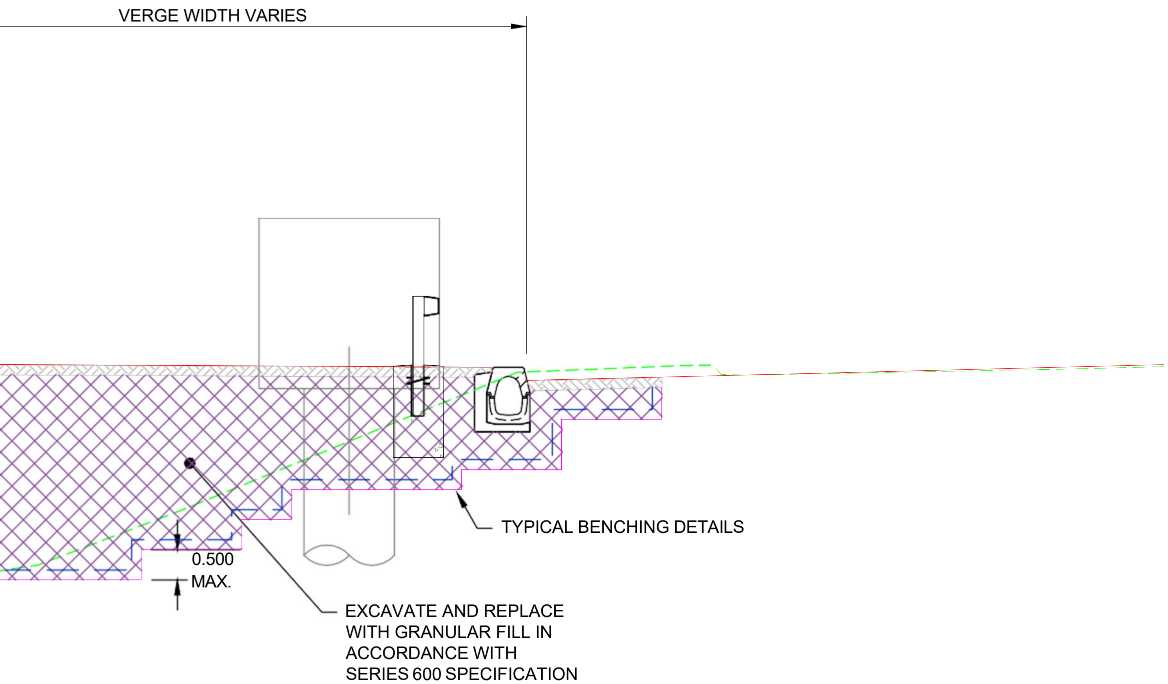
EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

SHEET PILE

X SETTING OUT POINT



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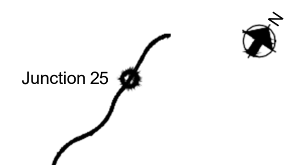
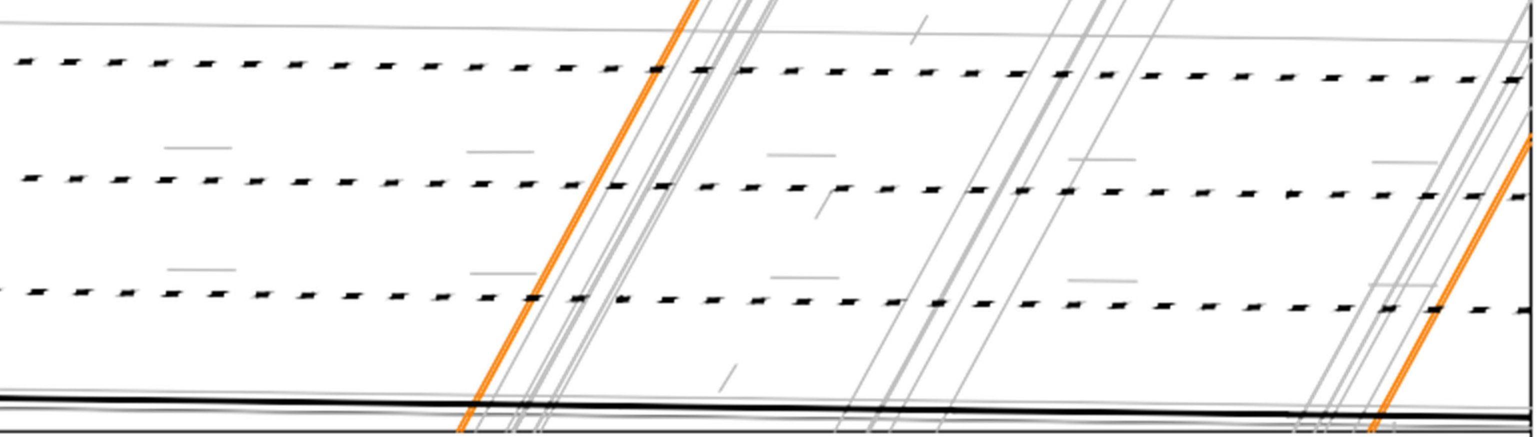
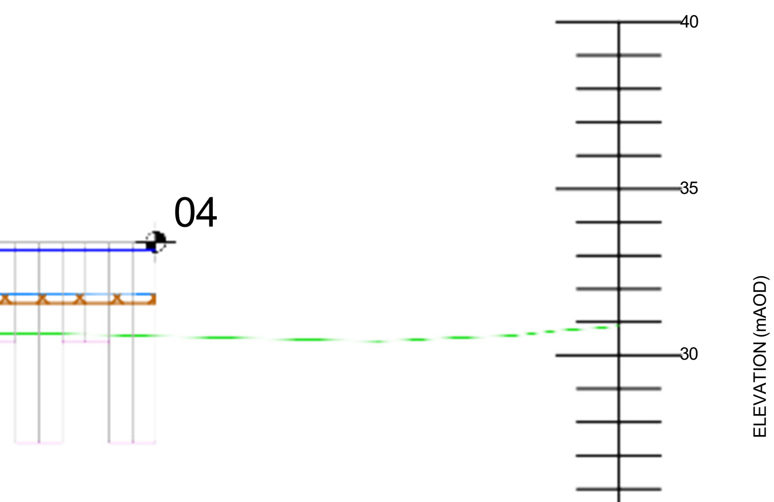
Key Plan





RET. WALL DETAILS

(C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
	1.34	6.00	3.00
	1.27	6.00	3.00
	1.55	6.00	3.00
	1.52	6.00	3.00



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)

8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN IN SECTION A-A.
9. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
10. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

PLAN LEGEND

- EXISTING HIGHWAY FENCELINE
- TOPO SURVEY (BEFORE SMP)
- KING SHEET PILE LOCATION
- X SETTING OUT POINTS
- SECTION LINE

Rev	Date	By	Chkd	Appd
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Project Title

SMP M1 J23a - J25

Key Plan

Junction 25

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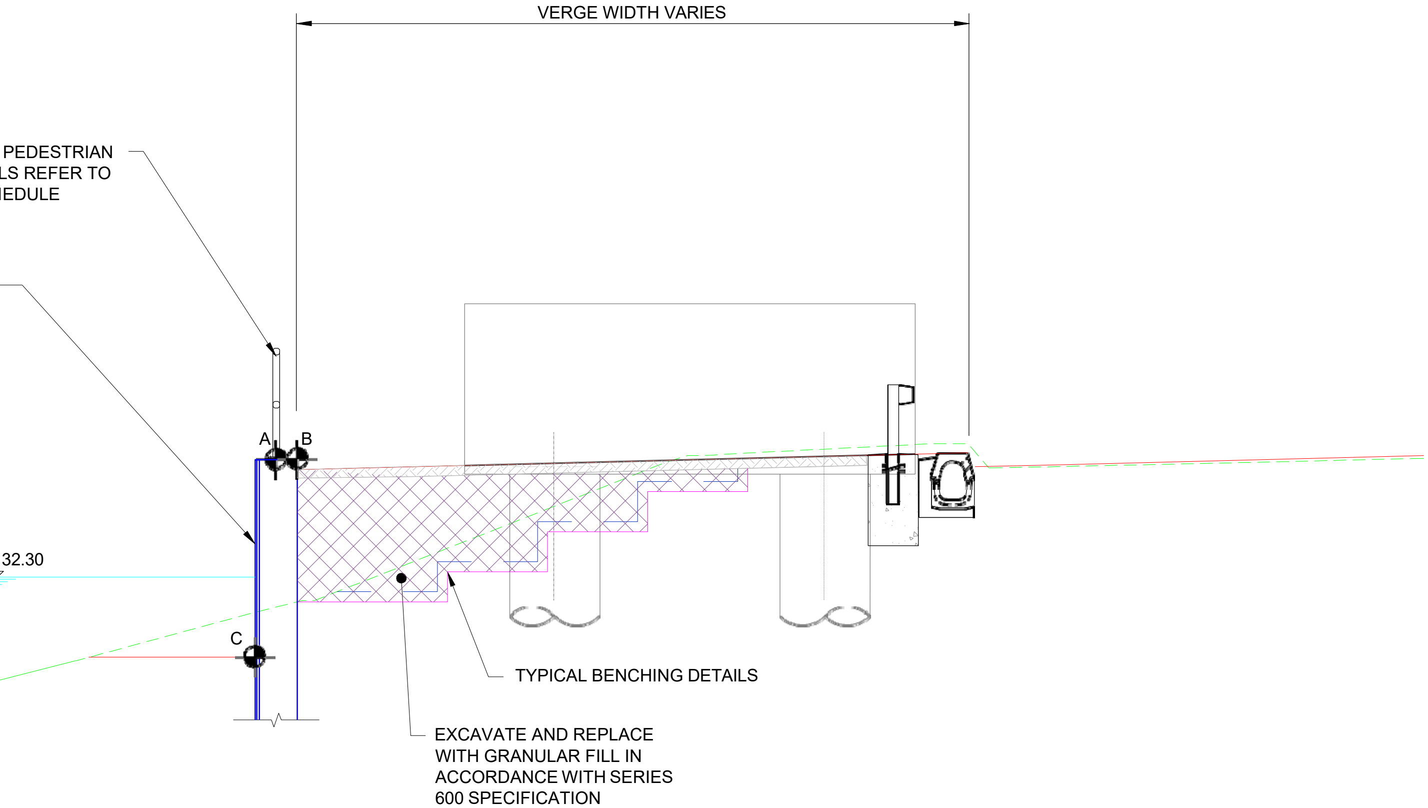

300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
9. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SUVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

CLASS 6N FILL

SHEET PILE

X

SETTING OUT POINT

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Project Title

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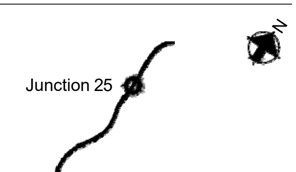
Key Plan



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IN HEIGHT.

8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN IN SECTION A-A.
9. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
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PLAN LEGEND

EXISTING HIGHWAY FENCELINE

TOPO SURVEY (BEFORE SMP)

KING SHEET PILE LOCATION

SETTING OUT POINT

SECTION LINE

RET. WALL DETAILS

TOM OF EXCAVATION (C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
34.50	2.01	9.00	4.50
33.57	2.63	9.00	4.50
33.48	2.69	9.00	4.50
33.48	2.69	9.00	4.50
32.92	2.94	9.00	4.50
32.93	2.93	9.00	4.50
34.05	1.65	9.00	4.50

ELEVATION LEGEND

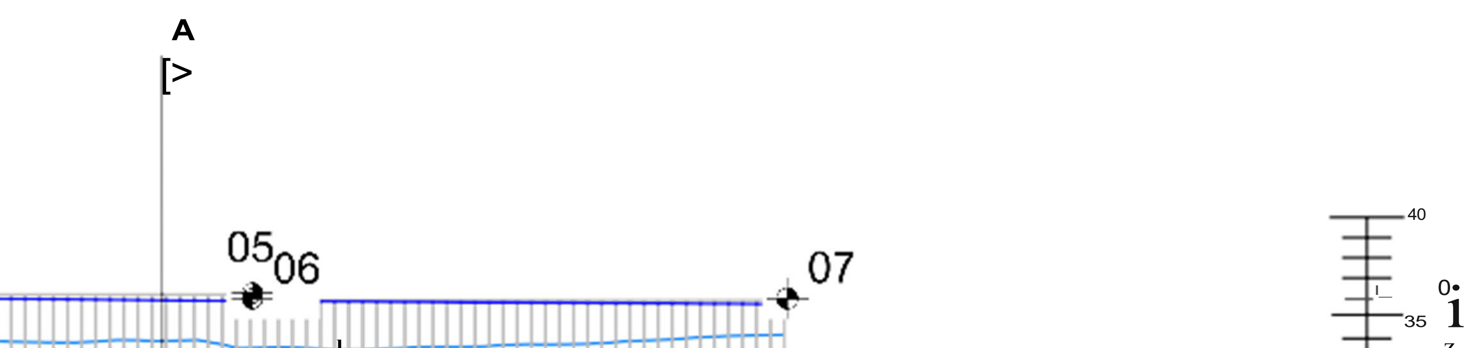
TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)

BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)

BASE OF EMBANKMENT

TOE OF SHEET PILE

SHEET PILES



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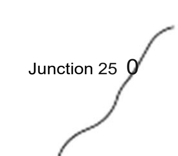

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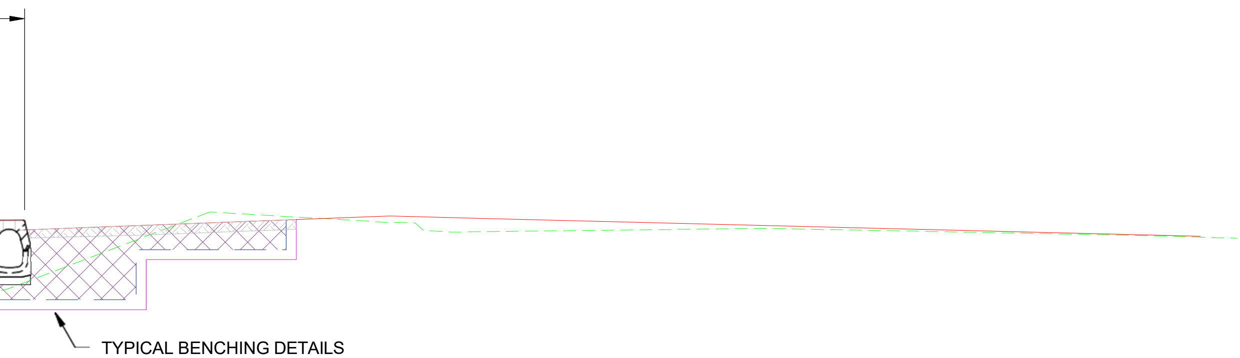
300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
9. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008



VATE AND REPLACE
GRANULAR FILL IN
RDANCE WITH
S 600 SPECIFICATION

SECTION LEGEND

	PROPOSED GROUND PROFILE
	EXISTING GROUND PROFILE (LIDAR SUVEY)
	EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
	INDICATIVE EXCAVATION PROFILE
	GEOTEXTILE SEPARATOR LAYER
	CLASS 6N FILL
	SHEET PILE
X	SETTING OUT POINT

Rev	Date	By	Chkd	Appd
C03	07/05/20	DR	MA	SV
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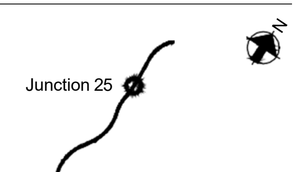
SMP M1 J23a - J25

Key Plan



300mm FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED ON SECTIONS.
9. ALL SHEET PILE SECTIONS SHALL BE Z SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

ET. WALL DETAILS

TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
8.50	3.50
10.00	3.50
8.50	3.50
8.50	3.50
10.00	3.50
1000	350
10.00	3.50
10.00	3.50
10.00	3.50
10.00	3.50
10.00	3.50
10.00	3.50
10.00	3.50
8.50	3.50
8.50	3.50
8.50	3.50
10.00	3.50

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]

PLAN LEGEND

- EXISTING HIGHWAY FENCELINE
- TOPO SURVEY (BEFORE SMP)
- KING SHEET PILE LOCATION
- GABIONWALL
- SECTION LINE
- SETTING OUT POINT

CD4	15/05/20	DR	MA	SV
As Built				
Re,	Date	By	Chkd	Appd

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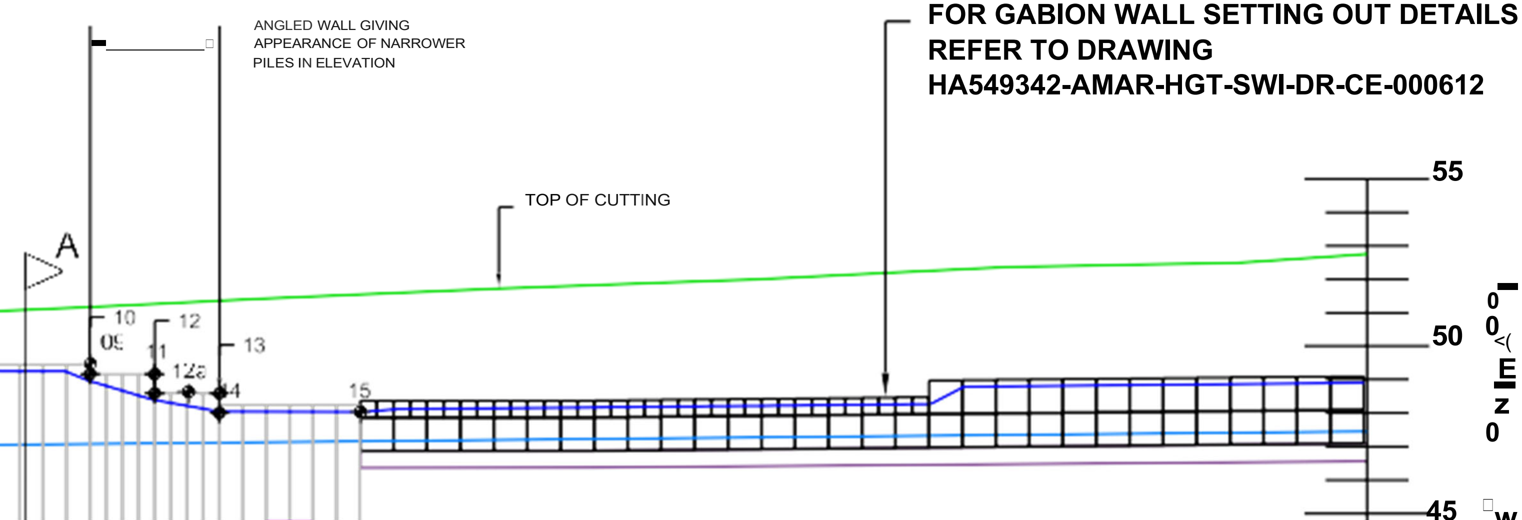
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 212 5000

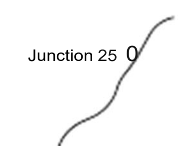
Client

Project Title
SMP M1 J23a - J25

FOR GABION WALL SETTING OUT DETAILS REFER TO DRAWING HA549342-AMAR-HGT-SWI-DR-CE-000612



Key Plan



300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
9. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SURVEY)

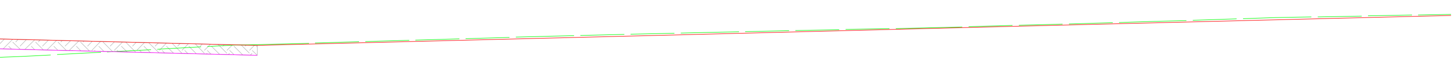
EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

SHEET PILE

X SETTING OUT POINT



C03	15/05/20	DR	MA	SV
As Built				
Rev	Date	By	Chkd	Appd

amey ARUP

The Colmore Building
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 212 5000

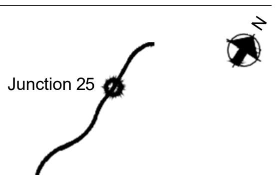
Client

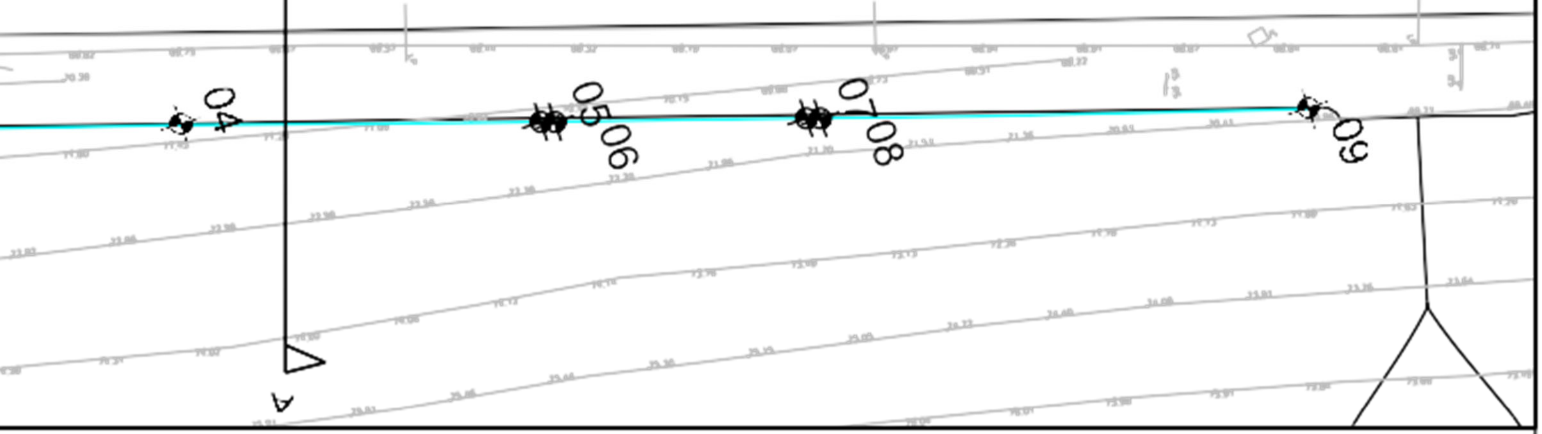
highways england driving forward

Project Title

SMP M1 J23a - J25

Key Plan





IN HEIGHT.

8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN IN SECTION A-A.
9. ALL KSP SECTIONS SHALL BEZ. REFER TO SERIES 1600 FOR FURTHER DETAILS.
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PLAN LEGEND

- EXISTING HIGHWAY FENCELINE
- TOPO SURVEY (BEFORE SMP)
- KING SHEET PILE LOCATION
- 4x 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

	RET. WALL DETAILS			
BOTTOM OF RETAINED HEIGHT (C)	TOTAL RETAINED HIEGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH	
71.05	1.03	5.50	2.50	
70.60	1.00	5.50	2.50	
70.61	0.98	5.50	2.50	
70.20	1.10	5.50	2.50	
69.83	1.17	5.50	2.50	
69.82	1.18	5.50	2.50	
69.11	1.19	5.50	2.50	
69.10	1.13	5.50	2.50	
69.30	0.60	5.50	2.50	

Rev	Date	By	Chkd	Appd
C03	15/05/20	DR	MA	SV
As Built				

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Client

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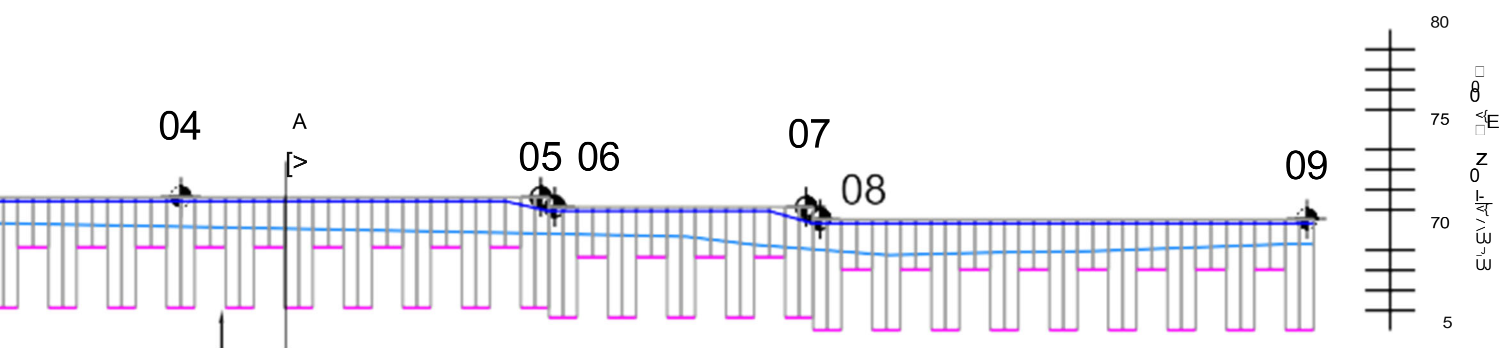
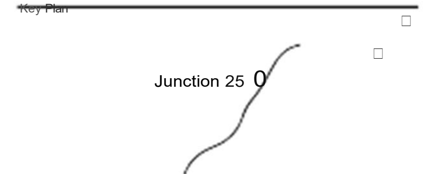
Project Title

SMP M1 J23a - J25



Key Plan



300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
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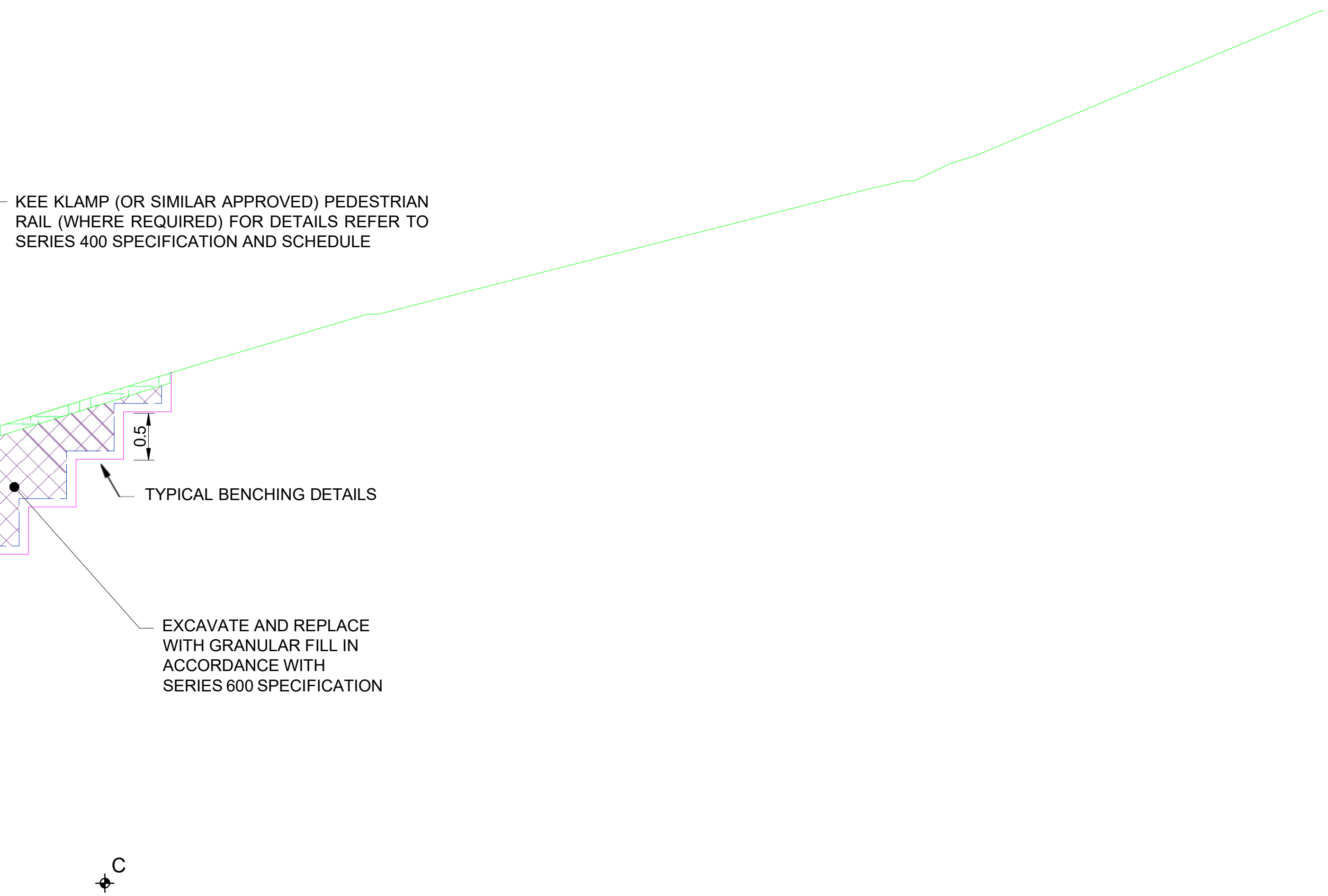

SECTION LEGEND

(red line)	PROPOSED GROUND PROFILE
(green line)	EXISTING GROUND PROFILE (LIDAR SURVEY)
(green dashed line)	EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
(magenta line)	INDICATIVE EXCAVATION PROFILE
(blue dashed line)	GEOTEXTILE SEPARATOR LAYER
(box)	SHEET PILE
X	SETTING OUT POINT

C02	15/05/20	DR	MA	SV
As Built				
Rev	Date	By	Chkd	Appd

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20 Colmore Circus Queensway
Birmingham B4 6AT
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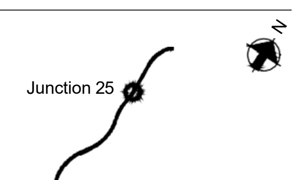
highways england driving forward

Project Title

SMP M1 J23a - J25

Key Plan



IN HEIGHT.

8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN IN SECTION A-A.
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PLAN LEGEND

EXISTING HIGHWAY FENCELINE

TOPO SURVEY (BEFORE SMP)

KING SHEET PILE LOCATION

+x SETTING OUT POINT

SECTION LINE

RET. WALL DETAILS

(C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
	1.30	6.50	3.30
	2.06	6.50	3.30
	2.06	6.50	3.30
	2.72	6.50	3.30
	2.72	6.50	3.30
	0.97	6.50	3.30

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

C04	15/05/20	DR	MA	SV
As Built				
Rev	Date	By	Chkd	Appd

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The Galmore Building
20 Galmore Circus Queensway
Birmingham 84 6AT
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Client

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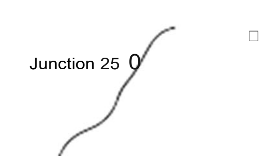
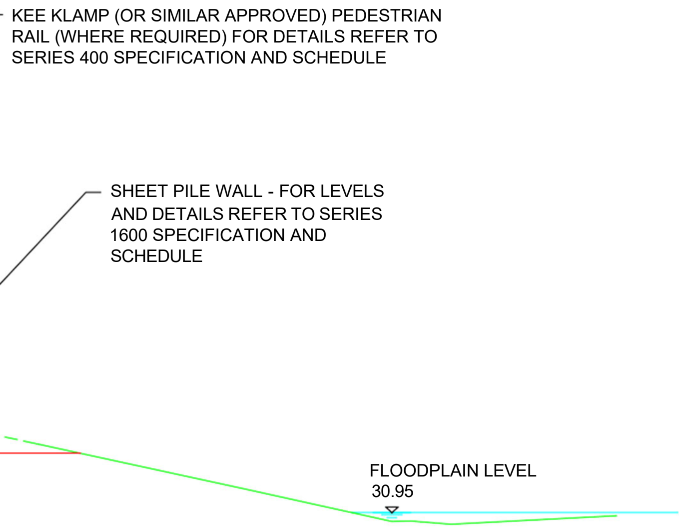
Project Title

SMP M1 J23a - J25

Key Plan





300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
9. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE (LIDAR SUVEY)
- EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- CLASS 6N FILL
- SHEET PILE
- X SETTING OUT POINT

Rev	Date	By	Chkd	Appd
C03	15/05/20	DR	MA	SV
As Built				

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Birmingham B4 6AT
Tel 0121 212 5000

Client

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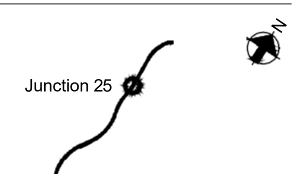
Project Title

SMP M1 J23a - J25

Key Plan



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8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN IN SECTION A-A.
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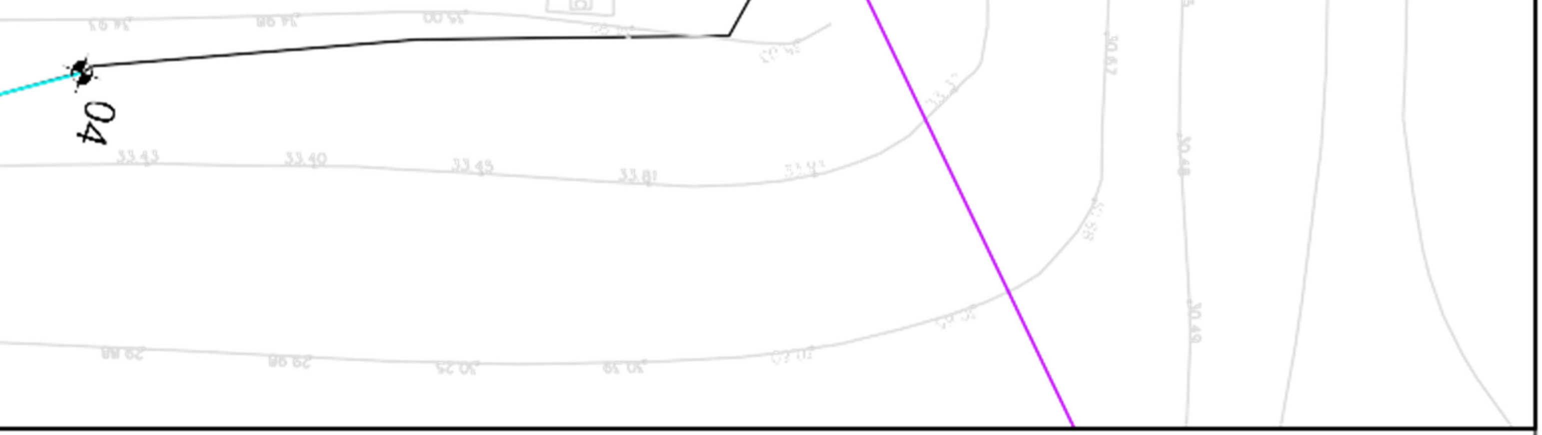


PLAN LEGEND

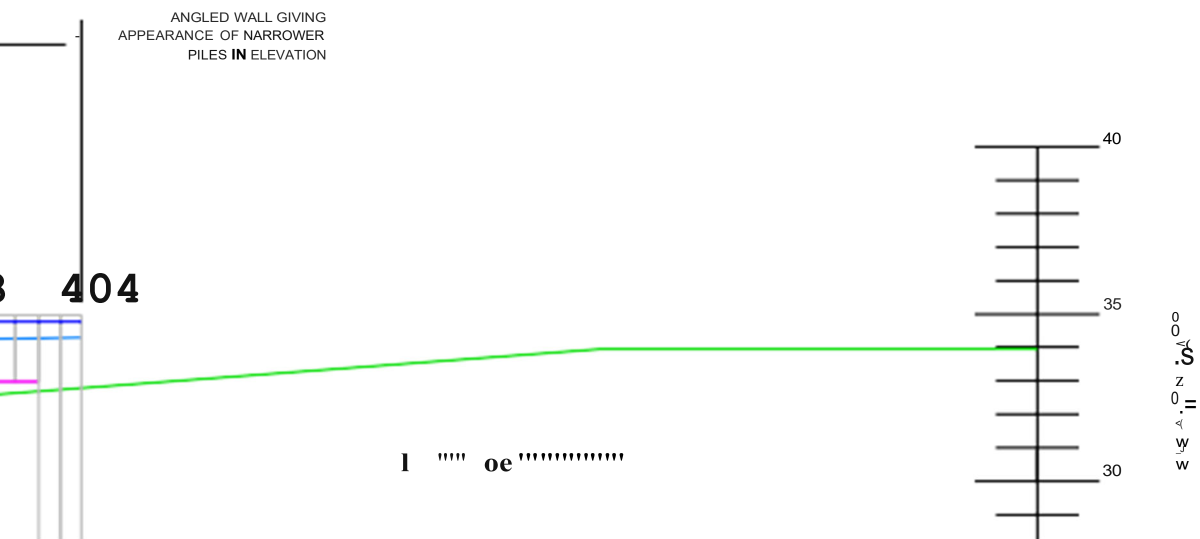
- EXISTING HIGHWAY FENCELINE
- TOPO SURVEY (BEFORE SMP)
- KING SHEET PILE LOCATION
- 4x SETTING OUT POINT
- SECTION LINE

RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
1.51	8.00	2.00
1.72	8.00	2.00
1.44	8.00	2.00
1.08	8.00	2.00

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



C03	15/05/20	DR	MA	SV
As Built				
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20 Galmore Circus Queensway
Birmingham 84 6AT
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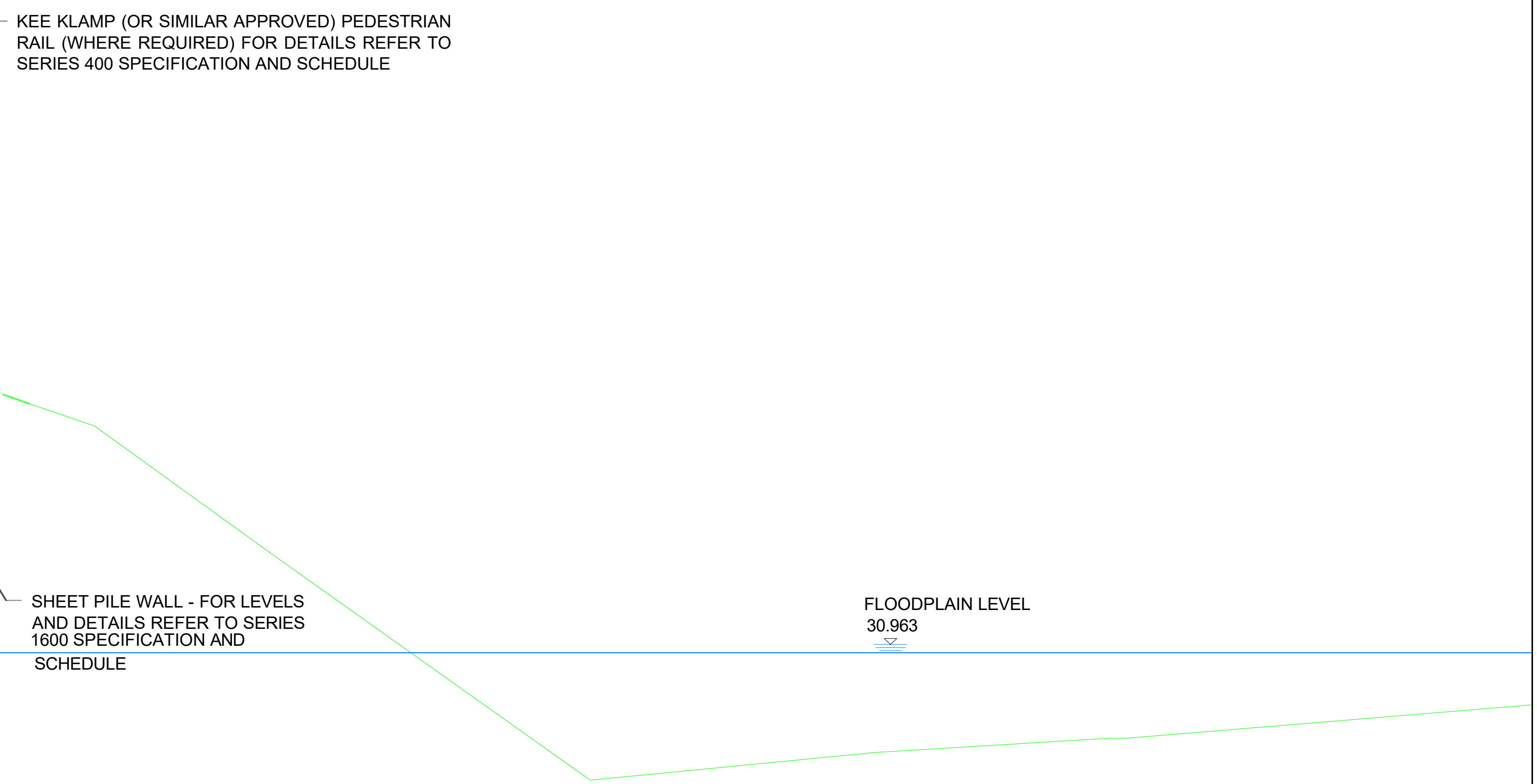
highways england driving forward

Project Title

SMP M1 J23a - J25

Key Plan

Junction 25



300mm FOR SHALLOWER GRADIENTS.

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SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SUVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

CLASS 6N FILL

SHEET PILE

X SETTING OUT POINT

Rev	Date	By	Chkd	Appd
C03	15/05/20	DR	MA	SV
As Built				

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Birmingham B4 6AT
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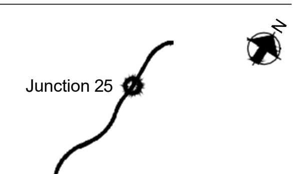
driving forward

Project Title

SMP M1 J23a - J25

Key Plan



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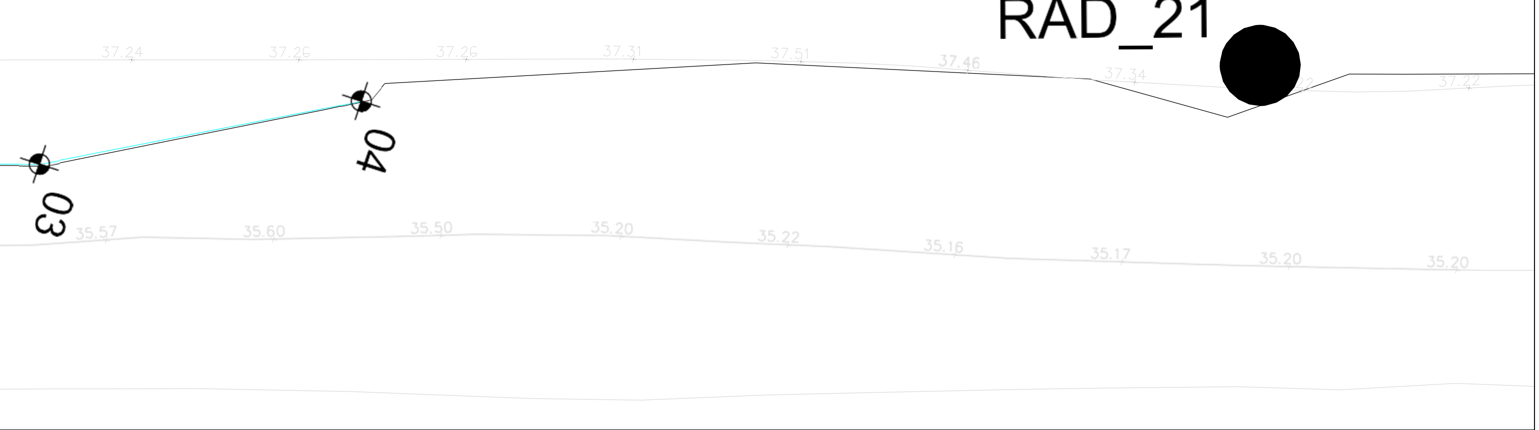

8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN IN SECTION A-A.
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PLAN LEGEND

EXISTING HIGHWAY FENCELINE

TOPO SURVEY (BEFORE SMP)

KING SHEET PILE LOCATION

4x SETTING OUT POINT

SECTION LINE

RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
1.14	7.00	2.40
1.47	7.00	2.40
1.44	7.00	2.40
1 01	7.00	240

ELEVATION LEGEND

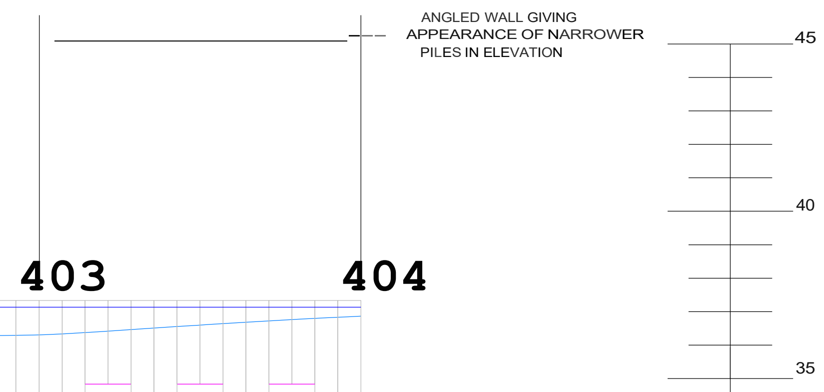
TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)

BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)

BASE OF EMBANKMENT

TOE OF SHEET PILE

SHEET PILES



C04	15/05/20	DR	MA	SV
As Built				
Rev	Date	By	Chkd	Appd

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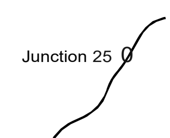
Project Title

SMP M1 J23a - J25

Key Plan



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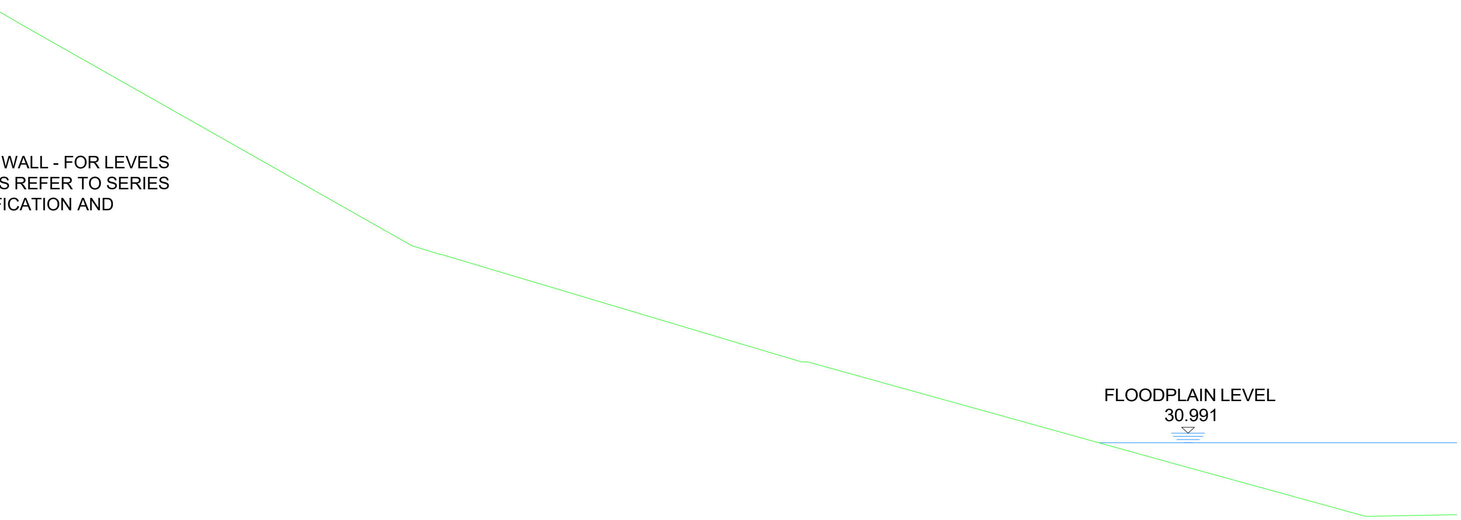
UIRED) FOR DETAILS REFER TO
FICATION AND SCHEDULE

WALL - FOR LEVELS
S REFER TO SERIES
FICATION AND



300mm FOR SHALLOWER GRADIENTS.

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8. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
9. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SUVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

CLASS 6N FILL

SHEET PILE

X SETTING OUT POINT

C03	15/05/20	DR	MA	SV
As Built				
Rev	Date	By	Chkd	Appd

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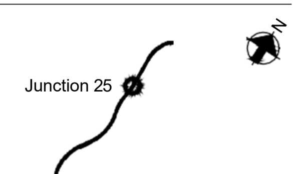
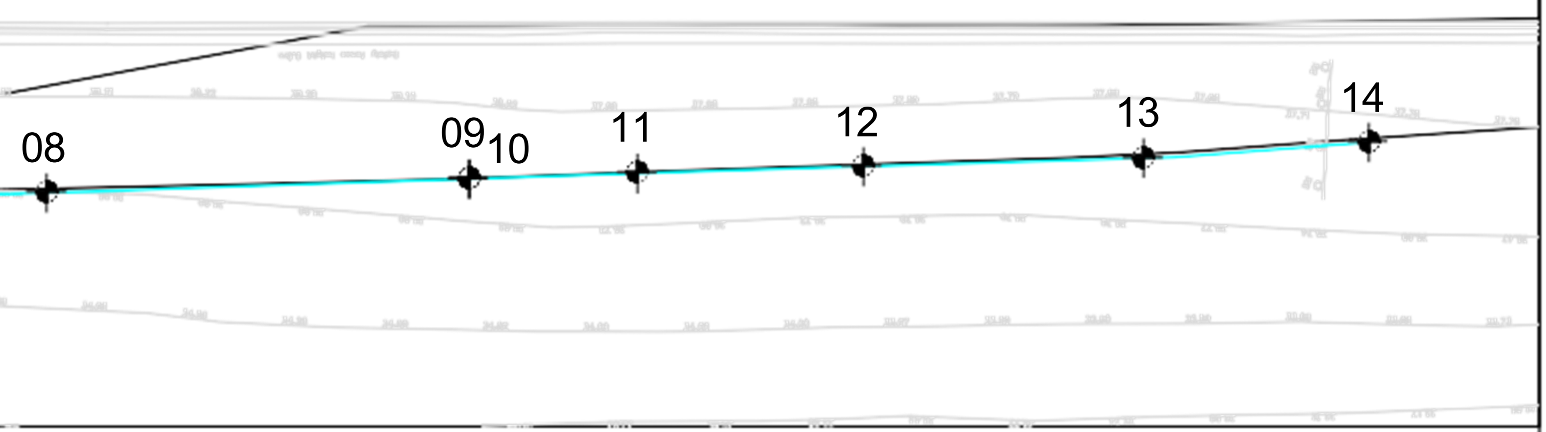
Project Title

SMP M1 J23a - J25

Key Plan





IN HEIGHT.
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PLAN LEGEND

EXISTING HIGHWAY FENCELINE
TOPO SURVEY (BEFORE SMP)
KING SHEET PILE LOCATION
X
SETTING OUT POINT
SECTION LINE

RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
2.23	11.00	4.00
1.99	11.00	4.00
1.97	11.00	4.00
2.38	11.00	4.00
2.62	11.00	4.00
3.09	11.00	4.00
3.25	11.00	4.00
2.97	11.00	4.00
2.11	11.00	4.00
2.11	8.00	3.00
2.13	8.00	3.00
2.11	8.00	3.00
2.14	8.00	3.00
1.60	8.00	3.00

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

C03	15/05/20	DR	MA	SV
As Built				
Rev	Date	By	Chkd	Appd

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20 Colmore Circus Queensway
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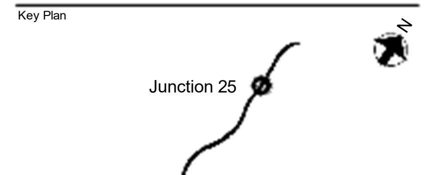
Project Title
SMP M1 J23a - J25

Key Plan


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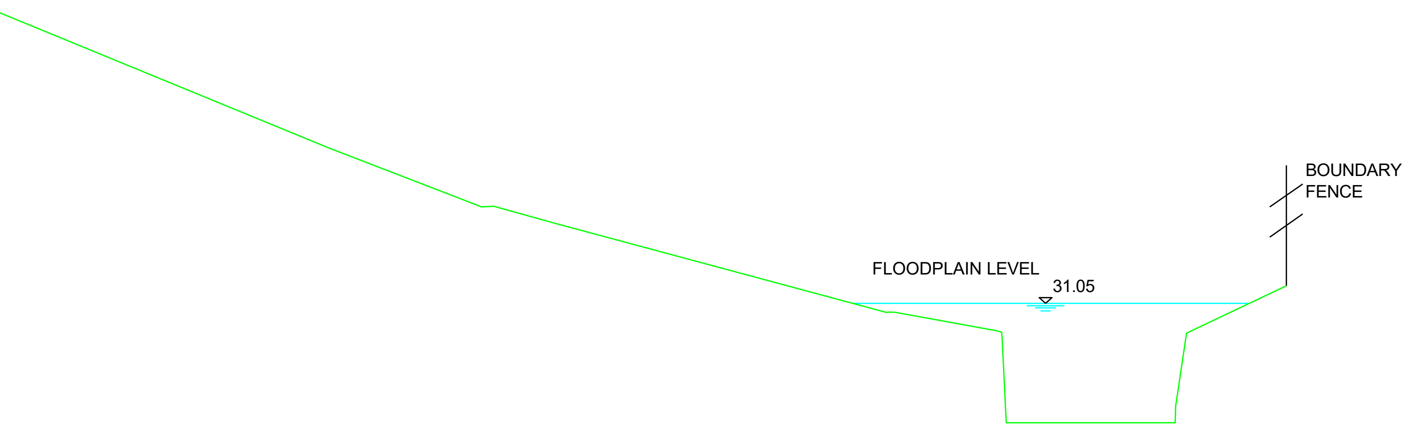

300mm FOR SHALLOWER GRADIENTS.

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SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SUVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

CLASS 6N FILL

SHEET PILE

SETTING OUT POINT

Rev	Date	By	Chkd	Appd
C03	15/05/20	DR	MA	SV
As Built				

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Birmingham B4 6AT
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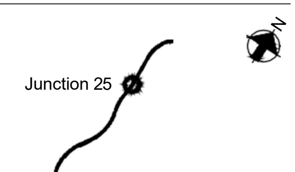
driving forward

Project Title

SMP M1 J23a - J25

Key Plan



IN HEIGHT.

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10. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

PLAN LEGEND

EXISTING HIGHWAY FENCELINE

TOPO SURVEY (BEFORE SMP)

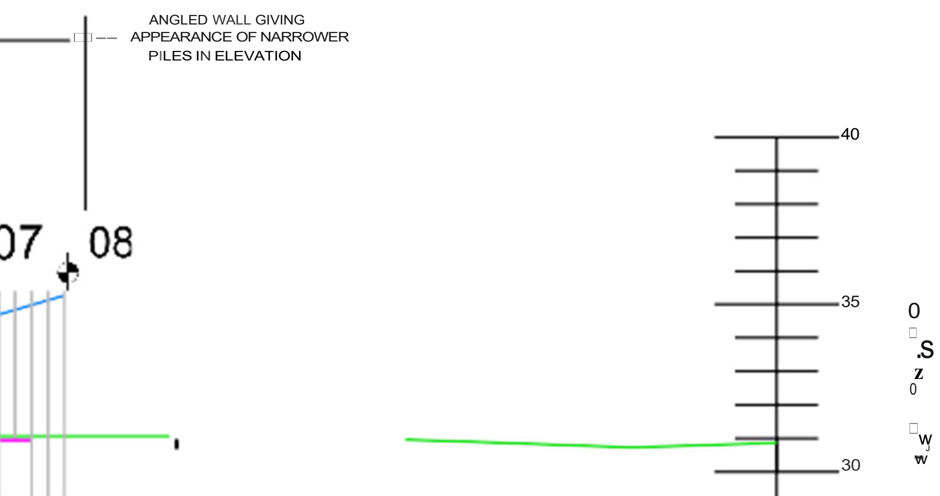
KING SHEET PILE LOCATION

SETTING OUT POINT

SECTION LINE

RET. WALL DETAILS

BASE OF EXCAVATION (C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
34.65	1.24	7.50	5.00
34.29	1.58	7.50	5.00
33.93	1.92	7.50	5.00
33.57	2.26	7.50	5.00
33.30	2.33	7.50	5.00
33.76	1.87	7.50	5.00
34.21	1.43	7.50	5.00
34.67	0.97	7.50	5.00



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

Re,	Date	By	Chkd	Appd
C03	15/05120	DR	MA	SV
As Built				

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20 Galmore Circus Queensway
Birmingham B4 6AT
Tel 0121 212 5000

Client

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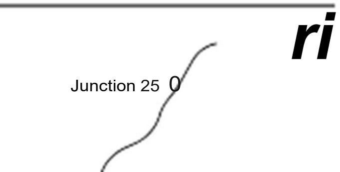
Project Title

SMP M1 J23a - J25

Key Plan



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300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. ALL KSP SECTIONS SHALL BEZ. REFER TO SERIES 1600 FOR FURTHER DETAILS.
9. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SUVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

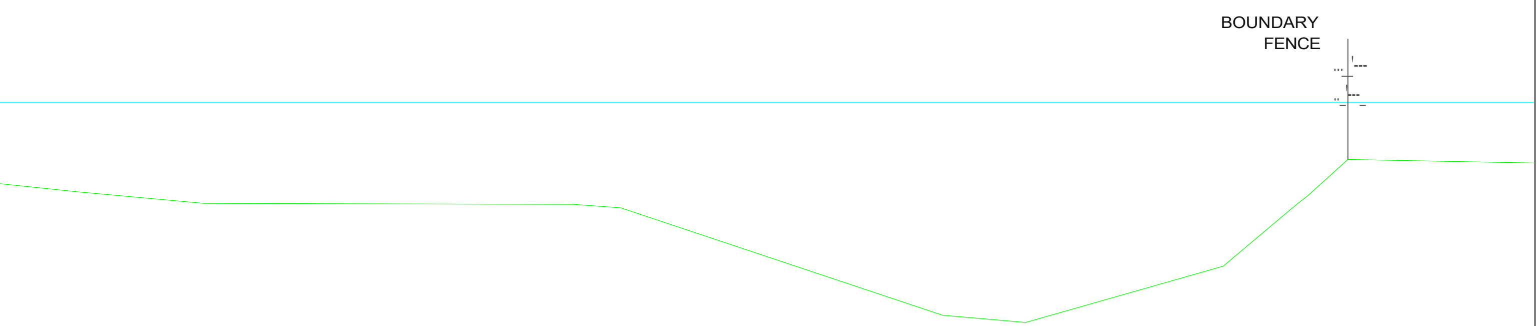
INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

K>(x)j CLASS 6N FILL

SHEET PILE

+X SETTING OUT POINT



C03	15/05/20	DR	MA	SV
As Built				
Rev	Date	By	Chkd	Appd

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Birmingham 84 6AT
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Client

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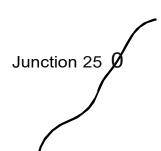
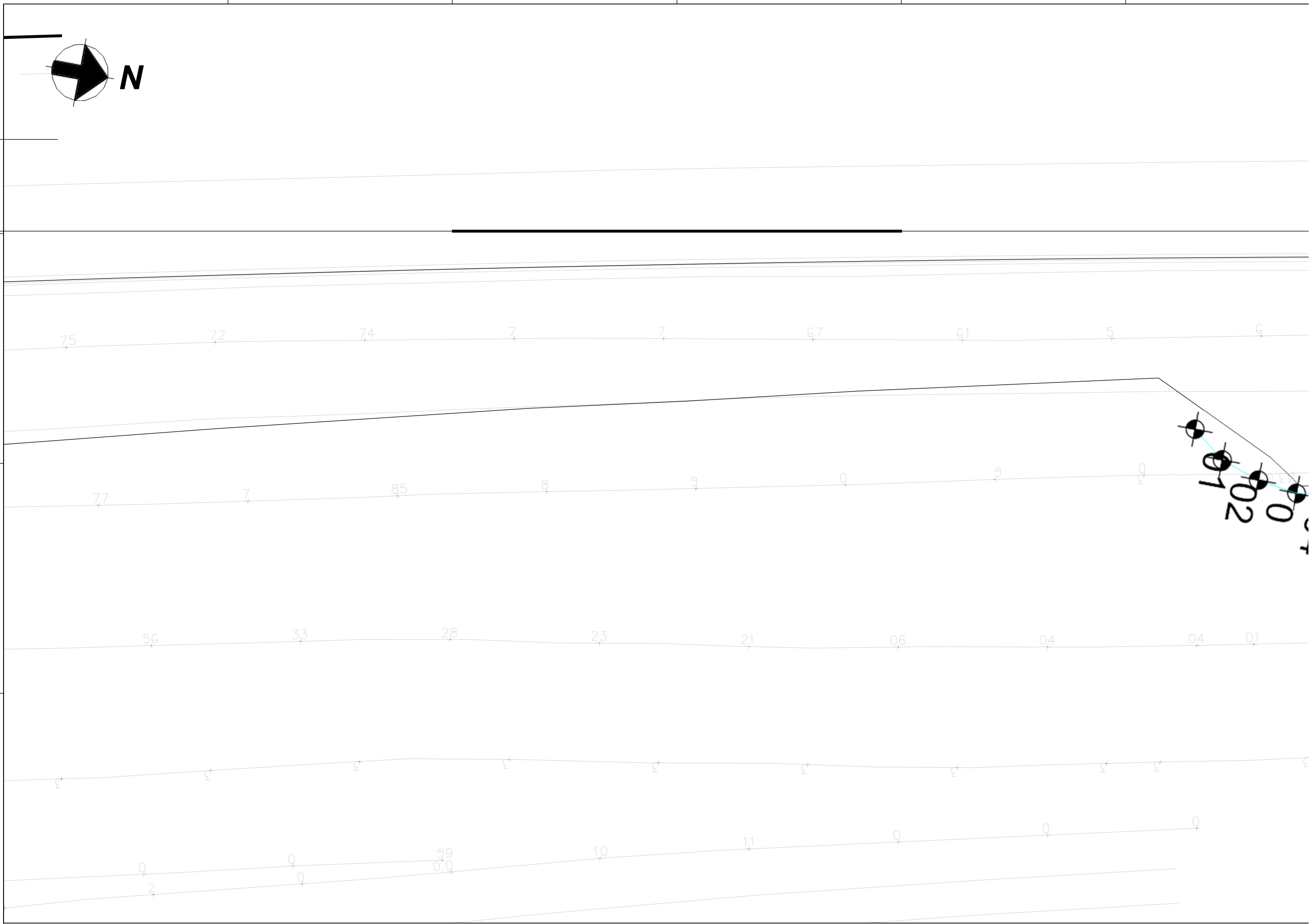
driving forward

Project Title

SMP M1 J23a - J25

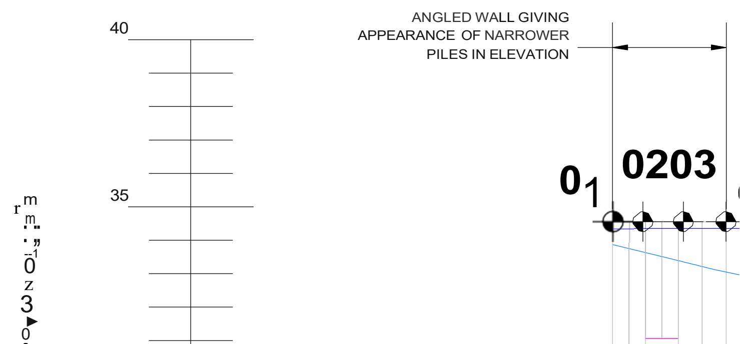
Key Plan





SHEET PILE SETTING OUT POINTS

REFERENCE	EASTING	NORTHING	TOP OF PILE (A)
01	446541.44	331165.93	34.56
02	446542.28	331167.01	34.56
03	446542.72	331168.32	34.56
04	446542.93	331169.72	34.56
05	446540.23	331183.40	34.56
06	446534.36	331187.26	34.56



300mm FOR SHALLOWER GRADIENTS.

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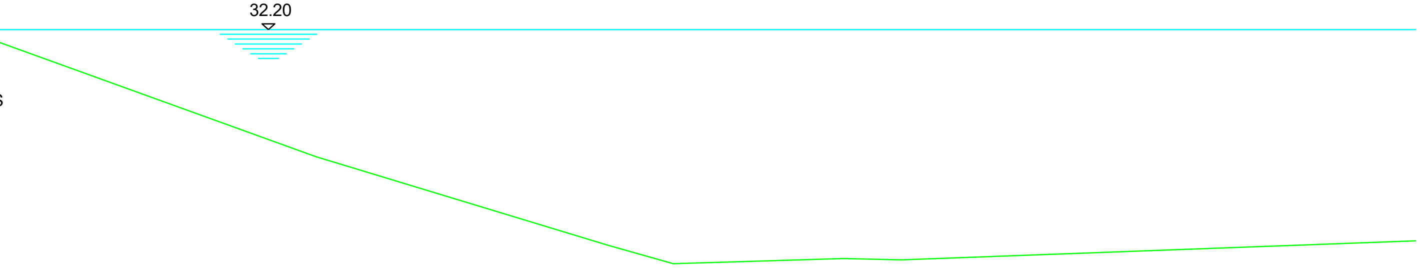
9. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

SECTION LEGEND

(red line)	PROPOSED GROUND PROFILE
(green line)	EXISTING GROUND PROFILE (LIDAR SUVEY)
(green dashed line)	EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
(pink line)	INDICATIVE EXCAVATION PROFILE
(dashed line)	GEOTEXTILE SEPARATOR LAYER
(cross-hatch)	CLASS 6N FILL
(box)	SHEET PILE
X	SETTING OUT POINT

(OR SIMILAR APPROVED) PEDESTRIAN
E REQUIRED) FOR DETAILS REFER TO
SPECIFICATION AND SCHEDULE

PILE WALL - FOR DETAILS REFER TO SERIES
ECIFICATION AND SCHEDULE



Rev	Date	By	Chkd	Appd
C03	15/05/20	DR	MA	SV
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Client

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Project Title

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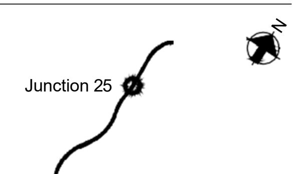
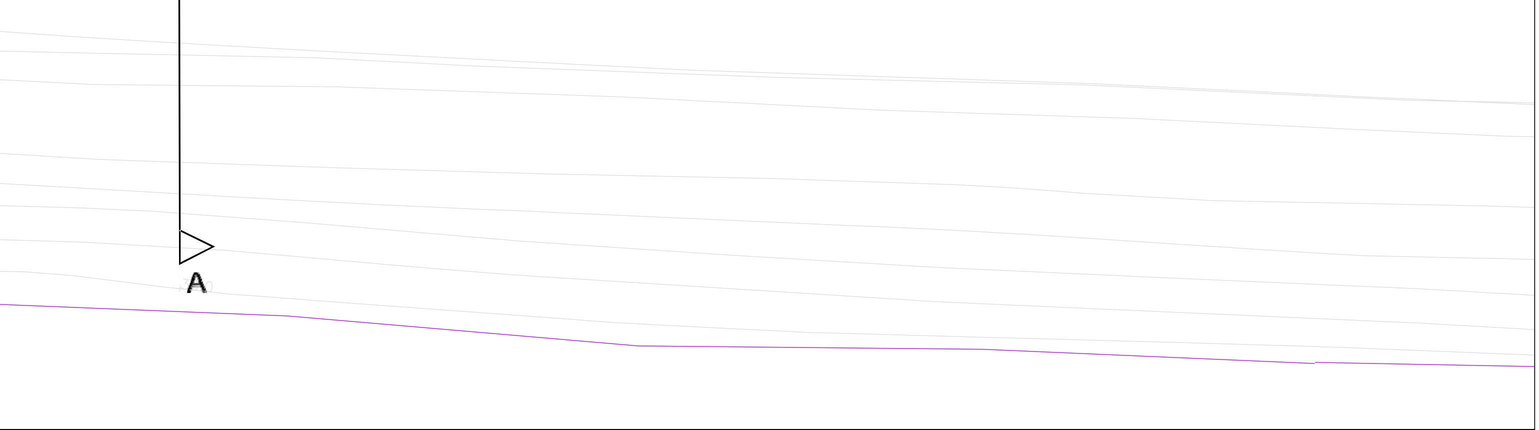
Key Plan



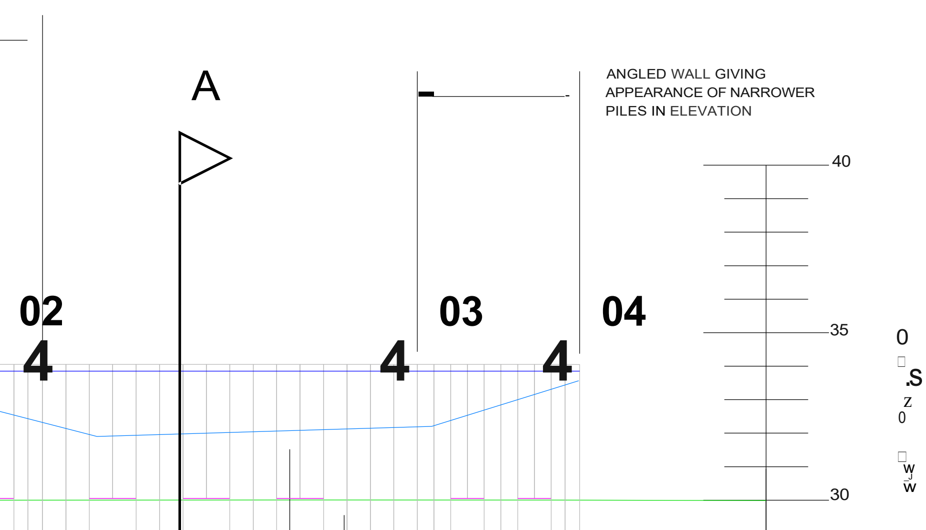


8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN **IN** SECTION A-A.
9. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
10. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

PLAN LEGEND

EXISTING HIGHWAY FENCELINE
TOPO SURVEY (BEFORE SMP)
KING SHEET PILE LOCATION
SETTING OUT POINT
SECTION LINE

	RET. WALL DETAILS		
ON (C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
	0.63	8.00	4.00
	2.16	8.00	4.00
	2.41	8.00	4.00
	0.65	8.00	4.00



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

C04	15/05120	DR	MA	SV
As Built				
Re,	Date	By	Chkd	Appd

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Project Title

SMP M1 J23a - J25

Key Plan

Junction 25

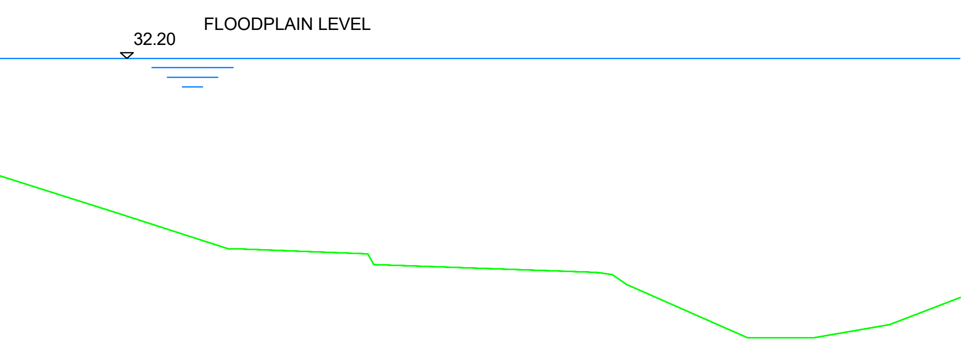
300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
9. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

SECTION LEGEND

	PROPOSED GROUND PROFILE
	EXISTING GROUND PROFILE (LIDAR SUVEY)
	EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
	INDICATIVE EXCAVATION PROFILE
	GEOTEXTILE SEPARATOR LAYER
	CLASS 6N FILL
	SHEET PILE
X	SETTING OUT POINT

LE WALL - FOR LEVELS
ILS REFER TO SERIES 1600
ATION AND SCHEDULE



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Rev	Date	By	Chkd	Appd

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Client

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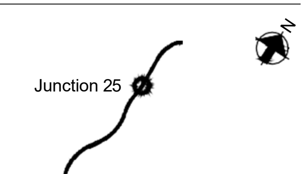
Key Plan



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IN HEIGHT.

8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN **IN** SECTION A-A.
9. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
10. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

PLAN LEGEND

EXISTING HIGHWAY FENCELINE

TOPO SURVEY (BEFORE SMP)

KING SHEET PILE LOCATION

SETTING OUT POINT

SECTION LINE

	RET. WALL DETAILS		
ON (C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
	1.04	6.50	2.50
	1.64	6.50	2.50
	1.76	6.50	2.50
	1.48	6.50	2.50
	1.24	6.50	2.50
	0.96	6.50	2.50

ELEVATION LEGEND

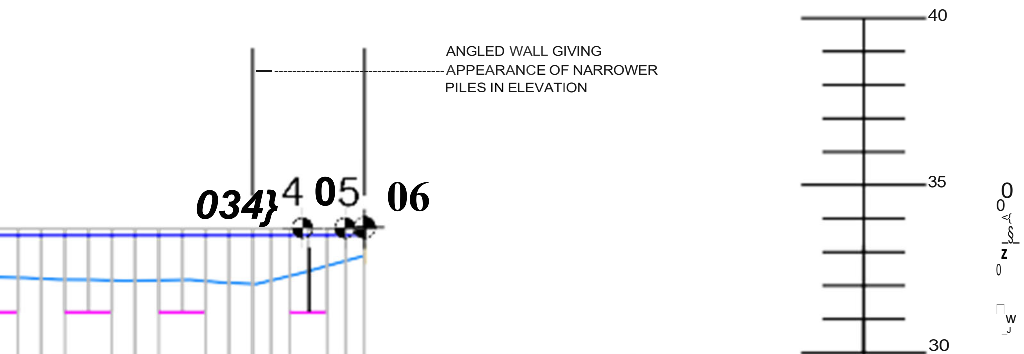
TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)

BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)

BASE OF EMBANKMENT

TOE OF SHEET PILE

SHEET PILES



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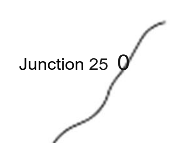
Tel 0121 212 5000

Client

Project Title

SMP M1 J23a - J25

Key Plan



300mm FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
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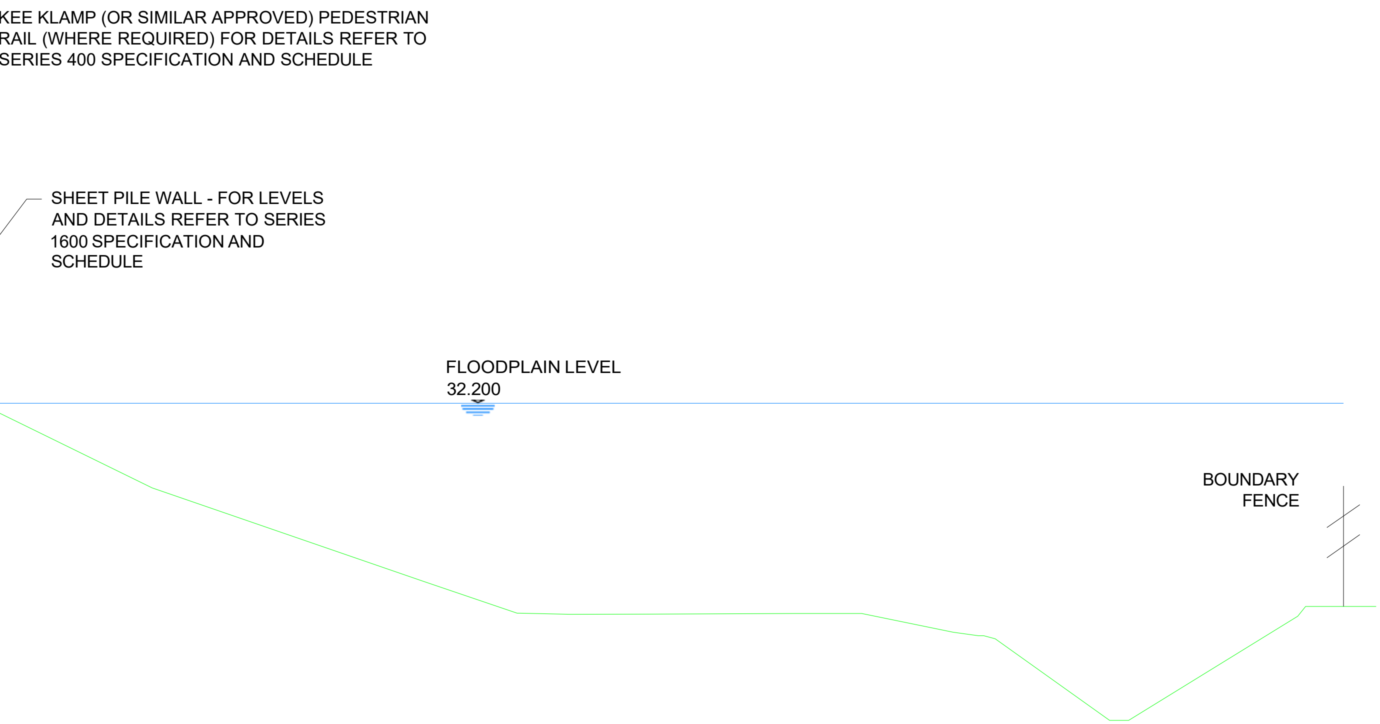

SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SUVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

CLASS 6N FILL

SHEET PILE

SETTING OUT POINT

C03	15/05/20	DR	MA	SV
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Rev	Date	By	Chkd	Appd

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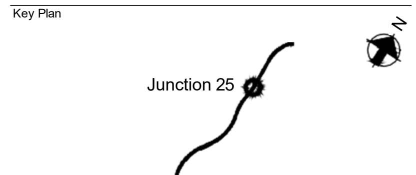
Tel 0121 212 5000

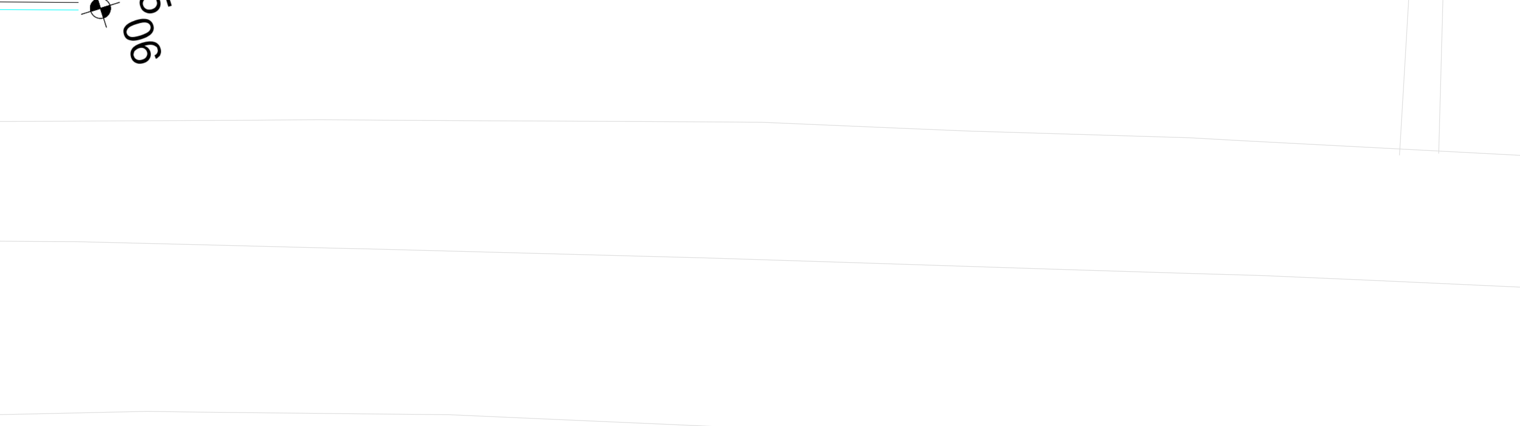
Client

Project Title

SMP M1 J23a - J25

Key Plan





IN HEIGHT.

8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN IN SECTION A-A.
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PLAN LEGEND

EXISTING HIGHWAY FENCELINE

TOPO SURVEY (BEFORE SMP)

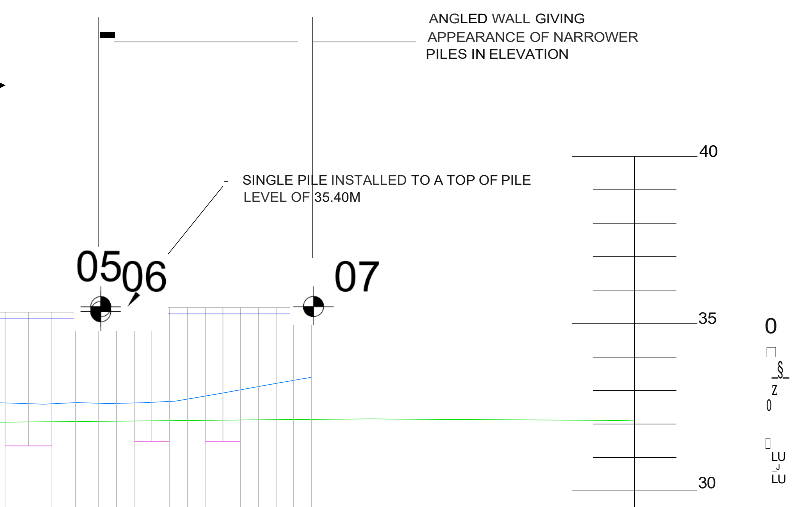
KING SHEET PILE LOCATION

SETTING OUT POINT

SECTION LINE

RET. WALL DETAILS

...ON (C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
	1.66	9.00	4.00
	1.43	9.00	4.00
	2.34	9.00	4.00
	2.50	9.00	4.00
	2.96	9.00	4.00
	3.11	9.00	4.00
	2.34	9.00	4.00



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

Re,	Date	By	Chkd	Appd
C03	15/05120	DR	MA	SV
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Client

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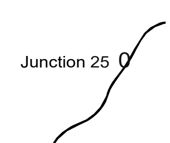
Project Title

SMP M1 J23a - J25

Key Plan



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300mm FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
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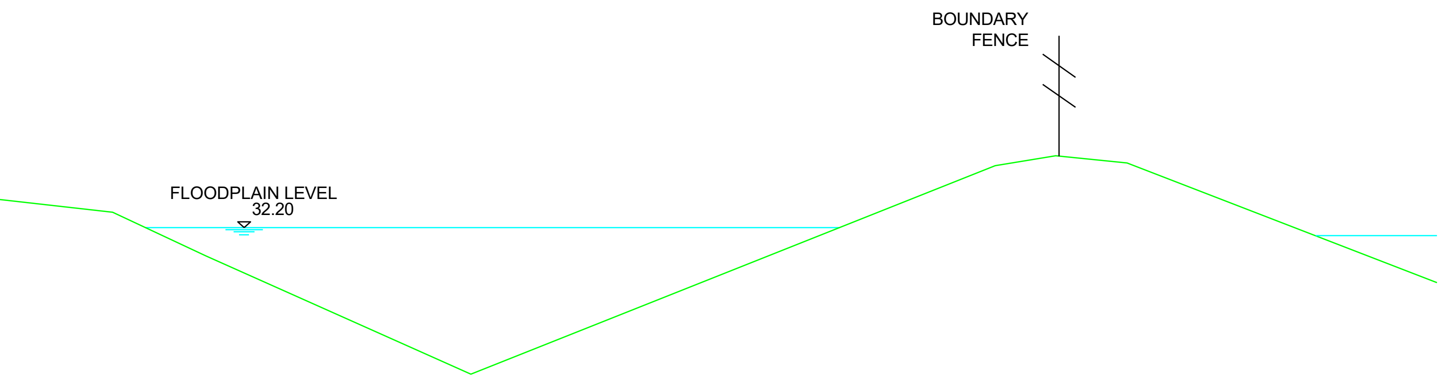
SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE (LIDAR SUVEY)
- EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- CLASS 6N FILL
- SHEET PILE
- X SETTING OUT POINT

MILAR APPROVED) PEDESTRIAN
JIRED) FOR DETAILS REFER TO
ICATION AND SCHEDULE

PILE WALL - FOR DETAILS REFER TO SERIES
PECIFICATION AND SCHEDULE



Rev	Date	By	Chkd	Appd
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As Built				

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Project Title

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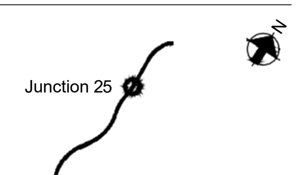
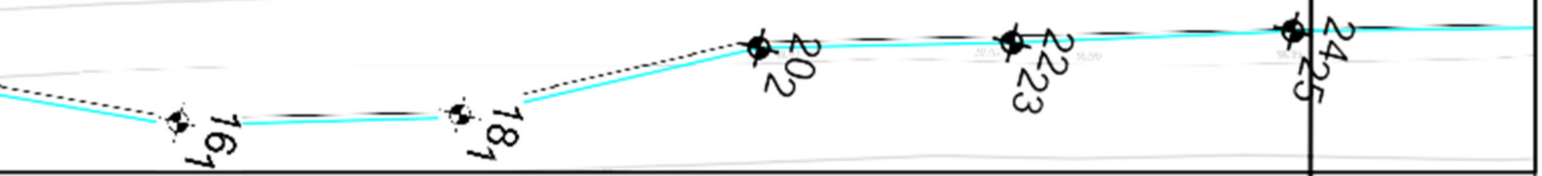
Key Plan





8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN **IN** SECTION A-A.
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RET. WALL DETAILS

TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
1.80	8.00	3.00
1.82	8.00	3.00
1.82	8.00	3.00
1.77	8.00	3.00
1.77	8.00	3.00
1.90	8.00	3.00
1.90	8.00	3.00
1.74	8.00	3.00
1.74	8.00	3.00
1.73	8.00	3.00
1.73	8.00	3.00
1.74	8.00	3.00
1.69	13.00	
2.10	13.00	
2.10	13.00	
3.49	13.00	
3.49	13.00	
3.98	13.00	
3.98	13.00	
2.52	13.00	
2.52	11.00	4.50
2.29	11.00	4.50
2.29	11.00	4.50
2.10	11.00	4.50
2.10	11.00	4.50

PLAN LEGEND

EXISTING HIGHWAY FENCELINE
TOPO SURVEY (BEFORE SMP)
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

C05	15/05120	DR	MA	SV
As Built				
Re,	Date	By	Chkd	Appd

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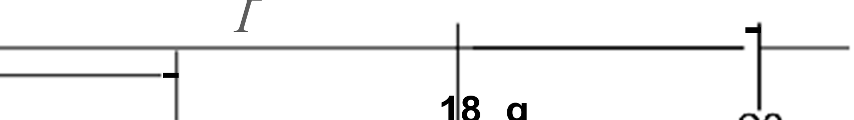
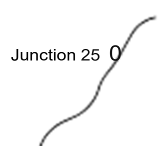
Project Title
SMP M1 J23a - J25

192300-192360 - CONTINUOUS SHEET PILE WALL



For continuation refer to drawing HA549342-AMAR-HGT-SWI-DR-CE-001660

Key Plan


8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN **IN** SECTION **A-A**.
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PLAN LEGEND

EXISTING HIGHWAY FENCELINE

TOPO SURVEY (BEFORE SMP)

KING SHEET PILE LOCATION

SETTING OUT POINT

SECTION LINE

RET. WALL DETAILS

XCAVATION (C)	TOTAL RETAINED HEIGHT	TOTAL SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
38.86	2.49	11.00	4.50
38.86	2.49	8.00	4.50
39.25	2.29	8.00	4.50
39.25	2.29	8.00	4.50
39.63	2.39	8.00	4.50
39.63	2.39	11.00	4.50
39.82	2.00	11.00	4.50
39.90	205	11.00	4.50
39.90	2.05	11.00	4.50
39.03	3.12	11.00	4.50
39.03	3.12	11.00	4.50
40.31	2.17	11.00	4.50
40.31	2.17	13.00	
39.32	3.46	13.00	-
39.32	3.46	13.00	-
39.01	4.04	13.00	-
39.01	4.04	13.00	-
39.89	3.46	13.00	-
39.89	3.46	13.00	-
40.67	2.85	13.00	-
40.67	2.85	11.00	4.50

ELEVATION LEGEND

TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)

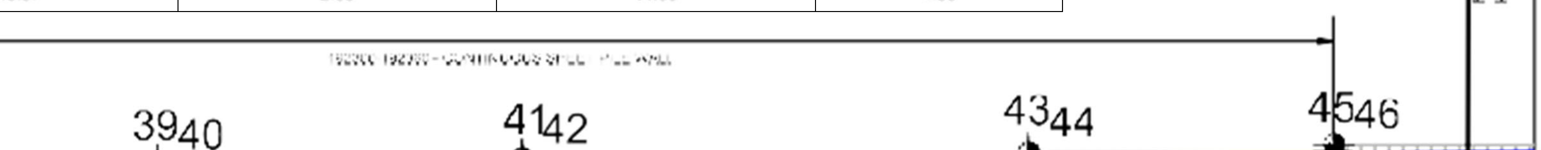
BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)

BASE OF EMBANKMENT

TOE OF SHEET PILE

SHEET PILES

For continuation refer to drawing HA[illegible]-AMAR-HGT-SWI-DR-CE-001[illegible]



C04	15/05120	DR	MA	SV
As Built				
Re,	Date	By	Chkd	Appd

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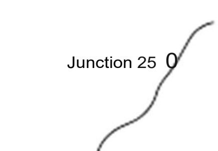
Project Title

SMP M1 J23a - J25

Key Plan



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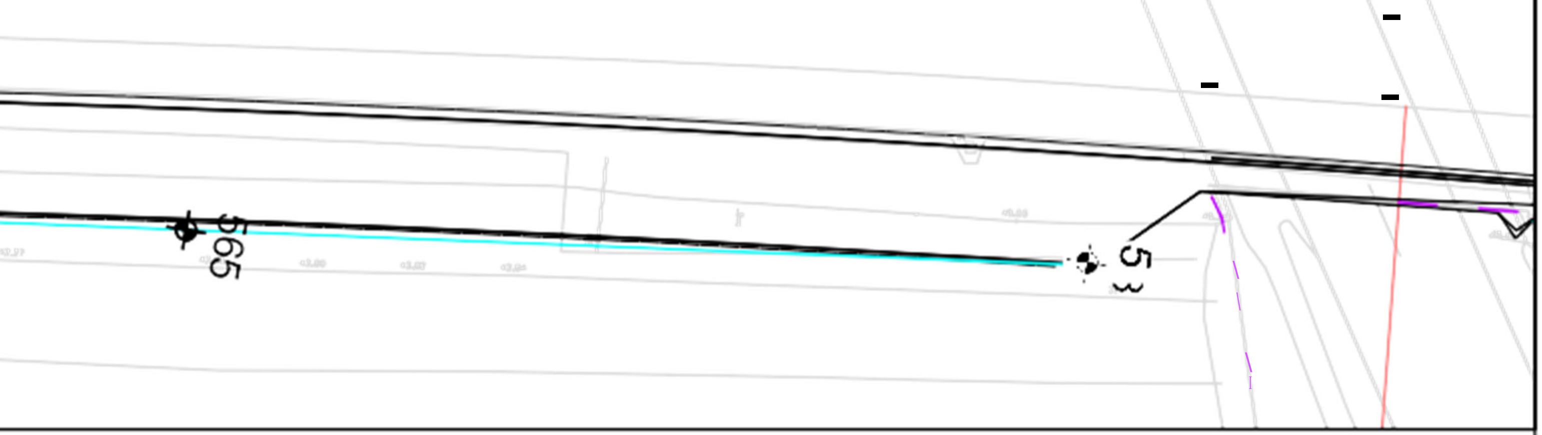

8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN IN SECTION A-A.
9. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
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PLAN LEGEND

EXISTING HIGHWAY FENCELINE

TOPO SURVEY (BEFORE SMP)

KING SHEET PILE LOCATION

SETTING OUT POINT

SECTION LINE

RET. WALL DETAILS

ON (C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE PILE LENGTH
	2	12.00	3.50
	2	12.00	3.50
	1.69	12.00	3.50
	1.69	12.00	3.50
	1.89	12.00	3.50
	2.42	12.00	3.50
	2.42	12.00	3.50
	2.07	12.00	3.50
	2.07	12.00	3.50
	2 01	12.00	3.50
	2.01	12.00	3.50
	2.42	12.00	3.50

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

Re,	Date	By	Chkd	Appd
C04	15/05120	DR	MA	SV
As Built				

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The Galmore Building
20 Galmore Circus Queensway
Birmingham B4 6AT
Tel 0121 212 5000

Client

highways england
driving forward

Project Title

SMP M1 J23a - J25

Key Plan

Junction 25

300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
9. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE (LIDAR SUVEY)
- EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- CLASS 6N FILL
- SHEET PILE
- X SETTING OUT POINT

C04	15/05/20	DR	MA	SV
As Built				
Rev	Date	By	Chkd	Appd

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The Colmore Building
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Birmingham B4 6AT
Tel 0121 212 5000

Client

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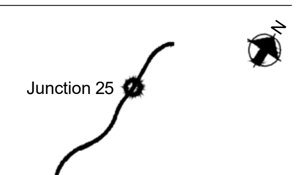
Project Title

SMP M1 J23a - J25

Key Plan



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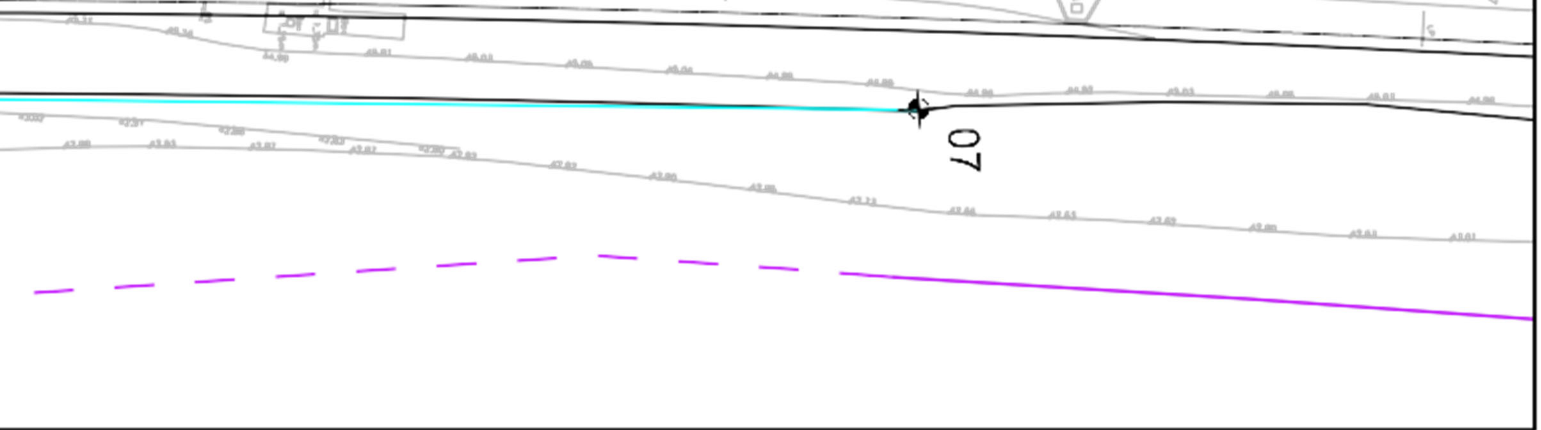


8. EXCAVATION PROFILES VARY. WORST CASE SCENARIO SHOWN IN SECTION A-A.
9. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
10. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079 COPYRIGHT BALFOUR BEATTY PLC 2008

PLAN LEGEND

EXISTING HIGHWAY FENCELINE

TOPO SURVEY (BEFORE SMP)

KING SHEET PILE LOCATION

SETTING OUT POINT

SECTION LINE

	RET. WALL DETAILS			
ASE OF EXCAVATION (C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH	
43.17	2.39	12.50	4.40	
42.40	3.05	12.50	4.40	
42.40	305	12.50	4.40	
43.29	2.02	12.50	4.40	
43.43	1.81	12.50	4.40	
43.43	1.81	8.50	3.50	
44.38	0.64	8.50	3.50	

ELEVATION LEGEND

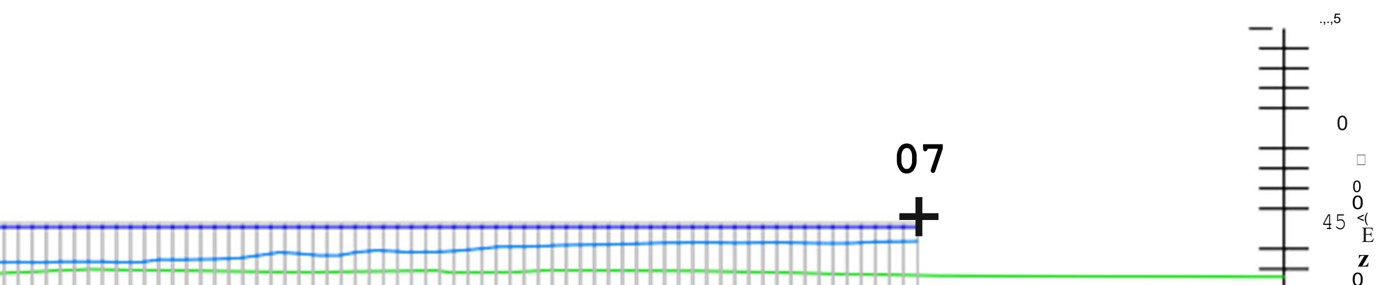
TOP OF RETAINED HEIGHT (BACK OF WALL GROUND LEVEL)

BASE OF RETAINED HEIGHT (FRONT OF WALL GROUND LEVEL)

BASE OF EMBANKMENT

TOE OF SHEET PILE

SHEET PILES



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As Built				
Re,	Date	By	Chkd	Appd

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Birmingham B4 6AT
Tel 0121 212 5000

Client

highways england driving forward

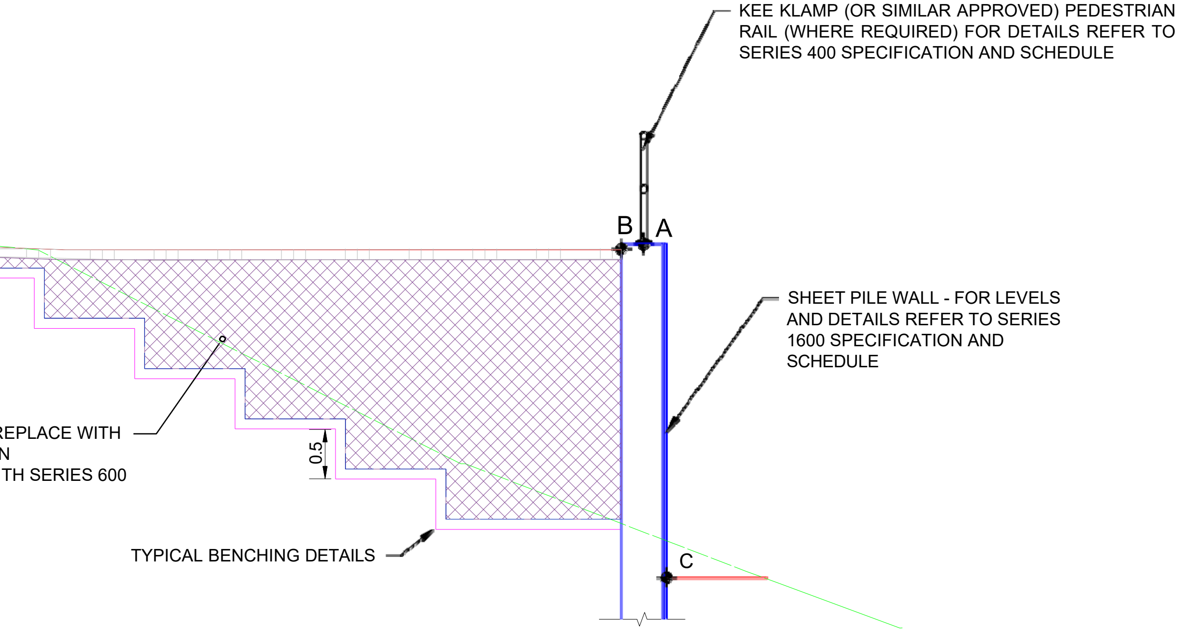
Project Title

SMP M1 J23a - J25

Key Plan

Junction 25

ri



300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
9. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE (LIDAR SUVEY)
- EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- CLASS 6N FILL
- SHEET PILE
- X SETTING OUT POINT

C03	15/05/20	DR	MA	SV
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Tel 0121 212 5000

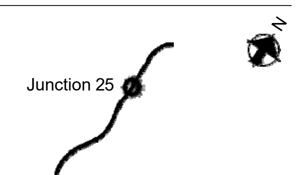
Client

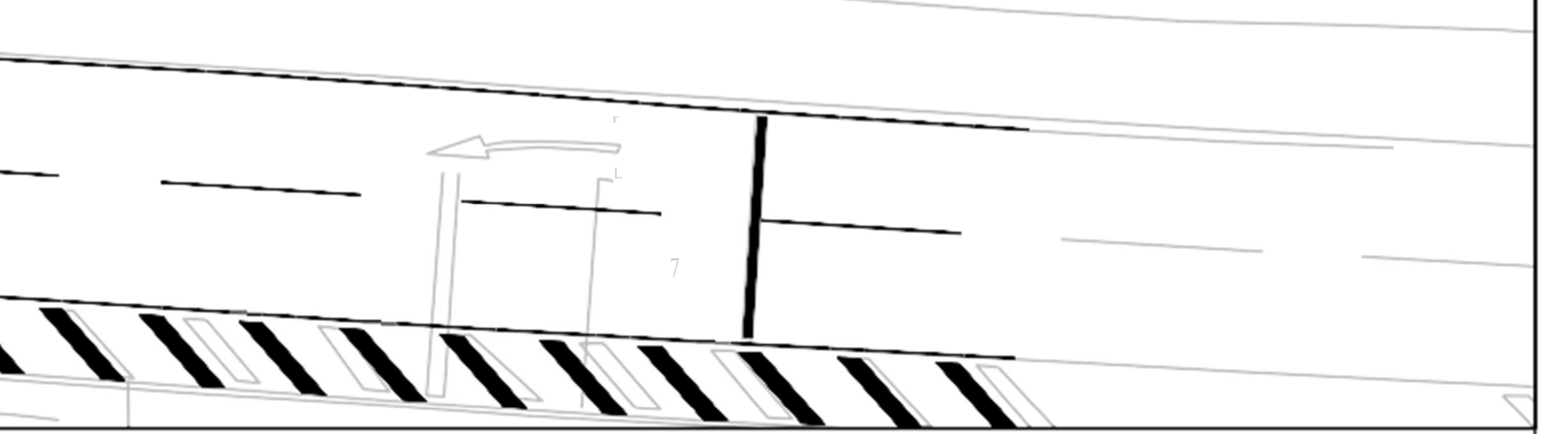
highways england driving forward

Project Title

SMP M1 J23a - J25

Key Plan





SLOPES OF 1(V):2(H) OR STEEPER, OR 300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED a.Sm IN HEIGHT.

8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED ON SECTIONS.

9. ALL SHEET PILE SECTIONS SHALL BEZ SECTIONS. REFER TO SERIES 1600 FOR FURTHER DETAILS.

PLAN LEGEND

- EXISTING HIGHWAY FENCELINE
- TOPO SURVEY (BEFORE SMP)
- KING SHEET PILE LOCATION
- GABIONWALL
- SECTION LINE
- SETTING OUT POINT

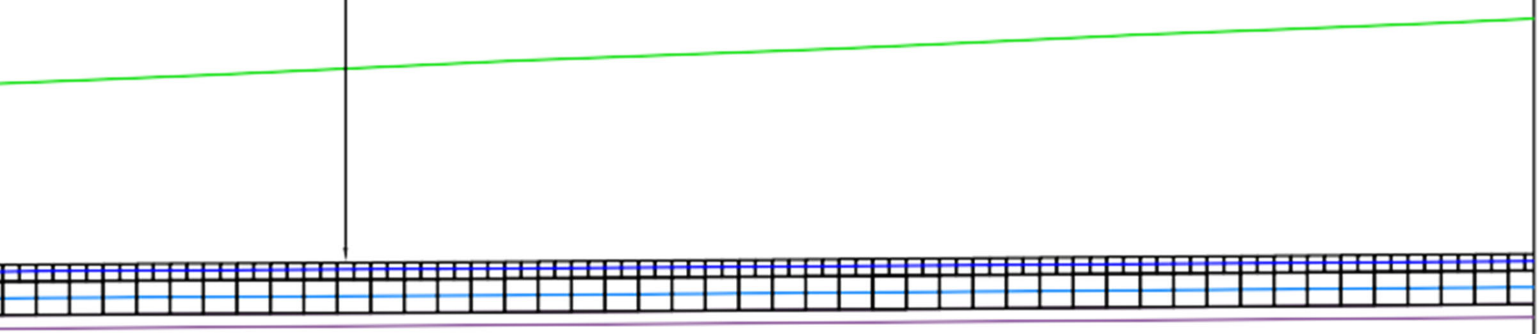
RET. WALL DETAILS

ETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH	TOTAL INTERMEDIATE SHEET PILE LENGTH
0.75	5.00	2.00
0.77	5.00	2.00
0.77	5.00	2.00
1.09	5.00	2.00

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]

FOR GABION WALL SETTING OUT DETAILS REFER TO DRAWINGS HA549342-AMAR-HGT-SW-DR-CE-000614 & HA549342-AMAR-HGT-SW-DR-CE-000615



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As Built				
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Birmingham B4 6AT
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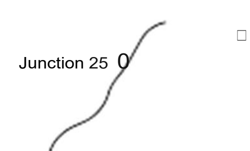
Project Title

SMP M1 J23a - J25

Key Plan



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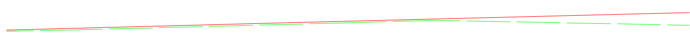

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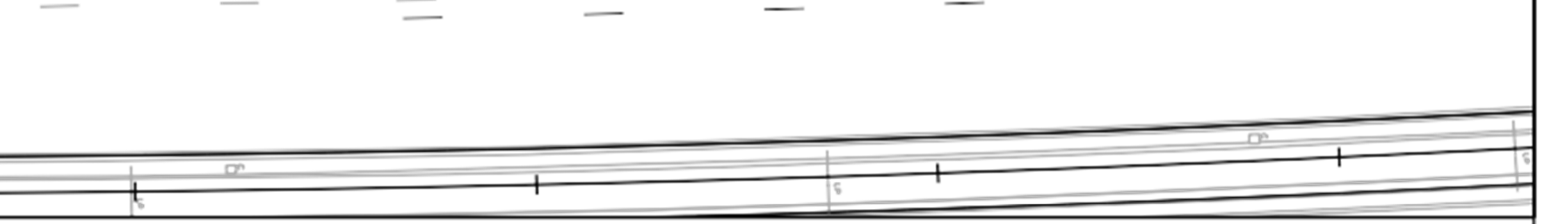

8. EXCAVATION PROFILES VARY, WORST CASE SCENARIO SHOWN **IN** SECTION A-A.
9. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
10. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

		RET. WALL DETAILS	
(B)	BASE OF EXCAVATION (C)	TOTAL RETAINED HEIGHT	TOTAL KING SHEET PILE LENGTH
	33.51	0.35	6.00
	33.54	0.40	6.00
	33.54	0.40	6.00
	33.58	0.64	6.00
	33.58	0.64	6.00
	33.62	0.80	6.00
	33.62	0.80	6.00
	33.66	0.97	6.00
	33.66	0.97	6.00
	33.69	1 08	6.00
	33.69	1.08	6.00
	33.73	1.17	6.00
	33.73	1.17	6.00
	33.77	1.25	6.00
	33.77	1.25	6.00
	33.81	1.25	6.00
	33.87	1.57	6.00
	33.88	1.67	6.00
	33.89	1.45	6.00
	33.89	1.45	6.00
	33.89	1.23	6.00
	33.89	1.23	6.00
	3389	098	600
	33.90	0.97	6.00
	33.90	0.71	6.00
	33.90	0.71	6.00
	33.90	0.50	6.00
	33.90	0.50	6.00
	33.91	0.27	6.00
	33.91	0.27	6.00
	33.91	0.06	6.00

PLAN LEGEND

EXISTING HIGHWAY FENCELINE
TOPO SURVEY (BEFORE SMP)
KING SHEET PILE LOCATION
4x 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

ANGLED WALL GIVING APPEARANCE OF NARROWER PILES IN ELEVATION

1—1

CO2	15/05/20	DR	MA	SV
As Built				
Re.	Date	By	Chkd	Appd

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Birmingham B4 6AT
Tel 0121 212 5000

Client

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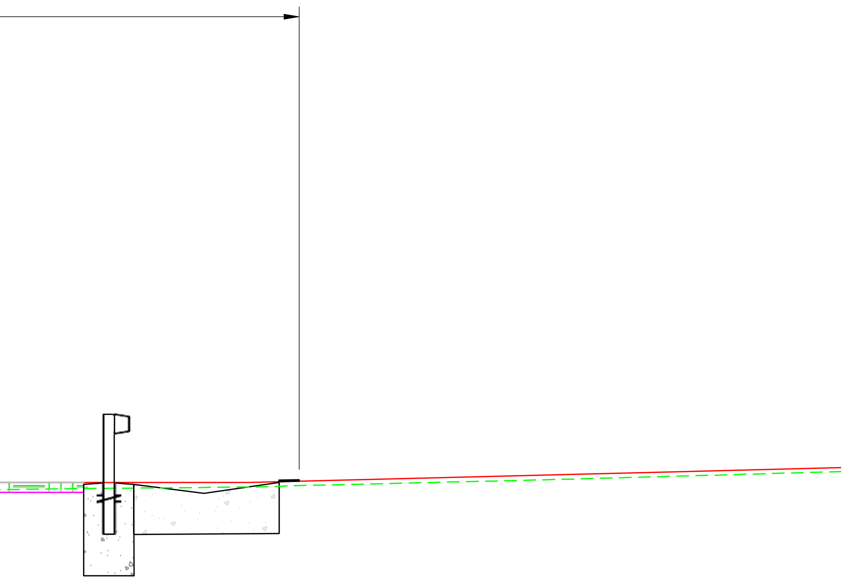
Project Title

SMP M1 J23a - J25

Key Plan

Junction 25



300mm FOR SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. ALL KSP SECTIONS SHALL BE Z. REFER TO SERIES 1600 FOR FURTHER DETAILS.
9. THE KING SHEET PILING (KSP®) SYSTEM IS COVERED BY ONE OR MORE PATENTS OR PATENT APPLICATIONS, INCLUDING GB2463079. COPYRIGHT BALFOUR BEATTY PLC 2008

SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SURVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

SHEET PILE

X SETTING OUT POINT

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Rev	Date	By	Chkd	Appd

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20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 212 5000

Client

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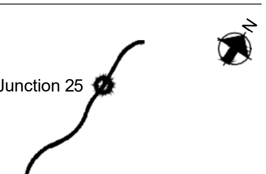
Project Title

SMP M1 J23a - J25

Key Plan



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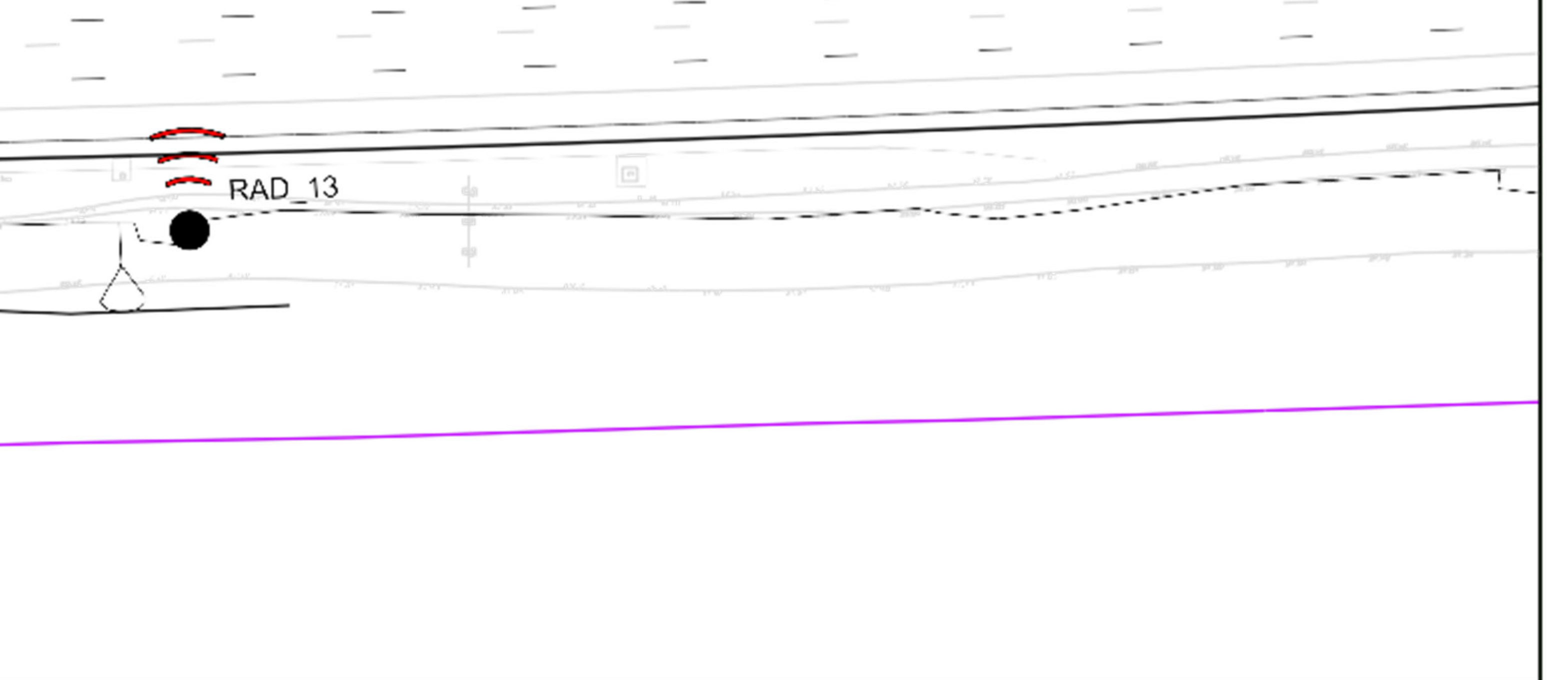

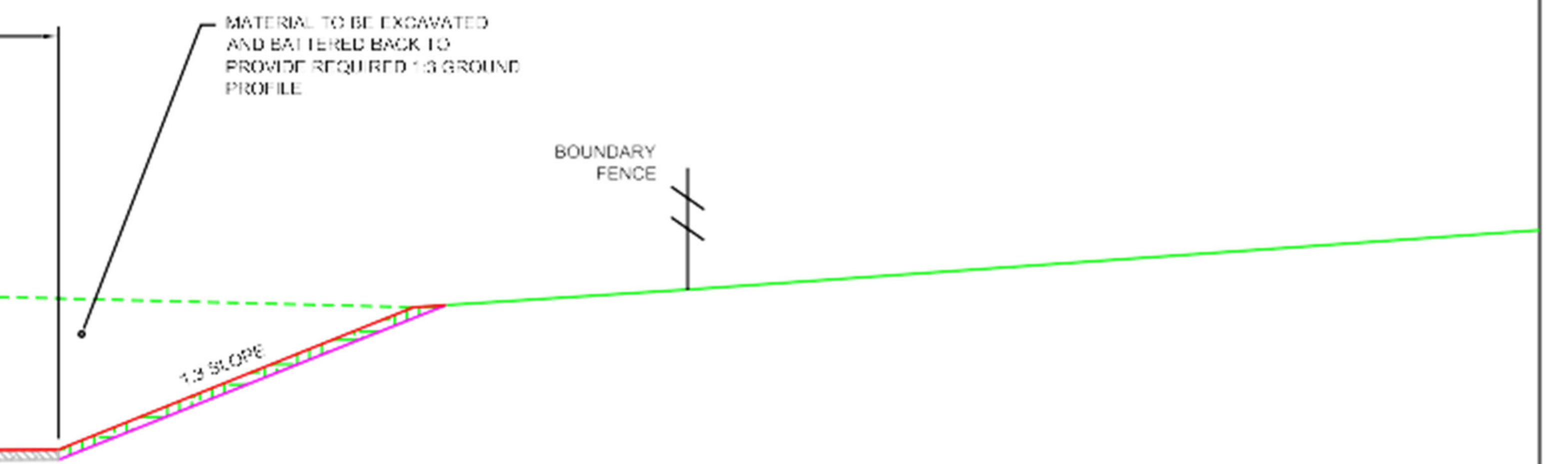

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY. WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. FOR TYPICAL DETAILS OF EARTHWORK SOLUTIONS REFER TO HA549342-AMAR-HGT-SW-DR-CE-000001

PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- TOPO SURVEY (BEFORE SMP

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE (LIDAR SURVEY)
- EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL
- GRANULAR FILL (REFER TO SERIES 600 SPECIFICATION)

C02	21/05/20	DR	MA	SV
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Rev	Date	By	Chkd	Appd

amey ARUP

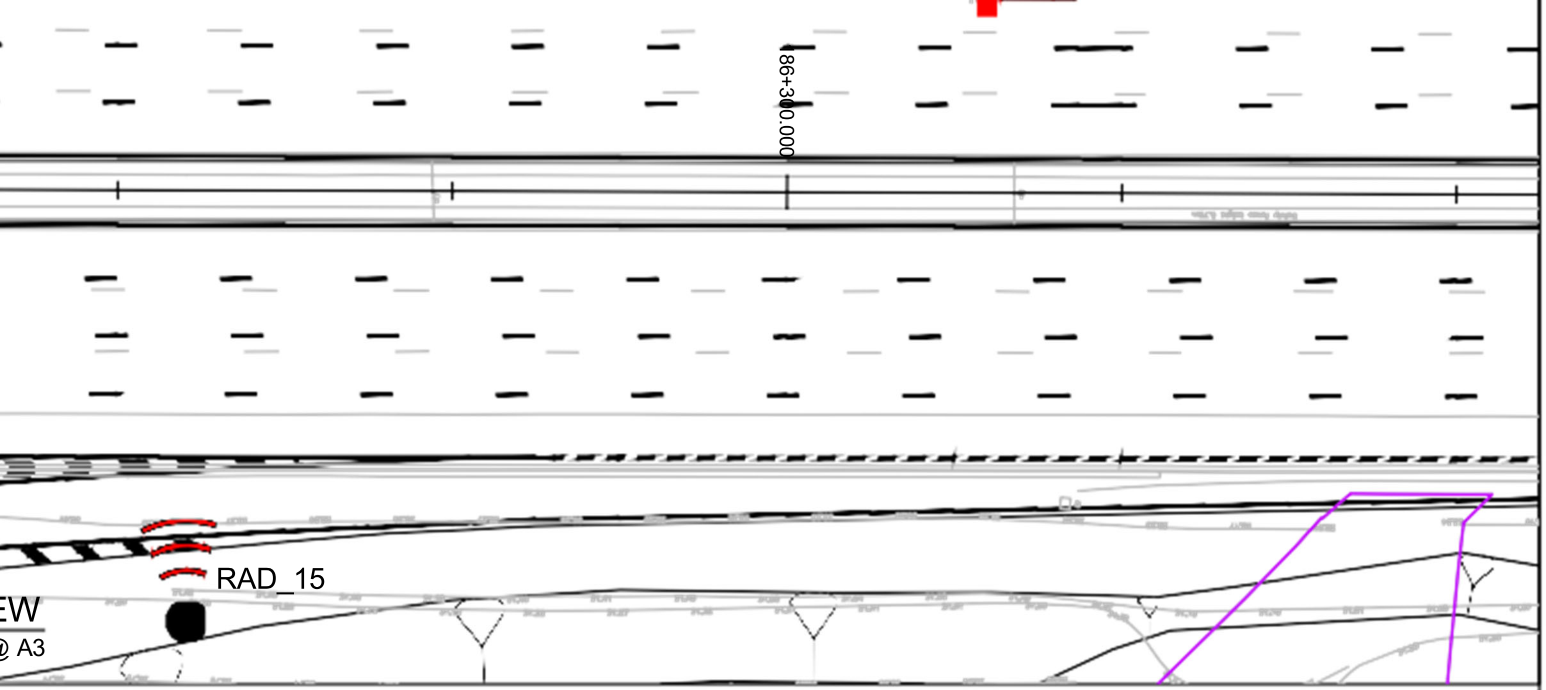
Client

highways england driving forward

Project Title

SMP M1 J23a - J25

Key Plan



IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-001601.

PLAN LEGEND

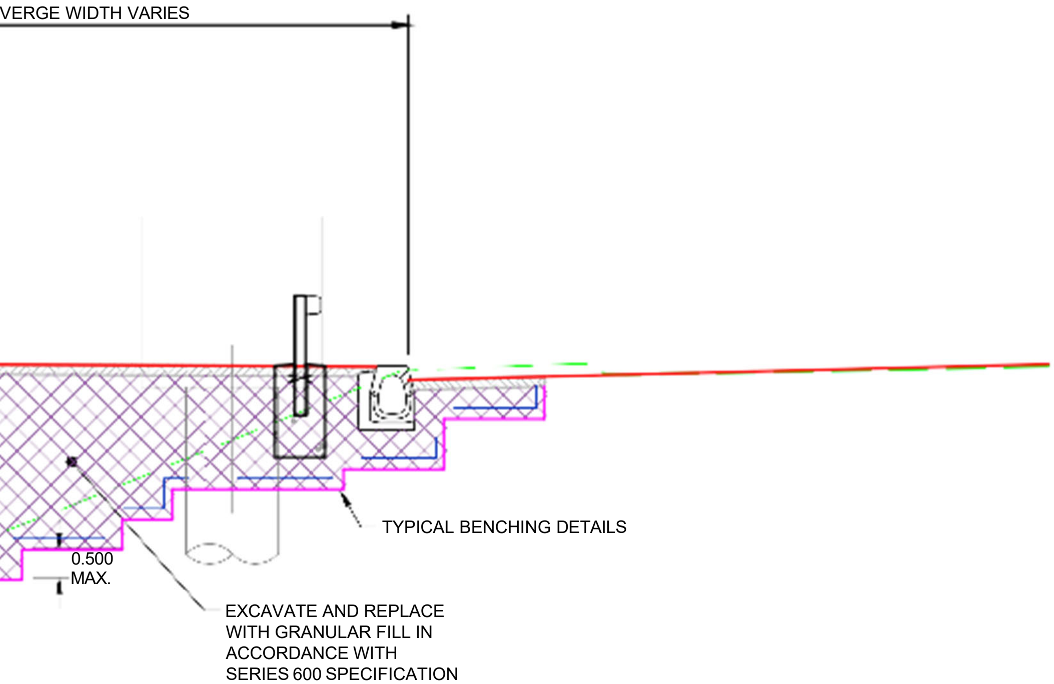
SECTION LINE
HIGHWAYS ENGLAND BOUNDARY
SHEET PILE
TOPO SURVEY (BEFORE SMP)

SECTION LEGEND

PROPOSED GROUND PROFILE
EXISTING GROUND PROFILE (LIDAR SURVEY)
EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
INDICATIVE EXCAVATION PROFILE
GEOTEXTILE SEPARATOR LAYER

GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION

SHEET PILE



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Client

Project Title
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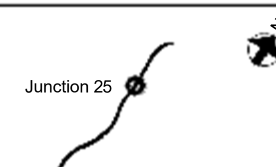

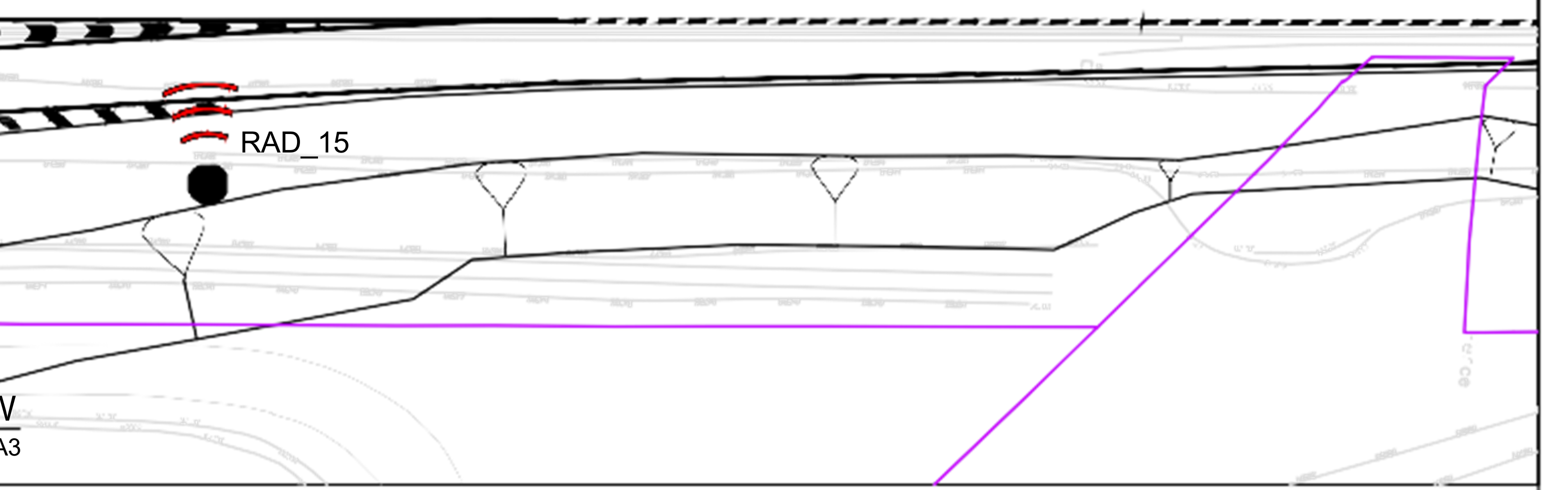

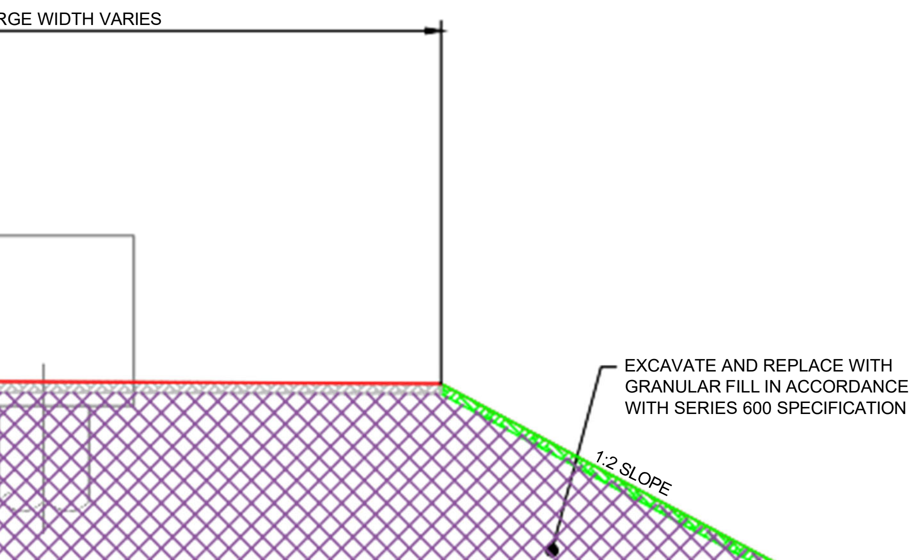

SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY. WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. FOR TYPICAL DETAILS OF EARTHWORK SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000601.

PLAN LEGEND

SECTION LINE

HIGHWAYS ENGLAND BOUNDARY

TOPO SURVEY (BEFORE SMP)

SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SURVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

TOPSOIL

GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

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C02	21/05/20	DR	MA	SV
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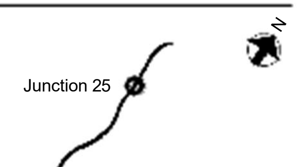
Key Plan



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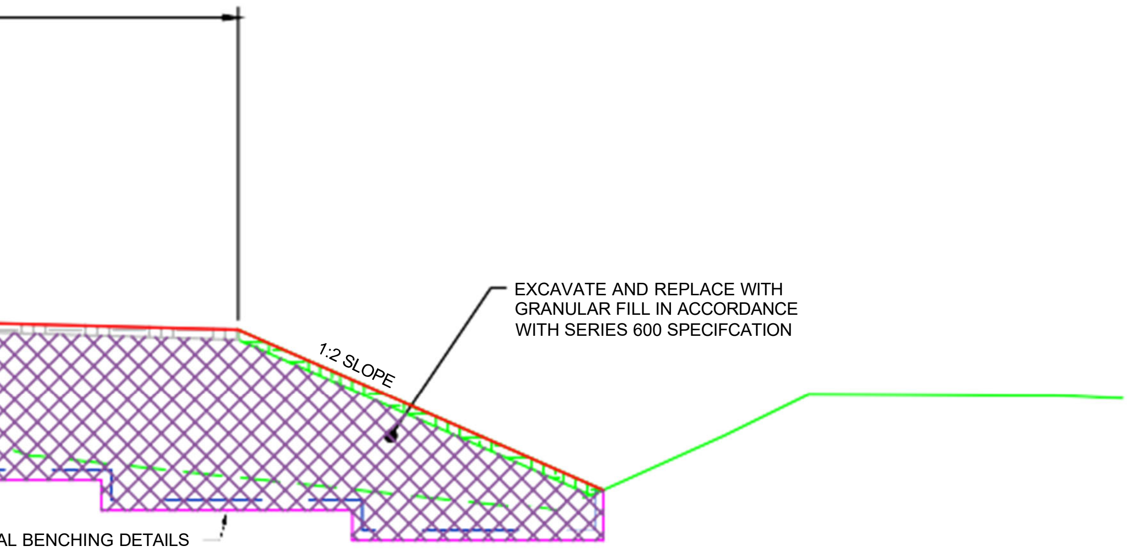

SHALLOWER GRADIENTS.

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PLAN LEGEND

SECTION LINE

HIGHWAYS ENGLAND BOUNDARY

TOPO SURVEY (BEFORE SMP)

SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SURVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

TOPSOIL

GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

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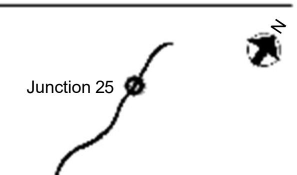
Project Title

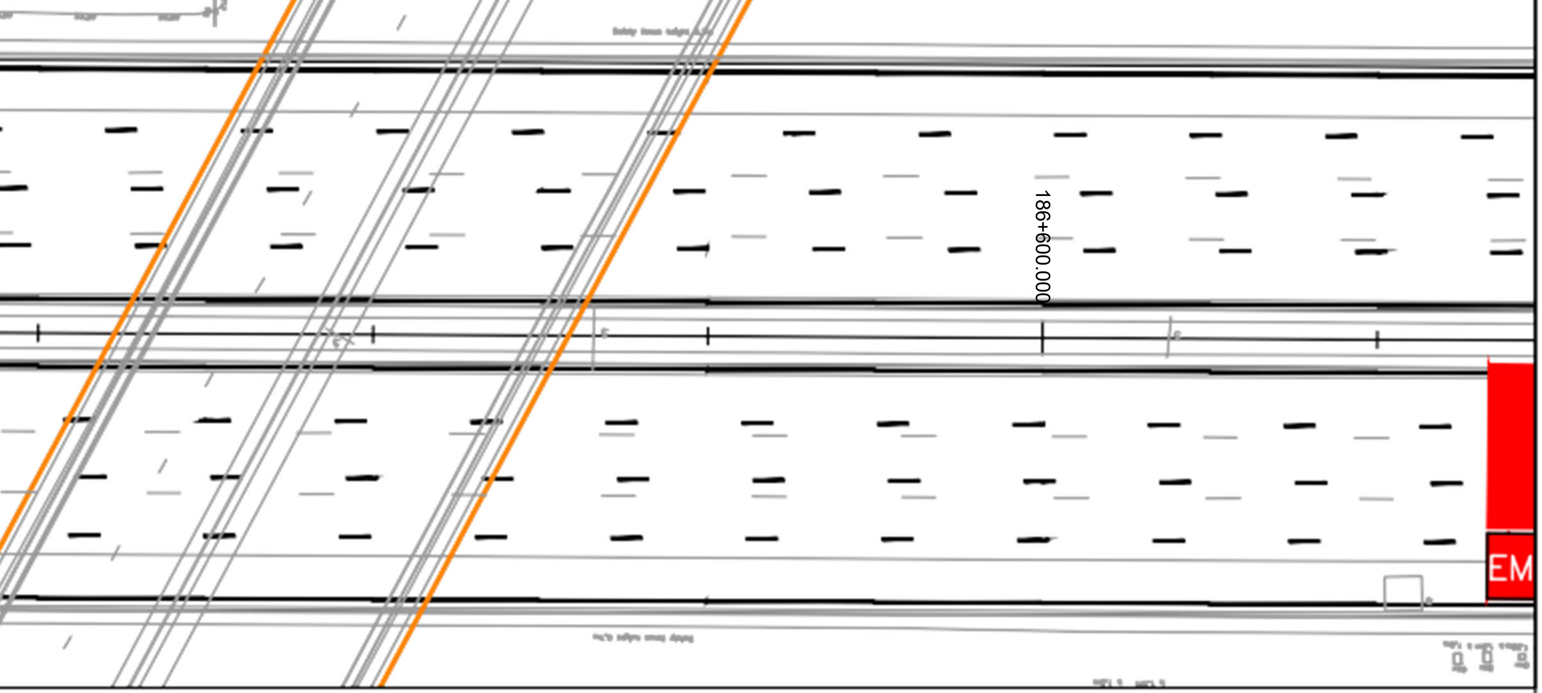
SMP M1 J23a - J25

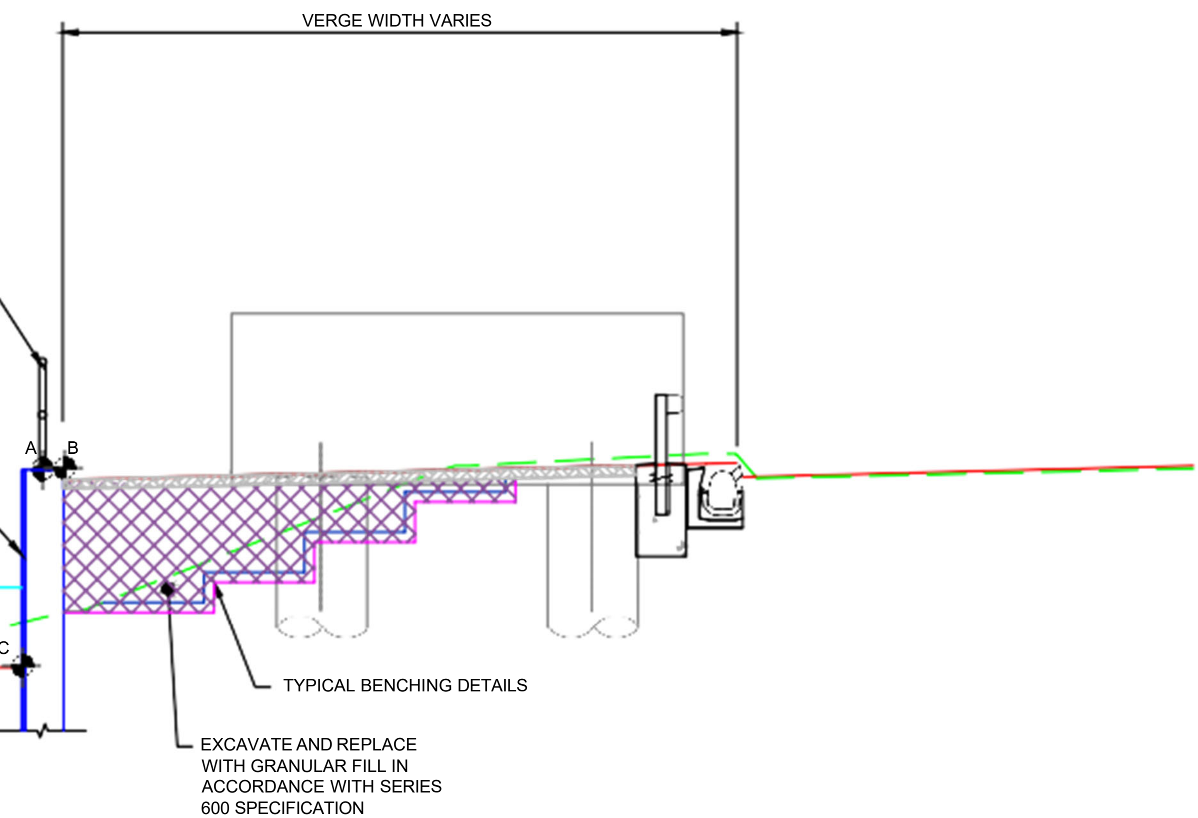
Key Plan



IN HEIGHT.

8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. 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
- TOPO SURVEY (BEFORE SMP)

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE (LIDAR SURVEY)
- EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION
- SHEET PILE

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C03	21/05/20	DR	MA	SV
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Client

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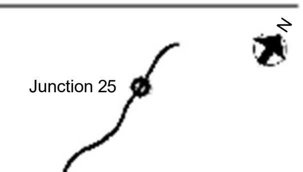
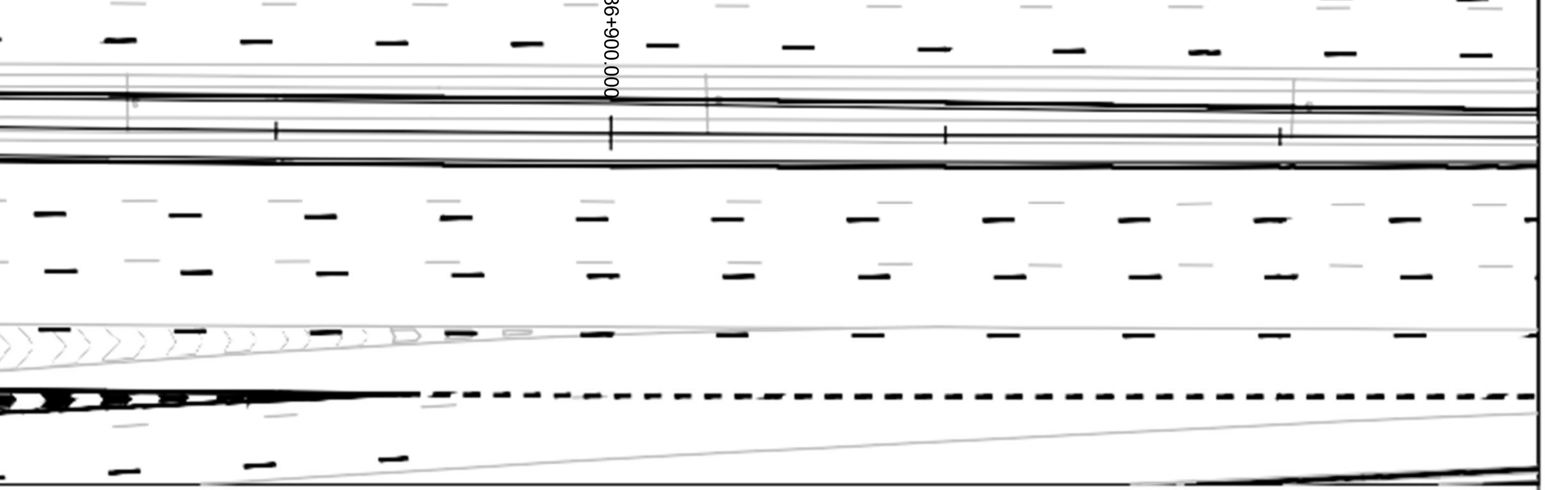
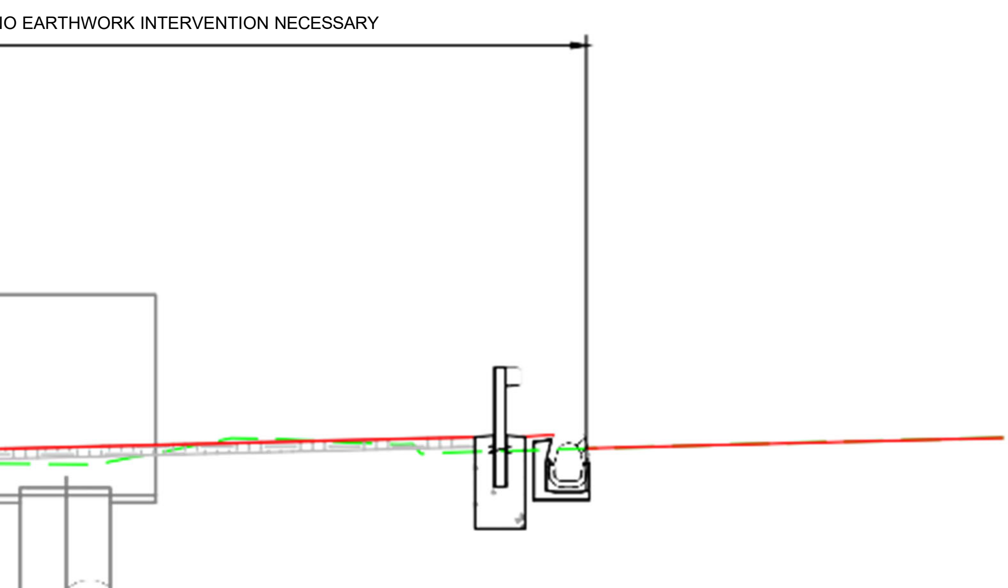
Project Title

SMP M1 J23a - J25

Key Plan







SHALLOWER GRADIENTS.

7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY. WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. FOR TYPICAL DETAILS OF EARTHWORK SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000601.

PLAN LEGEND

SECTION LINE

HIGHWAYS ENGLAND BOUNDARY

TOPO SURVEY (BEFORE SMP)

SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SURVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

TOPSOIL

GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

Rev	Date	By	Chkd	Appd
C02	21/05/20	DR	MA	SV
As Built				

amey ARUP

The Colmore Building
20 Colmore Circus Queensway
Birmingham B4 6AT
Tel 0121 212 5000

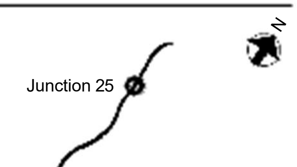
Client

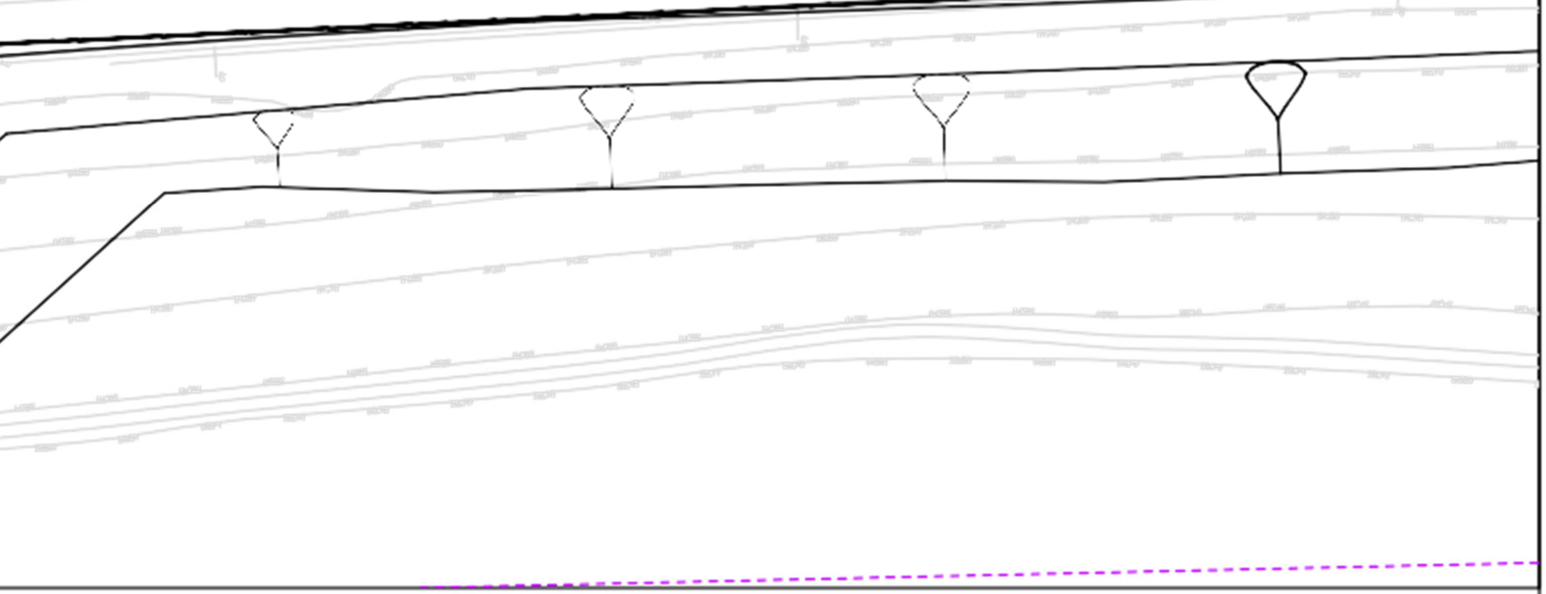
highways england
driving forward

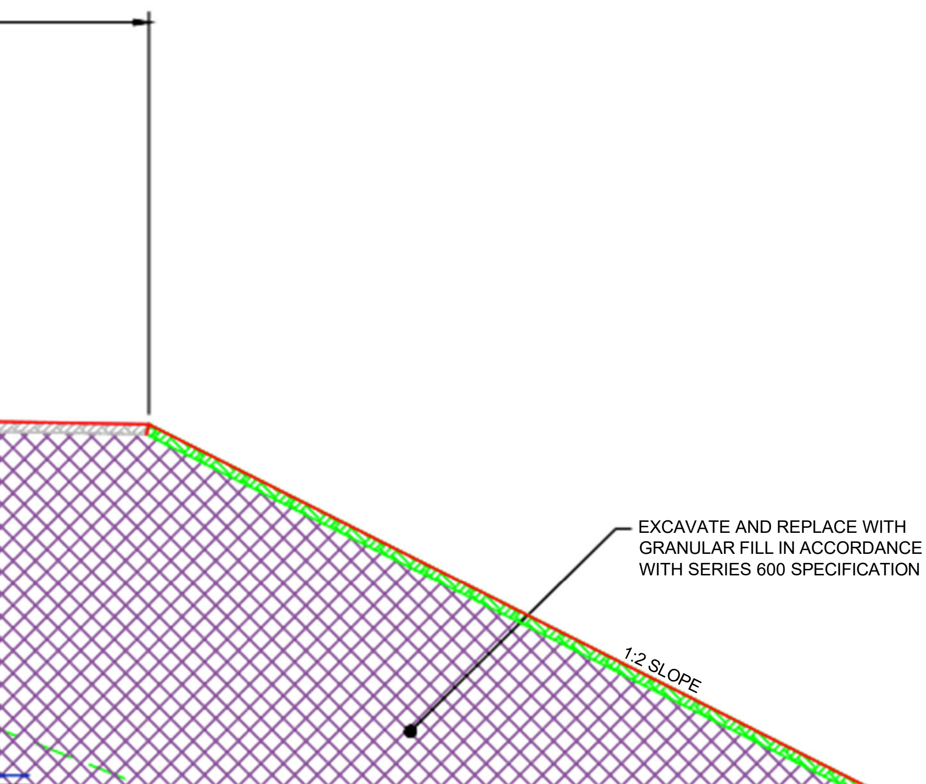
Project Title

SMP M1 J23a - J25

Key Plan







7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. EXCAVATION PROFILES WILL VARY. WORST CASE SCENARIOS INDICATED IN SECTION A-A.
9. FOR TYPICAL DETAILS OF EARTHWORK SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000601.

PLAN LEGEND

- SECTION LINE
- HIGHWAYS ENGLAND BOUNDARY
- TOPO SURVEY (BEFORE SMP)

SECTION LEGEND

- PROPOSED GROUND PROFILE
- EXISTING GROUND PROFILE (LIDAR SURVEY)
- EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- TOPSOIL
- GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

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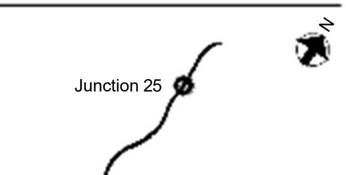

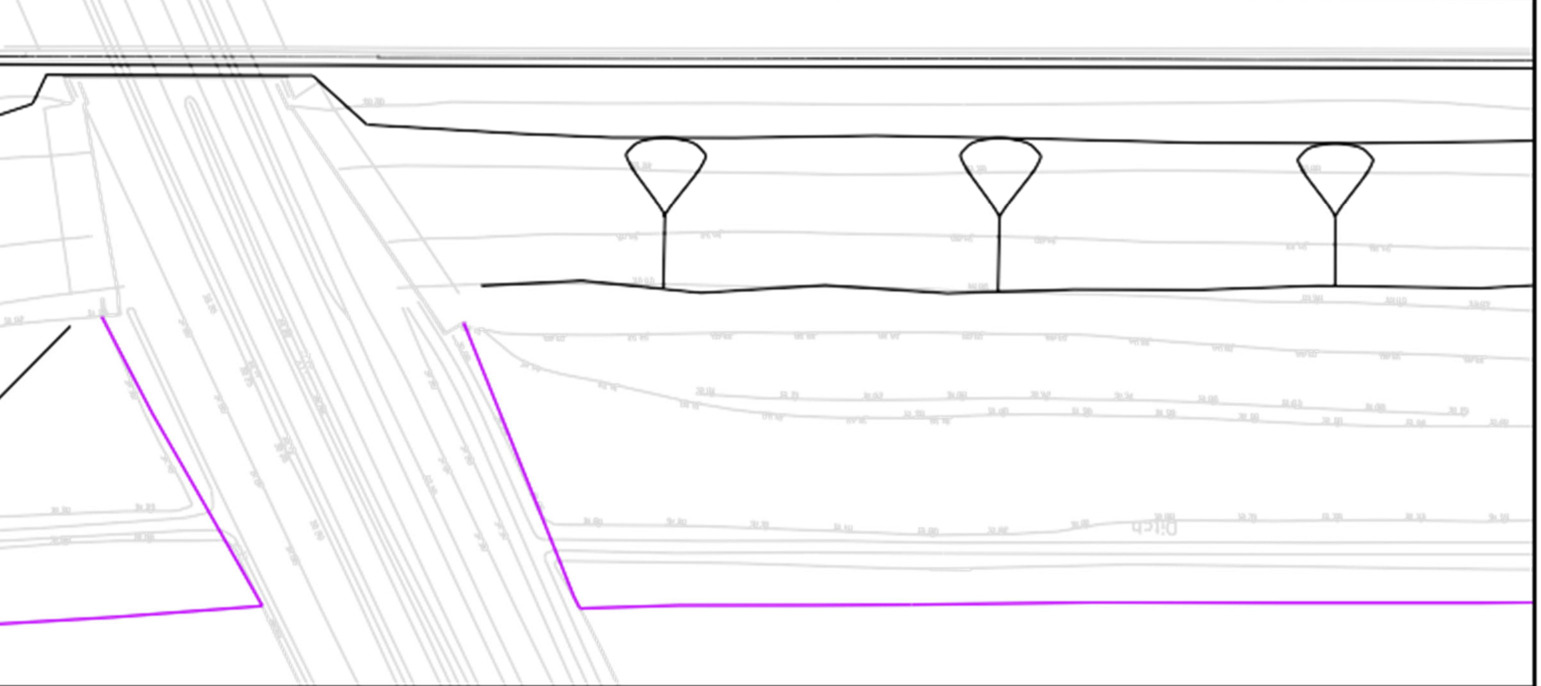

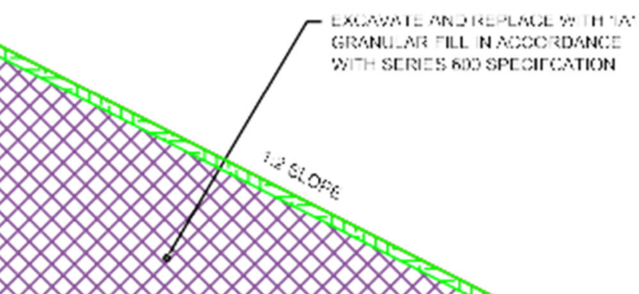

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PLAN LEGEND

SECTION LINE

HIGHWAYS ENGLAND BOUNDARY

TOPO SURVEY (BEFORE SMP)

SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SURVEY)

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INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

TOPSOIL

GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

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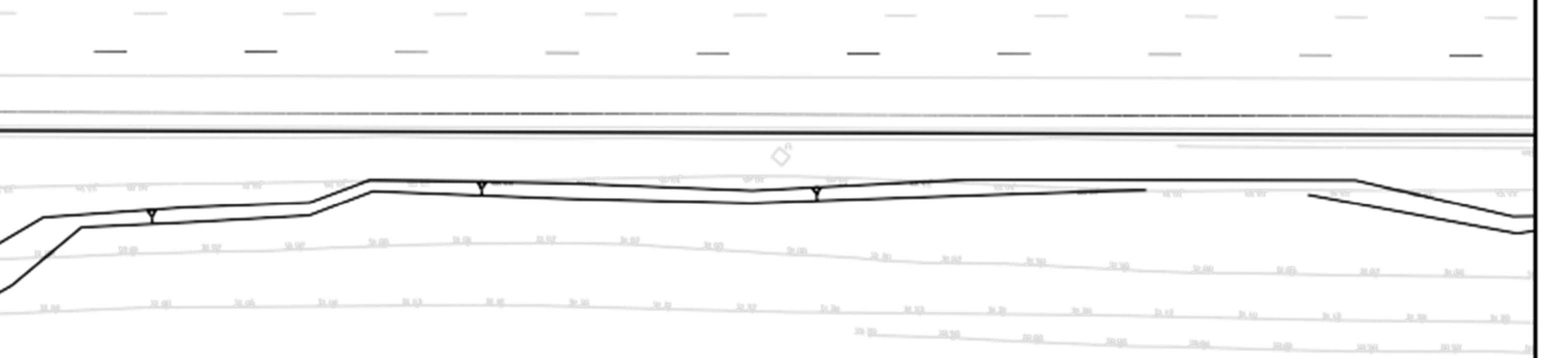
Project Title

SMP M1 J23a - J25

Key Plan

Junction 25



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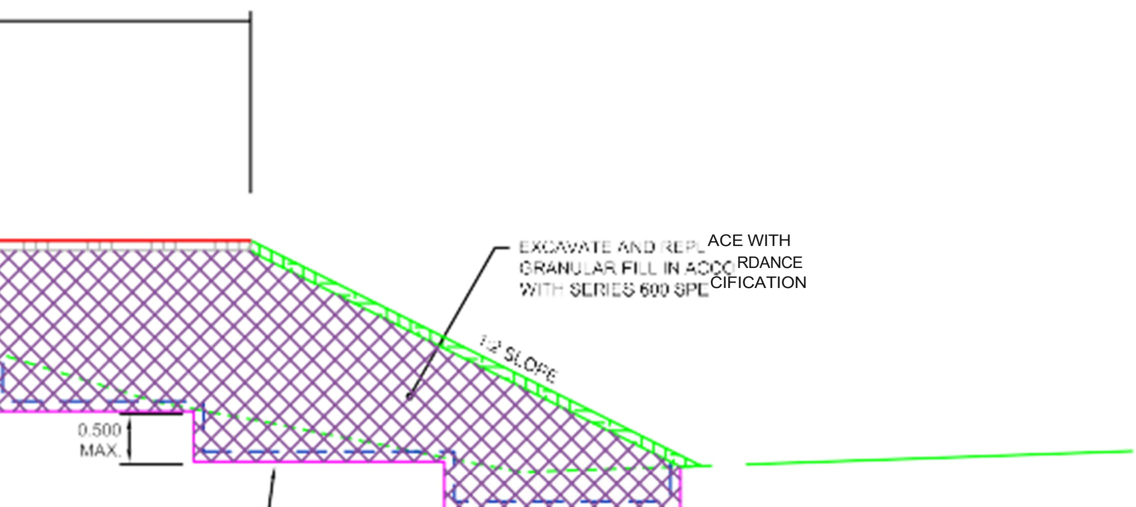

TYPICAL BENCHING DETAILS

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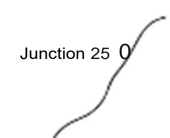

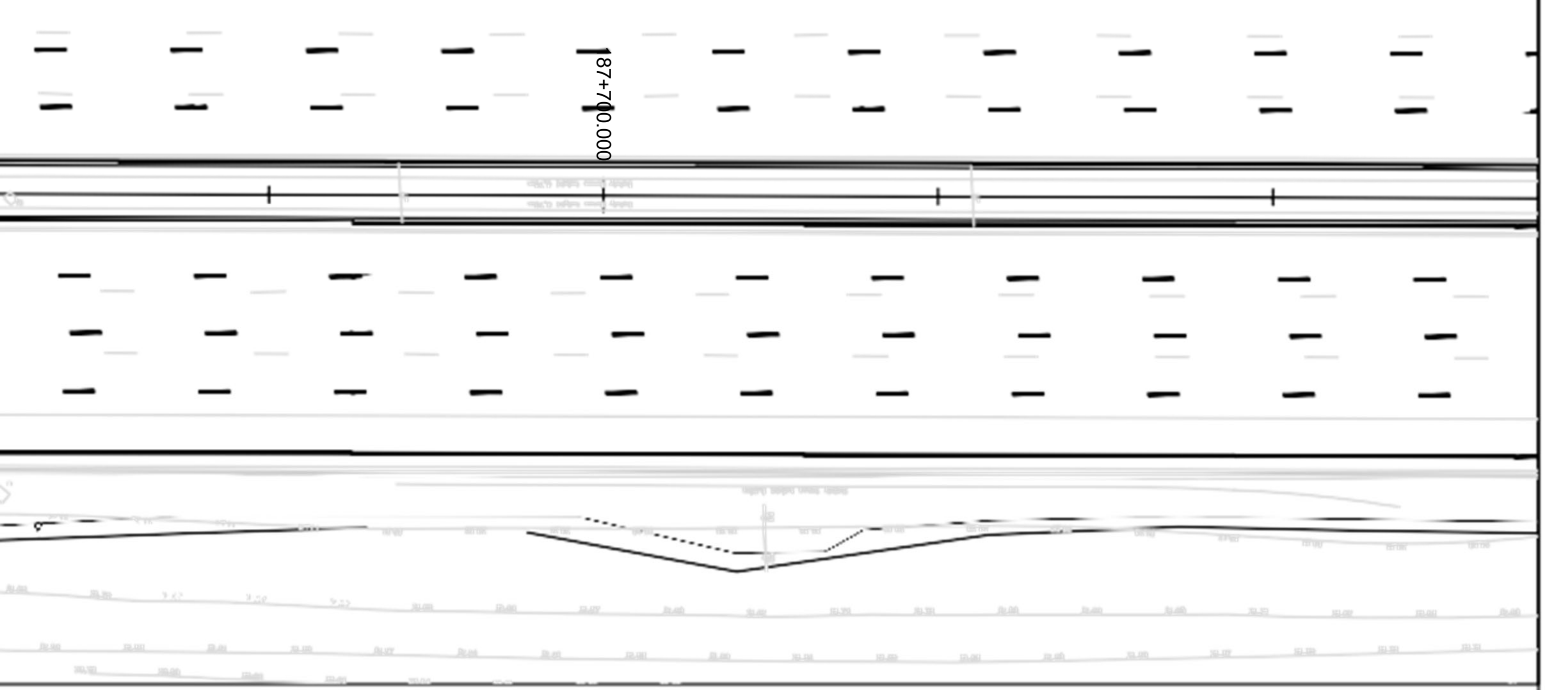

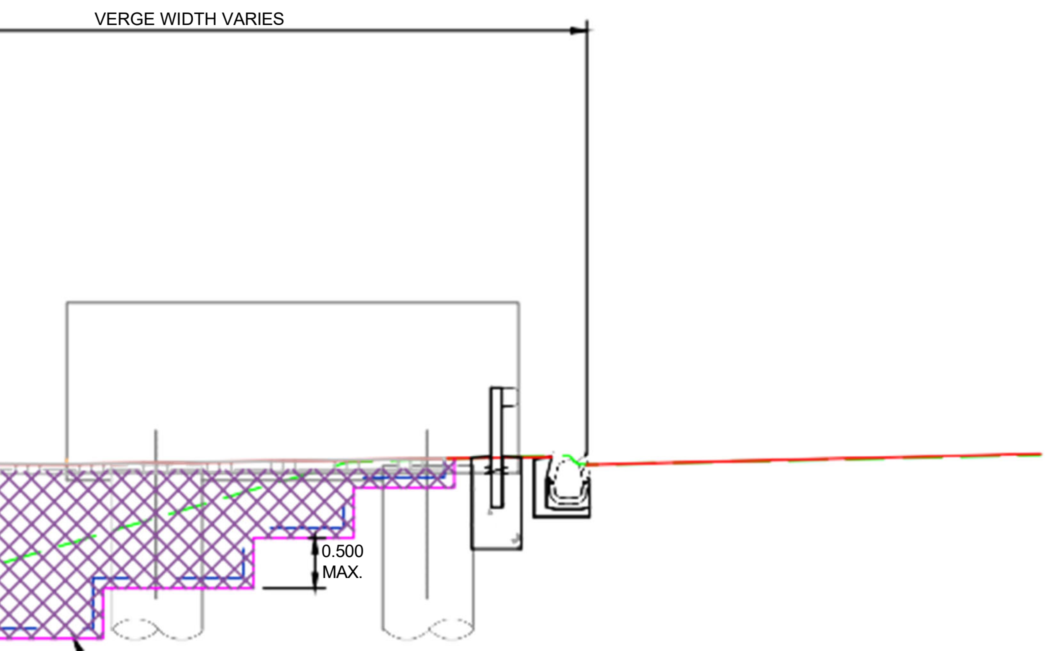

SHALLOWER GRADIENTS.

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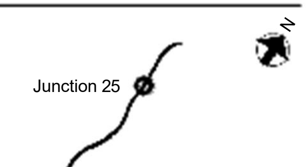

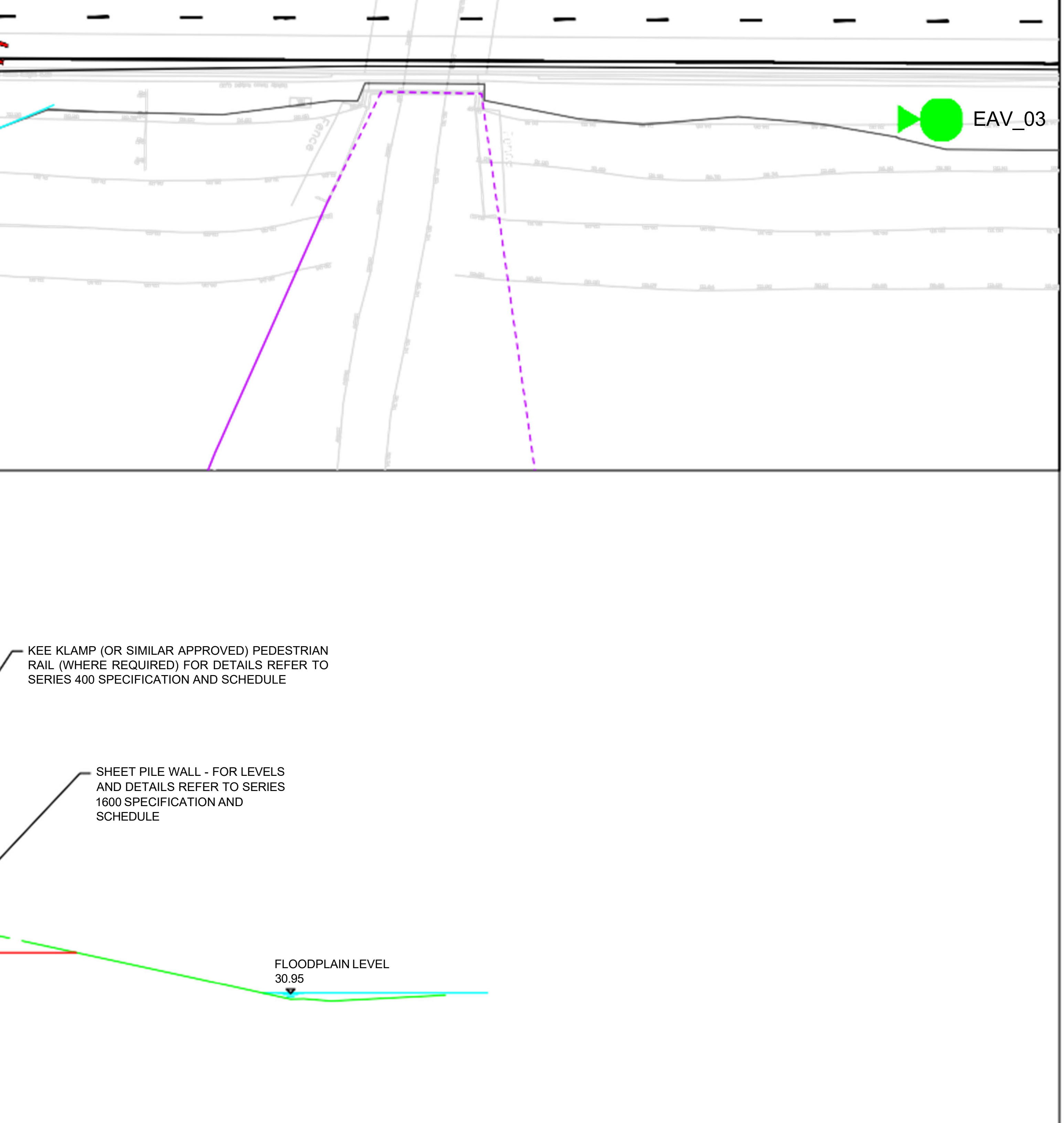

IN HEIGHT.

8. EXCAVATION PROFILES WILL VARY, WORST CASE SCENARIOS INDICATED IN SECTION A-A.
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- SHEET PILE
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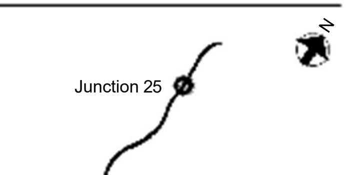

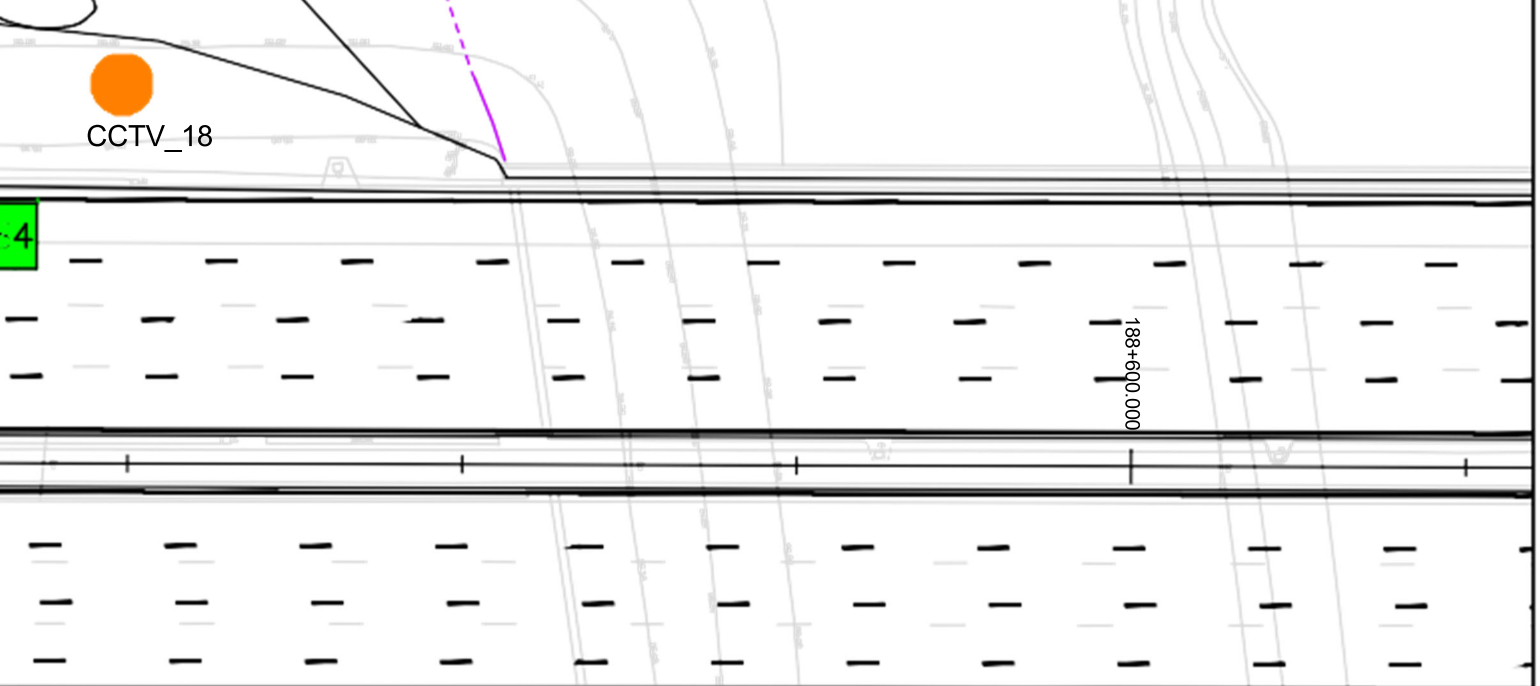

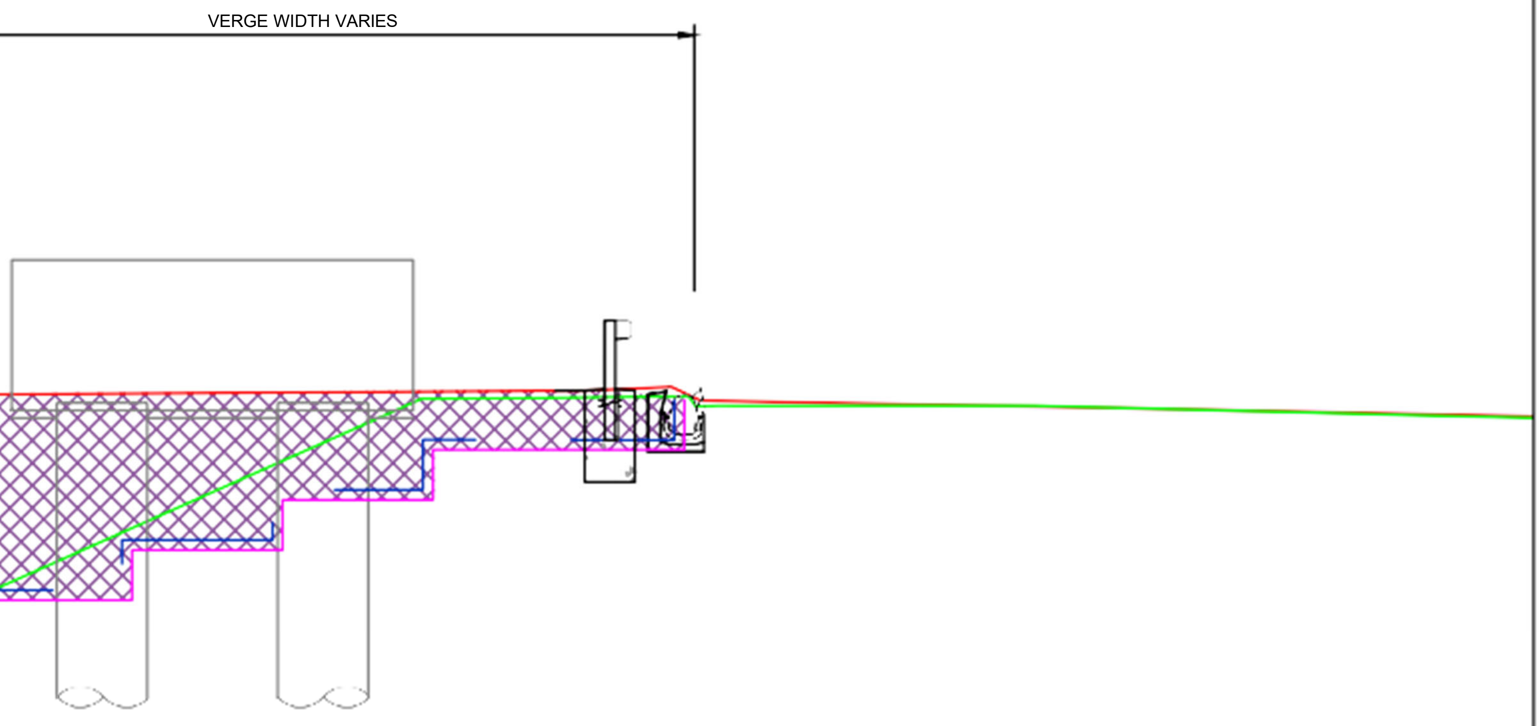

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TOPO SURVEY (BEFORE SMP)

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INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

TOPSOIL

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SMP M1 J23a - J25

Key Plan

Junction 25

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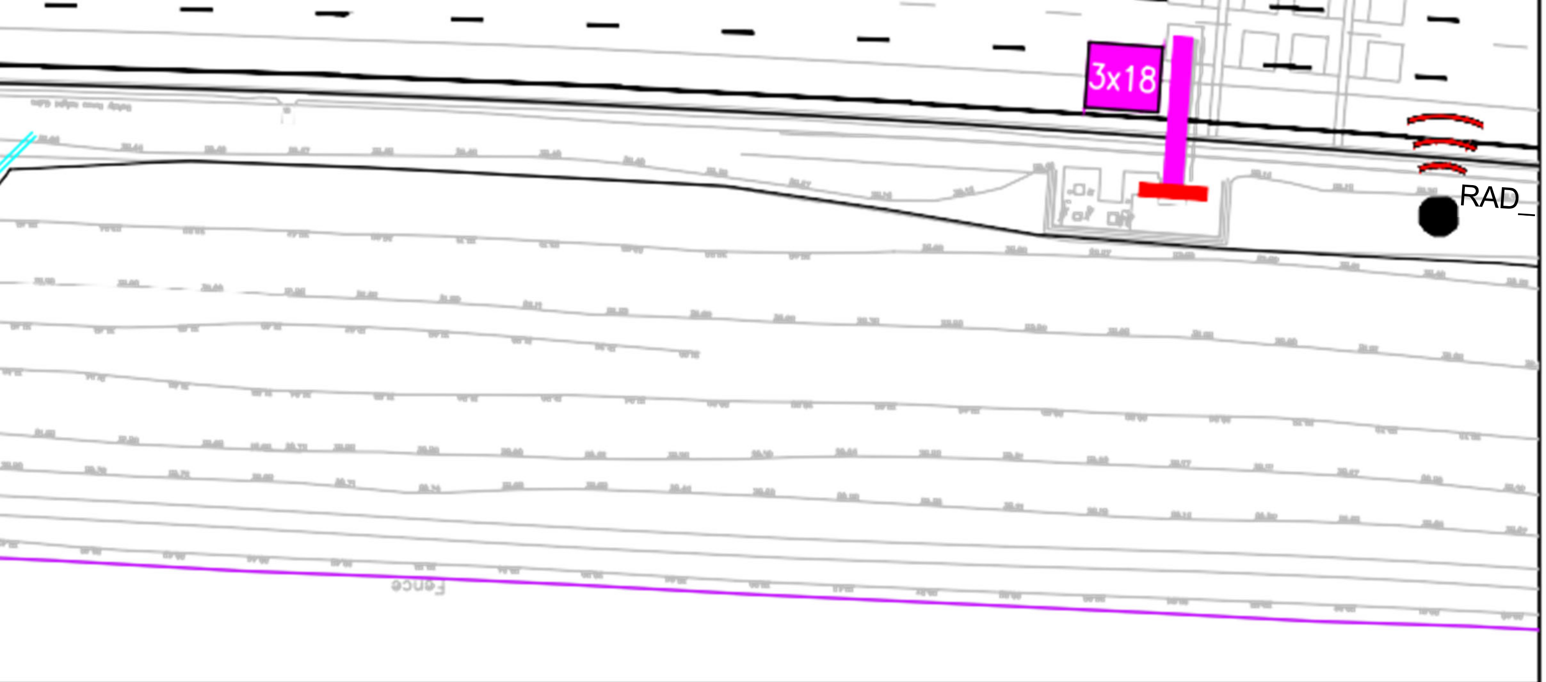

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- SHEET PILE
- TOPO SURVEY (BEFORE SMP)

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Project Title

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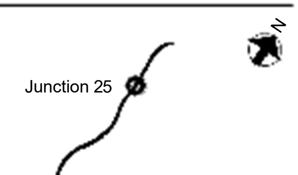

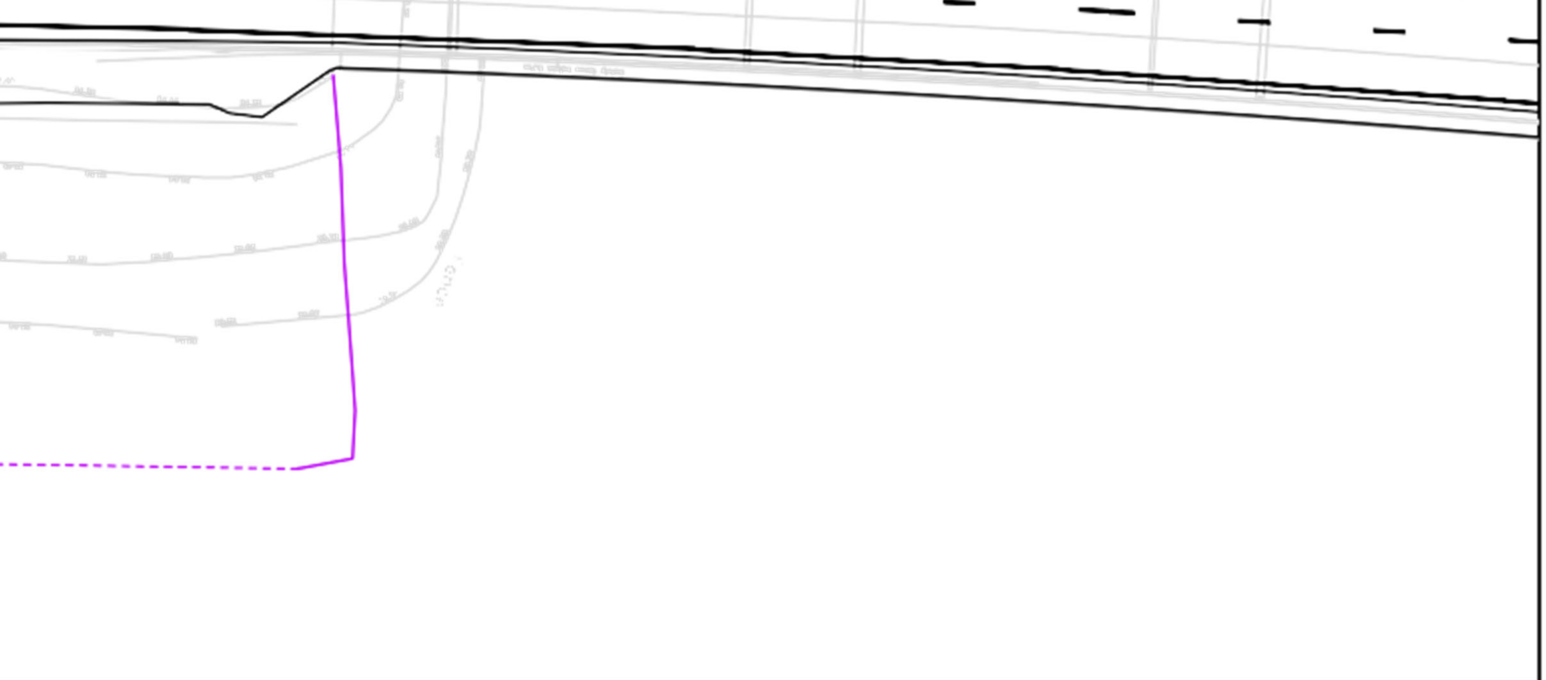

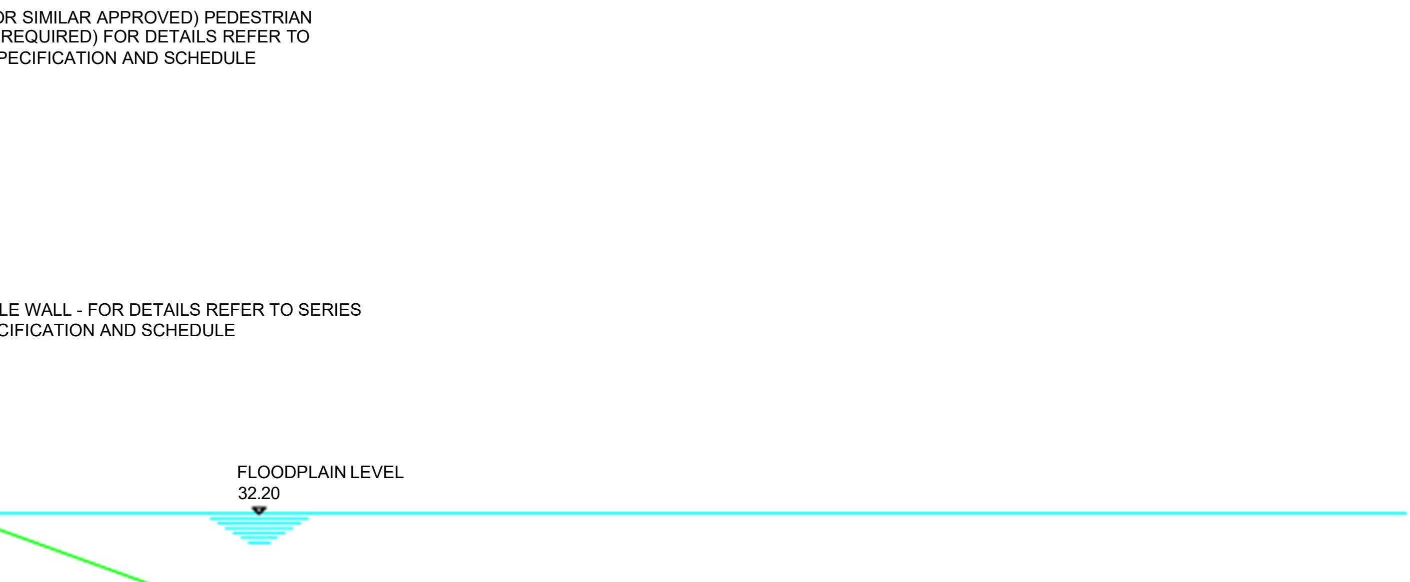

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SHEET PILE
TOPO SURVEY (BEFORE SMP)

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GEOTEXTILE SEPARATOR LAYER

GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION

SHEET PILE

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Project Title

SMP M1 J23a - J25

Key Plan

Junction 25

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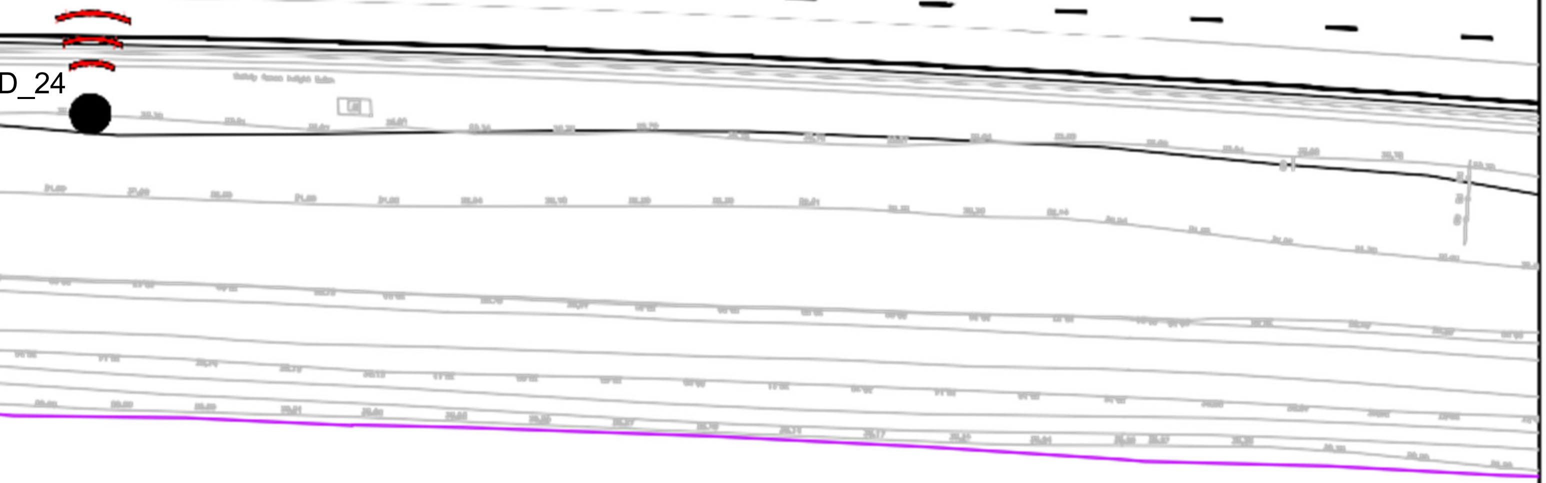

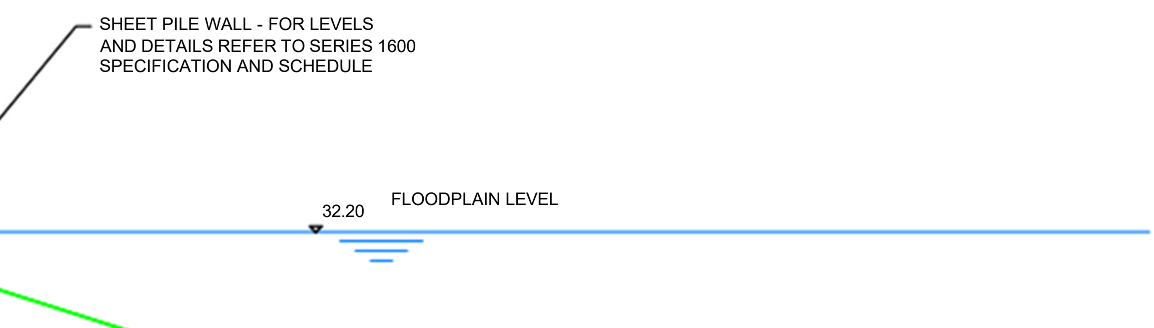

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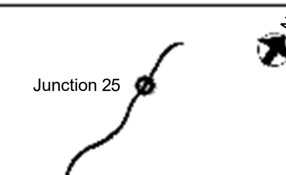

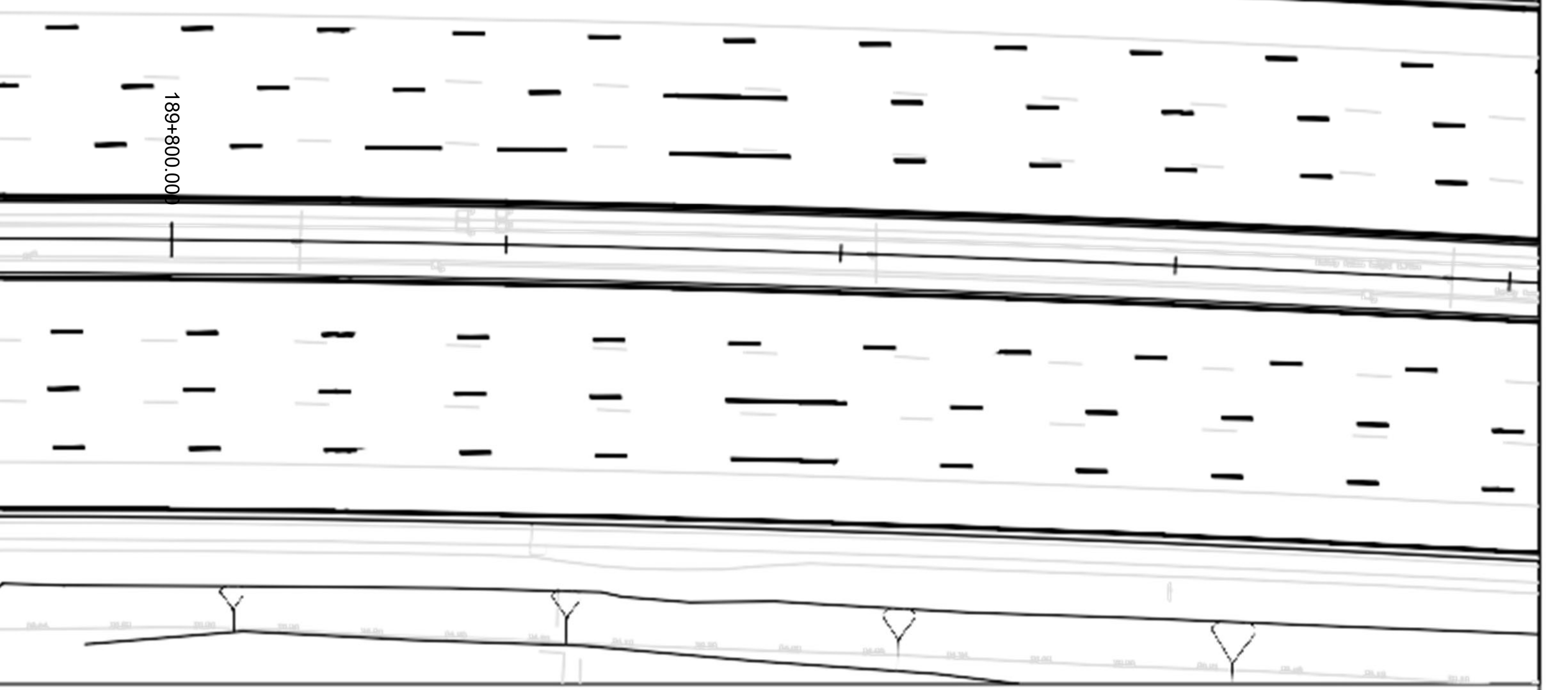

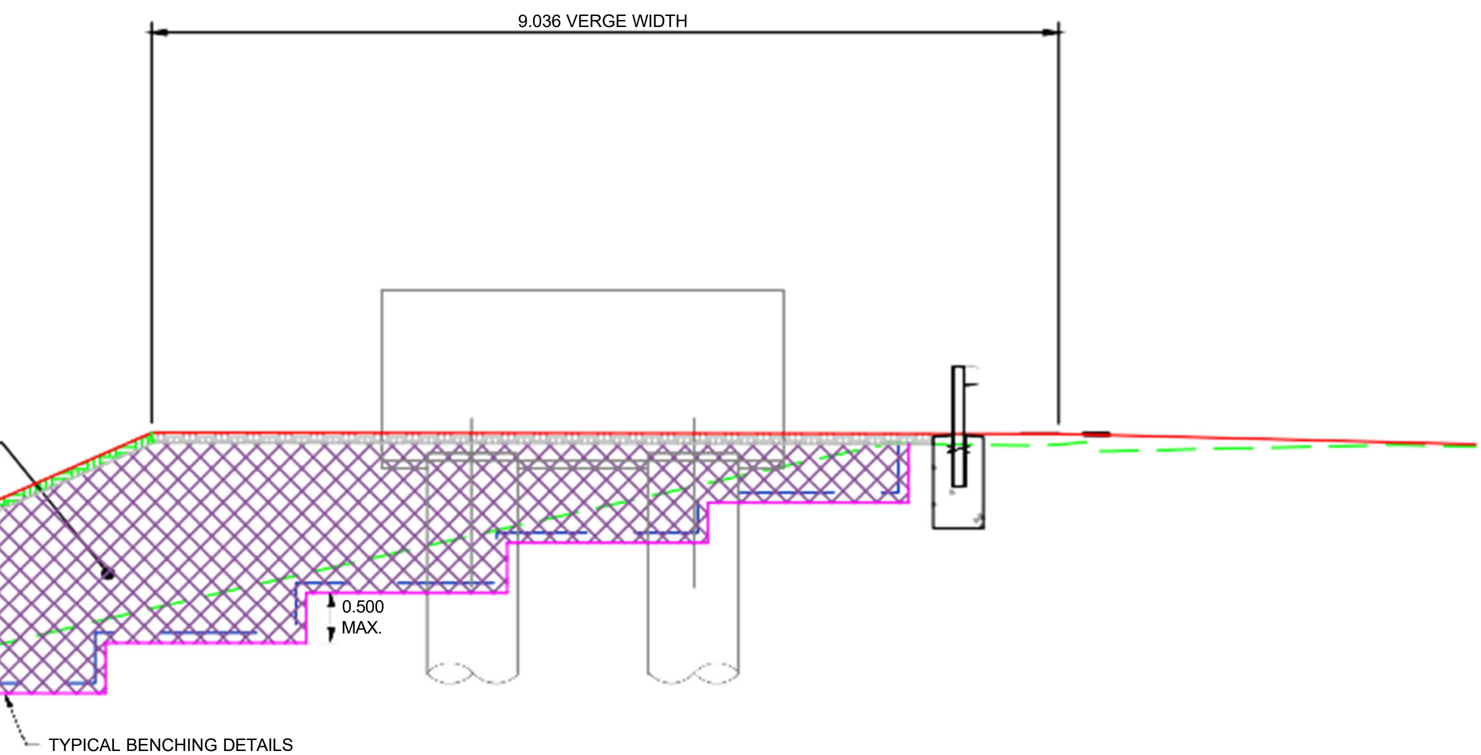

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PLAN LEGEND

SECTION LINE

HIGHWAYS ENGLAND BOUNDARY

TOPO SURVEY (BEFORE SMP)

SECTION LEGEND

PROPOSED GROUND PROFILE

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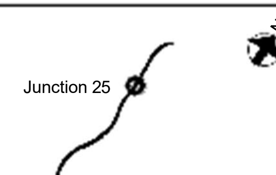

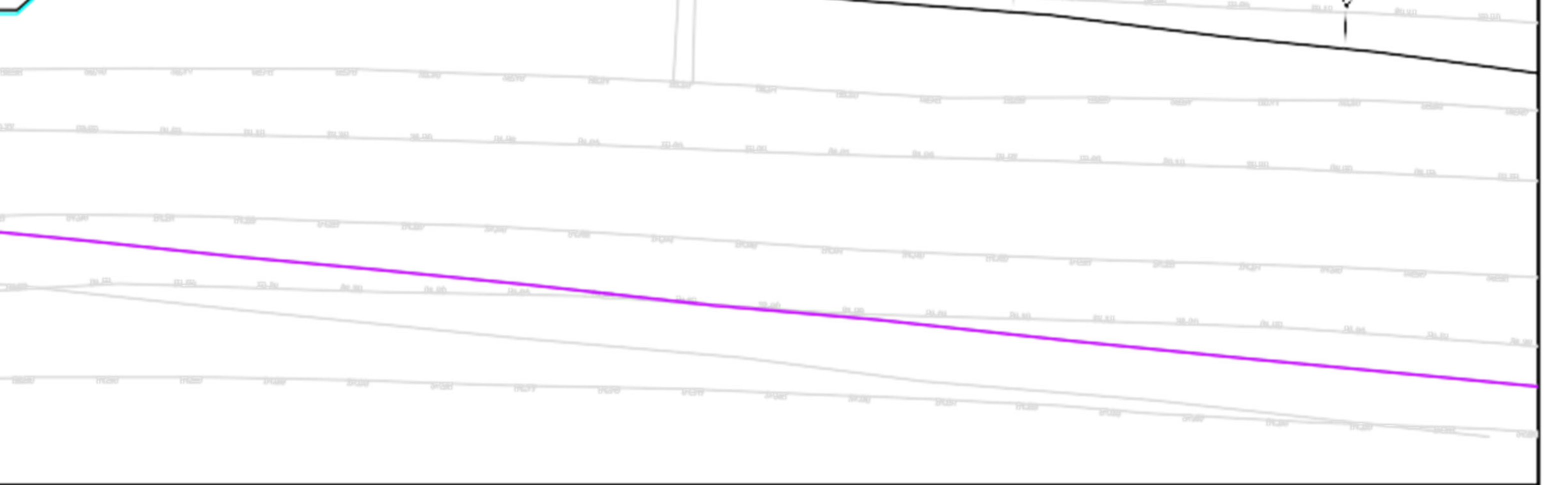

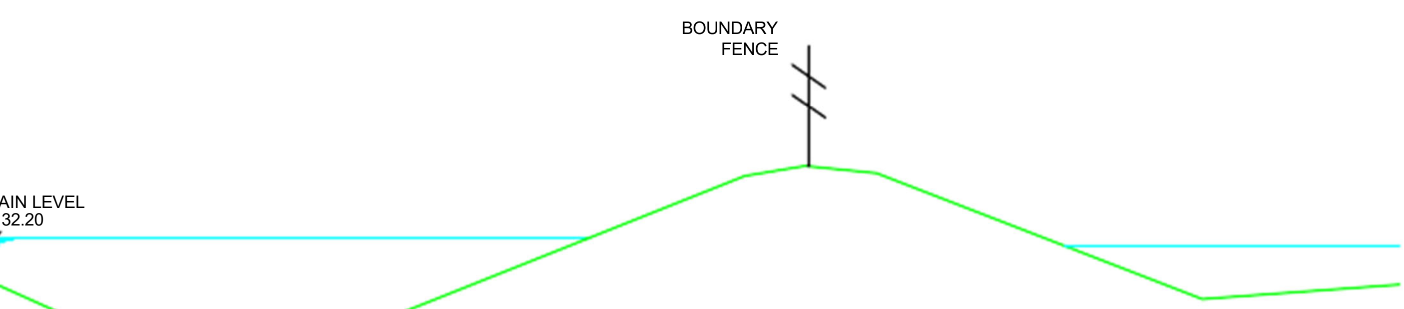

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PLAN LEGEND

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TOPO SURVEY (BEFORE SMP)

SECTION LEGEND

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GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION

SHEET PILE

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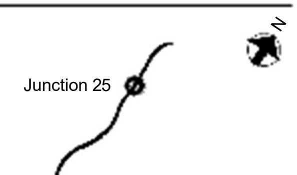

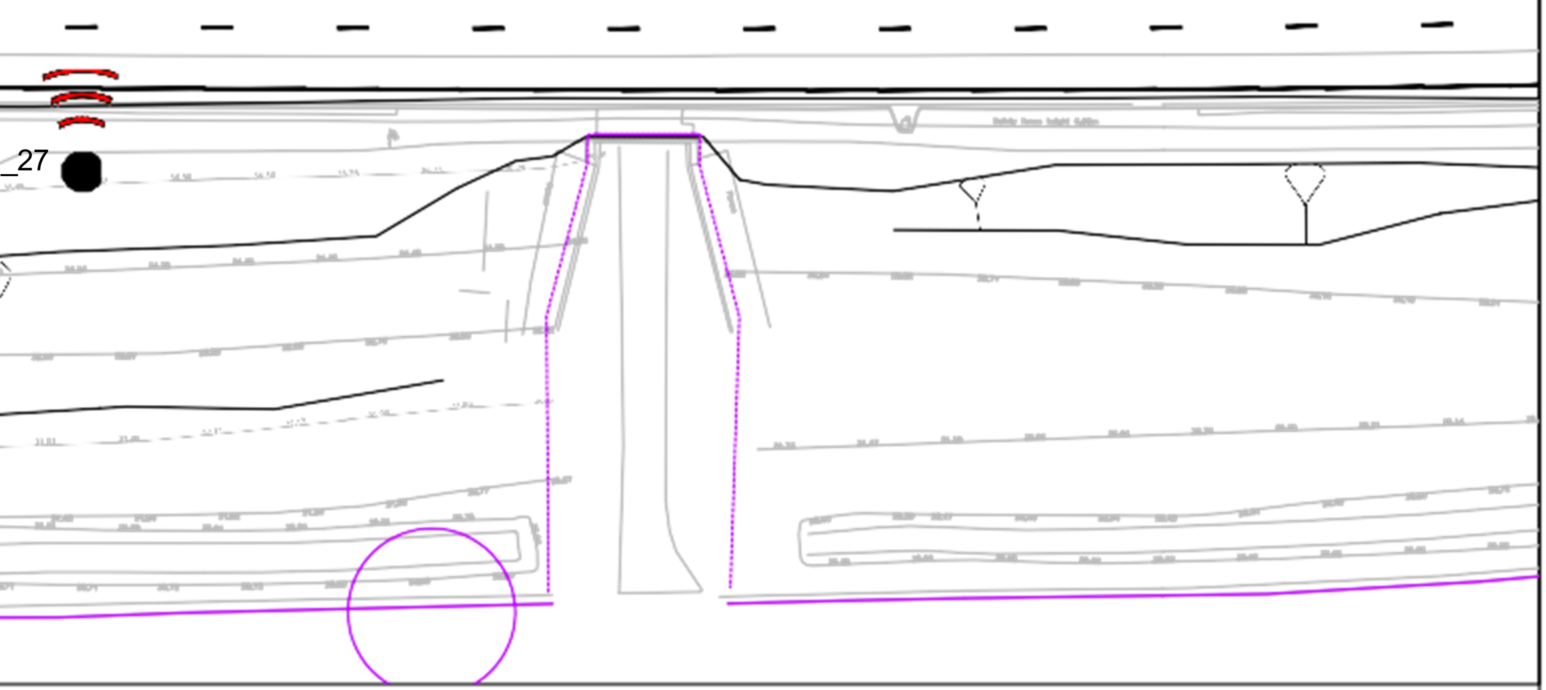

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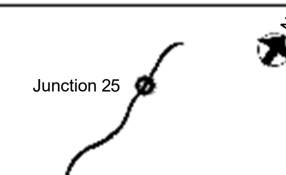

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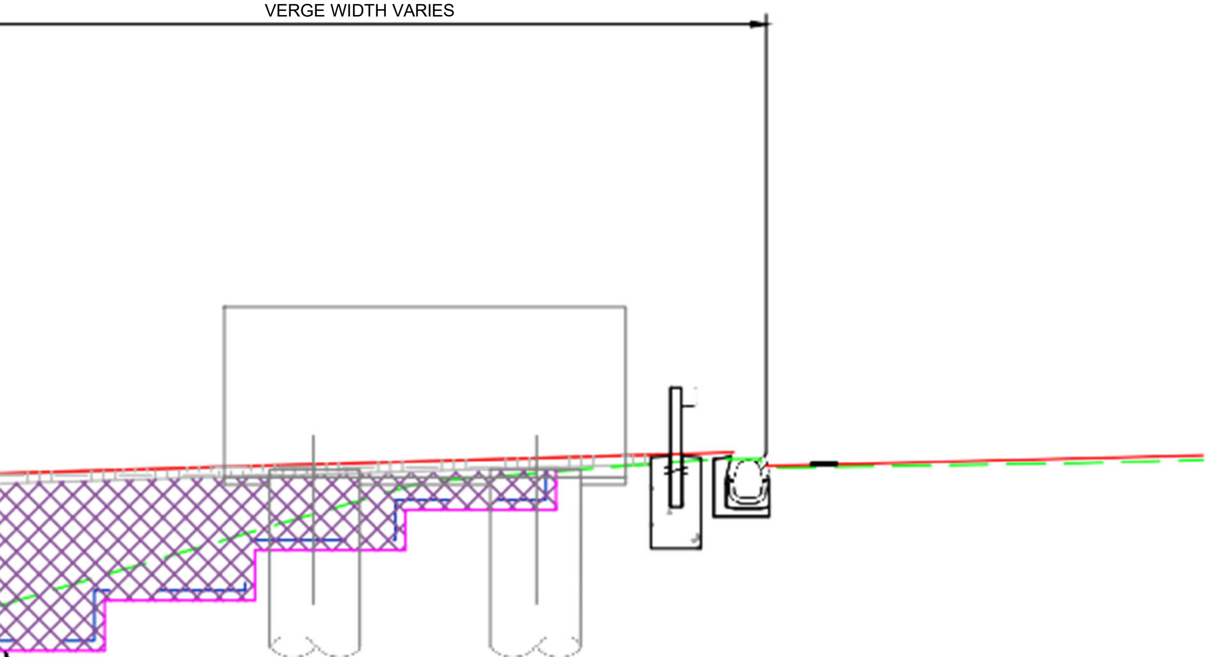

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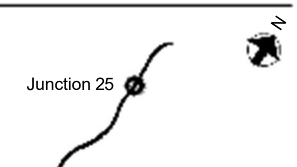

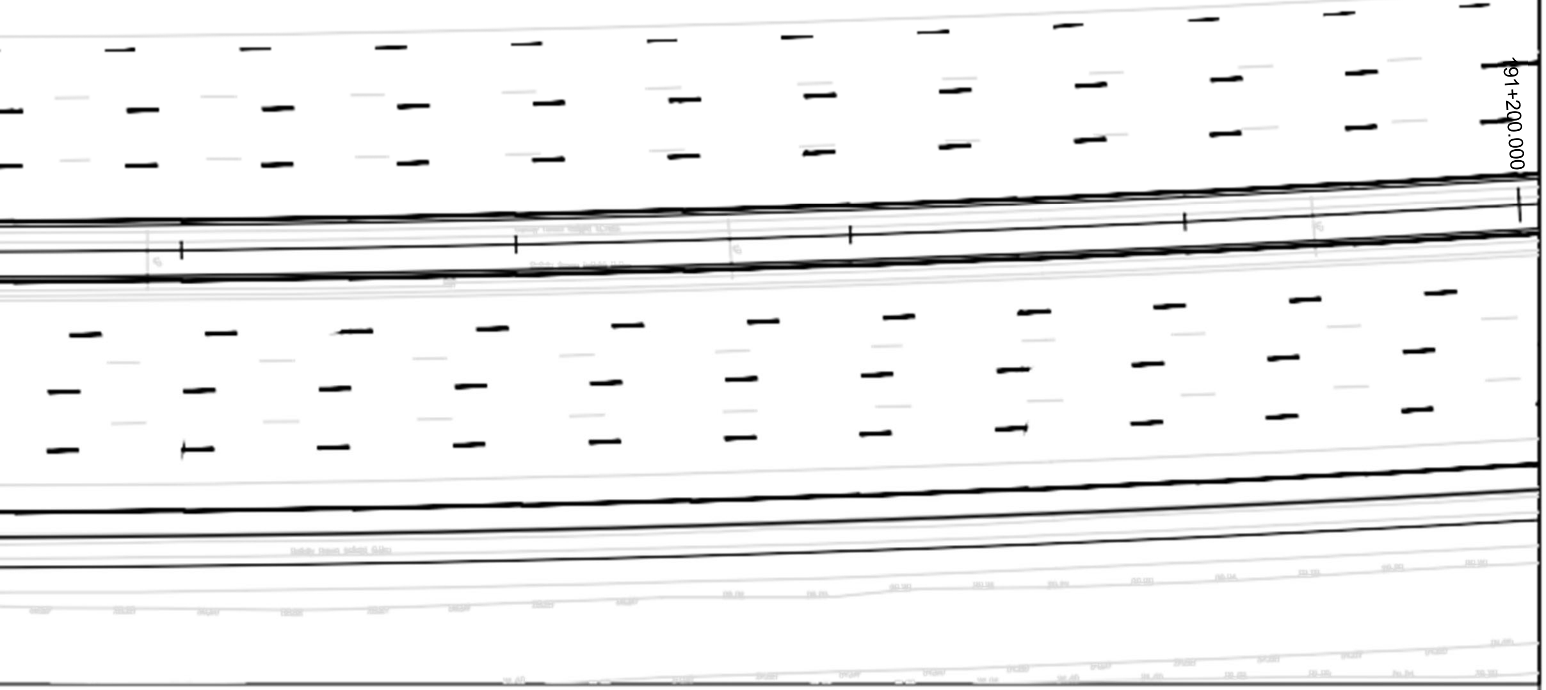

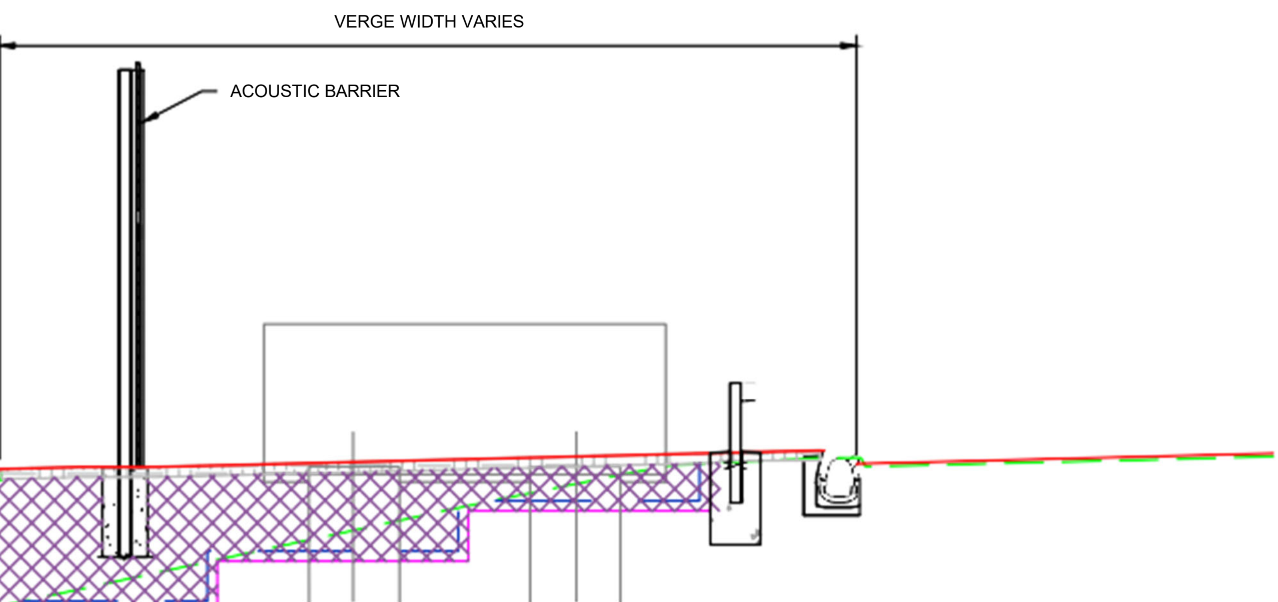

SHALLOWER GRADIENTS.

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9. FOR TYPICAL DETAILS OF EARTHWORK SOLUTIONS REFER TO HA549342-AMAR-HGT-SWI-DR-CE-000601.

PLAN LEGEND

SECTION LINE

HIGHWAYS ENGLAND BOUNDARY

TOPO SURVEY (BEFORE SMP)

SECTION LEGEND

PROPOSED GROUND PROFILE

EXISTING GROUND PROFILE (LIDAR SURVEY)

EXISTING GROUND PROFILE TO BE REMOVED (LIDAR SURVEY)

INDICATIVE EXCAVATION PROFILE

GEOTEXTILE SEPARATOR LAYER

TOPSOIL

GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

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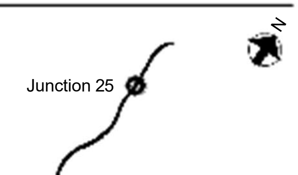
Client

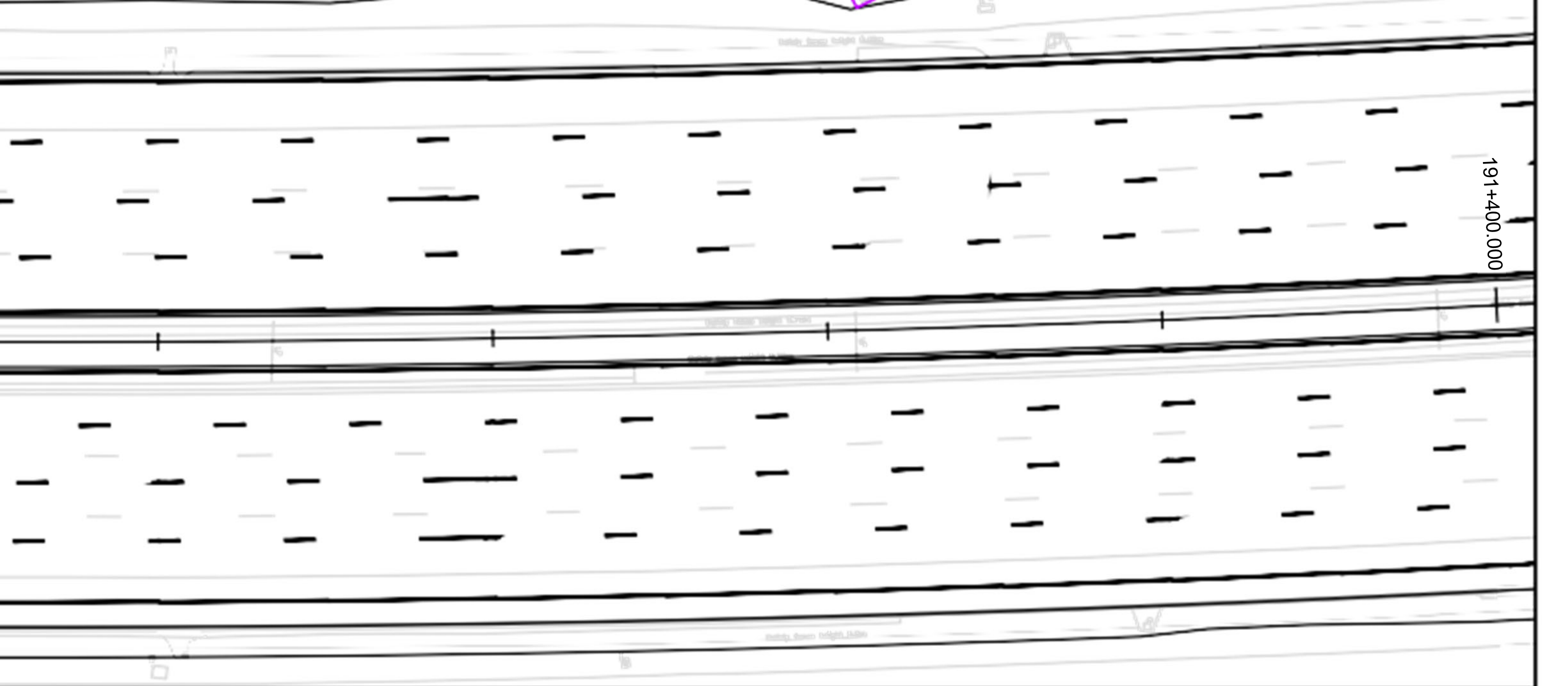
highways england driving forward

Project Title

SMP M1 J23a - J25

Key Plan





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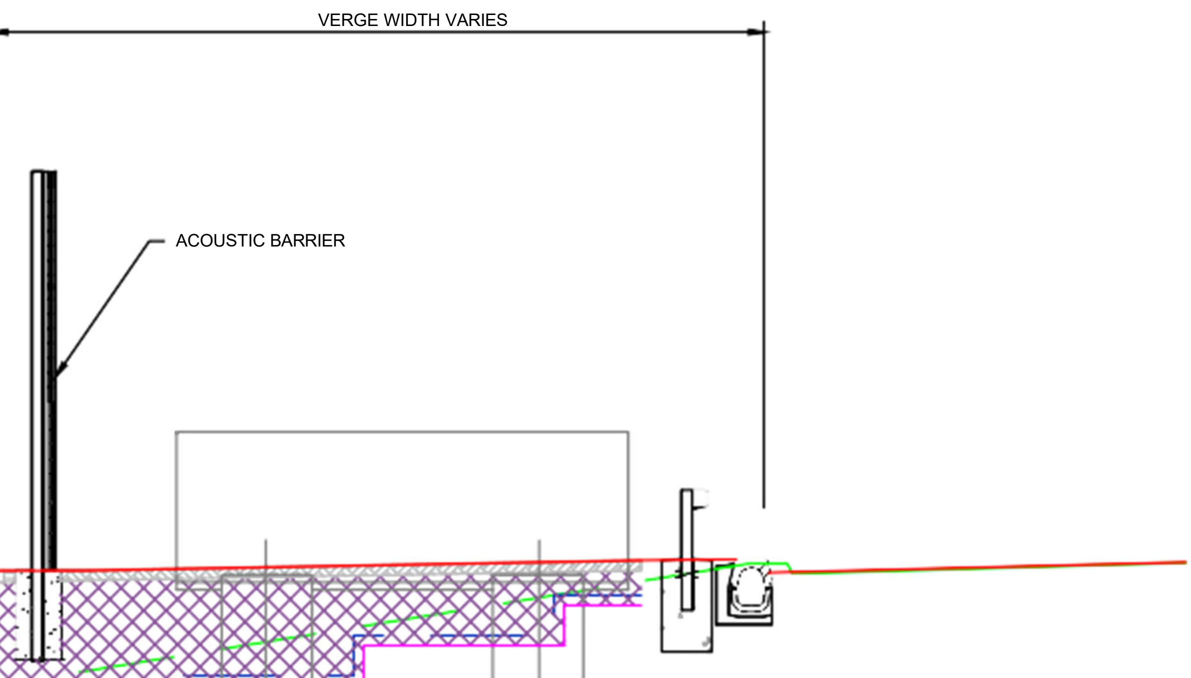

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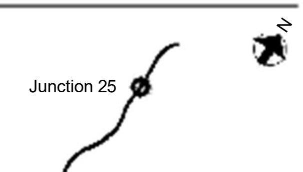

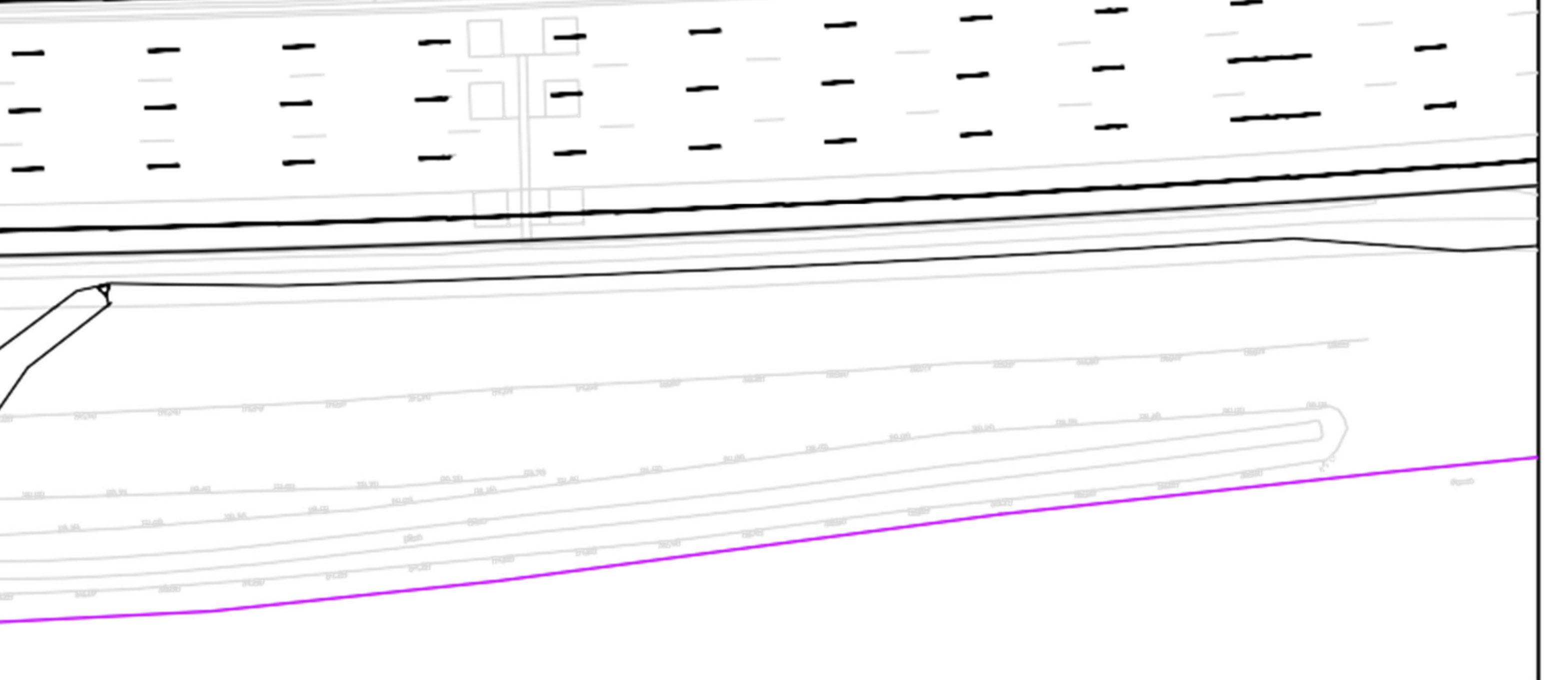

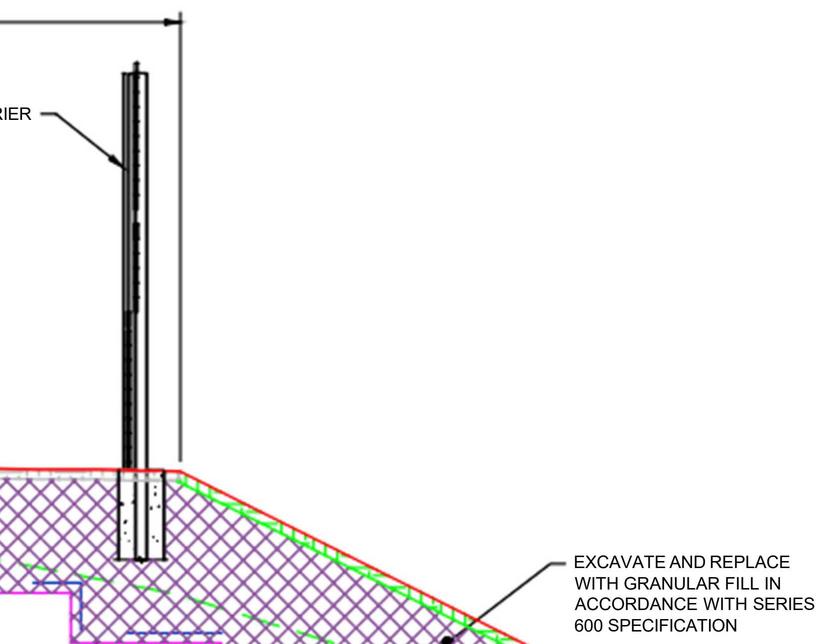

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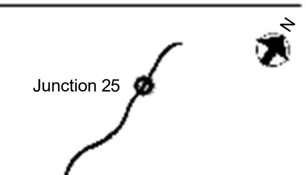

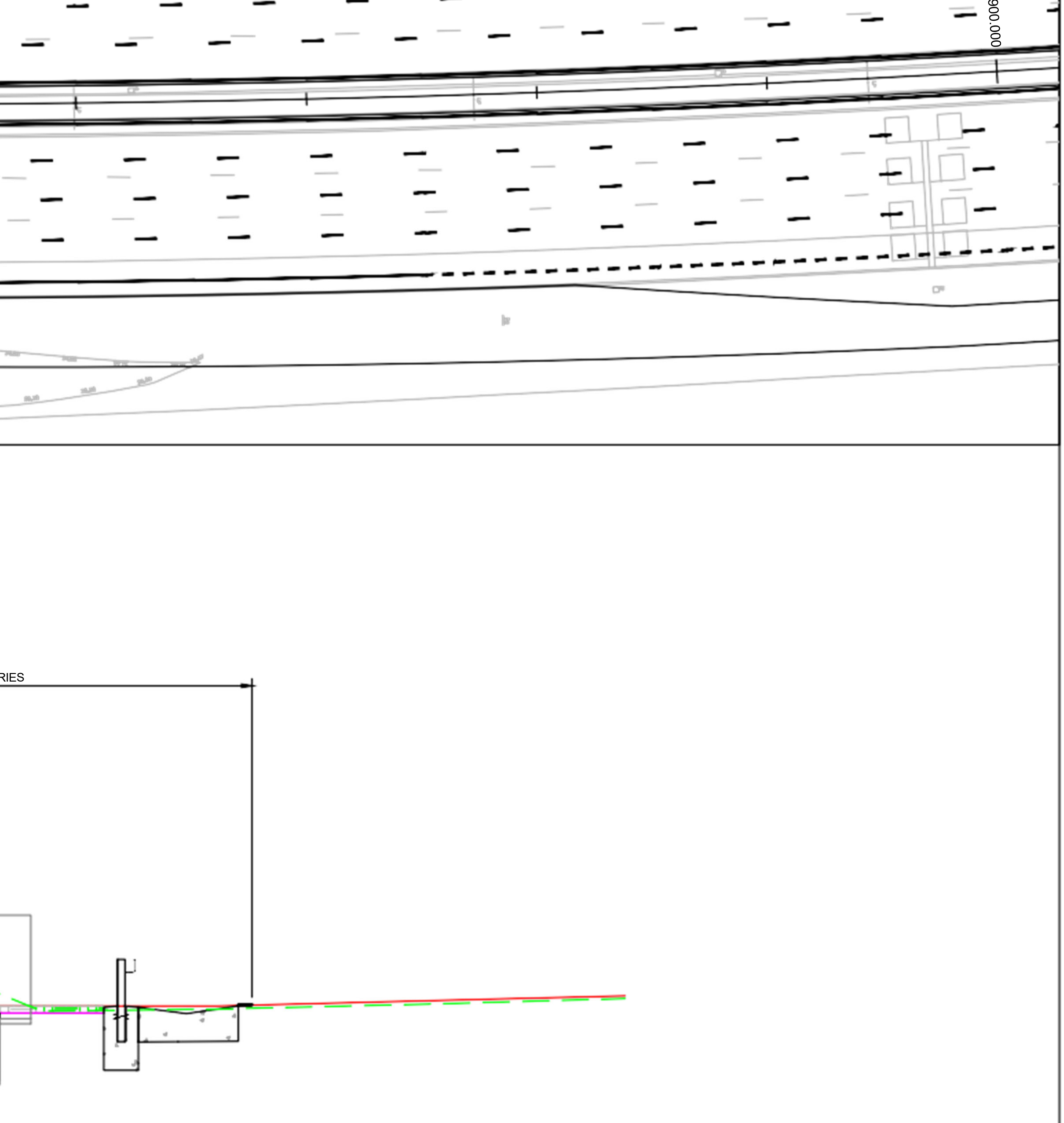

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SHEET PILE

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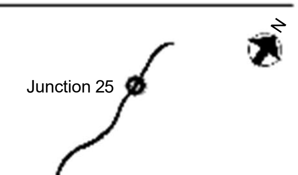

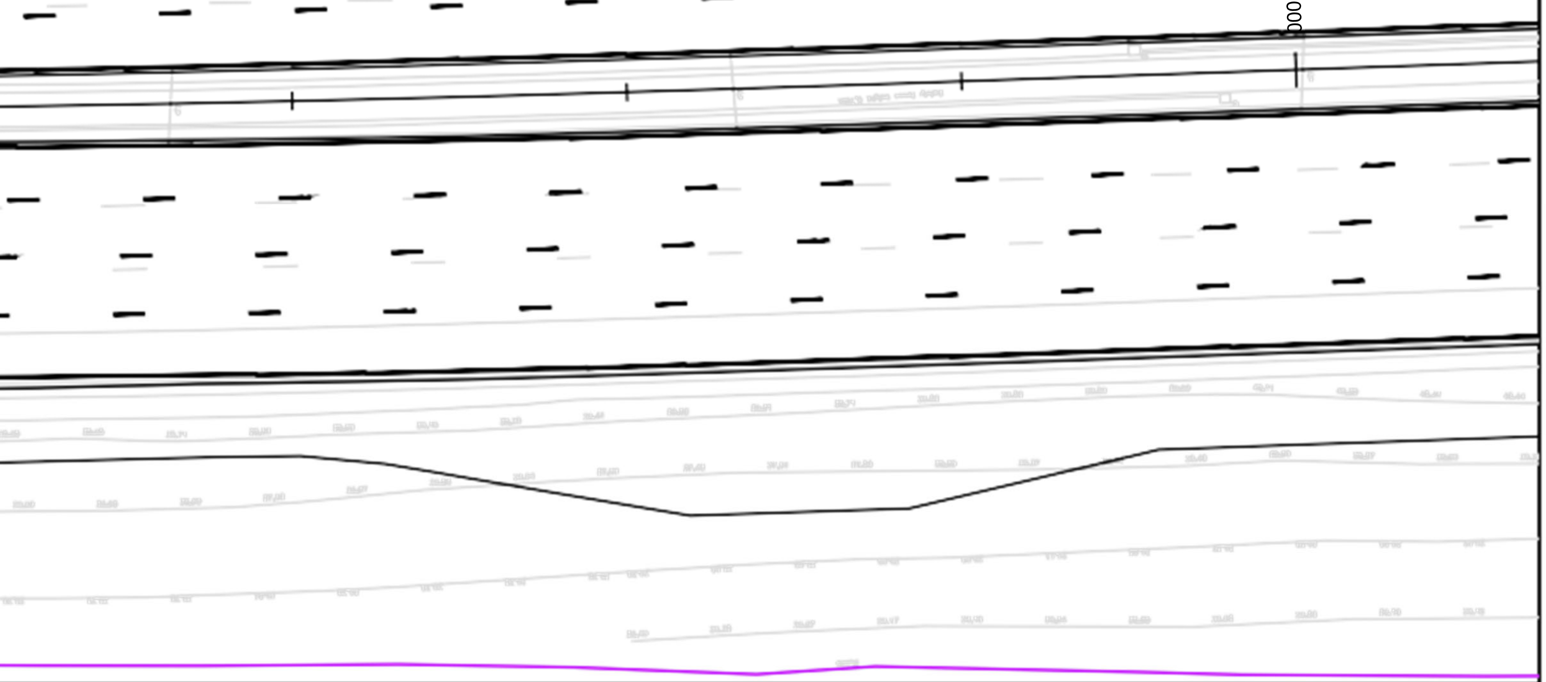

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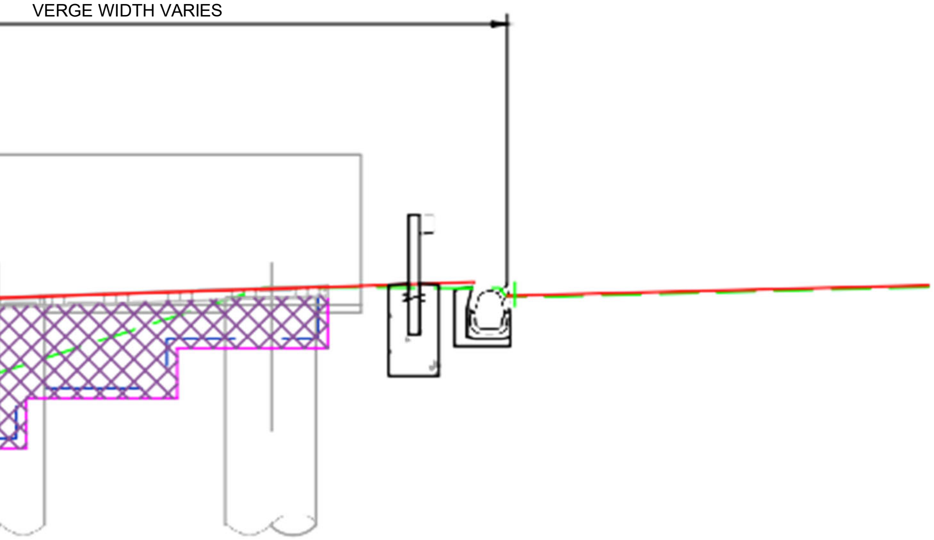
TOPSOIL

GRANULAR FILL [REFER TO SERIES 600 SPECIFICATION]

SECTION NOTES:

1. Ø900mm PIPE TO BE INSTALLED IN ACCORDANCE WITH SERIES 500 SPECIFICATION.
2. CONCRETE BAG WORK HEADWALL TO BE INSTALLED AT EACH END OF THE EARTHWORKS SOLUTION IN ACCORDANCE WITH HA 107/04.
3. THE GRADIENT OF THE Ø900mm PIPE SHOULD MATCH THE EXISTING GRADIENT OF THE DITCH.
4. MINIMUM 150mm COVER TO TOP OF Ø900mm PIPE IN ACCORDANCE WITH TYPE Z CONCRETE SURROUND. SLOPE TO BE LOCALLY ADJUSTED AS REQUIRED.
5. THE PIPE INVERT IS TO BE EMBEDDED 150mm BENEATH THE DITCH INVERT.



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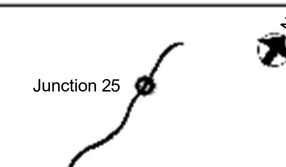

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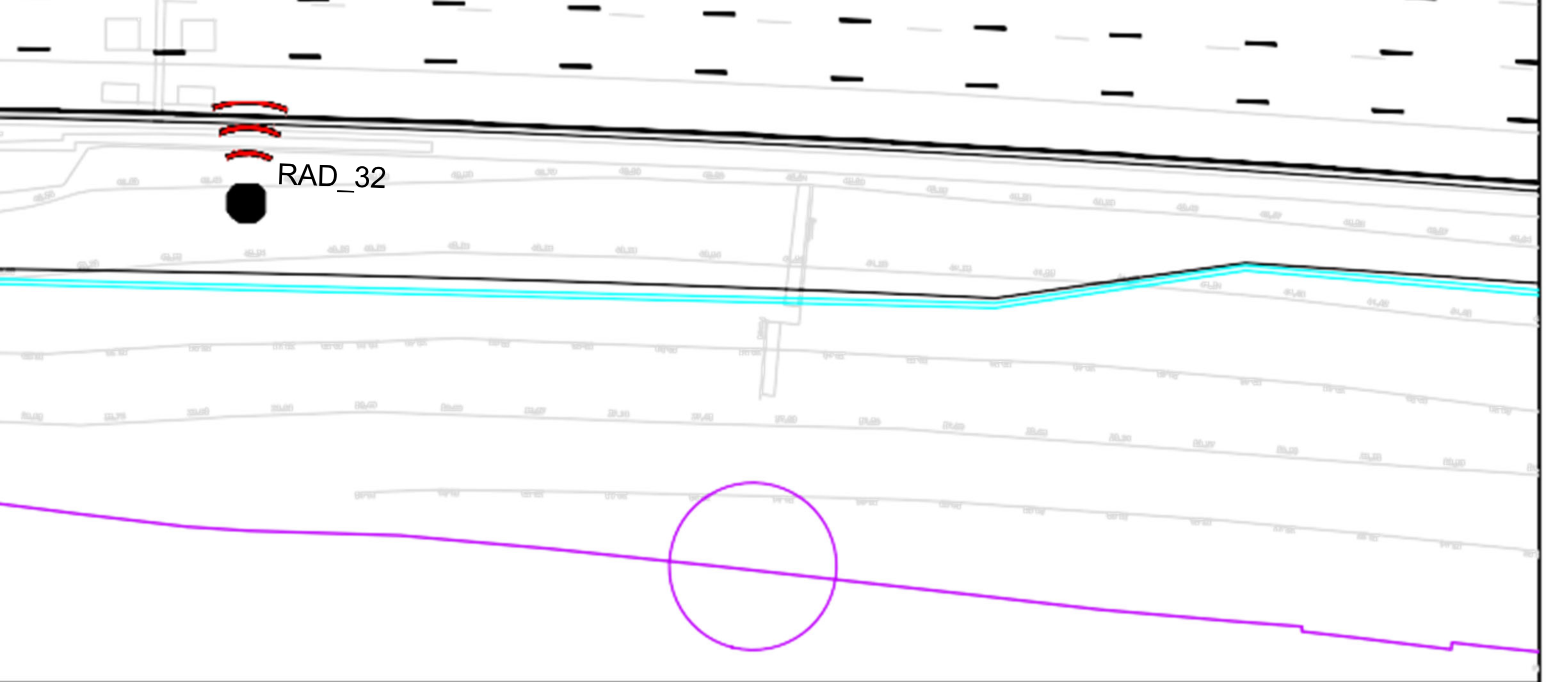

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SHEET PILE

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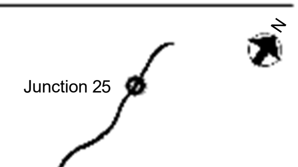
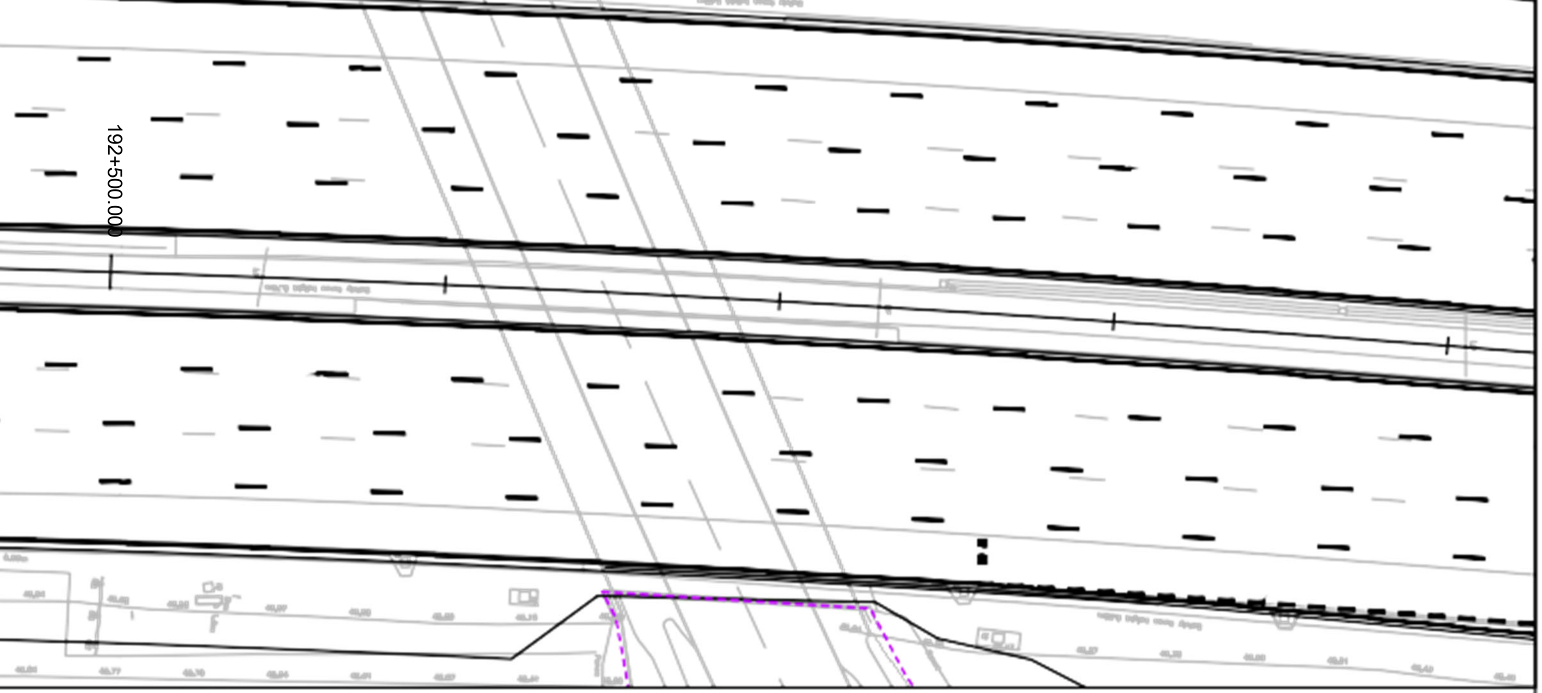
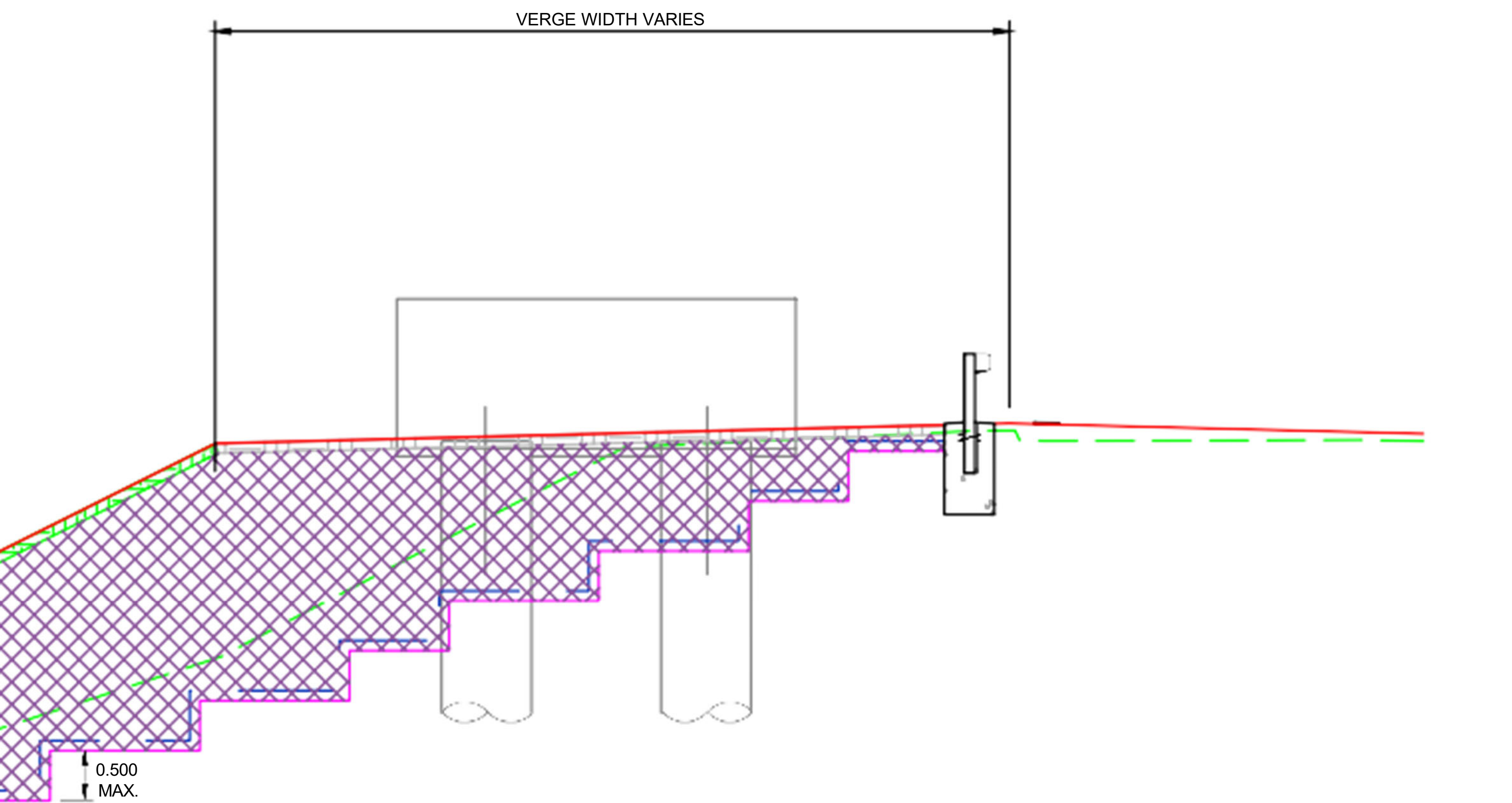


OR SIMILAR APPROVED) PEDESTRIAN
REQUIRED) FOR DETAILS REFER TO
PECIFICATION AND SCHEDULE

ET PILE WALL - FOR LEVELS
DETAILS REFER TO SERIES
SPECIFICATION AND
EDULE

BOUNDARY
FENCE





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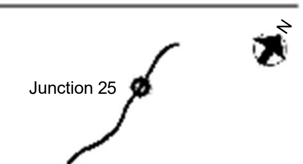

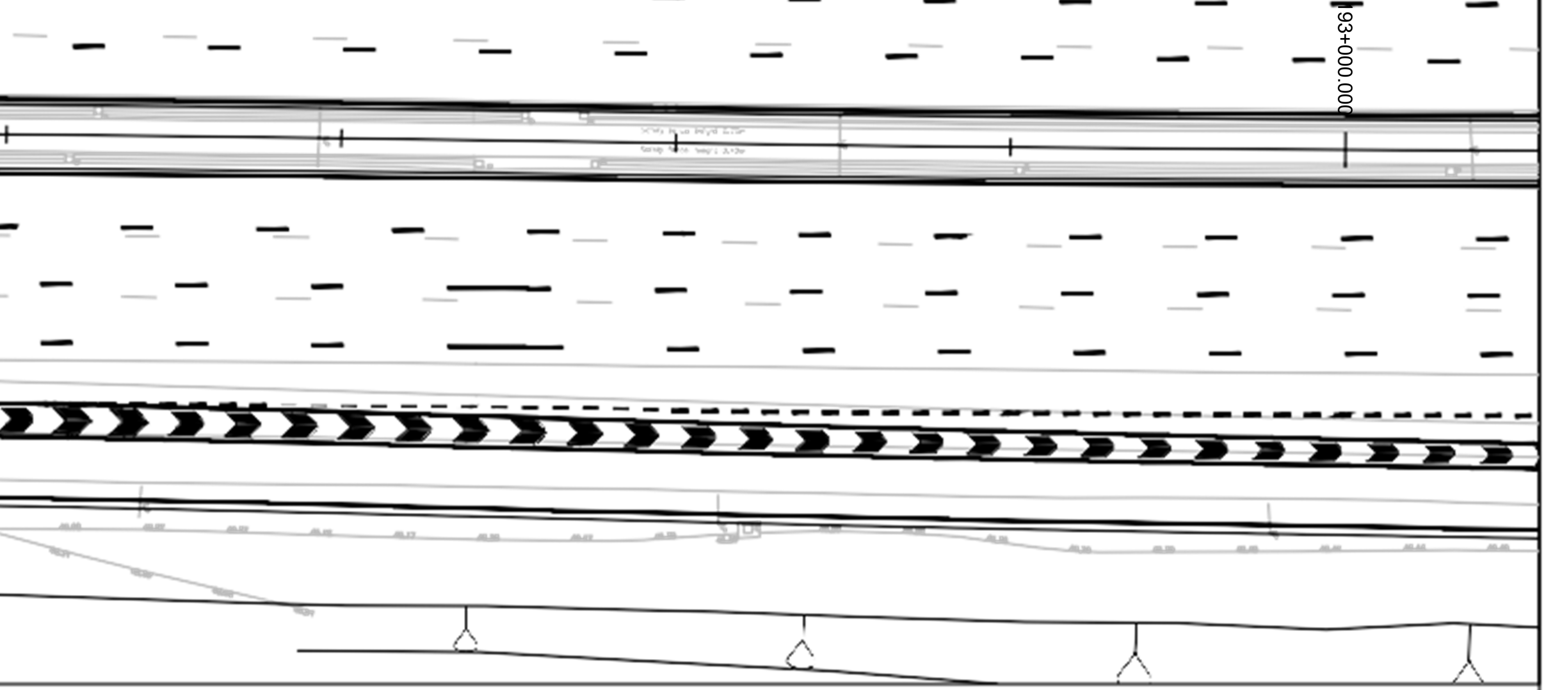

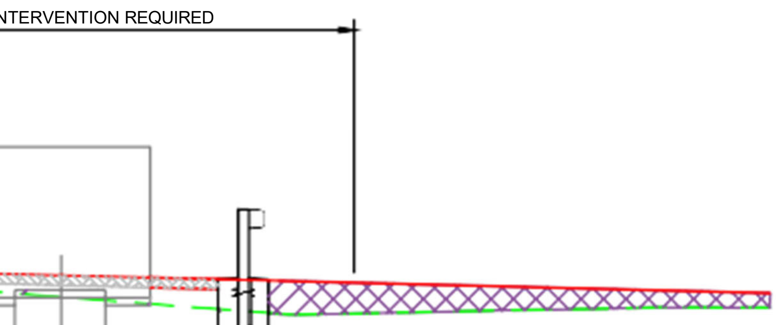

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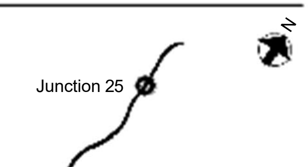

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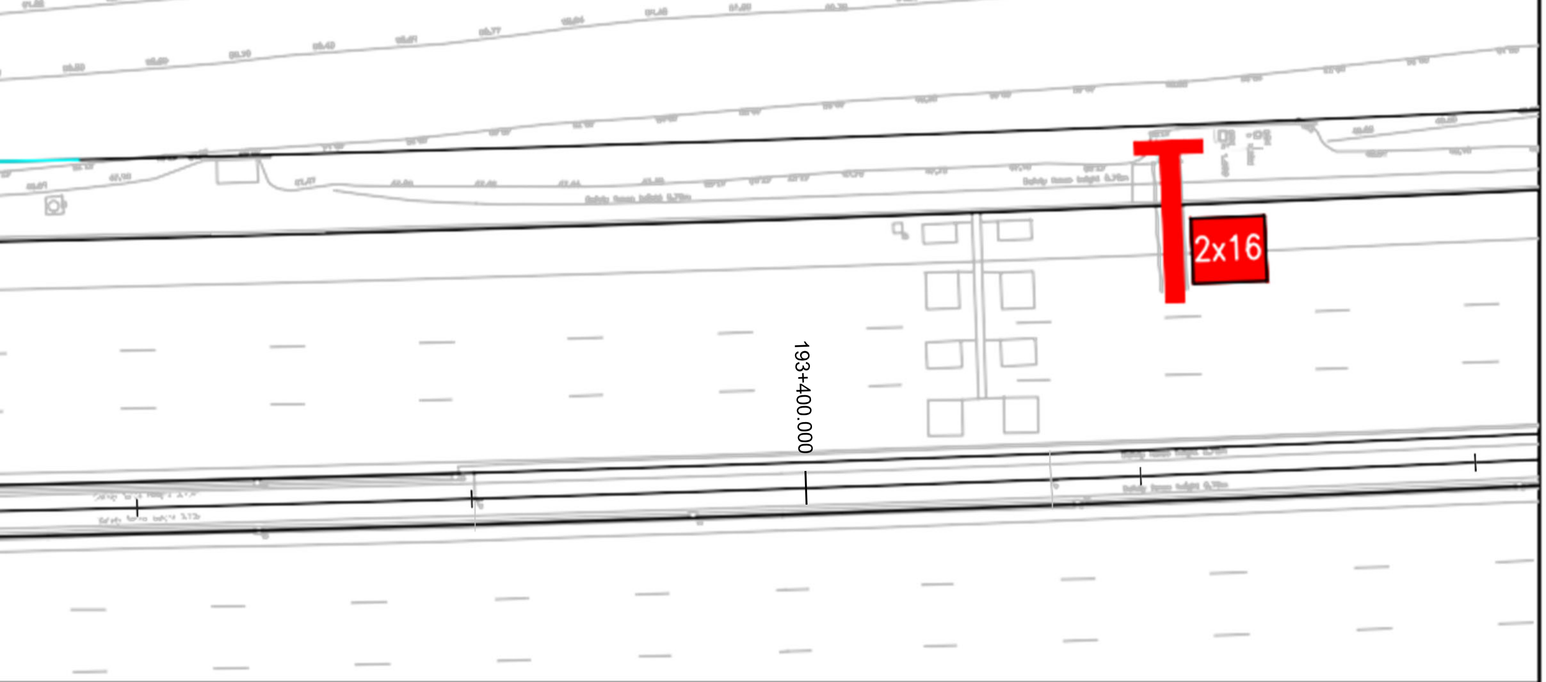

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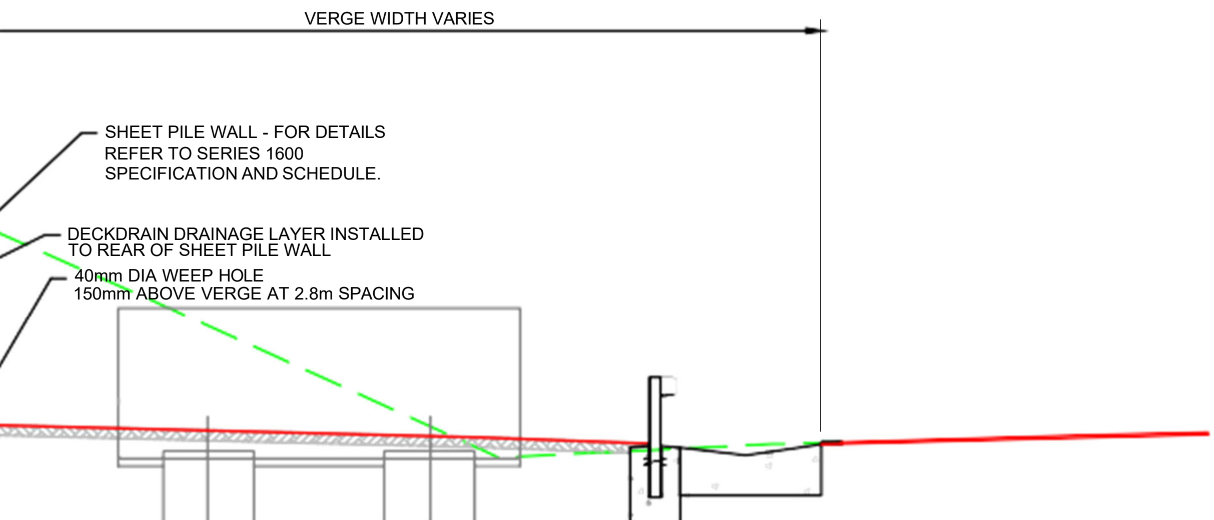
- SHEET PILE



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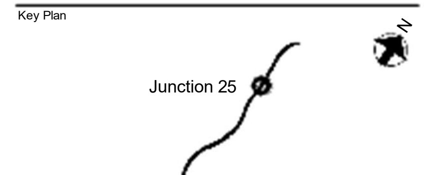

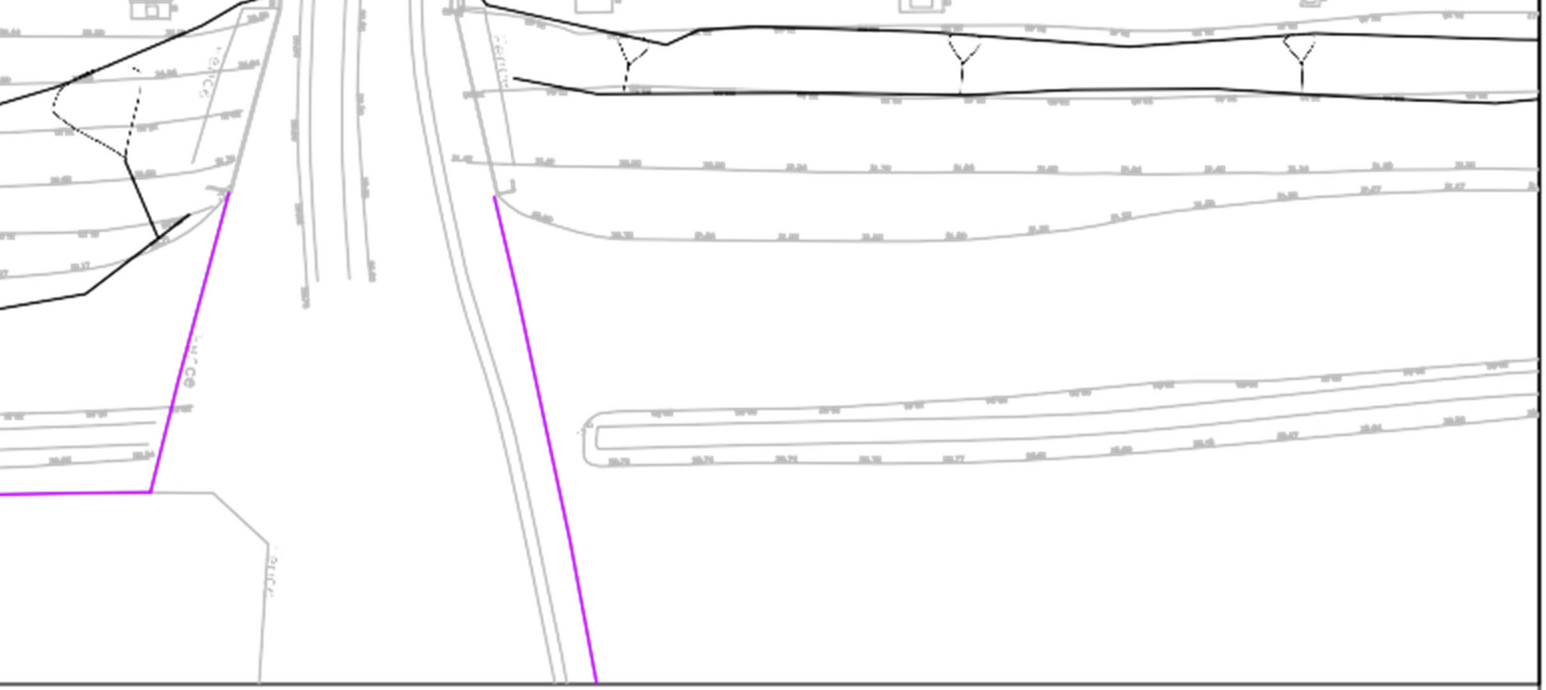

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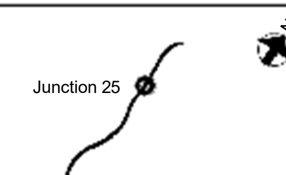

BOUNDARY FENCE

Appendix D Imported Material Test Results and Acceptance Certificates

D.1 – 6N Testing Results
D.2 – Topsoil Tests
D.3 – Sheet Piling Mill Certifies
D.4 – Gabion Wall Material
D.5 – Concrete Mix Design for Bored Piles
D.6 – Pre-cast Concrete Blocks
D.7 – Deckdrain

D.2 - Summary of Topsoil - Imported Material

Laboratory Reference No	Contract Sample No	Date Sampled	Material Description	Material Source	Location - Grid Ref	Location - Link Ref	Location - Layer
CIV/41963	C4135/899	43049	Topoil	Ex Site	NB, CH190930	Link 4B	6N Emtankment
CIV/29096	C4135/4	42853	Topsoil	M1 Southtound	SOUTH 184336		
CIV/29100	C4135/8	42853	Topsoil	Not Stated	SOUTH 182400		
CIV/29102	C4135/10	42853	Topsoil	Not Stated	SOUTH 183406		
CIV/32996	C4135/181	42935	Topsoil	Ex Site	SB	Link 2	Stockpile
CIV/32997	C4135/182	42935	Topsoil	Ex Site	NB, CH183180	Link 2	
CIV/33385	C4135/196	42944	TOPsoil	Ex Site	SB, CH183380	Link 2	
CIV/33390	C4135/201	42944	Topsoil	Ex Site	NB CH183320	Link 2	
CIV/33891	C4135/224	42951	Topsoil	Ex Site	SB, CH184350	Link 2	Re-Graded Emtankment
CIV/33892	C4135/225	42951	Topsoil	Ex Site	SB, CH183400	Link 2	
CIV/34205	C4135/240	42958	Topsoil	Ex Site	NB CH184250	Link 2	Re-Graded Emtankment
CIV/34206	C4135/241	42958	Topsoil	Ex Site	NB CH184250	Link 2	Re-Graded Emtankment
CIV/34391	C4135/249	42963	Topsoil	Ex-Site	NB, CH187150	Link 4A	Stockpile (Site Arisings
CIV/34396	C4135/254	42963	Topsoil	Ex-Site	NB, CH187570	Link 4A	Stockpile (Site Arisings
CIV/34575	C4135/264	42965	Topsoil	Ex-Site	SB, CH184070	Link 2	Re-Graded Emtankment
CIV/34576	C4135/265	42965	Topsoil	Ex-Site	SB, CH184130	Link 2	Re-Graded Emtankment
CIV/34581	C4135/270	42965	Topsoil	Ex-Site	SB, CH187060	Link 4 A	Stockpile (Site Arisings
CIV/34981	C4135/314	42972	Topsoil	Ex-Site	SB, CH186370	Link 3	Emtankment
CIV/34982	C4135/315	42972	Topsoil	Ex-Site	NB, CH184450	Link 3	Regraded Emtankment
CIV/35329	C4135/350	42979	Topsoil	Ex Site	SB, CH185950	Link 3	6N Emtankment
CIV/35903	C4135/388	42986	Topsoil	Ex Site	NB, CH187820	Link 4A	6N Emtankment
CIV/35904	C4135/389	42986	Topsoil	Ex Site	SB, CH186100	Link 3	6N Emtankment
CIV/36305	C4135/427	42992	Topsoil	Ex Site	NB, CH186680	Link 3	6N Emtankment
CIV/36306	C4135/428	42992	Topsoil	Ex Site	SB, CH182600	Link 2	Emtankment Regrade
CIV/36903	C4135/476	43000	Topsoil	Ex Site	SB, CH182350	Link 2	Ematankment Regrade
CIV/36904	C4135/477	43000	Topsoil	Ex Site	NB, CH187550	Link 4A	6N Emtankment
CIV/38283	C4135/560	43014	Topsoil	Ex Site	SB, CH187240	Link 4A	6N Emtankment
CIV/39000	C4135/567	43014	Topsoil	Ex Site	NB, CH187700	Link 4A	6N Emtankment
CIV/39435	C4135/593	43020	Topsoil	Ex Site	NB, CH187370	Link 4A	6N Emtankment
CIV/39460	C4135/618	43020	Topsoil	Ex Site	SB, CH186130	Link 3	6N Emtankment
CIV/39720	C4135/638	43026	Topsoil	Ex Site	NB, CH191200	Link 4B	
CIV/39967	C4135/649	43028	Topsoil	Ex Site	NB, CH188050	Link 4A	6N Emtankment
CIV/39977	C4135/659	43028	Topsoil	Ex Site	SB, CH187500	Link 4A	6N Emtankment
CIV/40264	C4135/665	43032	Topsoil	Ex Site	SB, CH191450	Link 4B	Stockpile
CIV/40463	C4135/715	43034	Topsoil	Ex-Site	NB, CH185880	Link 3	6N Emtankment
CIV/40464	C4135/716	43034	Topsoil	Ex-Site	SB, CH185550	Link 3	Emtankment Regrade
CIV/41453	C4135/827	43042	Topsoil	Not Stated	Not Stated	Not Stated	Not Stated
CIV/41454	C4135/828	43042	Topsoil	Not Stated	Not Stated	Not Stated	Not Stated
CIV/43008	C4135/967	43055	Topsoil	Ex Site	NB, CH190500	Link 4B	6N Emtankment
CIV/43009	C4135/968	43055	Topsoil	Ex Site	SB, CH183000	Link 2	6N Emtankment
CIV/43242	C4135/1000	43062	Topsoil	Ex Site	NB, CH192300	Link 4B	6N Emtankment
CIV/43251	C4135/1009	43062	Topsoil	Ex Site	SB, CH191050	Link 4B	6N Emtankment
CIV/43591	C4135/1020	43067	Topsoil	Ex Site	NB, CH192100	Link 4B	6N Emtankment
CIV/43604	C4135/1033	43067	Topsoil	Ex Site	SB, CH190920	Link 4B	6N Emtankment
CIV/44720	C4135/1071	43084	Topsoil	Ex Site	NB, CH191580	Link 4B	Emtankment Regrade
CIV/44721	C4135/1072	43084	Topsoil	Ex Site	SB, CH191580	Link 4B	Emtankment Regrade
CIV/37097	C4135/488	43006	Topsoil	Ex Site	NB, CH182950	Link 2	Ematankment Regrade
CIV/37098	C4135/489	43006	Topsoil	Ex Site	SB, CH182600	Link 2	Ematankment Regrade
CIV/41892	C4135/913	43049	Topsoil	Ex Site	SB, CH18350	Link 3	6N Emtankment
CIV/29105	C4135/13	42853	Topsoil + Root Material	Not Stated	NB 184303		
CIV/29108	C4135/16	42853	Topsoil + Root Material	Not Stated	183703		
CIV/29107	C4135/15	42853	Topsoil + Root material + Occ Clay	Not Stated	183152		
CIV/29110	C4135/18	42853	Topsoil Occ Stones Root Material Occ Clay	Not Stated	183987		
CIV/29106	C4135/14	42853	Topsoil Stones + Root Material	Not Stated	NB 182813		

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Quality Certificate of Product

Sales Agent

Consignee	SHEET PILING (UK) LTD	Conrnodity	HOT ROLLED STEEL SHEET PILE	Q.T. No.	ASZZ-SPUK-16001/1	ANSHAN ZIZHU INTERNATIONAL TRADING CO., LTD
Dimension Standard	EN10248-2	Chem. & Mech. Standard	EN10248-1	Weight method	Theoretical	Production Date I 2016.9.20

Inspection certificate 3.1 according to EN 10204:2004

Size	Heat No.	Steel Grade	Length (m)	Quantity (Pcs)	Weight (MT)	Surfcce Qual ity	Surface Dimension	Chemical Composition (%) G	Si	Mn	P	S	Cu	Cr	Ni	Mo	V	N	Ceq /CEV	Mechanical Properties Rel (Mpa)	Rm (Mpa)	A (%)	Impact Test (J) TestTemp ("C) Di menfion (IIIII) 1	2	3	Average
									x10-2					x10-3				x10-2								
ZZ18-700	16112054579	S355GP	8	154	94.494	ok	ok	24	22	125	17	9	15	79	21	14	7	0.42	-	375	580	26	-	-	-	-
ZZ18-700	16112054577	S355GP	8	151	92.654	ok	ok	25	27	131	20	3	21	83	24	18	3	0.4i	-	382	594	26.5	-	-	-	-
ZZ18-700	16112054346	S355GP	8	135	82.836	ok	ok	24	25	129	16	13	13	60	18	21	5	0.3	-	379	588	26.5	-	-	-	-
ZZ18-700	16112054603	S355GP	9	130	89.739	ok	ok	24	22	125	17	9	15	79	21	14	7	0.4	-	374	573	24.5	-	-	-	-
ZZ18-700	16112054614	S355GP	9	122	84.217	ok	ok	25	27	131	20	3	21	83	24	18	3	0. 4i	-	381	575	25.5	-	-	-	-
ZZ18-700	16112054607	S355GP	9	125	86.288	ok	ok	24	25	129	16	13	13	70	18	21	5	0.3	-	386	575	25	-	-	-	-
ZZ18-700	16112054601	S355GP	9	143	98.713	ok	ok	23	21	137	23	7	22	74	17	19	4	0.3E	-	377	581	25	-	-	-	-
ZZ18-700	16112054591	S355GP	10	122	93.574	ok	ok	23	29	131	22	11	15	79	22	14	11	0.41	-	377	588	26	-	-	-	-
ZZ18-700	16112054594	S355GP	10	133	102.011	ok	ok	24	21	127	19	3	21	83	24	18	3	0.41	-	382	579	25.5	-	-	-	-
ZZ18-700	16112054597	S355GP	10	124	95.108	ok	ok	24	25	121	16	13	13	82	19	21	6	0.3	-	379	586	25.5	-	-	-	-
ZZ18-700	16112054596	S355GP	10	131	100.477	ok	ok	24	23	126	21	7	22	74	17	22	4	0.4	-	375	592	25	-	-	-	-
TOTAL				1470	1020.110																					

Quality Manager **Mr.Gao Yu**

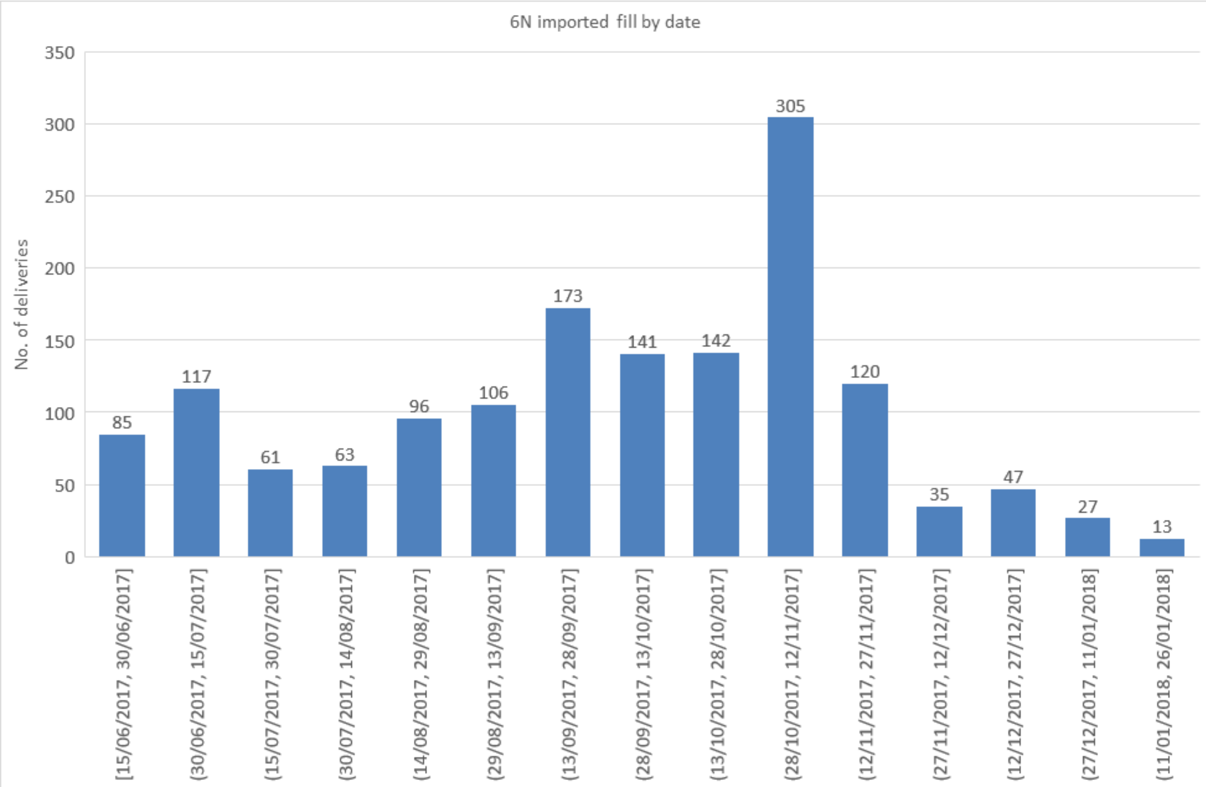
VY ,,,

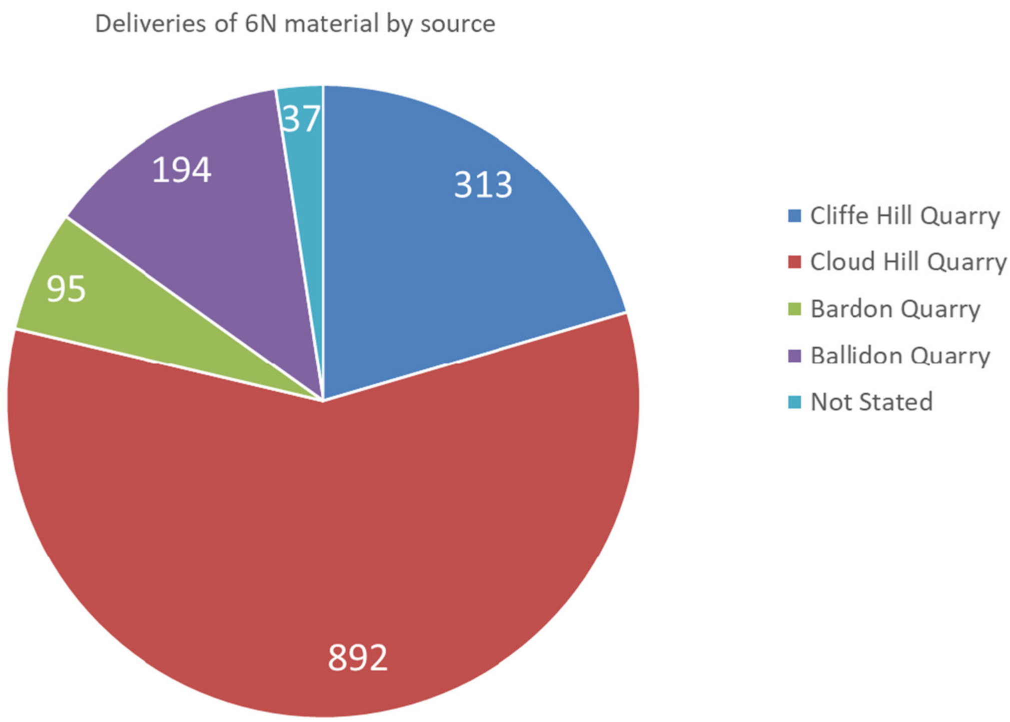
WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MANUFACTUREED AND TESTED WITH SATISFTRvTr&IMAoAtiYE WITH THE REOUIRMENTS OF THE

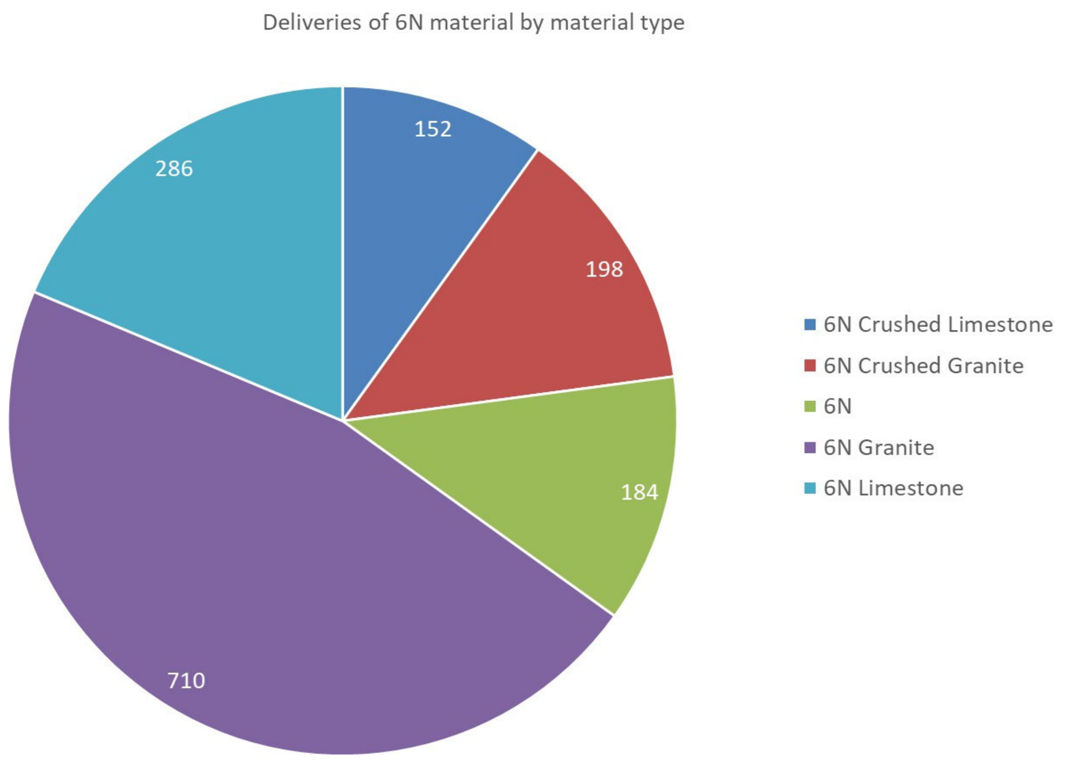
IODUCT QUALITY STAM

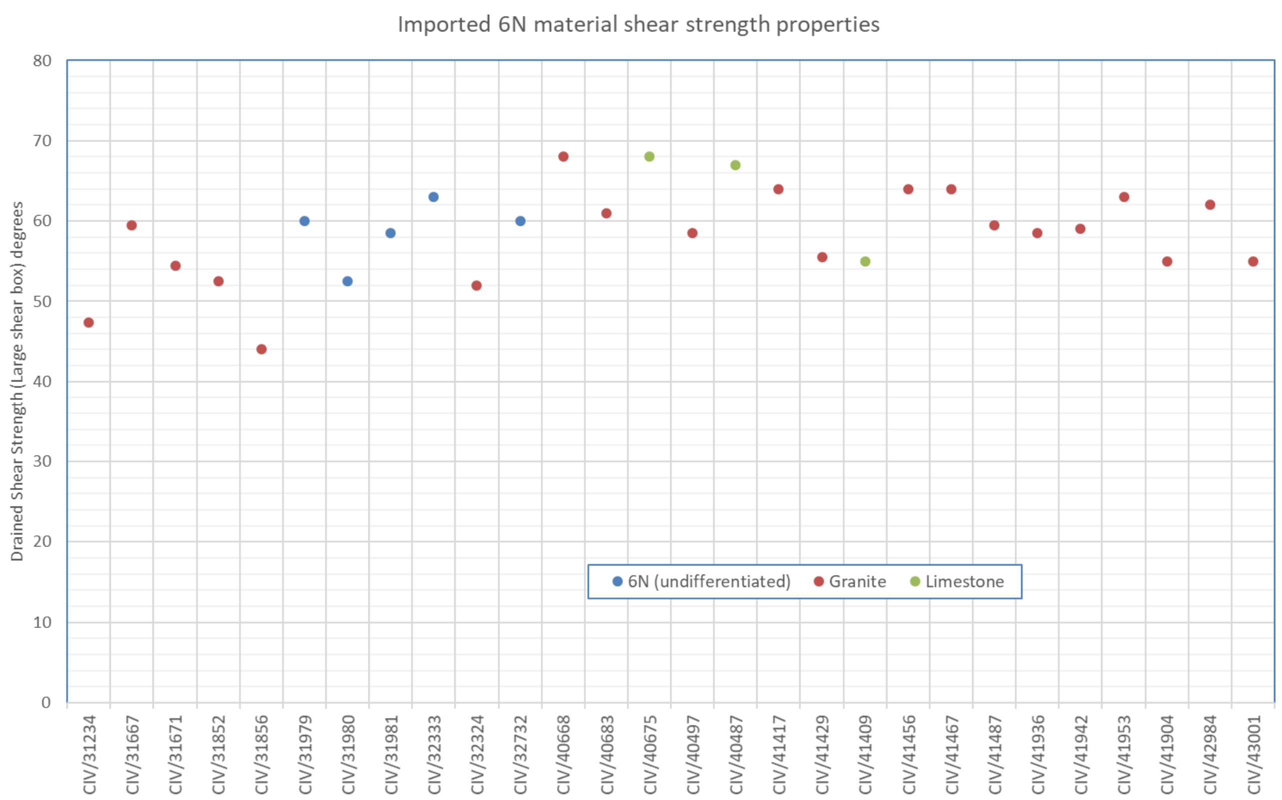
D1 Imported Fill Class 6N

The following charts summarise the delivery consignments of 6N from local quarries during the project. Full details are included in the Health and Safety file.






Deliveries of 6N material by material type
152
198
184
710
286
6N Crushed Limestone
6N Crushed Granite
6N
6N Granite
6N Limestone


Imported 6N material shear strength properties
Drained Shear Strength (Large shear box) degrees
0
10
20
30
40
50
60
70
80
6N (undifferentiated)
Granite
Limestone
CIV/31234
CIV/31667
CIV/31671
CIV/31852
CIV/31856
CIV/31979
CIV/31980
CIV/31981
CIV/32333
CIV/32324
CIV/32732
CIV/40668
CIV/40683
CIV/40675
CIV/40497
CIV/40487
CIV/41417
CIV/41429
CIV/41409
CIV/41456
CIV/41467
CIV/41487
CIV/41936
CIV/41942
CIV/41953
CIV/41904
CIV/42984
CIV/43001

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Quality Certificate of Product

Sales Agent

Consignee	NEWCO 5148 LIMITED	Coomodity	HOT ROLLED STEEL SHEET PILE	Q.T. No.	ASZZ-SPUK-16001/1	ANSHAN ZIZHU INTERNATIONAL TRADING CO., LTD	
Dimension Standard	EN10248-2	Chem. & Mech. Standard	EN10248-1	Weight method	Theoretical	Production Date	2016.9.20

Inspection certificate 3.1 according to EN 10204:2004								Chemical Composition (%)												Mechanical Properties			Impact Test (J)			
Size	Heat No.	Steel Grade	Length (m)	Quantity (Pcs)	Weight (MT)	Surfcce Quality	Surface Dimension	C	Si	Mn	P	S	Cu	Cr	Ni	Mo	V	N	Ceq /CEV	Rel	Rm	A	TestTemp ("C) Dimenfion (nm)			
								x10-2			x10-3							x10-2		(Mpa)	(Mpa)	(%)	1	2	3	Average
2218-700	16112054579	S355GP	8	154	94.494	ok	ok	24	22	125	11	9	15	79	21	14	7	10.421	-	375	580126•-					
2218-700	16112054577	S355GP	8	151	92.654	ok	ok	25	27	131	20	3	21	83	24	18	3	10.471	-	382	594	26. 5,	-			
2218-700	16112054346	S355GP	8	135	82.836	ok	ok	24	25	129	16	13	13	60	18	21	5	10.391	-	379	588	26.5,	-			
2218-700	16112054603	S355GP	9	130	89. 739	ok	ok	24	22	125	17	9	15	79	21	14	7	10.421	-	374	573	24. 5,	-			
2218-700	16112054614	S355GP	9	122	84.217	ok	ok	25	27	131	20	3	21	83	24	18	3	lo.471	-	381	575	25. 5,	-			
2218-700	16112054607	S355GP	9	125	**86.288**	**ok**	**ok**	24	25	129	16	13	13	*10*	18	21	5	10.391	-	386	575	**25**				
2218-700	16112054601	S355GP	9	143	98. 713	ok	ok	23	21	137	23	7	22	74	11	19	4	10.381	-	377	581	25				
2218-700	16112054591	S355GP	10	122	93.574	ok	ok	23	29	131	22	11	15	79	22	14	11	10.411	-	377	588	26				
2218-700	16112054594	S355GP	10	133	102. 011	ok	ok	24	21	1211	19	3	21	83	24	18	3	I0.471	-	382	579	25. 5,	-			
2218-700	16112054597	S355GP	10	124	95. 108	ok	ok	24	25	121	16	13	13	82	19	21	6	10.391	-	379	586	25. 5,	-			
2218- 700	16112054596	S355GP	10	131	100.477	ok	ok	24	23	126	21	7	22	74	17	22	4	10.421	-	375	592	25				
TOTAL				1470	1020. 110																					

Quality **Manager**	**Mr.Gao** Yu

WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MANUFACTUREED AND TESTED WITH SATISFACTRY THE REQUIRMENTS OF THE ABOVE MATERIAL SPECIFICATION.

QUAllfYSTAIIP

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Quality Certificate of Product

Sales Agent

Consignee	NEWCO 5148 LIMITED	Con1110dity	HOT ROLLED STEEL SHEET PILE	Q.T. No.	ASZZ-SPUK-16001/1	ANSHAN ZIZHU INTERNATIONAL TRADING CO., LTD	
Dimension Standard	EN10248-2	Chem. & Mech. Standard	EN10248-1	Weight method	Theoretical	Production Date	2016.9.20

Inspection certificate 3.1 according to EN 10204:2004

Size	Heat No.	Steel Grade	Length (m)	Quantity (Pcs)	Weight (MT)	Surfcce Qual ity	Surface Dimension	Chemical Composition (%) G	Si	Mn	p	S	Cu	Cr	Ni	Mo	V	N	Ceq /CEV	Mechanical Properties Rel	Rm	A	Impact Test (J) TestTemp ('C) Dimenfion (nm) 1	2	3	Average
								x10-2						x10-3				x10-2		(Mpa)	(Mpa)	(%)	1	2	3	Average
ZZ18-700	16112054579	S355GP	8	154	94.494	ok	ok	24	22	125	17	9	15	79	21	14	7	0.4:1	-	375	580	26	-	-	-	-
ZZ18-700	16112054577	S355GP	8	151	92.654	ok	ok	25	27	131	20	3	21	83	24	18	3	0.41	-	382	594	26.5	-	-	-	-
ZZ18-700	16112054346	S355GP	8	135	82.836	ok	ok	24	25	129	16	13	13	60	18	21	5	0.39	-	379	588	26.5	-	-	-	-
ZZ18-700	16112054603	S355GP	9	130	89.739	ok	ok	24	22	125	17	9	15	79	21	14	7	0.4:1	-	374	573	24.5	-	-	-	-
ZZ18-700	16112054614	S355GP	9	122	84.217	ok	ok	25	27	131	20	3	21	83	24	18	3	0.41	-	381	575	25.5	-	-	-	-
ZZ18-700	16112054607	S355GP	9	125	86.288	ok	ok	24	25	129	16	13	13	70	18	21	5	0.39	-	386	575	25	-	-	-	-
ZZ18-700	16112054601	S355GP	9	143	98.713	ok	ok	23	21	137	23	7	22	74	17	19	4	0.38	-	377	581	25	-	-	-	-
ZZ18-700	16112054591	S355GP	10	122	93.574	ok	ok	23	29	131	22	11	15	79	22	14	11	0.41	-	377	588	26	-	-	-	-
ZZ18-700	16112054594	S355GP	10	133	102.011	ok	ok	24	21	127	19	3	21	83	24	18	3	0.41	-	382	579	25.5	-	-	-	-
ZZ18-700	16112054597	S355GP	10	124	95.108	ok	ok	24	25	121	16	13	13	82	19	21	6	0.39	-	379	586	25.5	-	-	-	-
ZZ18 700	16112054596	S355GP	10	131	100.477	ok	ok	24	23	126	21	7	22	74	17	22	4	0.4:1			592	25	-	-	-	-
TOTAL				1470	1020.110																					

Quality Manager Mr.Gao Yu

Anshan Zizhu Heavy Casting Co.,Ltd.

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Qyality Certificate of Product

Sales Agent

Consignee	NEWCO 5148 LIMITED	Co111110dity	HOT ROLLED STEEL SHEET PILE	Q.T. No.	ASZZ-SPUK-16001/1	ANSHAN ZIZIIJ INTERNATIONALT.RADINGCO.. LTD	
Di11ension Standard	EN10248-2	Chern. & Mech. Standard	EN10248-1	Weight •thod	Theoretical	Product ion Date	2016.9.20

1nepeotion oertific•te 3.1 acoordln1 to EN 10204:2004

Siie	Heit No.	StHI Grede	Len1th (m)	Quantity (Pcs)	Weicht (MT)	Surfoce Qual ity	Surface Dimension	(i	Si	lln	p	S	Cu	Cr	Ni	llo	V	N	Ceq /CEV	Rel	Rm	A	TestTemp ("C) Dimenfion (nm)				- -
								x10-2			X10-3							X10-2		(Mpa)	(Mpa)	(%)	1	2	3		Average
ZZ18-700	16112054579	S355GP	8	154	94.494	ok	ok	24	22	125	17	9	15	79	21	14	7	0.42	-	375	580	26	-	-	-		-
ZZ18-700	16112054577	S355GP	8	151	92.654	ok	ok	25	27	131	20	3	21	83	24	18	3	0.47	-	382	594	26.5	-	-	-		-
ZZ1B-700	16112054346	S355GP	8	135	82.836	ok	ok	24	25	129	16	13	13	60	18	21	5	0.39	-	379	588	26.5	-	-	-		-
ZZ1B-700	16112054603	S355GP	9	130	89.739	ok	ok	24	22	125	17	9	15	79	21	14	7	0.42	-	374	573	24.5	-	-	-		-
ZZ18-700	16112054814	S355GP	9	122	84.217	ok	ok	25	27	131	20	3	21	83	24	18	3	0.47	-	381	575	25.5	-	-	-		-
ZZ1B-700	16112054607	S355GP	9	125	86.288	ok	ok	24	25	129	16	13	13	70	18	21	5	0.39	-	386	575	25	-	-	-		-
ZZ18-700	16112054601	S355GP	9	143	98.713	ok	ok	23	21	137	23	7	22	74	17	19	4	0.38	-	377	581	25	-	-	-		-
ZZ18-700	16112054591	S355GP	10	122	93.574	ok	ok	23	29	131	22	11	15	79	22	14	11	0.41	-	377	588	26	-	-	-		-
ZZ18-700	16112054594	S355GP	10	133	102.011	ok	ok	24	21	127	19	3	21	83	24	18	3	0.47	-	382	579	25.5	-	-	-		-
ZZ18-700	18112054597	S355GP	10	124	95.108	ok	ok	24	25	121	16	13	13	82	19	21	6	0.3[illegible]	-	379	586	25.5	-	-	-		-
ZZ19-700	18112054598	S355GP	10	131	100.477	ok	ok	24	23	126	21	7	22	74	17	22					592	25	-	-	-		-
	TOTAL			1470	1020.110																						

Header groups: Chemical Composition (%) — columns (i to Ceq/CEV; Mechanical Properties — Rel, Rm, A; Irnpact Test (J) — TestTemp to Average.

Qua1ity Manager Mr.Gao Yu

Anshan Zizhu Heavy Casting Co.,Ltd.

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Quality Certificate of Product

Sales Agent

Consignee	SHEET PILING (UK) LTD	C0111110dity	HOT ROLLED STEEL SHEET PILE	Q.T. No.	ASZZ-SPUK-16001/2	ANSHAN ZIZHU INTERNATIONAL TRADING CO., LTD	
Dimension **Standard**	EN10248-2	Chem. & **Mech. Standard**	**EN10248-1**	**Weight method**	**Theoretical**	**Production Date**	2016.9.20

Inspection certificate 3.1 according to EN 10204:2004

Size	Heat No.	Steel Grade	Length (m)	Quantity (Pcs)	**Wei,:ht (MT)**	Surfcce Qual ity	Surface Dimension	Chemical Composition (") C	Si	Mn	p	S	Cu	Cr	Ni	Mo	V	N	Ceq /CEV	Mechanical Properties Rel (Mpa)	Rm (Mpa)	A (%)	Impact Test (J) TestT□("C) Dimenfion(nm) 1	2	3	Average
								x10-2			x10-3							x10-2								
2218-700	16112054595	S355GP	11	103	86.901	ok	ok	24	30	131	17	9	22	79	35	14	9	0.39	-	372	586	26	-	-	-	-
2218-700	16112054587	S355GP	11	96	80.995	ok	ok	24	27	127	19	3	21	83	19	25	12	0.4,	-	377	579	25	-	-	-	-
2218-700	16112054632	S355GP	11	101	85.214	ok	ok	23	25	129	15	10	13	82	21	21	6	0.4□	-	384	581	26	-	-	-	-
2218-700	16112054613	S355GP	12	103	94.801	ok	ok	23	29	130	21	11	22	79	15	14	13	0.41	-	380	578	26	-	-	-	-
2218-700	16112054615	S355GP	12	99	91.120	ok	ok	24	27	135	19	3	25	83	19	25	12	0.4,	-	375	578	25.5	-	-	-	-
2218-700	16112054616	S355GP	12	98	90.199	ok	ok	25	25	129	23	10	13	82	21	21	6	0.4□	-	377	583	25.5	-	-	-	-
2226-700	16112054344	S355GP	14	76	109.592	ok	ok	24	29	125	17	9	15	79	21	14	7	0.4□	-	378	579	26	-	-	-	-
2226-700	16112054352	S355GP	14	74	106.708	ok	ok	23	31	132	15	2	4	81	19	7	4	0.4□	-	379	582	26	-	-	-	-
2226-700	16112054350	S355GP	16	47	77.456	ok	ok	24	25	137	18	2	8	100	20	9	4	0.4□	-	374	579	26	-	-	-	-
2226-700	16112054351	S355GP	16	50	82.400	ok	ok	25	27	126	15	2	4	81	19	7	4	0.4'		[illegible]	580	26.5	-	-	-	-
2226-700	16112054346	S355GP	16	53	87.344	ok	ok	25	30	130	14	12	12	120	21	14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	26	-	-	-	-
TOTAL				900	992.730																					

QuaI ity **Manager** Mr.Gao Yu

ABOVE MATERIAL SPECIFICATION.

Anshan Zizhu Heavy Casting Co.,Ltd.

NO.555, ZIZHU ROAD,TENGAO TOWN
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Quality Certificate of Product

Sales Agent

Consignee	SHEET PILING (UK) LTD	Commodity	HOT ROLLED STEEL SHEET PILE	Q.T.No.	**ASZZ-SPUK-** 16001/1	**ANSHAN** ZIZHU **INTERNATIONAL TRADING** CO., LTD	
Dimension **Standard**	EN10248-2	Chem. & **Mech. Standard**	EN10248-1	**Weight** method	Theoretical	Production **Date**	**2016.9.20**

Inspection certificate 3.1 according to EN 10204:2004								Chemical Composition (%)												Mechanical Properties			Impact Test (J)			
Size	Heat No.	Steel Grade	Length (m)	Quantity (Pcs)	Weight (MT)	Surfcce Oual ity	Surface Dimension	G	**Si**	**Mn**	p	**S**	Cu	Cr	**Ni**	**Mo**	V	**N**	**Ceq** /CEV	Rel	Rm	**A**	TestTemp ("C) Dimenfion(rrm)			- -
								X10-2			x10-3							x10-2		**(Mpa)**	(Mpa)	(%)	1	2	3	**Average**
2218-700	16112054579	S355GP	8	154	94.494	ok	ok	24	22	125	17	9	15	79	21	14	7	0.4[illegible]	-	375	580	26	-	-	-	-
2218-700	16112054577	S355GP	8	151	92.654	ok	ok	25	27	131	20	3	21	83	24	18	3	0.41	-	382	594	26.5	-	-	-	-
2218-700	16112054346	S355GP	8	135	82.836	ok	ok	24	25	129	16	13	13	60	18	21	5	0.3S	-	379	588	26.5	-	-	-	-
2218-700	16112054603	S355GP	9	130	89.739	ok	ok	24	22	125	17	9	15	79	21	14	7	0.4[illegible]	-	374	573	24.5	-		-	-
2218-700	16112054614	S355GP	9	122	84.217	ok	ok	25	27	131	20	3	21	83	24	18	3	0.4"J	-	381	575	25.5	-	-	-	-
2218-700	16112054607	S355GP	9	125	86.288	ok	ok	24	25	129	16	13	13	70	18	21	5	0.3S	-	386	575	25	-	-	-	-
2218-700	16112054601	S355GP	9	143	98.713	ok	ok	23	21	137	23	7	22	74	17	19	4	0.38	-	377	581	25	-	-	-	-
2218-700	16112054591	S355GP	10	122	93.574	ok	ok	23	29	131	22	11	15	79	22	14	11	0.41	-	377	588	26	-	-	-	-
2218-700	16112054594	S355GP	10	133	102.011	ok	ok	24	21	127	19	3	21	83	24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	25.5	-	-	-	-
2218-700	16112054597	S355GP	10	124	95.108	ok	ok	24	25	121	16	13	13	82	19	21	[illegible]	[illegible]	[illegible]	[illegible]	579	25.5				
2218-700	16112054596	S355GP	10	131	100.477	ok	ok	24	23	126	21	7	22	74	17	22	[illegible]	[illegible]	[illegible]	375	[illegible]	25	-	-	-	-
TOTAL				1470	1020.110																					
QuaI i ty **Manager**				Mr.Gao Yu																						

QUALITY STAMP

WE HEREBY CERTIFY THAT THE MATERIAL DESCRIBED HEREIN HAS BEEN MANUFACTUREED AND TESTED WITH SATISFACTRY RESULTS IN ACCORDANCE WITH THE REQUIRMENTS OF THE ABOVE MATERIAL SPECIFICATION.

Material Approval Request

Costain Galliford Try
Smart Motorways Joint Venture

DATE 9/10/17	PROCUREMENT **MATERIAL APPROVAL REQUEST**	**MAR** REF. NUMBER **0148**

CONTRACT:	**M1 Jct 23a to Jct 25**
SUBCONTRACTOR/ SUPPLIER	**CGT**
SPECIFIED PRODUCT OR SYSTEM	**Gabion stone**
PROPOSED PRODUCT OR SYSTEM AND MANUFACTURER	**Aggregate Industries Bardon Hill Coalville Leicestershire LE67 1TL**
CONTRACT SPECIFICATION	**SHW 600 series**
DEVIATION FROM CURRENT SPECIFICATION, IF ANY	**non**
DRAWING REFERENCE	
WHERE TO BE USED	
OFFSITE OR PRE-DELIVERY INSPECTION REQUIRED	**YES ☐ NO ☒ (If Yes, see page 2)**
ON-SITE MOCK UP REQUIRED	**YES ☐ NO ☒ (If Yes, see page 2)**
SAMPLE REQUIRED	**YES ☐ NO ☒ (If Yes, see page 2)**
TECHNICAL LITERATURE/CATALOGUE REQUIRED	**YES ☒ NO ☐ (If Yes, see page 2)**
TEST CERTIFICATE REQUIRED	**YES ☐ NO ☒ (if Yes, see page 2)**
COSHH ASSESSMENTS REQUIRED	**YES ☐ NO ☒ (if Yes, see page 2)**
PLANNED DATE FOR INCORPORATION INTO THE WORKS:	

SUBCONTRACTOR/SUPPLIER COMMENTS:

Signe[redacted]	**Name:**	**Gareth Worral**	**Date:**	**9/10/17**

Material Approval Request

Costain Galliford Try
Smart Motorways Joint Venture

SITE TEAM COMMENTS:					
Signed:	[redacted]	Name:	A.F.D'Rozario	Date:	9thOct 17

DESIGNER/ SPECIFIER COMMENTS:			
✓	MATERIAL/ SYSTEM ACCEPTED		MATERIAL/ SYSTEM NOT ACCEPTED

Signed for designer	[redacted] ne:	G Summerfield	Date:	17th Oct 17

LIST OF SUPPORTING DOCUMENTS, INCLUDING RECORDS OF SAMPLES SUPPLIED, MOCK-UPS AND OFF SITE INSPECTIONS

ITEM	TITLE	No. OF PAGES	NOTES
1	Grading & LA	1	PDF 6G (1).pdf
2	Grading & LA	1	6G.doc
3	Data sheet	2	PDF Bardon Summary - Bardon Hill Quarry -

Data Sheet Prepared By: Ian Jones

BARDON AGGREGATES

celtest
independent materials testing — diamond core drilling & sawing

Aggregate Industries
Bardon Hill
Coalville
Leicestershire
LE67 1TL

Celtest Limited
Trefelin
Llandegai
Bangor
Gwynedd
LL57 4LH
Tel: 01248 355269 e-mail: postmaster@celtest.com
Fax: 01248 351563 Web: www.celtest.com

UKAS TESTING 0494

Unit: **BARDON HILL QUARRY**
Address: Bardon Hill
Coalville
Leicestershire
LE67 1TL
Telephone: 01530 510066

Date Issued : 6th August 2014

Aggregate Type:-	Crushed granite
Aggregate Colour:-	Grey

AGGREGATE PROPERTIES SUMMARY DATA SHEET

Test Description		Specification Reference	Type 1	STR No.	Date	Dust	STR No.	Date	6mm	STR No.	Date
Particle Density (Mg/m^3)	Apparent	EN 1097-6 : 2000	2.78	370685	Jun-14	2.78	370964	Jun-14	2.77	371320	Jun-14
	S.S.D		2.73			2.77			2.73		
	Oven Dry		2.71			2.77			2.71		
Water Absorption (%)			0.5			0.2			0.8		
Chemical Analysis* -	SiO_2	X-Ray Fluorescent Techniques				63.0	370695	Jun-14			
	TiO_2					0.7					
	Al_2O_3					16.0					
	Fe_2O_3					7.9					
	MnO					0.3					
	MgO					3.2					
	CaO					4.3					
	Na_2O					2.1					
	K_2O					2.4					
	P_2O					0.2					
	BaO					0					
	SO_3					0.1					
	Loss on Ignition					0					
Water Soluble Chloride Ion Content		BS EN 1744-1				0.001	370696	Jun-14			
Water Soluble Sulfate Content SO_3		BS EN 1744-1	<0.01	370686	Jun-14	<0.01	370697	Jun-14			
Acid Soluble Sulfate Content SO_3		BS EN 1744-1	<0.1	370687	Jun-14	<0.1	370698	Jun-14			
Total Sulfur Content		BS EN 1744-1				<0.1	370699	Jun-14			
Frost Heave		BS 812 : Part 124 : 1989	8.8	370688	Jun-14						
Drying Shrinkage											
Petrographical Examination*											
Magnesium Sulphate Soundness Value		BS EN 1367-2				16	370700	Jun-14			
Methylene Blue (MB) Value		BS EN 933-9				0.8	370701	Jun-14			
Bulk Density Loose (Mg/m^3)		EN 1097-3 : 1998	1.51	370967	Jun-14	1.49	370702	Jun-14	1.34	370706	Jun-14
Bulk Density Compacted (Mg/m^3)		EN 1097-3 : 1998 Annex D.1	1.85			1.8			1.56		
Plastic Limit (%)		BS 1377 : Part 2 : 1990	N-P	364940	Jun-14						
pH Value		BS 1377 : Part 3 : 1990				8.9	370703	Jun-14			
Organic Content		BS 1377 : Part 3 : 1990									
Calcium Carbonate Equivalent (%)		EN 196-21 : 1992				1.86	370704	Jun-14			
Redox Potential*		DTp SHW Clause 638	500	370693	Jun-14						
Lightweight Contaminators		BS EN 1744-1				<0.1	370705	Jun-14			

All tests carried out are UKAS accredited unless otherwise denoted by *

Comments:

* Full report available upon request

[redacted]

E.R.Goulden - Technical Director

Aggregate Industries Technical Department
Class 6 Earthworks Specification Datasheet

Material: Class 6G Table 6/1 & 6/5 EN13285
(Selected Granular Fill)
Aggregate Petrographic Group: Granite
Supply Plant: Bardon Hill

GRADING

SIEVE SIZE	TYPICAL GRADING	SPECIFICATION
180mm	100	
125mm	27	
90mm	0	
63mm	0	
45mm	0	
31,5mm	0	
22,4mm	0	
10mm	0	
2mm	0	
0,125mm	0	
0.063mm	0	

MATERIAL PROPERTIES

PROPERTY	REPORTED VALUE	SPECIFICATION LIMITS
Los Angeles	12	Max 50

Issued by: Richard Williams Date: 16/05/16

BARDON AGGREGATES

celtest

independent materials testing — *diamond core drilling & sawing*

UKAS TESTING 0494

Aggregate Industries
Bardon Hill
Coalville
Leicestershire
LE67 1TL

Celtest Limited
Trefelin
Llandegai
Bangor
Gwynedd
LL57 4LH
Tel: 01248 355269 e-mail: postmaster@celtest.com
Fax: 01248 351563 Web: www.celtest.com

Unit: **BARDON HILL QUARRY** **Date Issued : 6th August 2014**

Address: Bardon Hill
Coalville
Leicestershire
LE67 1TL
Telephone: 01530 510066

Aggregate Type:-	Crushed granite
Aggregate Colour:-	Grey

AGGREGATE PROPERTIES SUMMARY DATA SHEET

Test Description		Specification Reference	10mm	STR No.	Date	14mm	STR No.	Date	20mm	STR No.	Date
Particle Density (Mg/m^3)	Apparent	EN 1097-6 : 2000	2.77	370707	Jun-14	2.76	370710	Jun-14	2.80	370724	Jun-14
	S.S.D		2.74			2.73			2.70		
	Oven Dry		2.73			2.72			2.78		
Water Absorption (%)			0.6			0.4			0.3		
Aggregate Impact Value (Dry)		BS 812 Pt 112				20	370711	Jun-14			
Aggregate Impact Value (Soaked)		BS 812 Pt 112				19	370712	Jun-14			
Aggregate Crushing Value		BS 812 Pt 110				16	370714	Jun-14			
Aggregate Abrasion Value		BS EN 1097-8				3.1	370715	Jun-14			
10% Fines Value (Dry)		BS 812 Pt 111				180	370717	Jun-14			
10% Fines Value (Soaked)		BS 812 Pt 111				240	370716	Jun-14			
Water Soluble Chloride Ion Content		BS EN 1744-1				<0.001	370718	Jun-14			
Polished Stone Value		BS EN 1097-8	61	37078	May-14						
Micro Deval Coefficient		BS EN 1097-1				20	370720	Jun-14			
Los Angeles Coefficient		BS EN 1097-2				18	370721	Jun-14			
Petrographical Examination*						Non	370722	Jun-14			
Bulk Density Loose (Mg/m3)		EN 1097-3 : 1998	1.40	370709	Jun-14	1.33	370723	Jun-14	1.40	370725	Jun-14
Bulk Density Compacted (Mg/m3)		EN 1097-3 : 1998 Annex D.1	1.58			1.54			1.60		

All tests carried out are UKAS accredited unless otherwise denoted by *

Comments:

* Full report available upon request

Test Description		Specification Reference	32mm	STR No.	Date	Ballast	STR No.	Date			
Particle Density (Mg/m^3)	Apparent	EN 1097-6 : 2000	2.76	370726	Jun-14						
	S.S.D		2.78								
	Oven Dry		2.77								
Water Absorption (%)			0.3								
Bulk Density Loose (Mg/m3)		EN 1097-3 : 1998	1.39	370727	Jun-14						
Bulk Density Compacted (Mg/m3)		EN 1097-3 : 1998 Annex D.1	1.60								
						6	365795	1/5/14			

All tests carried out are UKAS accredited unless otherwise denoted by *

Comments:

* Full report available upon request

[redacted]

E.R.Goulden - Technical Director

AGGREGATE CERTIFICATION DATA
SHW 600 GABION STONE 6G

BARDON AGGREGATES

PRODUCTION UNIT: BARDON HILL QUARRY

MATERIAL DESCRIPTION: Selected Granular Material - 100 - 150mm
Gabion Filling Table 6/1 Cl 6G

TYPICAL PROPERTIES: Individual Test Certificates can be supplied on request-UKAS Certificates unless stated otherwise.

PARTICLE SIZE DISTRIBUTION

Obtained by measurement using calibrated vernier gauge.

A Uniformly graded Aggregate to meet sizes of 100mm - 150mm range as per Cl 626

GAUGED		% PASS
175.0	mm	100
170.0	mm	100
160.0	mm	74
150.0	mm	45
140.0	mm	25
125.0	mm	17
115.0	mm	6
100.0	mm	1

Los Angeles	10
Micro Deval	13
Particle density - Oven Dried	2.81
Saturated and Surface Dried	2.82
Apparent	2.84
Water absorption	0.3%

Richard Williams
AREA TECHNICAL MANAGER

Issue 6

Material Approval Request

DATE 5th July 18	PROCUREMENT **MATERIAL APPROVAL REQUEST**	**MAR** REF. NUMBER **0300**

CONTRACT:	**M1 Jct 23a to Jct 25**

SUBCONTRACTOR/ SUPPLIER	**CGT/GRS**
SPECIFIED PRODUCT OR SYSTEM	**Gabion stone**
PROPOSED PRODUCT OR SYSTEM AND MANUFACTURER	Tarmac Unnamed Rd, Ashbourne DE6 1QX,
CONTRACT SPECIFICATION	**SHW 600 series**
DEVIATION FROM CURRENT SPECIFICATION, IF ANY	**non**
DRAWING REFERENCE	
WHERE TO BE USED	
OFFSITE OR PRE-DELIVERY INSPECTION REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
ON-SITE MOCK UP REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
SAMPLE REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
TECHNICAL LITERATURE/CATALOGUE REQUIRED	YES ☒ NO ☐ (If Yes, see page 2)
TEST CERTIFICATE REQUIRED	YES ☐ NO ☒ (if Yes, see page 2)
COSHH ASSESSMENTS REQUIRED	YES ☐ NO ☒ (if Yes, see page 2)
PLANNED DATE FOR INCORPORATION INTO THE WORKS:	**Only if granite runs out - use as back up**

SUBCONTRACTOR/SUPPLIER COMMENTS: **Only if granite runs out - use as back up**

	Name:	**Martin Cox**	**Date:**	**5th July 18**

Costain Galliford Try
Smart Motorways Joint Venture

Material Approval Request

SITE TEAM COMMENTS: **Only if granite runs out - use as back up**

Signed:	[redacted]	Name:	A.F.D'Rozario	Date:	5th July 18

DESIGNER/ SPECIFIER COMMENTS:

X	MATERIAL/ SYSTEM ACCEPTED		~~MATERIAL/ SYSTEM NOT ACCEPTED~~

Signed for designer	[redacted]	Name:		Date:	9th July 18

LIST OF SUPPORTING DOCUMENTS, INCLUDING RECORDS OF SAMPLES SUPPLIED, MOCK-UPS AND OFF SITE INSPECTIONS

ITEM	TITLE	No. OF PAGES	NOTES
1	Grading	1	PDF BALLIDON QUARRY GABION - 100mm-15
2	LA	1	PDF BALLIDON QUARRY GABION - 100mm-15

GRADATION ANALYSIS TEST REPORT

Product: **100/150MM GRADED AGGREGATE**

Material Code: **110A4547**

Supplied by: BALLIDON QUARRY

Customer:

Site Address:

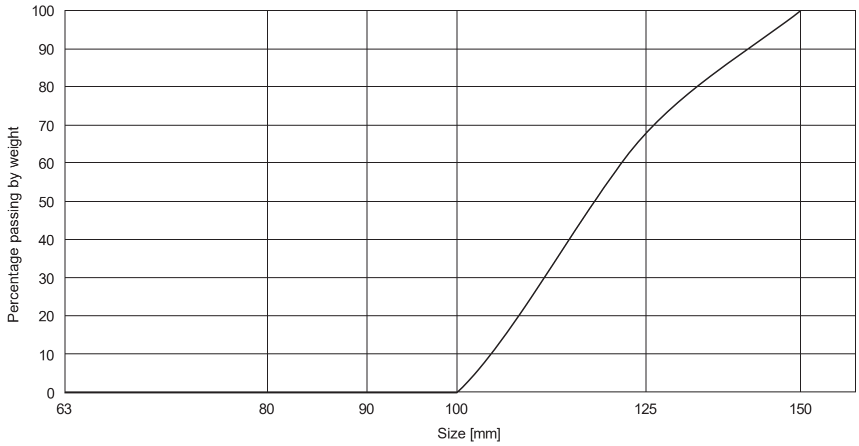
Material type: No Specification / Limestone

Sampled to: LPM 3.2 Methods for sampling aggregates

Prepared to: LPM 3.3 Aggregate reduction to test portion from a bulk sample

Test method: BS EN 933-1: 2012

Sample number	60
Ticket No	
Sampled by	LAB
Date Sampled	06/11/2017
Sample location	LP 17
Weather Conditions	
Remarks	



Sieve Size (mm)	Percent passing	Specification	Complies (Spec)	Control limits	Complies (Ctrl)
200		-			
150	100	-			
125	68	-			
100	0	-			
90	0	-			
80	0	-			
63	0	-			
50	0	-			
31.5	0	-			
20	0	-			
10	0	-			
2	0				
0.063	0.0				
Moisture content (%)	0.2				
Uniformity Coefficient	1		Yes		

Sampled By: LAB Tested By: Date Tested: 06/11/2017

celtest
INDEPENDENT MATERIALS TESTING I DIAMOND DRILLING & SAWING

Test Houses Ltd
Wolverhampton Laboratory,
Millfields Road,
ETTINGSHALL,
Wolverhampton,
WV4 6JP

Date: 09 January 2018
Test Report Ref: STR 567175

Order No: NLT1/17/390

Contract: W/17/093

LABORATORY TEST REPORT

TEST REQUIREMENTS: To determine the Fragmentation of Aggregate - Los Angeles Test Method in accordance with **BS EN 1097-2: 2010**

SAMPLE DETAILS:

Certificate of sampling received:	**Yes**
Laboratory Ref. No:	**S69927**
Client Ref. No:	**17/1715 - Ballidon LA COEFFICIENT September 2017**
Date and Time of Sampling:	**Unknown**
Date of Receipt at Lab:	**28/11/2017**
Date of Start of Test:	**13/12/2017**
Sampling Location:	**Unknown**
Name of Source:	**Ballidon Quarry**
Method of Sampling:	**Unknown**
Sampled By:	**Client**
Material Description	**Aggregate**
Target Specification:	**N/A**

RESULTS

Size fraction from which the test portion was obtained: **14mm to 12.5mm**
12.5mm to 10.0mm

Los Angeles Coefficient (LA) = 26

Comments:	Report checked and approved by
None	[redacted] Aggregate Team Coordinator

UKAS TESTING 0494

Material Approval Request

DATE 9/10/17	PROCUREMENT **MATERIAL APPROVAL REQUEST**	**MAR** REF. NUMBER **0148**

CONTRACT:	**M1 Jct 23a to Jct 25**

SUBCONTRACTOR/ SUPPLIER	**CGT**
SPECIFIED PRODUCT OR SYSTEM	**Gabion stone**
PROPOSED PRODUCT OR SYSTEM AND MANUFACTURER	**Aggregate Industries Bardon Hill Coalville Leicestershire LE67 1TL**
CONTRACT SPECIFICATION	**SHW 600 series**
DEVIATION FROM CURRENT SPECIFICATION, IF ANY	**non**
DRAWING REFERENCE	
WHERE TO BE USED	
OFFSITE OR PRE-DELIVERY INSPECTION REQUIRED	**YES ☐ NO ☒ (If Yes, see page 2)**
ON-SITE MOCK UP REQUIRED	**YES ☐ NO ☒ (If Yes, see page 2)**
SAMPLE REQUIRED	**YES ☐ NO ☒ (If Yes, see page 2)**
TECHNICAL LITERATURE/CATALOGUE REQUIRED	**YES ☒ NO ☐ (If Yes, see page 2)**
TEST CERTIFICATE REQUIRED	**YES ☐ NO ☒ (if Yes, see page 2)**
COSHH ASSESSMENTS REQUIRED	**YES ☐ NO ☒ (if Yes, see page 2)**
PLANNED DATE FOR INCORPORATION INTO THE WORKS:	

SUBCONTRACTOR/SUPPLIER COMMENTS:

Signe[redacted]	**Name:**	**Gareth Worral**	**Date:**	**9/10/17**

Material Approval Request

SITE TEAM COMMENTS:						
Signed:	[redacted]	**Name:**	**A.F.D'Rozario**	**Date:**	**9thOct 17**	
DESIGNER/ SPECIFIER COMMENTS:						
✓	**MATERIAL/ SYSTEM ACCEPTED**			**MATERIAL/ SYSTEM NOT ACCEPTED**		
Signed for designer	[redacted]	**ne:**	**G Summerfield**	**Date:**	**17th Oct 17**	

LIST OF SUPPORTING DOCUMENTS, INCLUDING RECORDS OF SAMPLES SUPPLIED, MOCK-UPS AND OFF SITE INSPECTIONS

ITEM	TITLE	No. OF PAGES	NOTES
1	Grading & LA	1	6G (1).pdf
2	Grading & LA	1	6G.doc
3	Data sheet	2	Bardon Summary - Bardon Hill Quarry -

Data Sheet Prepared By: Ian Jones

BARDON AGGREGATES

celtest
independent materials testing — diamond core drilling & sawing

UKAS TESTING 0494

Aggregate Industries
Bardon Hill
Coalville
Leicestershire
LE67 1TL

Celtest Limited
Trefelin
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LL57 4LH
Tel: 01248 355269 e-mail: postmaster@celtest.com
Fax: 01248 351563 Web: www.celtest.com

Unit: **BARDON HILL QUARRY**
Address: Bardon Hill
Coalville
Leicestershire
LE67 1TL
Telephone: 01530 510066

Date Issued : **6th August 2014**

Aggregate Type:-	Crushed granite
Aggregate Colour:-	Grey

AGGREGATE PROPERTIES SUMMARY DATA SHEET

Test Description		Specification Reference	Type 1	STR No.	Date	Dust	STR No.	Date	6mm	STR No.	Date
Particle Density (Mg/m^3)	Apparent	EN 1097-6 : 2000	2.78	370685	Jun-14	2.78	370964	Jun-14	2.77	371320	Jun-14
	S.S.D		2.73			2.77			2.73		
	Oven Dry		2.71			2.77			2.71		
Water Absorption (%)			0.5			0.2			0.8		
Chemical Analysis* -	SiO2	X-Ray Fluorescent Techniques				63.0	370695	Jun-14			
	TiO2					0.7					
	Al2O3					16.0					
	Fe2O3					7.9					
	MnO					0.3					
	MgO					3.2					
	CaO					4.3					
	Na2O					2.1					
	K2O					2.4					
	P2O					0.2					
	BaO					0					
	SO3					0.1					
	Loss on Ignition					0					
Water Soluble Chloride Ion Content		BS EN 1744-1				0.001	370696	Jun-14			
Water Soluble Sulfate Content SO3		BS EN 1744-1	<0.01	370686	Jun-14	<0.01	370697	Jun-14			
Acid Soluble Sulfate Content SO3		BS EN 1744-1	<0.1	370687	Jun-14	<0.1	370698	Jun-14			
Total Sulfur Content		BS EN 1744-1				<0.1	370699	Jun-14			
Frost Heave		BS 812 : Part 124 : 1989	8.8	370688	Jun-14						
Drying Shrinkage											
Petrographical Examination*											
Magnesium Sulphate Soundness Value		BS EN 1367-2				16	370700	Jun-14			
Methylene Blue (MB) Value		BS EN 933-9				0.8	370701	Jun-14			
Bulk Density Loose (Mg/m3)		EN 1097-3 : 1998	1.51	370967	Jun-14	1.49	370702	Jun-14	1.34	370706	Jun-14
Bulk Density Compacted (Mg/m3)		EN 1097-3 : 1998 Annex D.1	1.85			1.8			1.56		
Plastic Limit (%)		BS 1377 : Part 2 : 1990	N-P	364940	Jun-14						
pH Value		BS 1377 : Part 3 : 1990				8.9	370703	Jun-14			
Organic Content		BS 1377 : Part 3 : 1990									
Calcium Carbonate Equivalent (%)		EN 196-21 : 1992				1.86	370704	Jun-14			
Redox Potential*		DTp SHW Clause 638	500	370693	Jun-14						
Lightweight Contaminators		BS EN 1744-1				<0.1	370705	Jun-14			

All tests carried out are UKAS accredited unless otherwise denoted by *

Comments:

* Full report available upon request

[redacted]

E.R.Goulden - Technical Director

Aggregate Industries Technical Department
Class 6 Earthworks Specification Datasheet

Material: Class 6G Table 6/1 & 6/5 EN13285
(Selected Granular Fill)
Aggregate Petrographic Group: Granite
Supply Plant: Bardon Hill

GRADING

SIEVE SIZE	TYPICAL GRADING	SPECIFICATION
180mm	100	
125mm	27	
90mm	0	
63mm	0	
45mm	0	
31,5mm	0	
22,4mm	0	
10mm	0	
2mm	0	
0,125mm	0	
0.063mm	0	

MATERIAL PROPERTIES

PROPERTY	REPORTED VALUE	SPECIFICATION LIMITS
Los Angeles	12	Max 50

Issued by: Richard Williams Date: 16/05/16

BARDON AGGREGATES

celtest

independent materials testing — *diamond core drilling & sawing*

Aggregate Industries
Bardon Hill
Coalville
Leicestershire
LE67 1TL

Celtest Limited
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Tel: 01248 355269 e-mail: postmaster@celtest.com
Fax: 01248 351563 Web: www.celtest.com

UKAS TESTING 0494

Unit: **BARDON HILL QUARRY** **Date Issued : 6th August 2014**

Address: Bardon Hill
Coalville
Leicestershire
LE67 1TL
Telephone: 01530 510066

Aggregate Type:-	Crushed granite
Aggregate Colour:-	Grey

AGGREGATE PROPERTIES SUMMARY DATA SHEET

Test Description		Specification Reference	10mm	STR No.	Date	14mm	STR No.	Date	20mm	STR No.	Date
Particle Density (Mg/m^3)	Apparent	EN 1097-6 : 2000	2.77	370707	Jun-14	2.76	370710	Jun-14	2.80	370724	Jun-14
	S.S.D		2.74			2.73			2.70		
	Oven Dry		2.73			2.72			2.78		
Water Absorption (%)			0.6			0.4			0.3		
Aggregate Impact Value (Dry)		BS 812 Pt 112				20	370711	Jun-14			
Aggregate Impact Value (Soaked)		BS 812 Pt 112				19	370712	Jun-14			
Aggregate Crushing Value		BS 812 Pt 110				16	370714	Jun-14			
Aggregate Abrasion Value		BS EN 1097-8				3.1	370715	Jun-14			
10% Fines Value (Dry)		BS 812 Pt 111				180	370717	Jun-14			
10% Fines Value (Soaked)		BS 812 Pt 111				240	370716	Jun-14			
Water Soluble Chloride Ion Content		BS EN 1744-1				<0.001	370718	Jun-14			
Polished Stone Value		BS EN 1097-8	61	37078	May-14						
Micro Deval Coefficient		BS EN 1097-1				20	370720	Jun-14			
Los Angeles Coefficient		BS EN 1097-2				18	370721	Jun-14			
Petrographical Examination*						Non	370722	Jun-14			
Bulk Density Loose (Mg/m3)		EN 1097-3 : 1998	1.40	370709	Jun-14	1.33	370723	Jun-14	1.40	370725	Jun-14
Bulk Density Compacted (Mg/m3)		EN 1097-3 : 1998 Annex D.1	1.58			1.54			1.60		

All tests carried out are UKAS accredited unless otherwise denoted by *

Comments:

* Full report available upon request

Test Description		Specification Reference	32mm	STR No.	Date	Ballast	STR No.	Date			
Particle Density (Mg/m^3)	Apparent	EN 1097-6 : 2000	2.76	370726	Jun-14						
	S.S.D		2.78								
	Oven Dry		2.77								
Water Absorption (%)			0.3								
Bulk Density Loose (Mg/m3)		EN 1097-3 : 1998	1.39	370727	Jun-14						
Bulk Density Compacted (Mg/m3)		EN 1097-3 : 1998 Annex D.1	1.60								
						6	365795	1/5/14			

All tests carried out are UKAS accredited unless otherwise denoted by *

Comments:

* Full report available upon request

[redacted]

E.R.Goulden - Technical Director

AGGREGATE CERTIFICATION DATA
SHW 600 GABION STONE 6G

BARDON AGGREGATES

PRODUCTION UNIT: BARDON HILL QUARRY

MATERIAL DESCRIPTION: Selected Granular Material - 100 - 150mm
Gabion Filling Table 6/1 Cl 6G

TYPICAL PROPERTIES: Individual Test Certificates can be supplied on request-UKAS Certificates unless stated otherwise.

PARTICLE SIZE DISTRIBUTION

Obtained by measurement using calibrated vernier gauge.

A Uniformly graded Aggregate to meet sizes of 100mm - 150mm range as per Cl 626

GAUGED		% PASS
175.0	mm	100
170.0	mm	100
160.0	mm	74
150.0	mm	45
140.0	mm	25
125.0	mm	17
115.0	mm	6
100.0	mm	1

Los Angeles	10
Micro Deval	13
Particle density - Oven Dried	2.81
Saturated and Surface Dried	2.82
Apparent	2.84
Water absorption	0.3%

Richard Williams
AREA TECHNICAL MANAGER

Issue 6

Costain Galliford Try
Smart Motorways Joint Venture

Material Approval Request

DATE 5/02/18	PROCUREMENT **MATERIAL APPROVAL REQUEST**	**MAR** REF. NUMBER **0226**

CONTRACT:	**M1 Jct 23a to Jct 25**
SUBCONTRACTOR/ SUPPLIER	**CGT**
SPECIFIED PRODUCT OR SYSTEM	**Bi-axial Welded Mesh for Gabion Baskets**
PROPOSED PRODUCT OR SYSTEM AND MANUFACTURER	**Enviromesh Garner Street Business Park • Etruria • Stoke-on-Trent • Staffordshire ST4 7BH**
CONTRACT SPECIFICATION	**SHW 600 series**
DEVIATION FROM CURRENT SPECIFICATION, IF ANY	**non**
DRAWING REFERENCE	
WHERE TO BE USED	
OFFSITE OR PRE-DELIVERY INSPECTION REQUIRED	**YES ☐ NO ☒ (If Yes, see page 2)**
ON-SITE MOCK UP REQUIRED	**YES ☐ NO ☒ (If Yes, see page 2)**
SAMPLE REQUIRED	**YES ☐ NO ☒ (If Yes, see page 2)**
TECHNICAL LITERATURE/CATALOGUE REQUIRED	**YES ☒ NO ☐ (If Yes, see page 2)**
TEST CERTIFICATE REQUIRED	**YES ☐ NO ☒ (if Yes, see page 2)**
COSHH ASSESSMENTS REQUIRED	**YES ☐ NO ☒ (if Yes, see page 2)**
PLANNED DATE FOR INCORPORATION INTO THE WORKS:	

SUBCONTRACTOR/SUPPLIER COMMENTS:

	Name:	**Dave Mantle**	**Date:**	**5/2/18**

SITE TEAM COMMENTS:

Signed:	[redacted]	**Name:**	**A.F.D'Rozario**	**Date:**	**5th Feb 18**

Material Approval Request

DESIGNER/ SPECIFIER COMMENTS: Welded gabion baskets are acceptable assuming that the gabions are formed using welded steel mesh conforming to BS EN 10223-8 and have a 120-design life.					
✓	**MATERIAL/ SYSTEM ACCEPTED**			**MATERIAL/ SYSTEM NOT ACCEPTED**	
Signed for designer	[redacted]**ne:**	**G Summerfield**	**Date:**	**5th Feb 18**	

LIST OF SUPPORTING DOCUMENTS, INCLUDING RECORDS OF SAMPLES SUPPLIED, MOCK-UPS AND OFF SITE INSPECTIONS

ITEM	TITLE	No. OF PAGES	NOTES
1	Technical data	4	2.7-3.2mm PVC.PDF

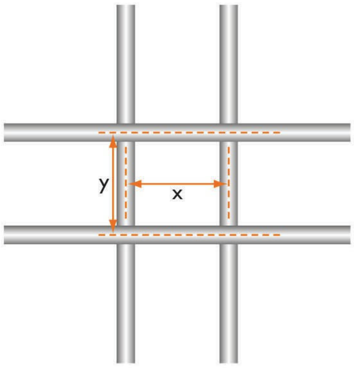
ENVIROMESH®

Garner Street Business Park · Etruria · Stoke-on-Trent · Staffordshire ST4 7BH

Tel: +44 (0) 845 136 0101 · **Fax: +44 (0)845 136 0202** · **Online: www.enviromeshgabions.co.uk**

Gabion Design Specification : Bi-Axial Welded Mesh

GABION ENV-P27 (Polymer Powder Coated Grey)



SPECIFIED MESH BI-AXIAL WELDED

Nominal dimensions (x) and (y) : Gabions, 75mm Mattresses, 75mm

Gabions are to be manufactured and / or supplied by:

Enviromesh, Garner Street Business Park, Etruria, Stoke-on-Trent, Staffordshire, ST4 7BH.

Telephone +44 (0)845 136 0101 Fax +44 (0)845 136 0202 Email: enquiries@enviromeshgabions.co.uk Online: www.enviromeshgabions.co.uk

The certification, materials, manufacture, assembly and installation of the above-mentioned product shall comply with all of the following criteria:

Certification

1. All gabion materials and accessories must be certified in accordance with **British Board of Agrément (BBA)** certificate no. 05/4215. This is for current General Building Regulations.

2. All gabion products are manufactured in accordance with the requirements of BS EN 10223-8:2013 where the gabions are considered to have a life expectancy **of 120 years**.

3. Evidence of current BBA certification and relevant certificates of conformity with respect to wire strength, weld strength and coating weights used in the manufacture of the mesh fabric and wire products are to be issued upon request.

Materials

The wire used in the manufacture of the gabions and installation accessories shall comply with the following:

Mesh Fabric
The mesh fabric shall be formed by electrically welding at each and every intersection, hard drawn steel line and cross wires into a dimensionally stable bi-axial square metric mesh of size **75mm x 75mm**.

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The weld strength shall be **75%** of the minimum ultimate tensile strength of the wire.

The nominal wire diameter for the mesh fabric shall be **2.70mm** for the base, front, rear, end, diaphragm panels and lid, all within the tolerances specified in BS EN 10218-2:2012 and shall have a tensile strength that falls within a range of **540-770 N/mm²**.

Lacing Wire

The lacing wire used for site assembly shall be of a nominal **2.2mm** wire diameter in accordance with BS EN 10218-2:2012 and shall have a tensile strength that falls within a range of **350 to 550 N/mm²**.

Corrosion Resistance

All wire used in the mesh fabric or accessories shall be Zinc coated in accordance with BS EN 10244-2:2009 (Class A). An additional nominal thickness is applied of **0.25mm** organic polymer powder coating (grey) for the mesh fabric and a nominal **0.5mm** organic polymer powder coating (grey) for the lacing wire. This coating being in accordance with BS EN 10245-1:2011 and BS EN 10245-2:2011

Manufacture

Unit Formation

The gabion is to be formed from mesh panels such that the front, rear, ends and diaphragm panels are connected to the base panel with either **Stainless Steel CL35 clips** or **Stainless Steel CL50 'C' rings** at a maximum spacing of 225mm for all joints. This process must be undertaken in a factory-controlled environment. The lid may be supplied loose or fixed in the same manner to the rear or face panel. Diaphragm (partitioning panels) spacings should not exceed 1.050m on units oriented as stretchers and 1.65m oriented as headers.

Should units be required to be prefilled and lifted as opposed to filling in situ, additional clips, rings and mesh panels may be required. In such circumstances the manufacturer must be consulted prior to supply to ensure product is suitable for application.

Gabion Sizes

It should be noted that it is industry standard for gabions to be quoted as overall nominal sizes. The actual gabion sizing is dependant upon the physical mesh configuration.

Clarification should always be sought from the manufacturer in relation to gabion sizing.

Designation of sizes **length x width x height**

Gabion standard unit lengths: 975mm or 2025mm
Gabion standard unit widths: 450mm, 675mm, 975mm, 1350mm, 1500mm or 1650mm
Gabion standard unit heights: 300mm, 450mm or 975mm

Non-standard sizes available in multiples of 75mm on request.

Assembly and Installation

Note Please also refer to manufacturer's installation instructions, which are available upon request in either electronic or hard copy format.

Jointing

Gabions are supplied with lacing wire as standard for horizontal and vertical jointing of adjacent units whilst empty. Lacing is to be continuous along all joints using alternate single and double loops at a maximum spacing of 100mm ensuring that it forms a tight joint. Start or termination of lacing is formed by three turns ensuring the free end is turned into the unit.

If CL50 'C' rings are to be used for final jointing as an alternative to lacing then these must be installed at every other mesh opening to achieve the required joint strength.

Internal Bracing

Internal bracing is formed by creating a continuous windlass tie between the face and rear of the exposed cells within the structure.

For 1m high units, two internal windlass bracings are required at third widths and at each third height of the gabion.

In all cases the windlass tie is to span two or three mesh openings on the front and rear cells to spread the load. The exposed end gabions to the wall should also be braced in both directions to prevent end face deformation.

The same is required to the rear cell of each course (rear panel to side panels).

Geotextile Separators

Where a geotextile separator between the rear of the gabion and backfill is to be used, refer to the engineer's design proposal and specification.

Foundations

Reference to the engineer's design proposal must be made with respect to foundation requirement, wall inclination, face configuration (stepped, flush or combination thereof), drainage and backfilling requirements. Any soft areas in the sub grade should be excavated and replaced with a granular material to the engineer's requirements.

Filling

Units are to be filled with a hard, durable, non-frost susceptible rock, stone or clean crushed concrete as specified by design. The grading of the fill is to be 100 to 150mm or 100 to 200mm (6G). Where dual fills of the same grading are specified a separation panel is optional. Where the secondary fill grading is less than the mesh aperture size, it is necessary for the fills to be separated using pre-cut correx panels or geo-textile that is

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inserted into the gabion on site. If this is the case then this will require the fitting of an additional longitudinal diaphragm set back from the face. In such instances it is important to refer to the engineer's design proposal with respect to additional drainage that may be required. It is also important to note that cohesive fills are not to be used as a secondary fill within gabions.

The units shall be filled in layers not exceeding 340mm, if large voids are present then the stone must be re-orientated to minimise voids. Where specified the gabions are to have a hand placed front face.

The units shall be filled such that the mesh lid bears down onto the gabion filling material. It may be beneficial to blind the top of the filled unit with a 20 to 50mm aggregate.

Filling should be staged so that no adjacent cells have more than a half difference in the level of filling for units of greater height than 500mm.

To assist in maintaining face alignment and reduce deformation, the use of external formwork i.e. timber or scaffold tubes can be tied onto the external face of the structure at third heights and then removed upon completion.

Material Approval Request

DATE 6/10/17	PROCUREMENT **MATERIAL APPROVAL REQUEST**	**MAR** REF. NUMBER **0143**

CONTRACT:	**M1 Jct 23a to Jct 25**

SUBCONTRACTOR/ SUPPLIER	CGT
SPECIFIED PRODUCT OR SYSTEM	Hexagonal woven mesh for Gabion Baskets
PROPOSED PRODUCT OR SYSTEM AND MANUFACTURER	Enviromesh Garner Street Business Park • Etruria • Stoke-on-Trent • Staffordshire ST4 7BH
CONTRACT SPECIFICATION	SHW 600 series
DEVIATION FROM CURRENT SPECIFICATION, IF ANY	non
DRAWING REFERENCE	
WHERE TO BE USED	
OFFSITE OR PRE-DELIVERY INSPECTION REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
ON-SITE MOCK UP REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
SAMPLE REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
TECHNICAL LITERATURE/CATALOGUE REQUIRED	YES ☒ NO ☐ (If Yes, see page 2)
TEST CERTIFICATE REQUIRED	YES ☐ NO ☒ (if Yes, see page 2)
COSHH ASSESSMENTS REQUIRED	YES ☐ NO ☒ (if Yes, see page 2)
PLANNED DATE FOR INCORPORATION INTO THE WORKS:	

SUBCONTRACTOR/SUPPLIER COMMENTS:

Signe[redacted]	Name:	Gareth Worral	Date:	6/10/17

SITE TEAM COMMENTS:

Material Approval Request

Signed:	[redacted]	Name:	A.F.D'Rozario	Date:	6th Oct 17

DESIGNER/ SPECIFIER COMMENTS:

✓	MATERIAL/ SYSTEM ACCEPTED		MATERIAL/ SYSTEM NOT ACCEPTED

Signed for designer	[redacted]	Name:	G Summerfield	Date:	17th Oct 17

LIST OF SUPPORTING DOCUMENTS, INCLUDING RECORDS OF SAMPLES SUPPLIED, MOCK-UPS AND OFF SITE INSPECTIONS

ITEM	TITLE	No. OF PAGES	NOTES
1	Technical data	3	Gabion baskets woven.pdf

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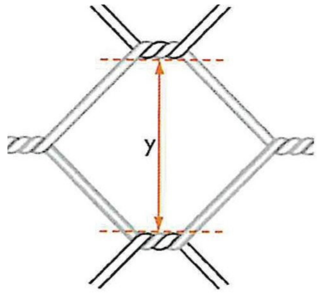
Gabion Design Specification • Hexagonal Woven Mesh

ENV-P27-HEX (Polymer Powder Coated Grey)



SPECIFIED MESH DOUBLE TWIST WOVEN

Nominal dimension (y) : Gabions, 80mm Mattresses, 60mm

Gabions are to be manufactured and/ or supplied by:

Enviromesh, Garner Street Business Park, Etruria, Stoke-on-Trent, Staffordshire, ST4 7BH.

Telephone +44 (0)845 136 0 IO I Fax +44 (0)845 136 0202 Email: enquiries@enviromeshgabions.co.uk Online: www.enviromeshgabions.co.uk

The certification, materials, manufacture, assembly and installation of the above-mentioned product shall comply with all of the following criteria:

Certification

I. Allgabion materials and accessories must be certified in accordance with British Board of Agrement **(BBA)** certificate no. 00/3682. This is for current General Building Regulations where the life expectancy is **120 years.**

2. All gabion products are manufactured in accordance with the requirements of BS EN I0223-3:2013.

3. Evidence of current BBA certification and relevant certificates of conformity with respect to wire strength and coating weights used in the manufacture of the mesh fabric and wire products are to be issued upon request.

Materials

The wire used in the manufacture of the gabions and installation accessories shall comply with the following:

Mesh Fabric

The mesh fabric shall be formed by twisting pairs of wires through one and a half turns to form a hexagonal flexible net pattern of nominal size **80mm x I 00mm.** The end wires of the mesh panel are terminated by being wrapped around a heavy selvedge wire.

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The nominal wire diameter for the mesh fabric shall be **2.70mm** and **3.40mm** for the selvedge wire. All wire is in accordance with BS EN I 0218-2:2012 and BS EN I 0223-3:2013 with an ultimate tensile strength of between **350 to 500N/mm^2**.

Lacing Wire

The lacing wire used for site assembly shall be of a nominal **2.2mm** wire diameter in accordance with BS EN 10218-2:2012 and shall have a tensile strength that falls within a range of **350 to 550 N/mm^2**.

Corrosion Resistance

All wire used in the gabion production or accessories shall be Zinc or Zinc 95% Aluminium 5% coated in accordance with BS EN I 0244-2:2009 (Class A) with an additional extruded organic polymer powder coating (grey) of **0.5mm** nominal radial thickness.

This organic polymer powder coating is in accordance with BS EN I 0245-2:20 I I.

Manufacture

Unit Formation

The gabion is to be formed from mesh panels so that the front, rear, base and lid are formed from one continuous sheet, such that the front and rear faces have the mesh orientated vertically.

Diaphragms (partitioning panels) and end panels (all vertically orientated mesh) are connected to the base panel with full-length lacing. This process must be undertaken in a factory-controlled environment. Diaphragm spacings should not exceed I .00m. The supply of loose diaphragm panels for fitting on site is not acceptable.

Gabion Sizes

It should be noted that it is industry standard for gabions to be quoted as overall nominal sizes.

Designation of sizes **length x width x height**

Gabion standard unit lengths:	2000mm, 1500mm and I 000mm
Gabion standard unit widths:	1000mm
Gabion standard unit heights:	500mm and I 000mm

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Assembly and Installation

Note Please also refer to manufacturer's installation instructions, which are available upon request in either electronic or hard copy format.

Jointing

Gabions are supplied with lacing wire as standard for horizontal jointing of adjacent units whilst empty. Lacing is to be continuous along all joints using alternate single and double loops at a maximum spacing of I 00mm ensuring that it forms a tight joint. Start or termination of lacing is formed by three turns ensuring the free end is turned into the unit.

If CLS0 'C' rings are to be used for final jointing as an alternative to lacing, then these must be installed at every other mesh opening to achieve the required joint strength.

Where gabions are to be pre-filled and lifted instead of filling in situ, it is necessary to brace each cell in both directions. In such circumstances the manufacturer must be consulted prior to supply to ensure product is suitable for application.

Geotextile Separators

Where a geotextile separator between the rear of the gabion and backfill is to be used, refer to the engineer's design proposal and specification.

Foundations, Wall Inclinations, Face Configurations, Drainage and Backfilling

Reference to the engineer's design proposal must be made with respect to foundation requirements, wall inclination, face configuration (stepped, flush or combination thereof), drainage and backfilling requirements. Any soft areas in the sub-grade should be excavated and replaced with a granular material to the engineer's requirements.

Filling

Units are to be filled with a hard, durable, non-frost susceptible rock, stone or clean crushed concrete as specified by design. The grading of the fill is to be I 00 to 150mm or I 00 to 200mm (6G).

The units shall be filled in layers not exceeding 340mm, if large voids are present then the stone must be re-orientated to minimise voids. Where specified the gabions are to have a hand placed front face.

The units shall be filled such that the mesh lid bears down onto the gabion filling material. It may be beneficial to blind the top of the filled unit with a 20 to 50mm aggregate.

Filling should be staged so that no adjacent cells have more than a half difference in the level of filling for units of greater height than 500mm.

To assist in maintaining face alignment and reduce deformation, the use of external formwork i.e. timber or scaffold tubes can be tied onto the external face of the structure at third heights and then removed upon completion.

Material Approval Request

Costain Galliford Try
Smart Motorways Joint Venture

DATE 09/02/18	PROCUREMENT MATERIAL APPROVAL REQUEST	MAR REF. NUMBER 0227

CONTRACT:	M1 Jct 23a to Jct 25
SUBCONTRACTOR/ SUPPLIER	CGT
SPECIFIED PRODUCT OR SYSTEM	Lotrak 100 non woven geotextile
PROPOSED PRODUCT OR SYSTEM AND MANUFACTURER	Terrablue – Lotrak 100 non woven geotextile
CONTRACT SPECIFICATION	Volume 2 works information specification Appendices ,series 600 Earthworks
DEVIATION FROM CURRENT SPECIFICATION, IF ANY	Increased strength from 6.0 to 8.0 kN/M Cbr Puncture resistance increase to 1500N
DRAWING REFERENCE	HA549342-AMAR-HGT-SWI-DR-CE-000602 /601
WHERE TO BE USED	Separation from cohesive material and 6N
OFFSITE OR PRE-DELIVERY INSPECTION REQUIRED	NO ☒ (If Yes, see page 2)
ON-SITE MOCK UP REQUIRED	NO ☒ (If Yes, see page 2)
SAMPLE REQUIRED	NO ☒ (If Yes, see page 2)
TECHNICAL LITERATURE/CATALOGUE REQUIRED	YES ☒
TEST CERTIFICATE REQUIRED	NO ☒ (if Yes, see page 2)
COSHH ASSESSMENTS REQUIRED	NO ☒ (if Yes, see page 2)
PLANNED DATE FOR INCORPORATION INTO THE WORKS:	

SUBCONTRACTOR/SUPPLIER COMMENTS:

Signed:		Name:	Will Huskinson	Date:	08/02/18

SITE TEAM COMMENTS:

Signed:	[redacted]	Name:	A.F.D'Rozario	Date:	9th Feb 18

Material Approval Request

DESIGNER/ SPECIFIER COMMENTS:							
Y	MATERIAL/ SYSTEM ACCEPTED				MATERIAL/ SYSTEM NOT ACCEPTED		
Signed for designer	[redacted]	Name:	G Summerfield		Date:	15/2/18	

LIST OF SUPPORTING DOCUMENTS, INCLUDING RECORDS OF SAMPLES SUPPLIED, MOCK-UPS AND OFF SITE INSPECTIONS

ITEM	TITLE	No. OF PAGES	NOTES
1	Product information	2	PDF Technical Data Sheet.pdf
2	Lotrak Non-woven spec sheet	1	PDF Lotrak Non woven spec sheet.pdf
3	Don and Low BSI Certificate of Registration	1	PDF Don and Low BSI Certificate of Regist

Lotrak 100

(http://terrablue.co.uk/wp-content/uploads/2016/09/lotra100.jpg)

Lotrak 100

Nonwoven separation and filtration geotextile

Lotrak ® 100 is a mechanically bonded nonwoven geotextile, with market established technical and hydraulic properties to address everyday, industry requirements of separation and filtration.

Lotrak ® 100 is an effective separator beneath selected granular materials, and for lining french or narrow trench drains.

The main purpose of this geotextile is to prevent the loss of construction aggregates into the underlying soil.

– Proven separator

– CBR 1S00N

– Tensile strength - 8 kN x 8 kN

Roll size ; 4.Smt x 100mt

(http://terrablue.co.uk/)

Lotrak® nonwoven grades

Technical Data

Test	Standard		100	200	300
Tensile Strength (kN / m)	EN 10319	MD	8	18	25
		CD	8	18	25
Elongation at max. load (%)	EN 10319	MD	45	50	65
		CD	45	50	65
CBR Puncture Resistance	EN ISO 12236		1500	2900	4300
Cone Drop Penetration (mm)	EN 13433		36	18	13
Pore Size 90% finer than (microns)	EN ISO 12956		100	70	70
Water Permeability (m / sec)	EN ISO 11058		$130x10^{-3}$	$80x10^{-3}$	$65x10^{-3}$
Effect of UV Light			The Polypropylene used contains a UV inhibitor		
Weight (g/m^2)			100	200	300
Roll Size		Width	4.5	4.5	4.5
		Length	100	100	100

All products are manufactured under BS EN ISO 9001.

Don & Low Ltd, Glamis Road, Forfar, Angus, DD8 1FR, Scotland, UK
Tel: +44(0)1307 452200 Fax: +44 (0)1307 452201 www.donlow.co.uk email:enquiries@donlow.co.uk

bsi.

By Royal Charter

Certificate of Registration

QUALITY MANAGEMENT SYSTEM - ISO 9001:2008

This is to certify that:

Don & Low Ltd
Technical Textiles Division
Newford Park House
Glamis Road
Forfar
008 IFR
United Kingdom

Holds Certificate Number: FM 23905

and operates a Quality Management System which complies with the requirements of ISO 9001:2008 for following scope:

The manufacture and development of polyolefin tapes and yarns from 15 to 1000 tex with various cross sections. The manufacture, development and supply of woven polypropylene fabrics in widths up to 5 metres f9r industrial end uses. manufacture and supply of regranulated polypropylene pellets.

For and on behalf of BSI:

Frank Lee, EMEA Compliance & Risk Director

Original Registration Date: 19/04/1993

Latest Revision Date: 08/09/2015

Effective Date: 24/10/2015

Expiry Date: 23/10/2018

Page: 1 of 1

ACCREDITED

MANAGEMENT SYSTEMS CEATIFICATION OOOY

UKAS MANAGEMENT SYSTEMS 003

...making excellence a habit

Material Approval Request

DATE 27.10.2017	PROCUREMENT **MATERIAL APPROVAL REQUEST**	**MAR** REF. NUMBER **0165**

CONTRACT:	**M1 Jct 23a to Jct 25**

SUBCONTRACTOR/ SUPPLIER	Walker Sign Erectors Ltd/ Bettamix Concrete Limited - Volumetric Concrete Supplier Unit 1 Every Street, Bury, BL9 5BE.
SPECIFIED PRODUCT OR SYSTEM	Concrete
PROPOSED PRODUCT OR SYSTEM AND MANUFACTURER	C35/45 S4
CONTRACT SPECIFICATION	Series 1200 Series 1700
DEVIATION FROM CURRENT SPECIFICATION, IF ANY	None
DRAWING REFERENCE	Pad Reinforced Drawings: HA549342-AMAR-SMN-SWI-DR-CB-160003 to 160005
WHERE TO BE USED	To be used for the construction of sign bases as per Appendix 12/1 and 17/1
OFFSITE OR PRE-DELIVERY INSPECTION REQUIRED	**YES** ☐ **NO** ☒ **(If Yes, see page 2)**
ON-SITE MOCK UP REQUIRED	**YES** ☐ **NO** ☒ **(If Yes, see page 2)**
SAMPLE REQUIRED	**YES** ☐ **NO** ☒ **(If Yes, see page 2)**
TECHNICAL LITERATURE/CATALOGUE REQUIRED	**YES** ☒ **NO** ☐ **(If Yes, see page 2)**
TEST CERTIFICATE REQUIRED	**YES** ☒ **NO** ☐ **(if Yes, see page 2)**
COSHH ASSESSMENTS REQUIRED	**YES** ☐ **NO** ☒ **(if Yes, see page 2)**
PLANNED DATE FOR INCORPORATION INTO THE WORKS:	**October/November 2017**

SUBCONTRACTOR/SUPPLIER COMMENTS:
Revision 2 - correction to S4 slump
Revision 3 - Increased cement content to achieve Max water Cement Ratio - 0.45.

Signed:	[redacted]	**Name:**	**S. Hutchinson**	**Date:**	**R3 05.02.2018**

SITE TEAM COMMENTS: Revised mix submitted 6th Feb 18

Signed:	[redacted]	**Name:**	**A.F.D'Rozario**	**Date:**	**6th Feb 18**

Material Approval Request

Costain Galliford Try
Smart Motorways Joint Venture

DESIGNER/ SPECIFIER COMMENTS: C35/45 should conform to mix 2 of 1700 series specification. Max water/cement ratio should be 0.45. Please submit new mix design Revision dates 19/01/18 accepted					
✓	**MATERIAL/ SYSTEM ACCEPTED**			**MATERIAL/ SYSTEM NOT ACCEPTED**	
Signed for designer	[redacted]	**Name:**	**Josh Palmer**	**Date:**	**6th Feb 2018**

LIST OF SUPPORTING DOCUMENTS, INCLUDING RECORDS OF SAMPLES SUPPLIED, MOCK-UPS AND OFF SITE INSPECTIONS

ITEM	TITLE	No. OF PAGES	NOTES
1	Mix Design C35/45	1	WSEL - C35.45 Bettamix - Doc Evide
2	Additional Test Certs Sulphates Alkali, Chloride	3	
3	ISO 9001:2015	2	
4	Kite Mark 206	1	

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Concrete Mix Design

Customer Name:	
Site Address:	MI J23a - 25
Quotation Number:	N/A
Supplying Plant/s:	Burv Plant

Please find below the proposed concrete mix designs for the above contract.
we trust these to be satisfactory, however, should you have any queries, please contact us.

Quote Mix Number:	51			
Concrete Description:	C35/45			
Nom. Aggregate Size (mm):	20			
Cement Type:	CEM 1 52.5			
Slump (mm):	54			
Minimum Cement Content:	480			
Max. Water/Cement Ratio:	0.45			
Exposure Class(s):	XF4,XC4,XD3			
Design Chemical Class:	DC-1			

Design Saturated Surface Dry Masses for One Cubic Metre (Units kg)

Cement (kg):	480			
Addition (kg):	0			
Blend Proportion(%):				
Aggregate 1. (kg):	1098			
Aggregate 2 (kg):	695			
Aggregate 3 (kg):	0			
Aggregate 4 (kg):	0			
Fine Aggregate Content(%):	47			
Admixture 1.:	0.0			
Admixture 2:	0.0			
Admixture 3:	0.0			
Hand Added Material 1.:	0.0			
Hand Added Material 2:	0.0			
Water/Cement Ratio:	0.45			

Key to the constituents used m the above concrete mix designs.

Cement:	CEM 1 52.5	Ribblesdale-Hanson		
Addition:				
Aggregate 1.:	Stone 4/20	Doveholes		
Aggregate 2:	Sand 0/2	Doveholes		
Aggregate 3:				
Aggregate 4:				
Admixture 1.:				
Admixture 2:				
Admixture 3:				
Hand Added Material 1:				
Hand Added Material 2:				

Comments

Quote Mix Number: 5 1 .... C35/45

All information contained above is correct at the time of issue, but may change

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Authorised By:

Date of Issue: /C:; /1/(

Bettamix Concrete
Helping Build Solid Foundations

ON SITE DELIVERIES DAY AND NIGHT

Below is the calculated alkali content for the most onerous mix requested. Calculations in accordance with BRE Digest 330 and BS 8500 pt 2

EQUIVALENT ALKALI CONTENT

Contractor	Walker Signs
Contract	M1 J23a - 25
Supplying Plant	Bettamix Concrete
Mix Details	C35/C45

Agg Reactivity\CEM I	</=0.6% alkali	</=0.75% alkali	>0.75% alkali
Low	No Calc. Required	No Calc. Required	5kg
Normal	CEM I No Calc. Required. Blended cement 3.5kg	3.5kg 3.5kg	3kg 3kg
High	2.5kg	2.5kg	2.5kg

Aggregate reactivity for this concrete	Normal
Max Alkali for Mix kg/m3	3.5

Materials	Kg/m^3		% Alkali content			
CEM 1	480	x	0.75		CEM 1 Contribution	2.70

Contributions from cement additions are added as follows:

For low or normal reactivity aggregates.
If PFA is included in the mix at >/= 25% then no further calculation is required. (Factor = 0)
If PFA is included in the mix at 20-24% then add PFA kgs X %alkali X 0.2. (Factor = 0.2)
If PFA is included in the mix at < 20% then add PFA kgs X %alkali (Factor = 1)
For high reactivity aggregates
If PFA is included in the mix at >/= 35% then no further calculation is required. (Factor = 0)
If PFA is included in the mix at < 35% then add PFA kgs X %alkali. (Factor = 1)

For low or normal reactivity aggregates.
If GGBS is included in the mix at >/= 40% then no further calculation is required. (Factor = 0)
If GGBS is included in the mix at 25-39% then add GGBS kgs X %alkali X 0.5. (Factor = 0.5)
If GGBS is included in the mix at < 25% then add GGBS kgs X %alkali. (Factor = 1)
For high reactivity aggregates
If GGBS is included in the mix at >/= 50% then no further calculation is required. (Factor = 0)
If GGBS is included in the mix at < 50% then add GGBS kgs X %alkali (Factor = 1)

					Factor		
GGBS	0	x	0.00	x	0.00	Addition Contribution	0.00

Contributions from other sources (added if the sum total exceeds 0.2kg/m3) — **Others Contribution**

WRA	0	x	0.00			0.00
AEA	0	x	0.00			0.00
WATER	0	x	0.00			0.00
			% Chloride content		Factor	
4/20mm Aggregate	1098	x	0.010	x	0.76	0.08
Sand	695	x	0.001	x	0.76	0.01

Total Contribution from other sources 0.09 Add if >/=0.2kg 0.00

Alkali Content = 2.70 Kg/m^3

This Concrete Conforms with EN206 & BS8500 pt 2

Name	Julie Hanley	Signed		Date	02-Feb-18

Bettamix Concrete
Helping Build Solid Foundations

ON SITE DELIVERIES DAY AND NIGHT

CHLORIDE ION CONTENT

Below is the calculated Chloride content, expressed as a % of cement weight for the most onerous mix requested.

Contractor	**Walker Signs**
Contract	**M1 J23a - 25**
Supply Plant(s)	**Bettamix Concret e**
Mix Details	**C34/C45**

Materials	**Kg/m^3**		**% Chloride content**	**Contribution kg/m3**
CEM 1	480	x	0.07	0.34
WRA	0.00	x	0.00	0.00
AEA	0	x	0.00	0.00
4/20mm Aggregate	1098	x	0.01	0.11
Sand	695	x	0.001	0.01
			Total Chlorides per m3 =	0.45

The Total Chloride contribution is now expressed as a percentage of the total cement content thus

Chloride Content = 0.09 % by mass cement

This Concrete Conforms with EN206 & BS8500 pt 2

Name	Julie Hanley	Signed		Date	02-Feb-18

Bettamix Concrete

Helping Build Solid Foundations

ON SITE DELIVERIES DAY AND NIGHT

SULPHATE CONTENT

Below is the calculated Sulphate content, expressed as a % of cement weight for the most onerous mix requested.

Contractor	**Walker Signs**
Contract	**M1 J23a - 25**
Supply Plant(s)	**Bettamix Concrete**
Mix Details	**C35/45**

Materials	**Kg/m^3**		**% Sulphate content**	**Contribution kg/m3**
CEM 1	480	x	3.33	15.98
WRA	0.00	x	0.00	0.00
AEA	0	x	0.00	0.00
4/20mm Aggregate	1098	x	0.80	8.78
Sand	695	x	0.001	0.01
			Total Sulphates per m3 =	24.77

The Total Chloride contribution is now expressed as a percentage of the total cement content

Sulphate Content = 5.16 % by mass cement

This Concrete Conforms with SHW 2602

Name	**Julie Hanley**	Signed		Date	02-Feb-18

bsi.

By Royal Charter

Certificate of Registration

QUALITY MANAGEMENT SYSTEM - ISO 9001:2015

This is to certify that:

Bettamix Concrete Limited
Unit 1
Every Street
Bury
BL9 SBE
United Kingdom

Holds Certificate Number: FS 639381

and operates a Quality Management System which complies with the requirements of ISO 9001:2015 for the following scope:

Please see scope page.

For and on behalf of BSI: [redacted]

Andrew Launn, EMEA Sys Cert Ops & Compliance Director

Original Registration Date: 2016-03-21

Latest Revision Date: 2017-07-03

Effective Date: 2016-03-21

Expiry Date: 2019-03-20

national highway sector schemes

UKAS MANAGEMENT SYSTEMS 003

...making excellence a habiC

Certificate No: FS 639381

Registered Scope:

The manufacture and supply of concrete pre-mixes and products. The supply, installation and repair of fences for infrastructure works in accordance with National Highway Sector Scheme 2A. The supply, installation, maintenance and repair of vehicle restraint systems in accordance with National Highway Sector Scheme 2B. The management of static temporary traffic management on motorways and high speed dual carriageways including on-line widening schemes in accordance with National Highway Sector Scheme 12A/12B. The natural environment and landscape including ecology for infrastructure in accordance with National Highway Sector Scheme 18C, Landscape Maintenance, including litter picking, maintenance of established trees and shrubs, arboricultural work, tree and vegetation removal, hedgerow and verge maintenance (including mowing).

Original Registration Date: 2016-03-21

Latest Revision Date: 2017-07-03

Effective Date: 2016-03-21

Expiry Date: 2019-03-20

bs •I.Certificate of Entitlement

to use the

Kitemark

BS EN 206 & BS 8500

in respect of concrete supplied from Mobile Concrete Batching Units conforming to BS EN 206 and BS 8500-2 under a Quality System complying with ISO 9001.

The BSI Kitemark Scheme for Ready-Mixed Concrete is Accredited by UKAS, the UK Accreditation Service.

KITEMARK UCENCE No. KM 562981

The Kitemark Scheme Certification Technical Manager, BSI, hereby confirms that

Bettamix Concrete Limited
Unit 1
Every Street
Bury
Lancashire
BL9 SBE
United Kingdom

For mobile batching units identified as:
PO62 BFJ; MD16 LVU.

is entitled to use the Kitemark in accordance with the Conditions governing the use of the Kitemark.

[redacted]

Mike Wharton, 1st January 2017

Certificate of Entitlement valid to: 31st December 2017

...making excellence a habit:·

Costain Galliford Try
Smart Motorways Joint Venture

Material Approval Request

DATE	PROCUREMENT	MAR
11/01/18	**MATERIAL APPROVAL REQUEST**	REF. NUMBER 0218

CONTRACT:	**M1 Jct 23a to Jct 25**
SUBCONTRACTOR/ SUPPLIER	**Fencing Partnership/Severn Bore Piling/Hanson Readymix**
SPECIFIED PRODUCT OR SYSTEM	**Concrete**
PROPOSED PRODUCT OR SYSTEM AND MANUFACTURER	C35/45
CONTRACT SPECIFICATION	SHW 1700 series
DEVIATION FROM CURRENT SPECIFICATION, IF ANY	**None**
DRAWING REFERENCE	HA549342-AMAR-SMA-SWI-DR-CB-160002 & 3.
WHERE TO BE USED	Bored piles for Environmental Barrier
OFFSITE OR PRE-DELIVERY INSPECTION REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
ON-SITE MOCK UP REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
SAMPLE REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
TECHNICAL LITERATURE/CATALOGUE REQUIRED	YES ☒ NO ☐ (If Yes, see page 2)
TEST CERTIFICATE REQUIRED	YES ☐ NO ☒ (if Yes, see page 2)
COSHH ASSESSMENTS REQUIRED	YES ☒ NO ☐ (if Yes, see page 2)
PLANNED DATE FOR INCORPORATION INTO THE WORKS:	**January 18**

SUBCONTRACTOR/SUPPLIER COMMENTS:

Signed:		Name:	Mark Saunders	Date:	10th Jan 18

SITE TEAM COMMENTS:

Signed:	[redacted]	Name:	A.F.D'Rozario	Date:	11th Jan 18

Material Approval Request

DESIGNER/ SPECIFIER COMMENTS:.			
✓	MATERIAL/ SYSTEM ACCEPTED		MATERIAL/ SYSTEM NOT ACCEPTED

Signed for designer	[redacted]	Name:	Josh Palmer	Date:	11 Jan 2018

LIST OF SUPPORTING DOCUMENTS, INCLUDING RECORDS OF SAMPLES SUPPLIED, MOCK-UPS AND OFF SITE INSPECTIONS

ITEM	TITLE	No. OF PAGES	NOTES
1	Mix design	1	Hanson concrete Mix design certificat

CERTIFICATE OF CONCRETE COMPOSITION

Hanson
HEIDELBERGCEMENTGroup

Certificate No: 1950619118 28.11.2017 Page 1 of 1
Dated: 28.11.2017

Contractor:
Severn Bore Piling Ltd
Leys Road
BRIERLEY HILL
West Midlands DY5 3UP
UNITED KINGDOM

Site address:
JUNCTION 23A - 25 {JUNCTION 23A - 2
JUNCTION 23A - 25
NEWTON DE55 5TZ
UNITED KINGDOM

Your Reference:

Customer Service Centre
One Marlborough Court
SYSTON, LEICESTER
Leicestershire
LE7 1AD
UNITED KINGDOM

South East Sales: 0330 123 9385
South Central East Sales: 0330 123 4732
Central East Sales: 0330 123 0267
London Sales: 0330 123 0799
Concrete Orders: 0330 123 0766
www.hanson.co.uk

Supplying plant: 3086 Nottingham Concrete

MATERIAL	DESCRIPTION	SUPPLIER	SOURCE	ADMIXTURE UNITS
CEMENT	CEMI	HANSON CEMENT	RIBBLESDALE	
ADDITION1	GGBS	HANSON CEMENT	TEESPORT	
Aggregate 1	GRAVEL QUARTZ 20	HANSON AGGREGATES	SHARDLOW QUARRY	
Aggregate 2	SAND	HANSON AGGREGATES	SHARDLOW QUARRY	
ADMIXTURE 1	SK160	SIKA LTD		l/100 kg cement

MIX SPECIFICATIONS

Quote Line ID	10			
MAT ID				
MIX/GRADE	C35/45			
DC/CL CLASS	DC3			
MAX AGG SIZE	20			
CEMENT TYPE	CIIIA+SR			
CONSISTENCE	S4			
MCC	380			
MAX W/C	0.40			
CHLORIDE %	0.30 %			

SSD CONCRETE COMPOSITION kg/cubic metre

CEMENT	215			
ADDITION1	215			
Aggregate 1	960			
Aggregate 2	786			
WATER	169			

ADMIXTURE DOSAGES (SEE UNITS ABOVE)

Admix 1 & 2	0.950							
Admix 3 & 4								
Admix 5 & 6								
Admix 7 & 8								
W/C Ratio	0.40							
Alkali kg	1.81							
Cl % SO4 %	0.08	2.01						

Material sources and proportions may change subject to quality and availability. Concrete is supplied in accordance with the requirements of the current edition of BS8500-2.

All orders are made on Hansons Standard Conditions of Sale, a copy of which are available at www.hanson.co.uk.

Signed...

Hanson Concrete

ISO 9001 THE QUALITY SCHEME FOR READY MIXED CONCRETE
UKAS PRODUCT CERTIFICATION 009

Material Approval Request

DATE	PROCUREMENT	MAR
06/07/2017	**MATERIAL APPROVAL REQUEST**	REF. NUMBER 0093

CONTRACT:	**M1 Jct 23a to Jct 25**
SUBCONTRACTOR/ SUPPLIER	Van-Elle
SPECIFIED PRODUCT OR SYSTEM	Steel reinforcement
PROPOSED PRODUCT OR SYSTEM AND MANUFACTURER	Steel reinforcement from Total Construction Supplies Ltd & Lemon Groundwork Solutions Ltd
CONTRACT SPECIFICATION	1600 & 1700
DEVIATION FROM CURRENT SPECIFICATION, IF ANY	None
DRAWING REFERENCE	N/A
WHERE TO BE USED	Bored piles 450mm, 750mm and 900mm diameter.
OFFSITE OR PRE-DELIVERY INSPECTION REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
ON-SITE MOCK UP REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
SAMPLE REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
TECHNICAL LITERATURE/CATALOGUE REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
TEST CERTIFICATE REQUIRED	YES ☐ NO ☒ (if Yes, see page 2)
COSHH ASSESSMENTS REQUIRED	YES ☐ NO ☒ (if Yes, see page 2)
PLANNED DATE FOR INCORPORATION INTO THE WORKS: 17/07/2017	

SUBCONTRACTOR/SUPPLIER COMMENTS:

Signed:	[redacted]	Name:	Luke Gardiner	Date:	06/07/2017

SITE TEAM COMMENTS:

Signed:	[redacted]	Name:	A.F.D'Rozario	Date:	6th July 17

Material Approval Request

DESIGNER/ SPECIFIER COMMENTS:

✓	**MATERIAL/ SYSTEM ACCEPTED**		**MATERIAL/ SYSTEM NOT ACCEPTED**

Signed for designer	[redacted]	**Name:**	**Denis Shapley**	**Date:**	**09/07/17**

LIST OF SUPPORTING DOCUMENTS, INCLUDING RECORDS OF SAMPLES SUPPLIED, MOCK-UPS AND OFF SITE INSPECTIONS

ITEM	TITLE	No. OF PAGES	NOTES
1	LEMON CARES CERTIFICATE 2017 MIDLANDS	1	LEMON CARES CERTIFICATE 2017 M
2	(CARES) TCS Product Conformity - 2017	1	(CARES) TCS Product Conformity

CERTIFICATE OF APPROVAL

Product Conformity Certification

This is to certify that

Total Construction Supplies Limited

at its establishament at

Wolverhampton

has satisfied the Authority that it operates a quality management system that complies with the requirements of BS EN ISO 9001 2008 and the relevant CARES Quality and Operations Assessment Schedules. Where appropriate, and as listed below, it has further satisfied the Authority that it manufactures and/or supplies products that conform with the stated product standards and is entitled to use the CARES marks on its products using the processes and procedures registered with the Authority.

Scope of certification:

Processing of steel reinforcement to BS 8666 and BS 4466
Stocking and distribution of BS 4449, BS 4482 and BS 4483
Manufacture of pre-assembled MAG welded fabrications
using reinforcing bar in the size range 10 to 50mm to the relevant requirements of
BS 7123 and CARES Quality and Operations Assessment Schedules 6 and 10 using tack welds and semi-structural joints produced under factory conditions

This certificate remains the property of the Authority and is issued subject to the Regulations of the Authority. This certificate is uncontrolled when printed. To check the validity of this certificate please visit www.ukcares.com or contact us on +44 1732 450000.

CERTIFICATE NUMBER	FIRST APPROVAL	ISSUE DATE	EXPIRY DATE
111101	**November 2011**	**01 January 2017**	**31 December 2017**

SIGNED FOR UK CERTIFICATION AUTHORITY FOR REINFORCING STEELS

[redacted]

Chief Executive Officer

The use of the Accreditation Mark indicates accreditation in respect of those activities covered by the accreditation certificate number 002.
UK Certification Authority for Reinforcing Steels, Pembroke House, 21 Pembroke Road, Sevenoaks, Kent, TN13 1XR, UK.
A Company Limited by Guarantee. Registered in England No. 1762448.

Cert. Ref: AIC112010 59201 365

UKAS PRODUCT CERTIFICATION 002

CERTIFICATE OF APPROVAL

Product Conformity Certification

This is to certify that

Lemon Groundwork Solutions Ltd

at its establishament at

Rugby

has satisfied the Authority that it operates a quality management system that complies with the requirements of BS EN ISO 9001 2008 and the relevant CARES Quality and Operations Assessment Schedules. Where appropriate, and as listed below, it has further satisfied the Authority that it manufactures and/or supplies products that conform with the stated product standards and is entitled to use the CARES marks on its products using the processes and procedures registered with the Authority.

Scope of certification:

Processing of steel reinforcement to BS 8666 and BS 4466
Stocking and distribution of BS 4449, BS 4482 and BS 4483

This certificate remains the property of the Authority and is issued subject to the Regulations of the Authority. This certificate is uncontrolled when printed. To check the validity of this certificate please visit www.ukcares.com or contact us on +44 1732 450000.

CERTIFICATENUMBER	FIRSTAPPROVAL	ISSUEDATE	EXPIRY DATE
950601	**February 2000**	**01 January 2017**	**31 December 2017**

SIGNED FOR UK CERTIFICATION AUTHORITY FOR REINFORCING STEELS

lee Brankley,
Chief Executive Officer

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UKCertiliootion Authority for Rcinfotcing Steels, Perrbroke House, 21 Perm.-oke Rood, So,enooks, Kent, TNl3 IXR, UK

ACorrponylirrited byGuorontcc. Regi,tered in England No. 1762448.

Cert. Ref:AIICI12010 26502 79

UKAS
PRODUCT
CERTIFICATION
002

Material Approval Request

DATE 06.07.2017	PROCUREMENT **MATERIAL APPROVAL REQUEST**	**MAR** REF. NUMBER **0097**
CONTRACT:	**M1 Jct 23a to Jct 25**	

SUBCONTRACTOR/ SUPPLIER	Camel Pre-cast.
SPECIFIED PRODUCT OR SYSTEM	Pre-cast Brico Blocks
PROPOSED PRODUCT OR SYSTEM AND MANUFACTURER	Camel Pre-cast, Hoyle Mill, Kinsley, Pontefract, WF9 5JB
CONTRACT SPECIFICATION	Series 600 - earthworks
DEVIATION FROM CURRENT SPECIFICATION, IF ANY	N/A
DRAWING REFERENCE	Series 600 - earthworks
WHERE TO BE USED	Verges as an alternative to gabion baskets.
OFFSITE OR PRE-DELIVERY INSPECTION REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
ON-SITE MOCK UP REQUIRED	YES ☐ NO ☒ (If Yes, see page 2)
SAMPLE REQUIRED	YES ☐ NO ☐ (If Yes, see page 2)
TECHNICAL LITERATURE/CATALOGUE REQUIRED	YES ☒ NO ☐ (If Yes, see page 2)
TEST CERTIFICATE REQUIRED	YES ☒ NO ☐ (if Yes, see page 2)
COSHH ASSESSMENTS REQUIRED	YES ☐ NO ☒ (if Yes, see page 2)
PLANNED DATE FOR INCORPORATION INTO THE WORKS:	

SUBCONTRACTOR/SUPPLIER COMMENTS:

Signed:	[redacted]	Name:	Ben Morris	Date:	06.07.2017

SITE TEAM COMMENTS:

Signed:	[redacted]	Name:	A.F.D'Rozario	Date:	12th July 17

Material Approval Request

Costain Galliford Try
Smart Motorways Joint Venture

DESIGNER/ SPECIFIER COMMENTS:					
	MATERIAL/ SYSTEM ACCEPTED			MATERIAL/ SYSTEM NOT ACCEPTED	
Signed for designer		**Name:**		**Date:**	

LIST OF SUPPORTING DOCUMENTS, INCLUDING RECORDS OF SAMPLES SUPPLIED, MOCK-UPS AND OFF SITE INSPECTIONS

ITEM	TITLE	No. OF PAGES	NOTES
001	**Camel pre-cast brico block data.**	004	Brico earthwork retaining structure.
002	Camel pre-cast brico block installation brochure.	004	BRICO Brochure low res.pdf
003	Brico block structure design calculations.	015	Prologis RW_ 27-01-10.pdf
004	**Example of Brico block structural design calculation for previous scheme.**	016	2046_Structural design_Rev B.pdf
005	Lobslack 39444_Final Calcs rev.D		Lobslack 39444_Final Calcs re

Costain Galliford Try
Smart Motorways Joint Venture

MATERIAL APPROVAL REQUEST

	RFI 399 sheet pile wall drainage.docx
	backfill behind all sheet pile walls within a cutting
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	☒ ☐
	☐ ☒
	☐ ☒

SUBCONTRACTOR/SUPPLIER COMMENTS:

Signed:		**Name:**	**Ben Argyle**	**Date:**	**8/9/17**

SITE TEAM COMMENTS:

Signed:	[redacted]	**Name:**	**A.F.D'Roizario**	**Date:**	**8th Sep 17**

Material Approval Request

Costain Galliford Try
Smart Motorways Joint Venture

DESIGNER/ SPECIFIER COMMENTS: **Drainage and Geotechnics both accept this product in accordance with RFI399**							
✓	**MATERIAL/ SYSTEM ACCEPTED**				**MATERIAL/ SYSTEM NOT ACCEPTED**		
Signed for designer	[redacted]	**Name:**	**Michael Jones**	**Date:**	**19/09/2017**		

1	Catalogue	6	Catalogue.pdf
2	RFI 399		RFI 399 sheet pile wall drainage.docx
3	Datasheet		ABG DECK 1200S.ST170-D.CE.B
4	Case study	2	ABG Structural Drainage Bridge Ab
5	BBA cert	8	Deckdrain BBA certificate.pdf

Deckdrain 1200S/ST170

abg creative geosynthetic engineering

Data Sheet

DECKDRAIN 1200S/ST170 is a geocomposite drainage layer comprising a high performance single cuspated HDPE (High Density Polyethylene) core with a geotextile filter thermally bonded to one side. The textile filter has a flap that extends beyond the core on one edge. The product is practically impermeable one side. It is used as an engineered drainage layer in structural applications, its major areas of use being behind retaining structures, on roof decks and in subsurface works.

Geocomposite Properties						
Thickness at 2kPa	(mm)	11.8			±10%	EN ISO 9863-1
Mass per unit area	(g/m2)	1 120			approx	EN ISO 9864
Usable Tensile strength MD / CMD	(kN/m)	18 / 11			-10%	EN ISO 10319
Elongation at above load MD / CMD	(%)	45 / 30			nominal	EN ISO 10319
CBR puncture resistance	(N)	2 750			-20%	EN ISO 12236
Perpendicular Water Inflow	(dimple side only)					
Water flow at 50mm head	(l/m2·s)	67.5			±30%	EN ISO 11058
At 2kPa permeability *(coefficient)*	(m/s)	1.65×10^{-3}			±30%	EN ISO 11058
Breakthrough head	(mm)	0				BS 6906 pt 3
In-plane water flow MD and CMD		HG = 1.0		HG = 0.1		Hydraulic gradient
at 20kPa confining pressure	(l/m·s)	4.25	±0.50	1.25	±0.20	EN ISO 12958
at 100kPa confining pressure	(l/m·s)	3.20	±0.50	0.85	±0.20	EN ISO 12958
at 200kPa confining pressure	(l/m·s)	1.80	±0.50	0.45	±0.20	EN ISO 12958
with soft foam contact surfaces to simulate textile intrusion into the core due to soil pressure						
Resistance to weathering		To be covered in 14 days				EN 12224
Resistance to chemicals		Excellent				EN 14030
Design life		120 years (manufacturer's declaration)				
Geotextile Properties						
Thickness at 2kPa	(mm)	1.1			±20%	EN ISO 9863-1
Tensile strength MD/CMD	(kN/m)	14.5 / 15.5			-10%	EN ISO 10319
Pore size O_{90}	(µm)	70			±30%	EN ISO 12956
CBR puncture resistance	(N)	2 200			-10%	EN ISO 12236
Dynamic perforation cone drop	(mm)	24			+13%	EN ISO 13433
Type and material	Non-woven needle-punched long staple fibre polypropylene					
Product Dimensions						
Standard roll dimensions	1.1 m x 50 m or 2.2 m x 25 m. Other sizes on request.					

Notes

1. The values given are indicative and correspond to nominal results obtained in our laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes without notice at any time.
2. The tolerance on roll length is 1.5% and on roll width is 1.0%.
3. Guidance on interface shear strength, creep and certain other parameters is available. Site specific tests are strongly recommended.
4. Final determination of the suitability of any information is the sole responsibility of the user. ABG will be pleased to discuss the use of this or any other product but responsibility for selection of a material and its application in any specific project remains with the user.
5. Please refer to separate sheets for fixing instructions. A COSHH certificate is available on request.

CE
0799-CPR-30

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HAPAS Certificate 14/H220

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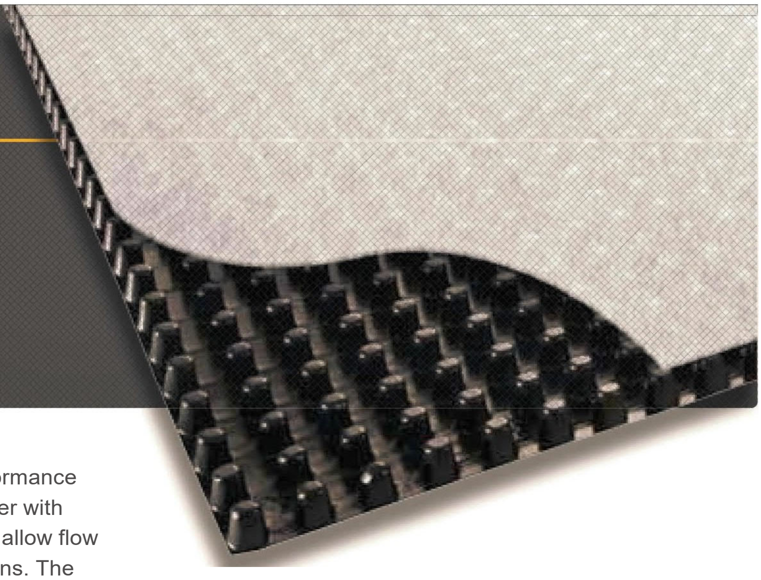
Deckdrain

A guide to the selection and specification of Deckdrain drainage geocomposite

abg | creative geosynthetic engineering

Deckdrain

Deckdrain is a high performance geocomposite which offers an environmentally friendly alternative to traditional structural drainage techniques that utilise aggregates



Deckdrain consists a high strength flexible polyethylene cuspated core with a non-woven geotextile bonded onto one or both sides.

The geotextile filters a wide range of materials allowing water to perculate into the core to be efficiently transported away to a discharge point. The geotextile is bonded to the core to ensure that it does not deform into the drainage passages under the load of the backfill material allowing continuity of the drainage void.

The single cuspated HOPE core forms a high··performance drainage layer with clear void to allow flow in all directions. The compressive strength and creep resistance properties of Deckdrain ensures that the core maintains its drainage capacity, even when subjected to compressive loads.

Deckdrain is durable and sufficiently robust to resist the mechanical stresses imposed during installation and throughout the design life.

Use of Deckdrain will eliminate the need for further protection of the waterproofing.

Deckdrain Applications

A strong, robust geocomposite layer designed to:

- Relieve external water pressure from buried structures.
- Provide drainage behind retaining walls, potable water reservoir roofs and walls, tunnels, roof gardens
- Provide drainage under block paving.
- Relief of uplift pressure beneath tanks, slabs and culverts.
- Capillary break layer below base slabs.
- Deckdrain can be applied horizontally on roofs and below base slabs or vertically against walls.

Advantages

When compared with aggregate drainage layers Deckdrain geocomposites are much thinner yet offer superior flow characteristics. This reduces dead loads associated with aggregate drainage layers and may reduce required thickness of the roof slab construction.

The wide roll Deckdrain composites are especially suited for rapid installation on large block paving or roof drainage projects.

Deckdrain enhances structural waterproofing performance by providing an additional barrier that prevents the majority of the water reaching the liner.

The high CBR puncture resistance of Deckdrain provides protection and prolongs the life of the waterproofing.

Installation

Deckdrain is easy to handle and is rapidly installed without the need for specialist plant.

Deckdrain has a built in geotextile overlap that ensures integrity of the drainage layer across the entire installation area.

Health safety and environment

All components of deckdrain are inert and do not present a hazard to health.

Supply

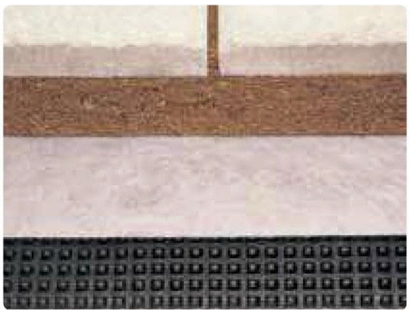
Deckdrain is Manufactured in 4mm, 6mm, 7mm, 12mm & 25mm thickness and I.Im, 2.2m or 4.4mm wide rolls.

Chemical resistance

Deckdrain has excellent resistance to petrol, oils, acid, alkalis, leachate and all common chemicals.

Deckdrain Advantages

- Cost effective
- Allows us of lower specification backfill materials.
- Reduced excavation and backfill.
- Technically defined filter properties
- High impact and crush strength.
- Long life performance and high flow capacity.
- Compatible with most waterproofing systems; provides additional protection to waterproofing system.
- Easy and quick to install.



Structural Drainage

Deckdrain geocomposite drainage layer is ideal for structural drainage applications; it provides sub-surface drainage with higher performance and lower cost than conventional granular filters layers. It has been specially designed to be compatible with structural waterproofing and to give the optimum performance over the whole life of the structure.

Deckdrain enhances the performance of the waterproofing systems by providing an additional barrier, preventing the majority of the water reaching the waterproofing system.

Deckdrain geocomposite drainage system has a proven record in structural drainage and offers a 120 year design life.

Buried structures

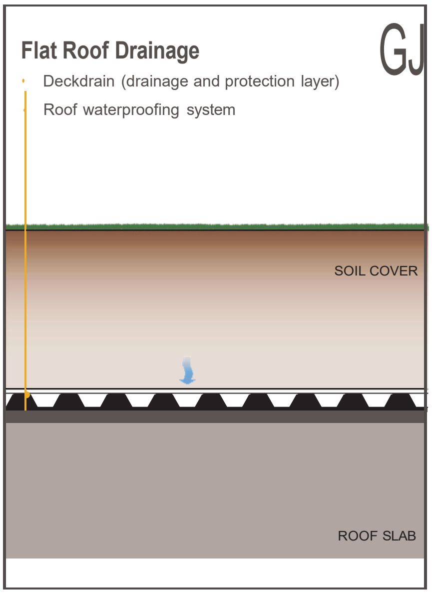
When installed on external faces of a buried structure Deckdrain collects and drains percolated groundwater from the backfill material. Installed with the flat face of the core against the structure and dimpled face against the backfill, Deckdrain also provides a high level of protection to the waterproofing system.

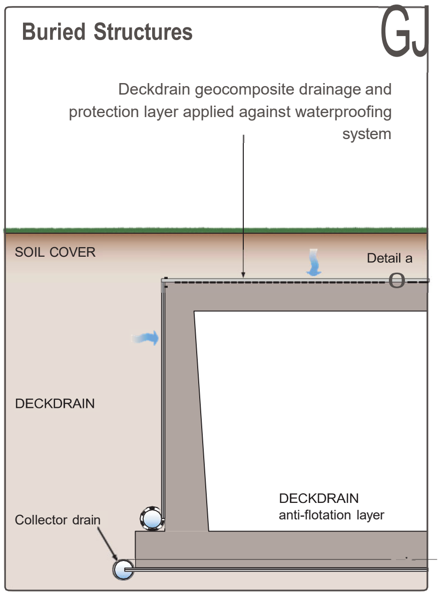
Retaining Structures

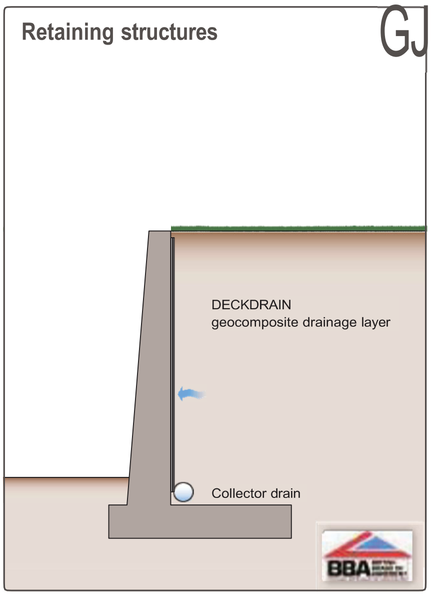
Deckdrain installed behind retaining structures acts as an efficient groundwater drainage system. Deckdrain provides a high-level of protection to the structure offering drainage capacity 10 to 50 times better than filter stone.

Applications

Potable water reservoirs, water/sewage treatment plants, pumping stations, basements and many other sub-surface applications. Deckdrain will resist the high loads of extremely deep basements and horizontal applications.







Block paving, roof and podium deck drainage

Deckdrain has a structure and the physical attributes to make it ideal for use in block paving drainage. Its hydraulic properties offer reliable and sustainable performance whilst the mechanical properties ensure the product endures the rigours of installation and long-term loading.

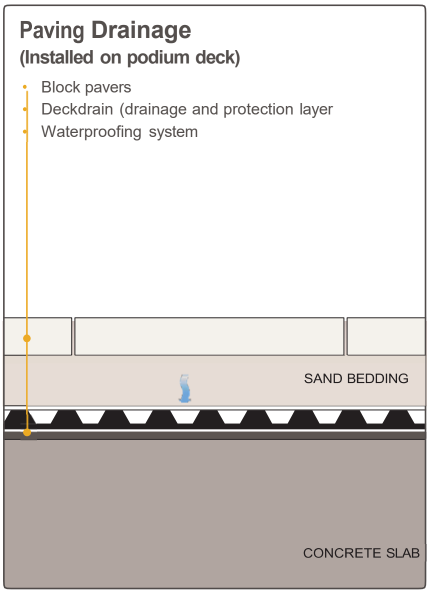
Its primary function is to collect and remove seepage water from the sand course below block paving. This helps prevent saturation of the sand, especially critical in constructions where traffic loading is expected and the foundation layer is relatively impermeable (e.g. concrete, asphalt, roof decks, etc.). In order for the sand course to provide adequate support to the blocks it must be relatively dry. If the sand becomes saturated with seepage water, the traffic load may liquifaction of the sand resulting pumping occuring through the joints. This condition is easily identified on existing sites by surface staining and open joints. In severe cases the blocks will be loose and uneven.

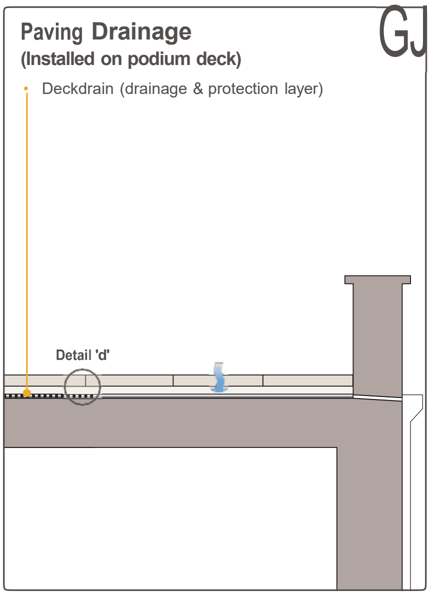
The solution is to lay Deckdrain below the sand to prevent the sand becoming saturated. Deckdrain also provides protection against puncture where a waterproofing membrane is required below the block paving (e.g. rooftop car parks or tanked SuDS pavements).

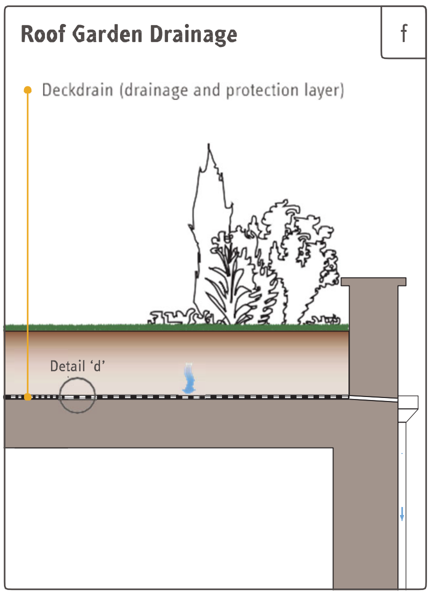
Green roofs and podium decks

Deckdrain offers an effective and reliable drainage system for roof gardens and podium decks of all sizes.

The high CBR puncture resistance of Deckdrain protects the waterproofing from backfilling forces and root penetration.







Special applications

Deckdrain geocomposites are widely used in structural drainage applications where its high flow capacity and puncture resistance offer excellent drainage and protection properties.

Deckdrain provides a more environmentally acceptable solution than crushed stone drainage layers. It is lighter, uses less transport and helps conserve finite natural resources. Due to its high drainage properties Deckdrain often enables low grade recycled material to be used as backfill.

Lost shuttering

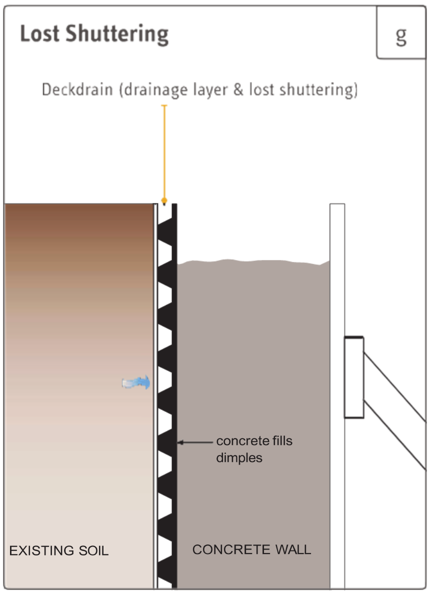
Deckdrain as a lost shuttering is installed with the flat face of the core towards the concrete and dimples against the existing soil. Poured concrete fills the dimples and Deckdrain becomes an integral part of the new structure. It acts as a groundwater drainage system providing a high level of protection to the new structure.

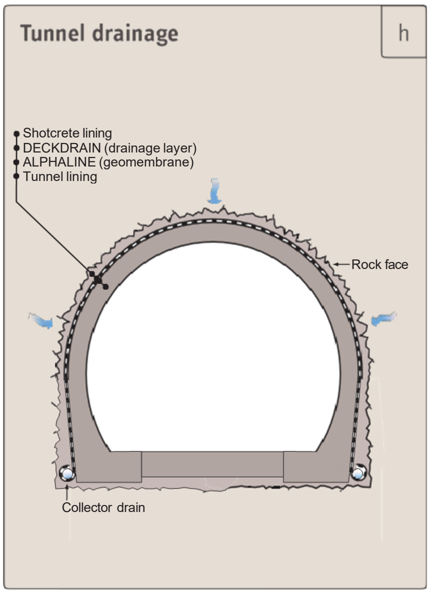
Tunnels

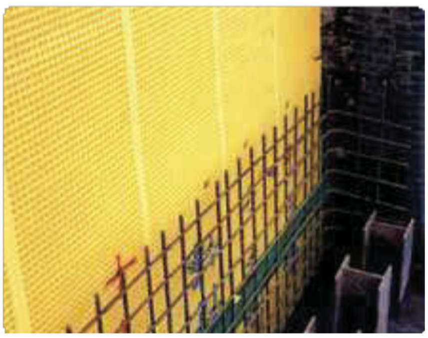
Deckdrain is highly effective for use in the structural drainage of cut and cover tunnel constructions.

In cut and cover tunnel constructions the use of Deckdrain provide a highly effective drainage zone. against the structure whilst offering the additional benefit of acting as a durable protection layer against the chosen waterproofing system protecting it from damage during the construction phase of the project..

Deckdrain is a direct replacement for the granular drainage backfill, traditionally used in these constructions, thereby saving material movements and handling both during the excavation and backfilling operations.







Associated materials

ABG manufacture a complementary range of geosynthetic materials to help solve associated problems. When contemplating the many aspects of landfill and environmental projects the following products may enhance your overall design:

Alphaline	Polyethylene and polypropylene geomembranes
Claymat	Geosynthetic clay liners
Abtex	Geotextiles for separation, protection and filtration
Erosamat	Erosion control mats to stabilise exposed soil areas
Erosaweb	Honeycomb web for slope stabilisation and access roads
Webwall	Environmental soil retaining walls

ABG Service

ABG provide full service from initial consultation, design and specification through to advice on installation and on-going maintenance. Our in-house Technical Team, many of whom are charted civil engineers offer practical advice and guidance to the project team whilst ensuring that the requirements of the regulatory requirements and codes of practice are met.

- Project design
- Design confirmation
- Feasibility study
- Cost advise
- System development

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Working on behalf of highways england

Appendix E Pile Installation Records

E.1: Concrete Pile Installation Records

E. 2: Sheet Pile Installation Records – Northbound

E.3: Sheet Pile Installation Records – Southbound

E.1 - Summary of Concrete Pile Installation Records

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
ENV	EAV01-3	EAV01-3	6832	3.1	CFA	180	450	•C35/45 •DC3 •S4 • 10mm	2.775	42990
ENV	EAV02	EAV02	6832	3.5	CFA	180	450	• C35/45 •DC3 •S4 • 10mm	2.775	43399
ENV	EAV06-3	EAV06-3	6832	3.1	CFA	220	450	• C35/45 •DC3 •S4 • 10mm	2.775	42983
ENV	EAV07	P1	6832	Full depth	CFA	200	450	•C35/45 •DC3 •S4 • 10mm	2.8	43113
CCTV	CCTV07	P1	6832	2.775	CFA	150	450	•C35/45 •DC3 •S4 • 10mm	3	42972
Rottm	ROTTM-FTP-S8S-800y	P1	6816	Full depth	CFA	200	450	•C35/45 •DC3 •S4 • 10mm	3	42983
CCTV	CCTV02	P1	6832	2.775	CFA	170	450	• C35/45 •DC3 •S4 • 10mm	3.1	42986
Small Sign	TS3	P5	6825	Full depth	CFA	210	450	• C35/45 •DC3 •S4 •10mm	3.1	42976
Small Sign	TS3	P6	6825	Full depth	CFA	150	450	•C35/45 •DC3 •S4 • 10mm	3.1	42972
Small Sign	TS4	P5	6825	Full depth	CFA	180	450	• C35/45 •DC3 •S4 •10mm	3.1	42977
Small Sign	TS4	P6	6825	Full depth	CFA	200	450	•C35/45 •DC3 •S4 • 10mm	3.1	42978
CCTV	CCTV33	P1	6832	2.775	8ored	180	450	•C35/45 •DC3 •S4 •10mm	3.5	43064
CCTV	CCTV33	P1	6832	2.775	8ored	180	450	•C35/45 •DC3 •S4 •10mm	3.5	43064
Small Sign	TS3	P2	6825	Full depth	CFA	150	450	•C35/45 •DC3 •S4 • 10mm	4	42972
Small Sign	TS3	P3	6825	Full depth	CFA	150	450	•C35/45 •DC3 •S4 • 10mm	4	42972
Rottm	ROTTM-FTP-S8S-800y	P2	6816	Full depth	CFA	180	450	•C35/45 •DC3 •S4 •10mm	4.1	42984
Small Sign	TS3	P1	6825	Full depth	CFA	210	450	• C35/45 •DC3 •S4 • 10mm	4.1	42976
Small Sign	TS3	P4	6825	Full depth	CFA	210	450	•C35/45 •DC3 •S4 • 10mm	4.1	42976

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
Small Sign	TS4	P3	6825	Full depth	CFA	200	450	•C35/45 •DC3 •S4 · 10mm	4.1	42978
Small Sign	TS4	P4	6825	Full depth	CFA	180	450	· C35/45 •DC3 •S4 · 10mm	4.1	42977
Small Sign	TS4	P1	6825	Full depth	CFA	180	450	•C35/45 •DC3 •S4 · 10mm	4.2	42977
Small Sign	TS4	P2	6825	Full depth	CFA	200	450	•C35/45 •DC3 •S4 · 10mm	4.2	42968
Small Sign	N831	P1	6825	4.825	CFA	220	450	•C35/45 •DC3 •S4 · 10mm	4.825	43013
CCTV	CCTV8	P1	6832	4.775	CFA	160	450	· C35/45 •DC3 •S4 •10mm	5	43055
Small Sign	N8S05	P1	6832	Full depth	CFA	220	450	•C35/45 •DC3 •S4 · 10mm	5	43041
Small Sign	N8S05	P2	6832	Full depth	CFA	220	450	•C35/45 •DC3 •S4 · 10mm	5	43040
Radar	RAD16	RAD16	6832	Full depth	CFA	220	450	· C35/45 •DC3 •S4 •10mm	5	43003
Radar	RAD27	P1	6832	4.77	8ored	180	450	· C35/45 •DC3 •S4 •10mm	5	43105
Radar	RAD19	RAD19	6832	Full depth	CFA	200	450	•C35/45 •DC3 •S4 •10mm	5.1	42999
Small Sign	S892	P1	6832	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	5.1	42979
Small Sign	S892	P2	6832	Full depth	CFA	200	450	•C35/45 •DC3 •S4 •10mm	5.1	42982
Small Sign	TS1	P1	6825	Full depth	CFA	200	450	•C35/45 •DC3 •S4 •10mm	5.15	42989
Small Sign	TS1	P2	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	5.15	42990
Small Sign	TS1	P3	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	5.15	42990
Small Sign	TS1	P4	6825	Full depth	CFA	200	450	•C35/45 •DC3 •S4 · 10mm	5.15	42989
Small Sign	TS1	P5	6825	Full depth	CFA	200	450	•C35/45 •DC3 •S4 · 10mm	5.15	42989
Small Sign	TS1	P6	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 •10mm	5.15	42990

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
Small Sign	N841	P1	6825	4.825	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	5.2	42997
Small Sign	N841	P2	6825	4.825	CFA	200	450	· C35/45 •DC3 •S4 · 10mm	5.2	42998
Radar	RAD03	RAD03	6832	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	5.2	42986
Radar	RAD06	RAD06	6832	Full depth	CFA	200	450	•C35/45 •DC3 •S4 · 10mm	5.2	42985
Radar	RAD17	RAD17	6832	Full depth	CFA	220	450	•C35/45 •DC3 •S4 · 10mm	5.2	43012
Small Sign	S869	P1	6825	Full depth	CFA	170	450	· C35/45 •DC3 •S4 •10mm	5.2	43000
Small Sign	S869	P2	6825	Full depth	CFA	220	450	•C35/45 •DC3 •S4 · 10mm	5.2	43003
Small Sign	S869	P3	6825	Full depth	CFA	220	450	· C35/45 •DC3 •S4 •10mm	5.2	43003
Small Sign	S869	P4	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	5.2	43000
Small Sign	TS2	P2	6825	Full depth	CFA	180	450	•C35/45 •DC3 •S4 •10mm	5.2	42991
Radar	RAD01	RAD01	6832	Full depth	CFA	180	450	•C40/45 •DC3 •S4 •10mm	5.3	42969
Radar	RAD06	P1	6832	Full depth	CFA	190	450	•C35/45 •DC3 •S4 •10mm	5.3	42996
Small Sign	TS1	P7	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	5.3	42990
Small Sign	TS1	P8	6825	Full depth	CFA	200	450	•C35/45 •DC3 •S4 · 10mm	5.3	42989
Small Sign	TS2	P3	6825	Full depth	CFA	180	450	•C35/45 •DC3 •S4 · 10mm	5.3	42991
Radar	RAD05	P1	6832	Full depth	CFA	200	450	•C35/45 •DC3 •S4 •10mm	5.4	42993
Radar	RAD15	RAD15	6832	Full depth	CFA	200	450	· C35/45 •DC3 •S4 · 10mm	5.4	43004
Small Sign	TS2	P1	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	5.4	42992
Small Sign	TS2	P4	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 •10mm	5.4	42992

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
Small Sign	TS2	P6	6825	Full depth	CFA	180	450	•C35/45 •DC3 •S4 •10mm	5.4	42991
Small Sign	TS2	P7	6825	Full depth	CFA	200	450	•C35/45 •DC3 •S4 •10mm	5.4	42991
ENV	EAV03	EAV03	6832	4.775	CFA	220	450	•C35/45 •DC3 •S4 •10mm	5.5	43042
Small Sign	N831	P2	6825	4.825	CFA	160	450	•C35/45 •DC3 •S4 •10mm	5.5	43012
Small Sign	N831	P3	6825	4.825	CFA	160	450	•C35/45 •DC3 •S4 •10mm	5.5	43012
Small Sign	N831	P4	6825	5.825	CFA	220	450	•C35/45 •DC3 •S4 •10mm	5.5	43013
Small Sign	N852	P1	6832	Full depth	CFA	180	450	•C35/45 •DC3 •S4 •10mm	5.5	43150
Small Sign	N858	P2	6832	Full depth	CFA	180	450	•C35/45 •DC3 •S4 •10mm	5.5	43145
Radar	RAD28	RAD28	6832	Full depth	CFA	185	450	•C35/45 •DC3 •S4 •10mm	5.5	43150
Radar	RAD30	RAD30	6832	Full depth	CFA	180	450	•C35/45 •DC3 •S4 •10mm	5.5	43150
Radar	RAD30	RAD30	6832	Full depth	CFA	180	450	•C35/45 •DC3 •S4 •10mm	5.5	43151
Radar	RAD34	RAD34	6832	Full depth	CFA	170	450	•C35/45 •DC3 •S4 •10mm	5.5	43151
Radar	RAD36	RAD36	6832	Full depth	CFA	190	450	•C35/45 •DC3 •S4 •10mm	5.5	43154
Small Sign	S837	P1	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 •10mm	5.5	43010
Small Sign	S837	P2	6825	Full depth	CFA	160	450	•C35/45 •DC3 •S4 •10mm	5.5	43011
Small Sign	S837	P3	6825	Full depth	CFA	160	450	•C35/45 •DC3 •S4 •10mm	5.5	43011
Small Sign	S837	P4	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 •10mm	5.5	43011
Small Sign	S872	P1	6825	Full depth	CFA	220	450	•C35/45 •DC3 •S4 •10mm	5.5	43005
Small Sign	S872	P2	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 •10mm	5.5	43004

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
Small Sign	TS2	P5	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	5.5	42992
CCTV	CCTV14	P1	12825	Full depth	CFA	170	750	· C35/45 •DC3 •S4 · 10mm	5.5	43109
CCTV	CCTV19	P1	12825	Full depth	CFA	170	750	•C35/45 •DC3 •S4 · 10mm	5.5	43112
CCTV	CCTV22	CCTV22	12825	4.8	CFA	200	750	•C35/45 •DC3 •S4 · 10mm	5.5	43076
CCTV	CCTV24	CCTV24	12825	4.8	CFA	170	750	•C35/45 •DC3 •S4 · 10mm	5.5	43132
CCTV	CCTV25	CCTV25	12825	4.8	CFA	170	750	· C35/45 •DC3 •S4 •10mm	5.5	43140
CCTV	CCTV26	CCTV26	12825	4.8	CFA	180	750	•C35/45 •DC3 •S4 · 10mm	5.5	43131
CCTV	CCTV27	CCTV27	12825	4.8	CFA	210	750	· C35/45 •DC3 •S4 •10mm	5.5	43449
Radar	RAD11	P1	12825	4.8	8ored	165	750	•C32/45 •DC3 •S4 •10mm	5.5	43056
Radar	RAD20	P1	6832	4.775	8ored	200	450	•C32/45 •DC3 •S4 · 10mm	5.5	43110
CCTV	CCTV04	P1	12825	Full depth	CFA	230	750	•C35/45 •DC3 •S4 •10mm	5.6	43025
CCTV	CCTV12	P1	6832	Full depth	CFA	180	450	•C35/45 •DC3 •S4 •10mm	5.7	43115
Small Sign	N830	P2	6832	4.775	CFA	240	450	•C35/45 •DC3 •S4 · 10mm	5.7	43025
Radar	RAD21	RAD21	6832	Full depth	CFA	160	450	•C35/45 •DC3 •S4 · 10mm	5.7	43031
Radar	RAD23	RAD23	6832	Full depth	CFA	200	450	•C35/45 •DC3 •S4 · 10mm	5.7	43018
Small Sign	S840	P1	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 •10mm	5.7	43014
Small Sign	S854	P1	6825	Full depth	CFA	170	450	· C35/45 •DC3 •S4 •10mm	5.7	43029
Small Sign	S854	P2	6825	Full depth	CFA	180	450	•C35/45 •DC3 •S4 · 10mm	5.7	43015
Small Sign	TS2	P8	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 •10mm	5.7	42992

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
Radar	RAD24	P1	6832	4.775	8ored	180	450	•C32/45 •DC3 •S4 · 10mm	5.7	43109
Small Sign	N830	P1	6832	4.775	CFA	180	450	· C35/45 •DC3 •S4 · 10mm	5.8	43026
Small Sign	N842	P1	6825	4.825	CFA	190	450	•C35/45 •DC3 •S4 · 10mm	5.8	42998
Small Sign	N842	P2	6825	4.825	CFA	200	450	•C35/45 •DC3 •S4 · 10mm	5.8	42999
Small Sign	N842	P3	6825	4.825	CFA	200	450	· C35/45 •DC3 •S4 · 10mm	5.8	42999
Small Sign	N842	P4	6825	4.825	CFA	190	450	•C35/45 •DC3 •S4 •10mm	5.8	42999
Radar	RAD33	RAD33	6832	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	5.8	43151
Small Sign	S855	P1	6825	Full depth	CFA	170	450	· C35/45 •DC3 •S4 •10mm	5.8	43006
Small Sign	S855	P2	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	5.8	43007
Small Sign	S854	P3	6825	Full depth	CFA	180	450	•C35/45 •DC3 •S4 •10mm	5.9	43015
Small Sign	S854	P4	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 •10mm	5.9	43029
CCTV	CCTV15	P1	12825	Full depth	CFA	200	750	•C35/45 •DC3 •S4 · 10mm	6	43028
CCTV	CCTV31	CCTV31	12825	4.8	CFA	190	750	•C35/45 •DC3 •S4 · 10mm	6	43125
CCTV	CCTV34	P1	12825	Full Depth	CFA	170	750	•C35/45 •DC3 •S4 · 10mm	6	43118
Radar	RAD14	RAD14	6832	Full depth	CFA	200	450	•C35/45 •DC3 •S4 · 10mm	6.2	43041
CCTV	CCTV21	CCTV21	12825	5.3	CFA	200	750	•C35/45 •DC3 •S4 · 10mm	6.5	43075
Radar	RAD18 S8 G326	P1	12825	4.8	8ored	200	750	•C32/45 •DC3 •S4 •10mm	6.5	43066
Small Sign	N844	P1	6825	Full depth	CFA	190	450	•C35/45 •DC3 •S4 · 10mm	7	43116
Radar	RAD22	P1 Anchor	40mm Dywidag 8ar	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	7	43033

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
Radar	RAD22	P2 Anchor	40mm Dywidag Bar	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	7	43033
Small Sign	S840	P2	6832	Full depth	CFA	220	450	•C35/45 •DC3 •S4 · 10mm	7	43017
CCTV	CCTV17	P1	12825	Full depth	CFA	160	750	· C35/45 •DC3 •S4 · 10mm	7	43032
Gantry	G323	P1	12825	6.8	Bored	180	750	· C32/45 •DC3 •S4 · 10mm	7	43138
Gantry	G323	P2	12825	6.8	Bored	NA	750	· C32/45 •DC3 •S4 · 10mm	7	43139
Gantry	G323	P3	12825	6.8	Bored	NA	750	· C32/45 •DC3 •S4 · 10mm	7	43139
Gantry	G323	P4	12825	6.8	Bored	160	750	· C32/45 •DC3 •S4 · 10mm	7	43138
Gantry	G323	P1	12825	6.8	Bored	180	750	· C32/45 •DC3 •S4 · 10mm	7	43138
Gantry	G323	P2	12825	6.8	Bored	NA	750	· C32/45 •DC3 •S4 · 10mm	7	43139
Gantry	G323	P3	12825	6.8	Bored	NA	750	· C32/45 •DC3 •S4 · 10mm	7	43139
Gantry	G323	P4	12825	6.8	Bored	160	750	· C32/45 •DC3 •S4 · 10mm	7	43139
CCTV	CCTV05	P5	6832	6.775	CFA	210	450	· C35/45 •DC3 •S4 · 10mm	7.1	42989
Small Sign	N828	N828	6832	6.775	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	7.3	43446
Small Sign	N852	N852	6832	Full depth	CFA	160	450	•C35/45 •DC3 •S4 · 10mm	7.4	43034
Small Sign	N856	N856	6832	Full depth	CFA	230	450	· C35/45 •DC3 •S4 •10mm	7.4	43035
Radar	RAD25	RAD25	6832	Full depth	CFA	220	450	•C35/45 •DC3 •S4 · 10mm	7.4	43035
Small Sign	N840	P1	6832	6.775	CFA	200	450	· C35/45 •DC3 •S4 •10mm	7.5	42998
Small Sign	N8S12	P1	6832	Full depth	CFA	220	450	•C35/45 •DC3 •S4 · 10mm	7.5	43012
Small Sign	N8S12	P2	6832	Full depth	CFA	220	450	•C35/45 •DC3 •S4 •10mm	7.5	42969

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
Radar	RAD26	RAD26	6832	Full depth	CFA	200	450	•C35/45 •DC3 •S4 · 10mm	7.5	43039
Small Sign	S822	S822	6832	Full depth	CFA	170	450	· C35/45 •DC3 •S4 · 10mm	7.5	43152
Small Sign	S825	S825	6832	Full depth	CFA	180	450	•C35/45 •DC3 •S4 · 10mm	7.5	22-02-218
Small Sign	S841	S841	6832	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	7.5	43017
CCTV	CCTV23	CCTV23	12825	6.8	CFA	210	750	· C35/45 •DC3 •S4 · 10mm	7.5	43122
CCTV	CCTV11	P1	12825	Full depth	CFA	200	750	· C35/45 •DC3 •S4 •10mm	7.9	43026
Radar	RAD22	RAD22	6832	Full depth	CFA	220	450	•C35/45 •DC3 •S4 · 10mm	8	43032
CCTV	CCTV10	P1	12825	Full depth	CFA	220	750	· C35/45 •DC3 •S4 •10mm	8	43042
CCTV	CCTV30	CCTV30	12825	6.8	CFA	200	750	· C35/45 •DC3 •S4 •10mm	8	43036
Gantry	G324	P1	12825	7.8	8ored	200	750	· C32/45 •DC3 •S4 •10mm	8	43136
Gantry	G324	P2	12825	7.8	8ored	NA	750	· C32/45 •DC3 •S4 •10mm	8	43137
Gantry	G324	P3	12825	7.8	8ored	NA	750	· C32/45 •DC3 •S4 •10mm	8	43137
Gantry	G324	P4	12825	7.8	8ored	220	750	· C32/45 •DC3 •S4 •10mm	8	43136
Gantry	G324	Anchor Pile	40mm Dywidag 8ar	Full Depth	8ored	200	750	· C32/45 •DC3 •S4 •10mm	8	43136
CCTV	CCTV18	P1	12825	Full depth	CFA	220	750	•C35/45 •DC3 •S4 •10mm	8.7	43116
Small Sign	S843	P1	6825	Full depth	CFA	140	450	•C35/45 •DC3 •S4 · 10mm	9.5	43019
Small Sign	S848	P2	6825	Full depth	CFA	200	450	•C35/45 •DC3 •S4 •10mm	9.5	43021
Small Sign	S848	P3	6825	Full depth	CFA	200	450	•C35/45 •DC3 •S4 · 10mm	9.5	43020
Small Sign	S850	P1	6825	Full depth	CFA	200	450	•C35/45 •DC3 •S4 •10mm	9.5	43028

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
Small Sign	S850	P2	6825	Full depth	CFA	220	450	•C35/45 •DC3 •S4 · 10mm	9.5	43028
Small Sign	S811	P2	6832	Full depth	CFA	180	450	· C35/45 •DC3 •S4 · 10mm	10	43154
Small Sign	S811	P3	6832	Full depth	CFA	180	450	•C35/45 •DC3 •S4 · 10mm	10	43154
Small Sign	S848	P4	6825	Full depth	CFA	140	450	•C35/45 •DC3 •S4 · 10mm	10	43019
Small Sign	S848	P5	6825	Full depth	CFA	200	450	· C35/45 •DC3 •S4 · 10mm	10	43021
Small Sign	S848	P6	6825	Full depth	CFA	200	450	•C35/45 •DC3 •S4 •10mm	10	43020
Small Sign	N846	P1	6832	9.77	8ored	200	450	· C32/45 •DC3 •S4 · 10mm	10	43112
Small Sign	N846	P1	6832	9.77	8ored	180	450	•C32/45 •DC3 •S4 •10mm	10	43111
Small Sign	S850	P3	6825	Full depth	CFA	220	450	•C35/45 •DC3 •S4 · 10mm	10.2	43027
Small Sign	S850	P4	6825	Full depth	CFA	200	450	•C35/45 •DC3 •S4 •10mm	10.2	43028
Small Sign	S811	P1	6825	Full depth	CFA	160	450	•C35/45 •DC3 •S4 •10mm	10.5	43152
Small Sign	S811	P4	6825	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	10.5	43152
Small Sign	S812	P1	6832	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	10.5	43152
Small Sign	S812	P2	6832	Full depth	CFA	170	450	•C35/45 •DC3 •S4 · 10mm	10.5	43152
Small Sign	S843	P1	6832	Full depth	CFA	170	450	•C35/45 •DC3 •S4 •10mm	10.5	43017
Small Sign	S843	P2	6832	Full depth	CFA	160	450	· C35/45 •DC3 •S4 · 10mm	10.5	43017
Small Sign	S828	P1	6832	9.775	8ored	200	450	•C32/45 •DC3 •S4 · 10mm	10.5	43108
Small Sign	S828	P2	6832	9.775	8ored	180	450	•C32/45 •DC3 •S4 · 10mm	10.5	43105
Small Sign	G101	Anchor Pile	40mm Dywidag 8ar	Full Depth	8ored	200	750	•C35/45 •DC3 •S4 · 10mm	12	42947

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
Gantry	G101	P1	12825 & 40mm Dywidag 8ar	11.8 & Full Depth	8ored	200	750	•C35/45 •DC3 •S4 · 10mm	12	42979
Gantry	G101	P3 Test Pile	12825	11.8	8ored	190	750	•C35/45 •DC3 •S4 · 10mm	12	42983
Gantry	G101	P2	12825	11.8	8ored	210	750	· C35/45 •DC3 •S4 · 10mm	12	42984
Gantry	G101	P1	12825	11.8	8ored	190	750	· C35/45 •DC3 •S4 · 10mm	12	42947
Gantry	G314	P2	12825	11.8	8ored	200	750	•C32/45 •DC3 •S4 · 10mm	12	43084
Gantry	G314	P3	12825	11.8	8ored	220	750	•C32/45 •DC3 •S4 · 10mm	12	43084
Gantry	G314	P4	12825 & 36mm Dywidag 8ar	11.8 & Full Depth	8ored	200	750	•C32/45 •DC3 •S4 · 10mm	12	43083
Gantry	G314	Test Anchor	36mm Dywidag 8ar	Full Depth	8ored	220	750	•C32/45 •DC3 •S4 · 10mm	12	43083
Gantry	G305	P1	12825	12.78	8ored	210	750	•C35/45 •DC3 •S4 · 10mm	12.5	43051
Gantry	G305	P2	12825 & 40mm Dywidag 8ar	12.78 & Full Length	8ored	200	750	· C35/45 •DC3 •S4 •10mm	12.5	43054
Gantry	G305	P3	12825	12.78	8ored	210	750	· C35/45 •DC3 •S4 •10mm	12.5	43038
Gantry	G305	Test	40mm Dywidag 8ar	Full Depth	8ored	180	750	•C35/45 •DC3 •S4 · 10mm	12.5	43049
Gantry	G305	P4	12825	12.78	8ored	220	750	•C35/45 •DC3 •S4 · 10mm	13	43048
Gantry	G320	P1	15832	12.8	8ored	NA	900	· C32/45 •DC3 •S4 · 10mm	13	43137
Gantry	G320	P2	15832	12.8	8ored	NA	900	•C32/45 •DC3 •S4 •10mm	13	43138
Gantry	G320	P3	15832	12.8	8ored	NA	900	•C32/45 •DC3 •S4 •10mm	13	43138
Gantry	G320	P3	15832	12.8	8ored	NA	900	· C32/45 •DC3 •S4 · 10mm	13	43137
Gantry	G307	P1	12825	Full Depth	8ored	160-200	750	· C35/45 •DC3 •S4 · 10mm	15	43110
Gantry	G307	P2	12825	Full Depth	8ored	210-190	750	•C32/45 •DC3 •S4 · 10mm	15	43111

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
Gantry	G309	P3	12825	Full Depth	8ored	180-160	750	•C32/45 •DC3 •S4 · 10mm	15	43111
Gantry	G309	P4	12825	14.88	8ored	190-210	750	•C32/45 •DC3 •S4 · 10mm	15	43110
Gantry	G313	P1-Test Pile	12825	14.8	8ored	NA	750	· C32/45 •DC3 •S4 · 10mm	15	43082
Gantry	G313	P2	12825	14.8	8ored	160-180	750	· C32/45 •DC3 •S4 · 10mm	15	43077
Gantry	G310	P1	12825	14.88	8ored	200-210	750	•C32/45 •DC3 •S4 · 10mm	15.5	43104
Gantry	G310	P2	12825	14.88	8ored	200-210	750	•C32/45 •DC3 •S4 · 10mm	15.5	43105
Gantry	G310	P3	12825	14.88	8ored	205-180	750	•C32/45 •DC3 •S4 · 10mm	15.5	43105
Gantry	G310	P4	12825	14.88	8ored	160-170	750	•C32/45 •DC3 •S4 · 10mm	15.5	43104
Gantry	G307	P1	12825	Full Depth	8ored	210-180	750	•C35/45 •DC3 •S4 · 10mm	16	43115
Gantry	G307	P4	12825	Full Depth	8ored	170-190	750	· C35/45 •DC3 •S4 •10mm	16	43115
Gantry	G321	P1	12825	15.78	8ored	210-220	750	· C32/45 •DC3 •S4 •10mm	16	43126
Gantry	G321	P2	12825	15.78	8ored	190-220	750	•C32/45 •DC3 •S4 · 10mm	16	43129
Gantry	G321	P3	12825	15.78	8ored	210-220	750	•C32/45 •DC3 •S4 · 10mm	16	43129
Gantry	G321	P4	12825	15.78	8ored	170-180	750	· C32/45 •DC3 •S4 •10mm	16	43126
Gantry	G301	Anchor Pile	Anchor 8ar	NA	8ored	NA	900	· C32/45 •DC3 •S4 •10mm	16	42879
Gantry	G301	Anchor Pile	Anchor 8ar	NA	8ored	NA	900	•C32/45 •DC3 •S4 •10mm	16	42879
Gantry	G202	Working Anchor Pile	15832	16.6	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	16.5	43021
Gantry	G202	Working Test	15832	16.6	8ored	NA	900	•C32/45 •DC3 •S4 •10mm	16.5	43020
Gantry	G202	6	15832	16.6	8ored	NA	900	•C32/45 •DC3 •S4 •10mm	16.5	43021

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
Gantry	G202 N8	1	15832	16.3	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	16.5	43104
Gantry	G202 N8	2	15832	16.3	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	16.5	43105
Gantry	G202 N8	3	15832	16.3	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	16.5	43104
Gantry	G301	P1	15840	NA	8ored	NA	900	· C32/45 •DC3 •S4 · 10mm	16.5	43033
Gantry	G301	P1 Working Test	15840	NA	8ored	NA	900	· C32/45 •DC3 •S4 · 10mm	16.5	43032
Gantry	G301	P3	15840	NA	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	16.5	43032
Gantry	G301	P4	15840	NA	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	16.5	43033
Gantry	G301	Anchor Pile	15840	NA	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	16.5	43033
Gantry	G311	P5	15832	26.3	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	16.5	43116
Gantry	G311	P6	15832	26.3	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	16.5	43115
Gantry	G311	P7	15832	16.3	8ored	NA	900	· C32/45 •DC3 •S4 •10mm	16.5	43115
Gantry	G311	P8	15832	16.3	8ored	NA	900	· C32/45 •DC3 •S4 •10mm	16.5	43116
Gantry	G311 N8	P1	15832	16.3	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	16.5	43042
Gantry	G311 N8	P2	15832	16.3	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	16.5	43045
Gantry	G311 N8	P3	15832	16.3	8ored	NA	900	· C32/45 •DC3 •S4 · 10mm	16.5	43055
Gantry	G311 N8	P4	15832	16.3	8ored	NA	900	· C32/45 •DC3 •S4 •10mm	16.5	43042
Gantry	G311 N8	Anchor Pile	15832	16.3	8ored	NA	900	· C32/45 •DC3 •S4 •10mm	16.5	43045
Gantry	G301	Test Pile	15840	17.745	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	17	42878
Gantry	G312	P1	12825	17.78	8ored	180-200	750	•C32/45 •DC3 •S4 · 10mm	18	43088

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
Gantry	G312	P2	12825 & 40mm Dywidag 8ar	17.78 & Full Length	8ored	220	750	•C32/45 •DC3 •S4 · 10mm	18	42784
Gantry	G312	P3	12825	17.85	8ored	170-185	750	•C32/45 •DC3 •S4 · 10mm	18	43090
Gantry	G312	P4-Test Pile	12825	17.78	8ored	160-180	750	•C32/45 •DC3 •S4 · 10mm	18	43089
Gantry	G312	Test Anchor	36mm Dywidage 8ar	Full Depth	8ored	190-205	750	· C32/45 •DC3 •S4 · 10mm	18	43090
Gantry	G326S8	Test Anchor	40mm Dywidag 8ar	Full Depth	8ored	180-190	750	•C32/45 •DC3 •S4 · 10mm	18	43068
Gantry	G326S8	Test Anchor	40mm Dywidag 8ar	Full Depth	8ored	180-190	750	•C32/45 •DC3 •S4 · 10mm	18	43068
Gantry	G326S8	P1	12825	17.78	8ored	200	750	•C32/45 •DC3 •S4 · 10mm	18.5	43136
Gantry	G326S8	P2	12825	17.78	8ored	190-200	750	· C32/45 •DC3 •S4 •10mm	18.5	43062
Gantry	G326S8	P3	12825	17.78	8ored	160-200	750	· C32/45 •DC3 •S4 •10mm	18.5	43070
Gantry	G326S8	P4	12825	17.78	8ored	160-170	750	•C32/45 •DC3 •S4 · 10mm	18.5	43069
Gantry	G112	Non-working Test	15832	20.3	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	20.5	42811
Gantry	G112	Test Pile	15 832	Full Depth	8ored	NA	900	· C32/45 •DC3 •S4 · 10mm	21.2	43117
Gantry	G112	Anchor Pile	Anchor 8ars	NA	8ored	NA	900	· C32/45 •DC3 •S4 •10mm	21.2	43026
Gantry	G112	P1	15832	20.6	8ored	NA	900	· C32/45 •DC3 •S4 •10mm	21.2	43026
Gantry	G112	P2	15832	20.6	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	21.2	43027
Gantry	G112	P3	15832	20.6	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	21.2	43027
Gantry	G319	P1	15832	25.3	8ored	NA	900	•C32/45 •DC3 •S4 •10mm	25.5	43123
Gantry	G319	P2	15832	25.3	8ored	NA	900	•C32/45 •DC3 •S4 •10mm	25.5	43122
Gantry	G319	P3	15832	25.3	8ored	NA	900	· C32/45 •DC3 •S4 · 10mm	25.5	43122

Structure	Foundation	Pile No	Cage Design	Cage Length [m]	Piling Method	Slump [mm]	Pile Diamter [mm]	Concrete	Depth of Pile from PPL [m]	Date
Gantry	G319	P4	15832	25.3	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	25.5	43123
Gantry	G308	P1	15832	26.3	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	26.5	43064
Gantry	G308	P2	15832	26.3	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	26.5	43068
Gantry	G308	P3	15832	26.3	8ored	NA	900	· C32/45 •DC3 •S4 · 10mm	26.5	43068
Gantry	G308	P4	15832	26.3	8ored	NA	900	· C32/45 •DC3 •S4 · 10mm	26.5	43064
Gantry	G308	Anchor Pile	Anchor 8ar	NA	8ored	NA	900	•C32/45 •DC3 •S4 · 10mm	26.5	43066
Gantry	G313	P3	12825	14.8	8ored	190-200	750	•C32/45 •DC3 •S4 · 10mm	NA	43082
Gantry	G313	Test Anchor	NA	NA	8ored	170-180	750	•C32/45 •DC3 •S4 · 10mm	NA	43078
Gantry	G314	P1	12825	11.8	8ored	220	750	•C32/45 •DC3 •S4 · 10mm	NA	43083
Gantry	G324	Test Anchor	40mm Dywidag 8ar	Full Depth	8ored	180-190	750	•C32/45 •DC3 •S4 · 10mm	NA	43068
Gantry	G326	P4	12825	17.78	8ored	160-170	750	· C32/45 •DC3 •S4 •10mm	NA	43136

E.2 - Summary of Sheet Pile Installation Records - Northbound

Chainage Start	Chainage End	Location	Earthwork Type	Date	Pre augerBelow Platform Level [m]	Sheet Pile Type	Total Structure Length (m)	king Sheet Pile			Intermediate Sheet Pile		
								Section	Steel Grade	Total King Sheet Pile Wall Length (m)	Section	Steel Grade	Total Intermediate Sheet Pile Wall Length (m)
185140	185220	N8	Cutting	19-08-2017 to 30-08-2017	9.2 to 8.0	Steel	80	ZZ26	S 355 GP	8.0	ZZ18	S 355 GP	3.0
185220	185270	N8	Cutting			Steel	50	ZZ26	S 355 GP	10.0	ZZ18	S 355 GP	3.3
185270	185320	N8	Cutting			Steel	50	ZZ26	S 355 GP	8.0	ZZ18	S 355 GP	3.0
185904	185950	N8	Embankment	23/02/2018	Handover Completion Certificate Available	Steel	46	ZZ26	S 355 GP	6.5	ZZ18	S 355 GP	3.0
185950	185990	N8	Embankment			Steel	40	ZZ26	S 355 GP	6.5	ZZ18	S 355 GP	3.1
185990	186040	N8	Embankment			Steel	50	ZZ26	S 355 GP	6.5	ZZ18	S 355 GP	3.0
186040	186090	N8	Embankment			Steel	50	ZZ26	S 355 GP	7.5	ZZ18	S 355 GP	3.3
186090	186230	N8	Embankment			Steel	140	ZZ26	S 355 GP	6.5	ZZ18	S 355 GP	3.0
186230	186270	N8	Embankment			Steel	40	ZZ26	S 355 GP	7.5	ZZ18	S 355 GP	3.5
186270	186340	N8	Embankment			Steel	70	ZZ26	S 355 GP	6.5	ZZ18	S 355 GP	3.0
186390	186443	N8	Embankment	24/01/2018	Handover Completion Certificate Available	Steel	53	ZZ18	S 355 GP	6.5	ZZ18	S 355 GP	2.4
186500	186530	N8	Embankment	20/12/2017	6	Steel	30	ZZ26	S 355 GP	6.0	ZZ18	S 355 GP	3.0
188760	188850	N8	Embankment	31/10/2017	Handover Completion Certificate Available	Steel	90	ZZ26	S 355 GP	9.0	ZZ18	S 355 GP	4.5
191770	191830	N8	Embankment	09-01-2018 to 10-01-2018	9.0 to 7.5	Steel	60	ZZ26	S 355 GP	6.0	NA	NA	NA
193320	193350	N8	Cutting	16/01/2018	9.0 to 7.5	Steel	30	ZZ26	S 355 GP	10.0	ZZ18	S 355 GP	3.5

E.3 - Summary of Sheet Pile Installation Records - Southbound

Chainage Start	Chainage End	Location	Earthwork Type	Date	Pre auger below platform level	Total Structure Length (m)	King Sheet Pile Wall			Intermediate Sheet Pile		
							Section	Steel Grade	Total Pile Length (m)	Section	Steel Grade	Total Length (m)
183860	183950	S8	Cutting	05-09-2017 to 06-09-2017	3.5-4.5	90	ZZ18	S 355 GP	5.5	ZZ18	S 355 GP	2.5
187800	187830	S8	Embankment	05/09/2017 to 06-09-2017	Handover Completion Certificate Available	30	ZZ 26	S 355 GP	6.5	ZZ18	S 355 GP	3.3
187910	187930	S8	Embankment			20	ZZ18	S 355 GP	7.5	ZZ18	S 355 GP	1.6
188100	188130	S8	Embankment	NA	NA	30	ZZ18	S 355 GP	7.0	ZZ18	S 355 GP	2.4
188410	188500	S8	Embankment	NA	NA	90	AZ46	S 390 GP	11.0	ZZ18	S 355 GP	3.7
188500	188540	S8	Embankment	NA	NA	40	ZZ26	S 355 GP	8.0	ZZ18	S 355 GP	3.0
188750	188770	S8	Embankment	31/10/2017	NA	20	ZZ26	S 355 GP	7.5	ZZ18	S 355 GP	4.8
188930	188950	S8	Embankment	NA	NA	20	ZZ26	S 355 GP	8.0	ZZ18	S 355 GP	3.3
189160	189180	S8	Embankment	NA	6	20	ZZ26	S 355 GP	8.0	ZZ18	S 355 GP	3.7
189280	189305	S8	Embankment	NA	NA	25	ZZ18	S 355 GP	6.5	ZZ18	S 355 GP	2.5
189750	189790	S8	Embankment	NA	NA	40	ZZ26	S 355 GP	9.0	ZZ18	S 355 GP	3.9
192090	192140	S8	Embankment	23/02/2018	Handover Completion Certificate Available	50	AZ36	S 390 GP	8.0	ZZ18	S 355 GP	3.0
192190	192240	S8	Embankment			50	AZ36	S 390 GP	11.0	ZZ18	S 355 GP	4.1
192240	192260	S8	Embankment			20	AZ36	S 390 GP	8.0	ZZ18	S 355 GP	3.0
192260	192300	S8	Embankment			40	AZ36	S 390 GP	11.0	ZZ18	S 355 GP	4.1
192370	192400	S8	Embankment			30	AZ36	S 390 GP	11.0	ZZ18	S 355 GP	4.1
192400	192480	S8	Embankment			80	AZ36	S 390 GP	12.0	ZZ18	S 355 GP	3.4
192480	192519	S8	Embankment			39	AZ36	S 390 GP	12.0	ZZ18	S 355 GP	3.5
192710	192747	S8	Embankment	06-02-2018 to 15-02-2018	Handover Completion Certificate Available	37	AZ50	S 390 GP	12.5	ZZ18	S 355 GP	4.5
192747	192830	S8		06-02-2018 to 15-02-2018	NA	83	AZ36	S 390 GP	8.5	ZZ18	S 355 GP	3.5
193300	193320	S8	Cutting	NA	NA	20	ZZ18	S 355 GP	5.0	ZZ18	S 355 GP	1.8

Appendix F Summary of Pile Testing

F.1: Preliminary Test Results

F.2: Working Pile Load Test Results

F.1 - Results of Preliminary Tests

G:101 Preliminary	Test Date	Working Load [kN]	Max. Test Load [kN]	Pile Dima [mm]	Pile Length [m]	Cycle	Cycle 1		Cycle 2		Cycle 3	
						Load [kN]	606	Zero*	909	Zero**	1212	Zero***
	14-15 Aug. 2017	606	1212	750	11	Sett. [mm]	0.45	0.133	0.86	0.29	1.9	0.7
G:304 Preliminary	**Test Date**	**Working Load [kN]**	**Max. Test Load [kN]**	**Pile Dima [mm]**	**Pile Length [m]**	**Cycle**	**Cycle 1**		**Cycle 2**		**Cycle 3**	
						Load [kN]	1517	Zero*	2275	Zero**	3034	Zero***
	18-19 Sep. 2017	1517	3034	900	13.4	Sett. [mm]	3.63	1.64	6.09	2.5	7.25	3.44
G:112 Preliminary	**Test Date**	**Working Load [kN]**	**Max. Test Load [kN]**	**Pile Dima [mm]**	**Pile Length [m]**	**Cycle**	**Cycle 1**		**Cycle 2**		**Cycle 3**	
						Load [kN]	1110	Zero*	2220	Zero**	3330	Zero***
	30-31 Aug. 2017	1110	2220	900	20	Sett. [mm]	1.32	0.64	2.07	1.06	2.65	1.24

Zero*: Unloading Settlement after 1st Cycle.
Zero**: Unloading Settlement after 2nd Cycle.
Zero**: Residual Settlement after 3rd Cycle.

F.2 - Results of Working Pile Load Tests

G:202	Test Date	Working Load [kN]	Maximum Test Load [kN]	Pile Dima [mm]	Pile Length [m]	Cycle	Cycle 1		Cycle 2	
						Load [kN]	849	Zero*	1273.5	Zero**
	20-21 Oct. 2017	849	1273.5	900	16.5	Sett. [mm]	0.62	0.36	1.15	0.69
G:203	Test Date	Working Load [kN]	Maximum Test Load [kN]	Pile Dima [mm]	Pile Length [m]	Cycle	Cycle 1		Cycle 2	
						Load [kN]	713	Zero*	1069.5	Zero**
	5-6 Jan. 2018	713	1069.5	900	25.5	Sett. [mm]	0.24	0.14	0.4	0.2
G:301 P2	Test Date	Working Load [kN]	Maximum Test Load [kN]	Pile Dima [mm]	Pile Length [m]	Cycle	Cycle 1		Cycle 2	
						Load [kN]	1539	Zero*	2308.5	Zero**
	2-3 Nov. 2017	1539	2308.5	900	16.5	Sett. [mm]	1.29	0.64	2.43	1.17
G:301	Test Date	Working Load [kN]	Maximum Test Load [kN]	Pile Dima [mm]	Pile Length [m]	Cycle	Cycle 1		Cycle 2	
						Load [kN]	1539	Zero*	2308.5	Zero**
	19-20 Dec. 2017	1539	2308.5	900	16.5	Sett. [mm]	1.12	0.49	2.22	1.19
G:303	Test Date	Working Load [kN]	Maximum Test Load [kN]	Pile Dima [mm]	Pile Length [m]	Cycle	Cycle 1		Cycle 2	
						Load [kN]	1033	Zero*	1549.5	Zero**
	5th Dec. 2017	1033	1549.5	900	21.5	Sett. [mm]	1.2	0.36	1.87	0.64
G:311	Test Date	Working Load [kN]	Maximum Test Load [kN]	Pile Dima [mm]	Pile Length [m]	Cycle	Cycle 1		Cycle 2	
						Load [kN]	590	Zero*	885	Zero**
	13-14 Nov. 2017	590	885	900	16.5	Sett. [mm]	0.23	0.03	0.42	0.11
G:313	Test Date	Working Load [kN]	Maximum Test Load [kN]	Pile Dima [mm]	Pile Length [m]	Cycle	Cycle 1		Cycle 2	
						Load [kN]	412	Zero*	618	Zero**
	20-21 Dec. 2017	412	618	750	15	Sett. [mm]	0.69	0.2	1.1	0.37
G:315	Test Date	Working Load [kN]	Maximum Test Load [kN]	Pile Dima [mm]	Pile Length [m]	Cycle	Cycle 1		Cycle 2	
						Load [kN]	1222	Zero*	1833	Zero**
	30 Nov-1Dec. 2017	1222	1833	900	26.5	Sett. [mm]	0.54	0.13	0.84	0.2

Zero*: Unloading Settlement after 1st Cycle.

Zero**: Residual Settlement after 2rd Cycle.

Appendix G Confirmatory Ground Investigation (Just in Time GI)

NICHOLLS COLTON GROUP

BOREHOLE RECORD - BH FTP NB2 _1M_2

(Window Sampler)

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 10.00m		G17057
Logged by: JP / Ground Level: 37.58 mAOD	Date: 24/07/2017	Location: 447106E - 329269N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
				37.46	0.12	MADE GROUND - Macadam road construction.		
				37.32	0.26	MADE GROUND - Macadam road construction.		
D1	0.50-0.60	(0)						
		133 kPa		36.68	0.90	MADE GROUND - Light grey fine to coarse SAND and angular fine to coarse siltstone GRAVEL. (road stone sub-base). a. . . soils noted as being wet below 0.60m.		
D2	1.10-1.30	(0)						
S	1.20	N=12						
D3	1.40-1.50	(0)						
D4	1.60-1.90	(0)						
S	2.00	N=21						
S	3.00	N=20						
D5	3.00-3.30	(0)		34.08	3.50	MADE GROUND - Stiff reddish brown and light grey silty slightly gravelly CLAY with occasional angular siltstone cobbles. Gravel is angular to sub-rounded quartz, siltstone and mudstone. a. . . pocket of soft brown organic sandy silt (topsoil?) from 1.40m to 1.50m. a. . . encountered obstruction at 2.20m (possible cobble or boulder), unable to dynamic sample through. Penetrated by open hole techniques.		
D6	3.60-3.90	(0)		33.58	4.00	MADE GROUND - Stiff reddish brown and light grey silty CLAY with many angular siltstone fragments.		
S	4.00	N=23						
D7	4.10-4.20	(0)		33.08	4.50	MADE GROUND - Stiff reddish brown and light grey silty slightly gravelly CLAY with occasional angular siltstone cobbles. Gravel is angular to sub-rounded quartz, siltstone and mudstone.		
D8	4.80-5.00	(0)						
S	5.00	N=45						
C	6.00	N=44		30.98	6.60	MADE GROUND - Stiff reddish brown and light grey silty CLAY with many angular siltstone fragments.		
C	7.00	50/60mm				MADE GROUND - brown fine to coarse SAND and sub-angular to sub-rounded quartz GRAVEL. (Determined from open hole arisings only).		
C	8.50	()/0mm						

(continued next sheet)

Remarks and Water Observations

1. Advanced through road construction using coring attachment.
2. Hand dug starter pit to 1.10m, to check for services.
3. Set of three Hand Shear Vane (HSV) tests undertaken at 1.00m gave average apparent undrained shear strength of 133 kPa, using the pilcon unit (HSV3) and the 19mm vane.
4. Soils noted as being wet below 0.60m, water (perched) forming to level of 0.75m in pit.
5. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques through overburden (to 6.60m) then by open-hole / driving casing from through dense coarse grained soils (to 10.00m).
6. Borehole backfilled with sodium bentonite (pellets) to 1.50m below surface, rapid setting concrete to 0.10m then surface reinstated upon completion.

NICHOLLS COLTON GROUP

REHOLE RECORD - BH FTP NB2 _1M_2

(Window Sampler)

Client Costain Galliford Try	Site M1 J23a to J25 Ground Investigation			
	Boring diameter: 120 mm to 10.00m	Casing diameter:	Project No.: G17057	
Logged by: JP	Ground Level: 37.58 mAOD	Date: 24/07/2017	Location: 447106E - 329269N	Scale: 1:50

Samples & In situ Tests			Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
Ref:	Depth (m)	SPT N						
						MADE GROUND - brown fine to coarse SAND and sub-angular to sub-rounded quartz GRAVEL. (Determined from open hole arisings only).		
C	10.00	()/0mm		27.58	10.00	*End of Borehole at 10.00 m*		

Sheet 2 of 2

Remarks and Water Observations

1. Advanced through road construction using coring attachment.
2. Hand dug starter pit to 1.10m, to check for services.
3. Set of three Hand Shear Vane (HSV) tests undertaken at 1.00m gave average apparent undrained shear strength of 133 kPa, using the pilcon unit (HSV3) and the 19mm vane.
4. Soils noted as being wet below 0.60m, water (perched) forming to level of 0.75m in pit.
5. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques through overburden (to 6.60m) then by open-hole / driving casing from through dense coarse grained soils (to 10.00m).
6. Borehole backfilled with sodium bentonite (pellets) to 1.50m below surface, rapid setting concrete to 0.10m then surface reinstated upon completion.

REHOLE RECORD - BH R FTPSB5_800Y

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site	M1 J23a to J25 Ground Investigation
Client	Costain Galliford Try
Boring diameter:	120 mm to 3.00m 100 mm to 10.00m
Casing diameter:	120 mm to 3.00m
Project No.:	G17057
Logged by:	JP
Ground Level:	
Date:	05/04/2017-06/04/2017
Location:	-
Scale:	1:50

Samples & In situ Tests

Ref:	Depth (m)	SPT N / TCR SCR RQD	FI FS
S	1.20	N=14	
S	2.00	N=14	
B1	2.00-2.40		
S	3.00	50/55 mm	
CR	3.00-4.00	50 39 21	0 5
CR	4.00-5.50	43 15 7	0 4 0
C	5.50	50/295 mm	
CR	5.50-7.00	85 84 44	10 6 0
CR	7.00-8.50	87 86 31	10
			10

Strata

Water	Level (mAOD)	Depth (m)	Strata Description
		0.15	MADE GROUND - Greyish brown silty fine to coarse SAND and angular to sub-rounded fine to coarse granite GRAVEL.
		1.00	MADE GROUND - Greyish brown slightly sandy angular coarse granite GRAVEL (French drain).
			MADE GROUND - No sample recovery, although probable continuation of drain.
		2.00	
		2.40	MADE GROUND - Medium dense brown and reddish brown slightly gravelly slightly clayey silty fine to coarse SAND. Gravel is angular fine to coarse granite, quartz, siltstone and mudstone.
		2.80	
		3.00	Firm reddish brown locally light brown, slightly sandy silty CLAY with occasional angular medium siltstone lithorelicts, becoming more frequent with depth.
			Extremely weak reddish brown SILTSTONE (recovered in gravel sized fragments within a silt and fine to coarse sand matrix).
			Very weak locally weak thinly laminated pale green mottled pale red sandy SILTSTONE with frequent thin laminations of firm to stiff green clay. No evidence of weathering.
			. . . band of firm green mottled red CLAY with mudstone and siltstone lithorelicts noted from 5.30m to 5.40m.
			. . . recovered as gravel between 5.40m and 5.50m.
			. . . fracture noted at 6.75m, sub-vertical, undulating rough, partly open to open, clean.
			. . . fracture noted at 7.70m, sub-vertical, undulating rough, partly open to open, clean.
			. . . fracture noted from 8.25m to 8.50m, sub-vertical, planar and undulating, smooth to slightly rough, black surface staining, soft red clay

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.00m to check for services.
2. Hand dug trial pit collapsing and unstable, unable to progress pit to 1.20m.
3. No sample recovery from 1.20m to 2.00m.
4. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 3.00m, then by rotary coring techniques from 3.00m to the borehole base, with a mist flush.
5. Borehole backfilled with sodium bentonite (pellets) upon completion.

NICHOLLS COLTON GROUP

REHOLE RECORD - BH R FTPSB5_800Y

(Window Sampler plus Rotary Core)

Site M1 J23a to J25 Ground Investigation			
Client Costain Galliford Try	Boring diameter: 120 mm to 3.00m 100 mm to 10.00m	Casing diameter: 120 mm to 3.00m	Project No.: G17057
Logged by: JP / Ground Level:	Date: 05/04/2017-06/04/2017	Location: -	Scale: 1:50

Core Data Ref:	Core Data Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	8.50-10.00	99 99 56	7			10.00	Remaining Detail : 8.25m - 8.25m : infill. Detail 9.00m - 9.00m : . . . fracture noted from 9.00m to 9.70m, sub-vertical, undulating rough, tight to partly open, no staining, soft red clay infill. . . . band of firm to stiff red silty CLAY with mudstone lithorelicts noted from 9.10m to 9.20m.		
							End of Borehole at 10.00 m		
		TCR SCR RQD	FI FS					Sheet 2 of 2	

Remarks and Water Observations

1. Hand dug starter pit to 1.00m to check for services.
2. Hand dug trial pit collapsing and unstable, unable to progress pit to 1.20m.
3. No sample recovery from 1.20m to 2.00m.
4. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 3.00m, then by rotary coring techniques from 3.00m to the borehole base, with a mist flush.
5. Borehole backfilled with sodium bentonite (pellets) upon completion.

NICHOLLS COLTON GROUP

REHOLE RECORD - BH R-FTPNB2_600Y

(Window Sampler plus Rotary Core)

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try	Boring diameter: 150 mm to 11.00m	Casing diameter: 120 mm to 10.50m	Project No.: G17057
Logged by: IG / Ground Level: 36.07 mAOD	Date: 20/04/2017-24/04/2017	Location: 329665E - 446979N	Scale: 1:50

Samples & In situ Tests

Ref:	Depth (m)	SPT N
B1	0.20-0.50	
B2	0.50-0.80	
B3	0.80-1.00	
D4	1.10-1.20	
S	1.20	N=13
D5	1.20-1.65	
B6	1.20-2.00	
S	2.00	N=18
D7	2.00-2.45	
B8	2.00-3.00	
S	3.00	N=15
B10	3.00-4.00	
D9	3.00-3.45	
S	4.00	50/135mm
D11	4.00-4.45	
S	5.00	50/110mm
D12	5.00-5.45	
S	6.00	N=25
D13	6.00-6.45	
D14	6.00-6.20	
D15	6.00-7.00	
S	7.00	N=47
S	8.00	N=17
S	9.00	50/206mm

Strata

Water	Level (mAOD)	Depth (m)	Strata Description
	35.57	0.50	MADE GROUND - Soft light brown slightly gravelly sandy SILT. Gravel is sub-angular to rounded fine to coarse quartzite, mudstone, sandstone, granite and flint.
	35.27	0.80	MADE GROUND - Firm reddish brown locally grey slightly gravelly CLAY. Gravel is sub-angular to rounded fine to coarse quartzite, mudstone and granite.
	34.97	1.10	MADE GROUND - Greyish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse limestone, quartzite and granite.
	34.42	1.65	MADE GROUND - Soft locally firm friable reddish brown locally grey slightly sandy SILT. . . . becoming firm locally stiff below 1.20m
	31.77	4.30	MADE GROUND - Soft locally firm reddish brown locally grey CLAY with frequent gravel sized fragments of sub-angular to sub-rounded fine to medium mudstone. . . . becoming firm below 3.60m.
	30.07	6.00	Yellowish brown fine to coarse SAND and sub-angular fine to coarse quartzite GRAVEL. . . . becoming very dense below 5.00m.
	27.07	9.00	Stiff reddish brown slightly gravelly CLAY with occasional gravel sized fragments of coal. Gravel is sub-angular to rounded fine to medium quartzite and mudstone.

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. No groundwater entries were encountered during drilling operations.
3. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques from 1.20m to 4.00m and 6.00m to 6.20m, then by open hole / driving casing from 4.00m to 6.00m and 6.00m to the borehole base (due to dense gravels and the borehole collapsing during dynamic sampling).
4. Borehole backfilled with sodium bentonite (pellets) upon completion.

NICHOLLS COLTON GROUP

REHOLE RECORD - BH R-FTPNB2_600Y

(Window Sampler plus Rotary Core)

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	150 mm to 11.00m	120 mm to 10.50m	G17057

Logged by: IG	Ground Level: 36.07 mAOD	Date: 20/04/2017-24/04/2017	Location: 329665E - 446979N	Scale: 1:50

Samples & In situ Tests			Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
Ref:	Depth (m)	SPT N						
						Very dense reddish brown sandy silty sub-angular to rounded fine to coarse quartzite GRAVEL.		
B16	9.50-10.50			26.57	9.50	Reddish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to medium quartzite.		
S D17 B18	10.50 10.50-10.95 10.50-11.00	50/180mm		25.57	10.50	Very dense reddish brown silty fine to medium SAND.		
				25.07	11.00	*End of Borehole at 11.00 m*		

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. No groundwater entries were encountered during drilling operations.
3. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques from 1.20m to 4.00m and 6.00m to 6.20m, then by open hole / driving casing from 4.00m to 6.00m and 6.00m to the borehole base (due to dense gravels and the borehole collapsing during dynamic sampling).
4. Borehole backfilled with sodium bentonite (pellets) upon completion.

REHOLE RECORD - BH R-FTPSB4_800Y

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation				
Client: Costain Galliford Try	Boring diameter: 120 mm to 15.00m		Casing diameter: 120 mm to 14.00m	Project No.: G17057
Logged by: PM	Ground Level:	Date: 10/05/2017-12/05/2017	Location: -	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
B1	0.20-0.40				0.20	MADE GROUND - Topsoil (soft brown organic sandy SILT with frequent rootlets).
B2	0.50-1.00				0.40	MADE GROUND - Light brown and grey slightly gravelly medium to coarse SAND. Gravel is angular to sub-rounded fine to coarse quartzite and sandstone with frequent medium to coarse igneous roadstone.
S	1.20	N=7				MADE GROUND - Reddish brown mottled grey slightly gravelly clayey medium to coarse SAND. Gravel is angular to sub-rounded fine to medium sandstone and mudstone.
B3	1.20-2.00					. . . becoming loose below 1.20m.
S	2.00	N=25			2.00	MADE GROUND - Stiff brown mottled yellow and grey friable slightly gravelly silty CLAY. Gravel is angular to sub-angular medium to coarse siltstone, sandstone and mudstone.
B4	2.00-3.00					. . . with a high sub-rounded sandstone cobble content between 2.00m and 4.00m.
S	3.00	N=25				
B5	3.00-4.00					
S	4.00	N=31				
B6	4.00-5.00					
S	5.00	N=30				
B7	5.00-6.00					
S	6.00	N=38				
B8	6.00-7.00					
S	7.00	50/275mm				. . . no sample recovery 7.00 to 7.50 due to installation of casing.
D9	7.50-7.80				7.50	MADE GROUND - Brown clayey sub-rounded to rounded medium to coarse quartzite and sandstone GRAVEL.
D10	7.80-8.00				7.80	MADE GROUND - Brown gravelly medium to coarse SAND. Gravel is sub-rounded to rounded fine to medium quartzite and sandstone. . . . No recovery 8.00 to 9.00 (due to casing
S	9.00	N=20			9.00	

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 10.00m and 12.00m to 15.00m then open hole / driving casing from 10.00m to 12.00m (due to dense gravels), with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to ground level on completion.

REHOLE RECORD - BH R-FTPSB4_800Y

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try

Boring diameter: 120 mm to 15.00m

Casing diameter: 120 mm to 14.00m

Project No.: G17057

Logged by: PM

Ground Level:

Date: 10/05/2017-12/05/2017

Location: -

Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
B11	9.00-10.00					7.80m - 9.00m : Remaining Detail : 8.00m - 8.00m : install)
S	10.00	43/220mm			10.00	9.00m - 10.00m : Firm grey brown organic CLAY with occasional fragments of black plant remains and a low sub-rounded sandstone cobble content.
						Very dense brown medium to coarse SAND and sub-rounded to rounded medium to coarse quartzite and sandstone GRAVEL.
S	12.00	N=30				. . . becoming dense below 12.00m.
B12	12.00-13.00					
S	13.00	N=33				
D13	13.80-14.00				13.80	Dense brown sub-rounded to rounded medium to coarse quartzite and sandstone GRAVEL.
S	14.00	N=36				
D14	14.50-15.00				14.50	Dense brown medium to coarse SAND and sub-rounded to rounded fine to coarse quartzite and sandstone GRAVEL.
S	15.00	N=41			15.00	*End of Borehole at 15.00 m*

Remarks and Water Observations

1. Hand dug starter pit to 1.20m.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 10.00m and 12.00m to 15.00m, then open hole / driving casing from 10.00m to 12.00m (due to dense gravels), with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to ground level on completion.

BOREHOLE RECORD - BH FTP-SB4-600Y

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	150 mm to 10.50m	120 mm to 10.50m	G17057

Logged by: IG | Ground Level: | Date: 15/05/2017-17/05/2017 | Location: - | Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
D1	0.20-0.50				0.15	MADE GROUND - Topsoil (soft light brown organic sandy SILT with frequent rootlets).
D2	0.50-0.80					MADE GROUND - Yellowish brown gravelly silty fine to medium SAND with occasional sub-angular gravel to cobble sized macadam and limestone fragments. Gravel is sub-angular to rounded fine to coarse quartz, flint, mudstone and limestone.
D3	1.00-1.20				1.00	
S	1.20	N=10			1.20	MADE GROUND - Greyish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse limestone and quartz.
D4	1.20-1.65					
D5	1.20-2.00					
S	2.00	N=8				MADE GROUND - Firm locally soft reddish brown slightly gravelly sandy CLAY. Gravel is sub-angular to rounded fine to coarse quartz and mudstone.
D6	2.00-2.45					
D7	2.00-3.00					
S	3.00	N=13				
D8	3.00-3.45					
D9	3.00-4.00					
S	4.00	N=18			4.00	MADE GROUND - Firm locally soft reddish brown slightly gravelly CLAY. Gravel is sub-angular to rounded fine to medium quartz and mudstone.
D10	4.00-4.45					
D11	4.00-5.00					
S	5.00	N=15				
D12	5.00-6.00					. . . becoming reddish brown mottled grey below 5.80m.
S	6.00	N=17				
D13	6.00-6.45					
D14	6.00-6.50					
D15	6.50-7.00				6.50	MADE GROUND - Firm locally soft yellowish brown mottled grey slightly gravelly sandy CLAY with occasional carbonaceous material. Gravel is sub-angular to rounded fine to medium quartz, mudstone and flint.
S	7.00	N=44			7.00	Yellowish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse quartz and mudstone.
D16	7.00-7.45					
C	8.50	N=32				
D17	8.50-9.50					

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques through overburden from 1.20m to 7.00m; 8.50m to 9.50m and advanced by driving casing from 7.00m to 8.50m and 9.50m to 10.00m due to dense gravels.
3. No groundwater seepages were encountered during boring operations.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH FTP-SB4-600Y

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation				
Client Costain Galliford Try	Boring diameter: 150 mm to 10.50m	Casing diameter: 120 mm to 10.50m	Project No.: G17057	
Logged by: IG	Ground Level:	Date: 15/05/2017-17/05/2017	Location: -	Scale: 1:50

Samples & In situ Tests			Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
Ref:	Depth (m)	SPT N						
C	9.50	N=49				Yellowish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse quartz and mudstone.		
C	10.50	50/175mm			10.50	*End of Borehole at 10.50 m*		

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques through overburden from 1.20m to 7.00m; 8.50m to 9.50m and advanced by driving casing from 7.00m to 8.50m and 9.50m to 10.00m due to dense gravels.
3. No groundwater seepages were encountered during boring operations.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH-FTP-NB2-800Y
(Window Sampler)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 10.45m	Casing diameter: 120 mm to 10.00m	Project No.: G17057
Logged by: SS / Ground Level: 38.30 mAOD	Date: 15/06/2017-16/06/2017	Location: 329484E - 447037N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
B1	0.30-0.50			38.14	0.16	MADE GROUND - Topsoil (greyish brown slightly gravelly silty SAND).
B2	0.80-1.10					MADE GROUND - Reddish-brown to greyish-brown slightly silty gravelly locally very gravelly fine to coarse SAND with a low angular to sub-rounded quartz, limestone and granite cobble content. Gravel is angular to rounded fine to coarse mixed lithology predominantly comprising granite limestone and quartz.
S	1.20	N=7		37.20	1.10	
B3	1.20-2.00					
S	2.00	N=5				MADE GROUND - Soft locally firm reddish-brown slightly sandy slightly gravelly silty CLAY. Gravel is angular fine to coarse mixed lithology, predominantly mudstone and siltstone. . . . noted as becoming soft and very soft greyish-brown and reddish-brown between 2.00m and 2.70m.
B4	2.00-2.60					
C	3.00	N=7				
B5	3.30-3.70					
C	4.00	N=16				
B6	4.40-5.00					
C	5.00	N=22				
B7	5.30-6.00					
C	6.00	N=17				
B8	6.30-6.90					
C	7.00	50/150mm		31.35	6.95	Very dense reddish brown fine to coarse SAND and rounded to sub-rounded fine to coarse quartz and chert GRAVEL.
C	8.50	50/225mm				
						(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 7.00m, then by open-hole / driving casing from 7.00m to 10.00m, through dense sands and gravels.
3. Dynamic sample refused at 6.97m, on very dense sands and gravels.
4. No groundwater entries were observed during boring operations.
5. Borehole backfilled with sodium bentonite (pellets), and surface reinstated upon completion.

BOREHOLE RECORD - BH-FTP-NB2-800Y

(Window Sampler)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 10.45m	120 mm to 10.00m	G17057

Logged by: SS	Ground Level: 38.30 mAOD	Date: 15/06/2017-16/06/2017	Location: 329484E - 447037N	Scale: 1:50

Samples & In situ Tests			Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
Ref:	Depth (m)	SPT N						
						Very dense reddish brown fine to coarse SAND and rounded to sub-rounded fine to coarse quartz and chert GRAVEL.		
C D9	10.00 10.00-10.31	50/160mm						
				27.85	10.45	*End of Borehole at 10.45 m*		

Sheet 2 of 2

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 7.00m, then by open-hole / driving casing from 7.00m to 10.00m, through dense sands and gravels.
3. Dynamic sample refused at 6.97m, on very dense sands and gravels.
4. No groundwater entries were observed during boring operations.
5. Borehole backfilled with sodium bentonite (pellets), and surface reinstated upon completion.

BOREHOLE RECORD - BH-FTP-SB2_600Y
(Window Sampler)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client	Boring diameter	Casing diameter	Project No.
Costain Galliford Try	120 mm to 3.00m 100 mm to 6.50m	120 mm to 3.00m	G17057

Logged by: SS	Ground Level: 45.58 mAOD	Date: 31/05/2017-01/06/2017	Location: 334599E - 447167N	Scale: 1:50

Samples & In situ Tests Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				45.28	0.30	MADE GROUND - Greyish-brown gravelly silty fine to coarse SAND. Gravel is angular fine to coarse limestone, sandstone and siltstone.
B1	0.40-0.60					
				44.88	0.70	MADE GROUND - Firm locally stiff reddish-brown, locally greyish-brown slightly gravelly sandy CLAY with a low sub-angular limestone cobble content. Gravel is angular fine to coarse siltstone, mudstone and limestone.
C	1.20	N=13				
				43.98	1.60	MADE GROUND - Light brown sandy GRAVEL. Gravel is angular fine to coarse limestone.
S B2	2.00 2.00-3.00	N=8				MADE GROUND - Firm reddish-brown slightly sandy gravelly CLAY with a medium sub-angular mudstone and siltstone cobble content. Gravel is angular to sub-angular fine to coarse mudstone and siltstone.
S B3	3.00 3.00-4.00	N=15				
S B4	4.00 4.00-5.00	N=12				
S D5	5.00 5.00-5.45	N=15				
S D6	6.00 6.00-6.45	N=24				
				39.10	6.48	MADE GROUND - concrete obstruction.
				39.08	6.50	*End of Borehole at 6.50 m*

Sheet 1 of 1

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques.
3. Encountered concrete obstruction (thought to be water pipe) at 6.50m, borehole terminated.
4. No groundwater entries were observed during boring operations.
5. Borehole backfilled with sodium bentonite (pellets), and surface reinstated upon completion.

BOREHOLE RECORD - BH-FTP-SB4-400Y

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 10.00m	120 mm to 10.00m	G17057

Logged by: JP	Ground Level: 37.61 mAOD	Date: 15/05/2017-16/05/2017	Location: 330387E - 446780N	Scale: 1:50

Samples & In situ Tests Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				37.41	0.20	MADE GROUND - Topsoil (soft light brown organic sandy SILT with occasional rootlets).
B1	0.50-0.60					
D2	0.70-0.80					MADE GROUND - Stiff friable reddish-brown locally grey SILT/CLAY with many gravel sized fragments of sub-angular siltstone sub-base.
				36.71	0.90	
				36.56	1.05	MADE GROUND - Grey fine to coarse SAND and angular fine to coarse sandstone GRAVEL (sub-base).
D3	1.10-1.20					
S	1.20	N=6				
D4	1.20-1.60					
D5	1.60-2.00					MADE GROUND - Firm locally stiff friable reddish brown locally light grey SILT/CLAY with many gravel to cobble sized fragments of sub-angular siltstone and mudstone.
S	2.00	N=7				
D6	2.00-2.50					
D7	2.50-3.00					
S	3.00	N=7				
D8	3.00-3.50					
D9	3.50-4.00					
S	4.00	N=22				. . . soft between 4.00m and 4.20m.
D10	4.00-4.50					. . . band of firm brown and grey slightly gravelly clay (boulder clay). Gravel is sub-angular to sub-rounded fine to medium sandstone. Band located from 4.20m to 4.40m.
D11	4.50-5.00					
S	5.00	N=18				
D12	5.00-5.50					
D13	5.50-6.00					
S	6.00	50/180mm		31.61	6.00	Very dense brown fine to coarse SAND and angular to sub-rounded fine to coarse quartz GRAVEL with a medium sub-rounded quartz cobble content.
S	7.50	N=21				
D14	7.50-7.80					
D15	7.80-8.40			29.81	7.80	Firm brown mottled black sandy silty CLAY with some local black staining.
D16	8.40-8.50			29.21	8.40	Very dense brown fine to coarse SAND and angular to sub-rounded fine to coarse quartz GRAVEL with a medium
S	9.00	50/152mm				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 8.50m, then by open hole / driving casing from 8.50m to 10.00m, with a mist flush (due to dense gravels).
4. Borehole backfilled with sodium bentonite (pellets) upon completion.

BOREHOLE RECORD - BH-FTP-SB4-400Y

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation				
Client Costain Galliford Try	Boring diameter: 120 mm to 10.00m	Casing diameter: 120 mm to 10.00m	Project No.: G17057	
Logged by: JP	Ground Level: 37.61 mAOD	Date: 15/05/2017-16/05/2017	Location: 330387E - 446780N	Scale: 1:50

Samples & In situ Tests			Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
Ref:	Depth (m)	SPT N						
						sub-rounded quartz cobble content.		
S	10.00	50/210mm		27.61	10.00	*End of Borehole at 10.00 m*		

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 8.50m, then by open hole / driving casing from 8.50m to 10.00m, with a mist flush (due to dense gravels).
4. Borehole backfilled with sodium bentonite (pellets) upon completion.

BOREHOLE RECORD - BH-FTP-SB4_1M

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try	Boring diameter: 120 mm to 8.45m	Casing diameter: 120 mm to 8.00m	Project No.: G17057	
Logged by: SS	Ground Level:	Date: 19/05/2017	Location: -	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
					0.20	MADE GROUND - Topsoil (soft greyish-brown sandy clayey SILT with many roots).
B1	0.30-0.40					
					0.45	MADE GROUND - Dark greyish-brown slightly gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse quartz, siltstone and mudstone.
B2	0.50-0.60					
					0.65	MADE GROUND - Firm reddish-brown slightly gravelly sandy CLAY. Gravel is angular fine to medium mudstone and siltstone.
					0.80	MADE GROUND - Light grey sandy angular fine to medium limestone GRAVEL.
B3	0.90-1.10					
S	1.20	N=16				
D4	1.20-1.65					
B5	1.20-2.00					
S	2.00	N=19				
D6	2.00-2.45					
D7	2.30-3.00					
					2.40	MADE GROUND - Reddish-brown gravelly slightly clayey silty fine SAND. Gravel is angular fine to coarse mudstone and siltstone. . . . becoming medium dense below 1.20m.
S	3.00	N=12			3.00	MADE GROUND - Firm reddish-brown slightly gravelly CLAY. Gravel is angular fine to coarse mudstone and siltstone.
SD8	3.00-3.45					
D9	3.40-3.60					
					3.50	MADE GROUND - Medium dense reddish-brown slightly clayey fine to coarse SAND and rounded fine to coarse quartz and chert GRAVEL.
D10	3.80-4.00				3.80	MADE GROUND - Firm reddish-brown slightly gravelly CLAY. Gravel is angular fine to coarse mudstone and siltstone.
						Very dense reddish-brown slightly silty fine to coarse SAND and rounded to sub-rounded fine to medium quartz and chert GRAVEL. (Description based on returned arisings from open hole drilling). . . . becoming dense between 5.00m and 6.00m.
S	4.00	50/120mm				
SD11	4.00-4.45					
S	5.00	N=47				
SD12	5.00-5.45					
S	6.00	50/210mm				
SD13	6.00-6.45					
S	7.00	50/235mm				
SD14	7.00-7.45					
C	8.00	50/220mm				
					8.45	*End of Borehole at 8.45 m*

Sheet 1 of 1

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 4.00m, then by open hole / driving casing to the borehole base (due to dense gravels), with a mist flush.
3. No groundwater entries were observed during boring operations.
4. Borehole backfilled with sodium bentonite (pellets), and surface reinstated upon completion.

BOREHOLE RECORD - CPT03-NB2_600Y

(Window Sampler)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 6.00m		G17057

Logged by: JP	Ground Level: 34.04 mAOD	Date: 17/07/2017	Location: 446928E - 329828N	Scale: 1:50

Samples & In situ Tests			Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
Ref:	Depth (m)	SPT N						
				33.84	0.20	MADE GROUND - Macadam road construction.		
				33.69	0.35	MADE GROUND - Weak concrete road construction (breaking up whilst being cored).		
				33.34	0.70	MADE GROUND - Light grey fine to coarse SAND and angular fine to coarse siltstone GRAVEL. (road stone sub-base).		
S	1.20	N=12				MADE GROUND - Stiff reddish brown and light grey silty slightly gravelly CLAY. Gravel is angular to sub-rounded quartz, siltstone and mudstone.		
SD1	1.20-1.65	(0)						
D2	1.50-1.80	(0)						
S	2.00	N=22		32.04	2.00	MADE GROUND - Stiff reddish brown and light grey silty CLAY with many angular siltstone fragments.		
D3	2.30-2.70	(0)						
D4	2.90-3.00	(0)		31.14	2.90	MADE GROUND - brown fine to coarse SAND and sub-angular to sub-rounded quartz GRAVEL.		
S	3.00	50/45mm						
C	4.50	N=48						
C	6.00	N=39		28.04	6.00	*End of Borehole at 6.00 m*		

Sheet 1 of 1

Remarks and Water Observations

1. Advanced through road construction using coring attachment.
2. Weak concrete at 0.20m broke up, damaging core attachment.
3. Borehole advanced to 1.00m (through concrete and sub-base) using open hole drilling techniques (rock roller).
4. Soils noted as being wet below 0.60m, water (perched) forming to level of 0.80m, sealed with casing.
5. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques through overburden (to 3.00m) then by open-hole / driving casing from through dense coarse grained soils (to 6.00m).
6. Borehole backfilled with sodium bentonite (pellets) to 1.50m below surface, rapid setting concrete to 0.10m then surface reinstated upon completion.
7. All arisings removed and area cleaned after shift

BOREHOLE RECORD - CPT04-NB2_200Y
(Window Sampler)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation				
Client: Costain Galliford Try	Boring diameter: 120 mm to 6.00m	Casing diameter: 120 mm to 6.00m	Project No.: G17057	
Logged by: JP	Ground Level: 33.60 mAOD	Date: 17/07/2017	Location: 446856E - 330048N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				33.38	0.22	MADE GROUND - Macadam road construction.
				33.05	0.55	MADE GROUND - Concrete road construction.
D1	0.70-0.80			32.70	0.90	MADE GROUND - Light grey fine to coarse SAND and angular fine to coarse siltstone GRAVEL. (Roadstone sub-base).
D2	1.10-1.20	125 kPa				
S	1.20	N=10				
D3	1.20-2.00					
S	2.00	50/80mm		31.60	2.00	MADE GROUND - Stiff reddish brown and light grey silty slightly gravelly CLAY with occasional sub-rounded quartz cobbles. Gravel is angular to sub-rounded quartz, siltstone and mudstone.
C	3.00	50/120mm				MADE GROUND - Very dense brown fine to coarse SAND and sub-angular to sub-rounded quartz GRAVEL. (Determined from open hole arisings only).
C	4.50	50/185mm				
C	6.00	50/170mm		27.60	6.00	*End of Borehole at 6.00 m*

Sheet 1 of 1

Remarks and Water Observations

1. Advanced through road construction using coring attachment.
2. Hand dug starter pit to 1.20m, to check for services.
3. Set of three Hand Shear Vane (HSV) tests undertaken at 1.00m gave average apparent undrained shear strength of 125 kPa, using the pilcon unit (HSV3) and the 19mm vane.
4. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques through overburden then by open-hole / driving casing from 2.00m to 6.00m, through the dense coarse grained soils.
5. Borehole backfilled with sodium bentonite (pellets) to 1.50m below surface, rapid setting concrete to 0.10m then surface reinstated upon completion.
6. All arisings removed and work area cleaned

BOREHOLE RECORD - R-FTP-SB4_200Y
(Window Sampler)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try	Boring diameter: 120 mm to 13.45m	Casing diameter: 120 mm to 13.00m	Project No.: G17057	
Logged by: SS	Ground Level: 35.00 mAOD	Date: 26/04/2017-28/04/2017	Location: 330200E - 446841N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
D1	0.20-0.40			34.85	0.15	MADE GROUND - Topsoil (greyish brown gravelly very silty fine to medium SAND with occasional gravel sized fragments of concrete and frequent rootlets. Gravel is angular to rounded fine to coarse quartz, siltstone and chert.
D2	0.60-0.90			34.50	0.50	MADE GROUND - Greyish brown slightly gravelly slightly clayey fine to medium SAND. Gravel is angular to sub-rounded fine to coarse granite, siltstone and sandstone.
D3	1.00-1.20			34.15	0.85	MADE GROUND - Stiff reddish brown slightly sandy slightly gravelly silty CLAY with a low sub-rounded siltstone cobble content. Gravel is angular to rounded fine to medium quartz, siltstone and mudstone.
D4	1.20-2.00			33.80	1.20	MADE GROUND - Greyish brown silty fine to coarse SAND and sub-angular to sub-rounded fine to coarse siltstone, sandstone and limestone GRAVEL.
D5	1.20-1.45					MADE GROUND - Firm locally stiff friable reddish brown gravelly silty CLAY with a low sub-angular siltstone and sandstone cobble content. Gravel is angular fine to coarse mudstone, siltstone and quartz.
S	2.00	N=13				
D6	2.00-2.45					
D7	2.10-3.00					
S	3.00	N=16				
D8	3.00-4.00					
D9	3.00-3.45					
S	4.00	N=41	▼			
D10	4.00-4.45		▽	30.70	4.30	Very dense reddish brown fine to coarse SAND and sub-angular to rounded fine to coarse quartz and chert GRAVEL. (Description based on returned arisings from open hole drilling).
C	5.00	50/210mm				
D11	5.00-6.00					
C	6.00	N=45				. . . becoming dense between 6.00m to 7.00m.
D12	6.00-7.50					
C	7.00	50/235mm				
D13	7.50-9.00					
C	8.00	50/285mm				
C	9.00	50/220mm				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Groundwater seepage was encountered at 4.60m rising to 4.10m after 20 minutes.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 4.30m, then by open hole / driving casing to the borehole base (due to dense gravels), with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - R-FTP-SB4_200Y

(Window Sampler)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation			
Client Costain Galliford Try	Boring diameter: 120 mm to 13.45m	Casing diameter: 120 mm to 13.00m	Project No.: G17057
Logged by: SS / Ground Level: 35.00 mAOD	Date: 26/04/2017-28/04/2017	Location: 330200E - 446841N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
						Very dense reddish brown fine to coarse SAND and sub-angular to rounded fine to coarse quartz and chert GRAVEL. (Description based on returned arisings from open hole drilling).		
C D14	10.50 10.50-10.78	50/160mm						
C D15	12.00 12.00-12.34	50/200mm						
C D16	13.00 13.00-13.32	50/190mm						
				21.55	13.45	*End of Borehole at 13.45 m*		

Sheet 2 of 2

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Groundwater seepage was encountered at 4.60m rising to 4.10m after 20 minutes.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 4.30m, then by open hole / driving casing to the borehole base (due to dense gravels), with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH E1-A1.2

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site	M1 J23a to J25 Ground Investigation
Client	Costain Galliford Try
Boring diameter:	120 mm to 4.70m
Casing diameter:	120 mm to 4.70m
Project No.:	G17057
Logged by:	IG
Ground Level:	36.06 mAOD
Date:	01/06/2017-21/06/2017
Location:	327635E - 447512N
Scale:	1:50

Ref:	Depth (m)	SPT N (TCR / SCR / RQD)	FI / FS	Water	Level (mAOD)	Depth (m)	Strata Description
D1	0.20-0.40						
D2	0.40-0.80				35.56	0.50	MADE GROUND - Soft dark brown slightly gravelly sandy SILT with frequent rootlets. Gravel is sub-angular to rounded fine to coarse quartz (topsoil).
D3	1.00-1.10						
S	1.10	N=24			34.96	1.10	Soft locally firm reddish brown slightly gravelly CLAY. Gravel is sub-angular medium to coarse mudstone and sandstone.
D4	1.10-1.55				34.86	1.20	Soft reddish brown sandy SILT with occasional gravel sized sub-angular siltstone lithorelics.
B5	1.10-2.00						
S	2.00	N=19			34.06	2.00	Medium dense reddish brown speckled grey silty fine SAND. . . . gypsum mineralisation at 1.30m.
D6	2.00-2.45						
B7	2.00-2.70						
B8	2.70-3.00				33.36	2.70	Firm reddish brown speckled grey sandy SILT.
S	3.00	N=25					Reddish brown silty fine to medium SAND. . . . becoming medium dense below 3.00m.
D10	3.00-5.00						
D9	3.00-3.45						
B11	3.50-4.00			▼	32.56	3.50	Firm locally stiff reddish brown locally grey sandy CLAY.
S	4.00	N=20					
D12	4.00-4.45						
B13	4.00-4.70						
S	4.70	N=35			31.36	4.70	Stiff friable reddish brown locally grey thinly laminated slightly sandy silty CLAY.
C	6.00	N=4					
CR	6.00-7.00	78 / 18 / 12					
			30		28.91	7.15	Extremely weak thinly laminated grey fine to medium SANDSTONE. Bedding discontinuities are horizontal to sub-horizontal, extremely closely spaced, smooth planar and smooth undulating, clean.
CR	7.00-8.50	100 / 47 / 39	6		28.51	7.55	
			27		28.06	8.00	Extremely weak fissile thinly laminated reddish brown MUDSTONE locally weathered to friable silty clay. Bedding discontinuities are horizontal to sub-horizontal, extremely closely spaced, smooth
C	8.50	50/11	5mm				
			25				
		TCR SCR RQD	FI FS				*(continued next sheet)*

Legend | Backfill

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. A groundwater seepages was encountered at 3.50m during boring operations.
3. Borehole advanced using P60 (slope climbing) combination rig P60C, using dynamic sampling techniques from 1.20m to 6.00m, then by rotary coring techniques to borehole base, with a mist flush.
4. Borehole backfilled with bentonite pellets to ground level upon completion.

BOREHOLE RECORD - BH E1-A1.2

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP	Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 4.70m	Casing diameter: 120 mm to 4.70m	Project No.: G17057	
Logged by: IG	Ground Level: 36.06 mAOD	Date: 01/06/2017-21/06/2017	Location: 327635E - 447512N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	8.50-10.00	83 43 33	5				7.55m - 8.00m : planar and smooth undulating, clean with local clay infill. (Grade III locally Grade IVa).		
CR	10.00-11.50	100 51 35	30				8.00m - 12.50m : Stiff friable reddish brown locally grey thinly laminated slightly sandy silty CLAY interbedded with extremely weak thinly laminated grey fine to medium SANDSTONE with horizontal to sub-horizontal, extremely closely spaced, smooth planar and smooth undulating clean, bedding discontinuities. Detail 11.20m - 11.20m : . . . locally weathered to silty fine to medium sand with frequent sandstone lithorelics. . . . locally weathered to silty fine to medium sand with frequent sandstone lithorelics.		
C	11.50	N=25							
C	12.50	50/150mm			23.56	12.50	*End of Borehole at 12.50 m*		
		TCR SCR RQD	FI FS					Sheet 2 of 2	

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. A groundwater seepages was encountered at 3.50m during boring operations.
3. Borehole advanced using P60 (slope climbing) combination rig P60C, using dynamic sampling techniques from 1.20m to 6.00m, then by rotary coring techniques to borehole base, with a mist flush.
4. Borehole backfilled with bentonite pellets to ground level upon completion.

BOREHOLE RECORD - BH E3-B1.1
(Window Sampler)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 14.00m	120 mm to 14.00m	G17057

Logged by: PM	Ground Level:	Date: 26/04/2017-28/04/2017	Location: -	Scale: 1:50

Samples & In situ Tests Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
					0.20	MADE GROUND - Brown slightly sandy slightly gravelly SILT with frequent rootlets. Gravel is sub-rounded ro rounded fine to medium quartz.		
D1	0.30-0.50							
					0.90	MADE GROUND - Brown gravelly slightly clayey fine to medium SAND. Gravel is sub-angular to sub-rounded fine to medium sandstone and granite.		
D2	1.00-1.20							
S	1.20	N=6			1.20	MADE GROUND - Soft friable brownish grey CLAY.		
D3	1.20-2.00					MADE GROUND - Stiff friable reddish brown mottled yellow slightly gravelly sandy CLAY. Gravel is sub-angular to sub-rounded fine to coarse sandstone and siltstone.		
S	2.00	N=13						
B4	2.00-3.00							
S	3.00	N=29						
B5	3.00-4.00							
S	4.00	N=24						
B6	4.00-5.00							
S	5.00	N=28						
B7	5.00-6.00							
S	6.00	50/235mm			6.00	MADE GROUND - Stiff reddish brown mottled yellow slightly gravelly slightly sandy silty CLAY. Gravel is sub-angular to sub-rounded fine to coarse sandstone and siltstone.		
B8	6.00-7.00							
S	7.00	50/265mm						
D9	7.50-8.00				7.50	MADE GROUND - Very dense brown gravelly medium to coarse SAND with occasional sub-rounded quartz cobbles. Gravel is sub-rounded to rounded fine to coarse sandstone and quartz (description based on limited arising returns from open hole drilling). . . . no recovery from 7.50m to 10.00m.		
S	8.00	50/95mm						
S	9.00	50/95mm						

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 8.00m and 10.00m to 11.00m, then by open hole / driving casing from 8.00m to 10.00m and 11.00m to the borehole base (due to very dense gravels).
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH E3-B1.1

(Window Sampler)

NICHOLLS COLTON GROUP

Site	M1 J23a to J25 Ground Investigation		
Client: Costain Galliford Try	Boring diameter: 120 mm to 14.00m	Casing diameter: 120 mm to 14.00m	Project No.: G17057
Logged by: PM / Ground Level:	Date: 26/04/2017-28/04/2017	Location: -	Scale: 1:50

Samples & In situ Tests			Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
Ref:	Depth (m)	SPT N						
S B10	10.00 10.00-11.00	50/260mm			10.00	MADE GROUND - Very dense brown gravelly medium to coarse SAND with occasional sub-rounded quartz cobbles. Gravel is sub-rounded to rounded fine to coarse sandstone and quartz (description based on limited arising returns from open hole drilling).		
						Very dense brown gravelly medium to coarse SAND with frequent clay pockets. Gravel is sub-angular to rounded fine to coarse quartz and sandstone.		
S	11.00	50/115mm			11.00	Very dense brown fine to coarse SAND and sub-rounded to rounded fine to coarse quartz and sandstone GRAVEL (description based on limited returned arisings from open hole drilling). . . . no recovery from 11.00m to 14.00m.		
S D11	12.00 12.00-12.18	50/85mm						
S D12	13.50 13.50-13.84	50/190mm						
S D13	14.00 14.00-14.29	50/150mm			14.00	*End of Borehole at 14.00 m*		

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 8.00m and 10.00m to 11.00m, then by open hole / driving casing from 8.00m to 10.00m and 11.00m to the borehole base (due to very dense gravels).
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH E3-B1.2

(Window Sampler)

NICHOLLS COLTON GROUP

Client Costain Galliford Try	Site M1 J23a to J25 Ground Investigation			
	Boring diameter: 120 mm to 11.45m	Casing diameter: 120 mm to 11.00m	Project No.: G17057	
Logged by: SS	Ground Level:	Date: 03/05/2017-05/05/2017	Location: -	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
D1	0.30-0.60				0.20	MADE GROUND - Greyish brown slightly gravelly silty fine to coarse SAND with occasional gravel sized fragments of concrete. Gravel is sub-rounded to rounded fine to coarse quartz.
D2	0.70-1.00					
D4	1.20-2.00				1.10	MADE GROUND - Firm light brown gravelly very sandy CLAY. Gravel is angular fine to coarse mudstone and siltstone.
S	1.30	N=17				
D3	1.30-1.55					MADE GROUND - Firm reddish brown slightly sandy slightly gravelly clayey SILT. Gravel is angular fine to coarse mudstone and siltstone.
S	2.00	N=28				
D5	2.00-2.45					
B6	2.00-3.00					
S	3.00	N=22				
D7	3.00-3.45					
D8	3.20-3.70				3.20	MADE GROUND - Stiff reddish brown slightly gravelly silty CLAY. Gravel is angular fine to medium mudstone and siltstone.
S	3.70	50/275mm				
					4.20	Very dense reddish brown slightly silty fine to coarse SAND and sub-angular to rounded fine to coarse quartz, chert and mudstone GRAVEL.
C	4.50	50/290mm				
C	6.00	50/250mm				
C	7.50	50/160mm				
C	9.00	50/220mm			9.00	

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 3.70m, then by driving casing / open hole from 3.70m to the borehole base due to very dense gravels.
3. No groundwater seepages were encountered during boring operations.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH E3-B1.2
(Window Sampler)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 11.45m	120 mm to 11.00m	G17057

Logged by: SS	Ground Level:	Date: 03/05/2017-05/05/2017	Location: -	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
D9	9.00-11.00					Very dense reddish brown slightly gravelly fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse quartz, chert and mudstone.		
C	10.00	50/160mm						
C	11.00	50/135mm						
					11.45	*End of Borehole at 11.45 m*		

Sheet 2 of 2

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 3.70m, then by driving casing / open hole from 3.70m to the borehole base due to very dense gravels.
3. No groundwater seepages were encountered during boring operations.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - E1-A1.1

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try	Boring diameter: 120 mm to 10.45m	Casing diameter: 120 mm to 2.60m	Project No.: G17057	
Logged by: IG	Ground Level: 36.12 mAOD	Date: 30/05/2017-31/05/2017	Location: 327605E - 447514N	Scale: 1:50

Ref:	Depth (m)	SPT N / TCR SCR RQD	FI FS	Water	Level (mAOD)	Depth (m)	Strata Description
D1	0.10-0.30						MADE GROUND - Topsoil (brown slightly gravelly sandy SILT with frequent rootlets. Gravel is sub-angular to rounded fine to coarse quartz and limestone).
D2	0.50-0.80				35.62	0.50	MADE GROUND - soft reddish brown slightly gravelly CLAY. Gravel is sub-angular to rounded fine to coarse quartz.
D3	1.00-1.20						
S	1.20	N=22			34.92	1.20	Firm friable reddish brown speckled grey SILT.
D4	1.20-1.65						
D5	1.20-2.00						
S	2.00	N=37					
D6	2.00-2.45						
D7	2.00-2.70						
S	2.70	N=4					
D8	2.70-3.15						
CR	2.70-4.00	100 0 0					
CR	4.00-5.50	63 0 0					
					31.12	5.00	Weak grey fine grained SANDSTONE.
S	5.50	50/150mm					
D9	5.50-5.95						
CR	5.50-7.00	87 7 0					
			5		29.12	7.00	Weak reddish brown MUDSTONE.
CR	7.00-8.50	93 93 37					
S	8.50	50/75mm					
D10	8.50-8.95						

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Groundwater seepage was encountered at 4.60m during boring operations.
3. Borehole advanced using Commachio 205 combination rig CG01, using dynamic sampling techniques through overburden to 2.70m then by rotary coring techniques in rock to base, with a mist flush.
4. Borehole backfilled with bentonite to ground level upon completion.

BOREHOLE RECORD - E1-A1.1

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation				
Client Costain Galliford Try	Boring diameter: 120 mm to 10.45m	Casing diameter: 120 mm to 2.60m	Project No.: G17057	
Logged by: IG	Ground Level: 36.12 mAOD	Date: 30/05/2017-31/05/2017	Location: 327605E - 447514N	Scale: 1:50

Core Data: Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	8.50-10.00	93 87 61	6 0				Weak reddish brown MUDSTONE.		
S	10.00	50/75mm							
					25.67	10.45	*End of Borehole at 10.45 m*		
		TCR SCR RQD	FI FS					Sheet 2 of 2	

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Groundwater seepage was encountered at 4.60m during boring operations.
3. Borehole advanced using Commachio 205 combination rig CG01, using dynamic sampling techniques through overburden to 2.70m then by rotary coring techniques in rock to base, with a mist flush.
4. Borehole backfilled with bentonite to ground level upon completion.

BOREHOLE RECORD - BH G101

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site	M1 J23a to J25 Ground Investigation
Client	Costain Galliford Try
Boring diameter:	120 mm to 3.50m 100 mm to 16.50m
Casing diameter:	120 mm to 3.50m
Project No.:	G17057
Logged by:	JP
Ground Level:	60.51 mAOD
Date:	04/04/2017-07/04/2017
Location:	324392E - 446829N
Scale:	1:50

Samples & In situ Tests

Ref:	Depth (m)	SPT N / TCR SCR RQD	FI FS
D1	0.40	116 kPa	
B2	0.40		
D3	0.80	123 kPa	
B4	0.80		
S	1.20	N=25	
D5	1.20		
B6	1.20-1.50		
D7	1.50-2.00		
S	2.00	N=31	
D8	2.00-2.70		
S	3.00	N=4	
D9	3.00-3.45		0
CR	3.00-4.00	26 7 0	
CR	4.00-5.50	30 17 12	0
C	5.50	50/14 mm	
D10	5.50-5.76	100	
CR	5.50-6.00	84 34	6
CR	6.00-7.50	81 17 7	0 12 10
CR	7.50-9.00	81 59 5	0 5 8

Strata

Water	Level (mAOD)	Depth (m)	Strata Description
	60.21	0.30	MADE GROUND - Topsoil (soft light brown organic sandy SILT with frequent rootlets).
	59.91	0.60	MADE GROUND - Firm reddish brown slightly gravelly SILT / CLAY. Gravel is angular fine to coarse mudstone and siltstone.
	59.01	1.50	MADE GROUND - Stiff locally firm friable reddish brown slightly gravelly silty CLAY. Gravel is angular fine to coarse mudstone and siltstone.
	57.81	2.70	MADE GROUND - Very stiff friable reddish brown slightly gravelly silty CLAY. Gravel is angular fine to medium mudstone and siltstone.
	55.01	5.50	Extremely weak fissile reddish brown MUDSTONE with rare thin bands of very weak to weak greenish grey siltstone. Destructured to residually weathered. (Grade IVa).
	54.51	6.00	Very weak to weak thinly laminated red to green MUDSTONE with rare thin laminations of green siltstone. Evidence of weathering as slightly reduced strength and mottled discolouration. (Estimated Grade II).
	53.31	7.20	Very weak to weak red locally weathered MUDSTONE. Fractures are predominantly randomly oriented. Rare fractures are horizontal to sub-horizontal very closely spaced, planar smooth, tight to partly open, rare black surface staining. (Grade I locally Grade II).
			Very weak to weak locally medium strong thinly laminated red and green MUDSTONE. Bedding fractures are horizontal to sub-horizontal very closely to closely spaced, planar and undulating, smooth and rough, partly open, clean. (Grade I locally Grade II).

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Set of three Hand Shear Vane (HSV) tests undertaken at 0.50m gave average apparent undrained shear strength of 116 kPa, with residual reading of 15kPa, using the pilcon unit 1A and the 19mm vane.
3. Set of three HSV tests undertaken at 0.80m gave average apparent undrained shear strength of 123 kPa, with residual reading of 32 kPa.
4. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 3.00m, then by rotary coring techniques from 3.00m to base of the borehole, with a mist flush.
5. Groundwater entry recorded at 15.00m (not sealed) remaining level after 20 minutes.
6. Borehole backfilled with sodium bentonite (pellets) on completion.

BOREHOLE RECORD - BH G101

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try

Boring diameter: 120 mm to 3.50m; 100 mm to 16.50m

Casing diameter: 120 mm to 3.50m

Project No.: G17057

Logged by: JP | Ground Level: 60.51 mAOD | Date: 04/04/2017-07/04/2017 | Location: 324392E - 446829N | Scale: 1:50

Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description
			0				Remaining Detail : 7.50m - 7.50m : . . . with frequent thick laminations of siltstone between 7.20m and 7.50m.
CR	9.00-10.50	69 58 29	10				
CR	10.50-12.00	97 89 37	11, 14				
CR	12.00-13.50	95 9 8	9, 3				
CR	13.50-15.00	100 95 68	7	▼	46.66	13.85	Medium strong thinly laminated green locally weathered SILTSTONE with rare thin beds of very weak red mudstone. Fractures are horizontal to sub-horizontal, very closely to closely spaced, undulating and planar, rough and smooth, partly open, clean.
CR	15.00-16.50	84 73 41	10, 10, 0		44.86	15.65	Extremely weak to very weak red mottled green MUDSTONE with thin beds of interlaminated siltstone. Fractures are horizontal to sub-horizontal, very closely to closely space, planar, smooth to rough, tight to partly open, clean. (Grade I to Grade II).
					44.01	16.50	*End of Borehole at 16.50 m*

Sheet 2 of 2

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Set of three Hand Shear Vane (HSV) tests undertaken at 0.50m gave average apparent undrained shear strength of 116 kPa, with residual reading of 15kPa, using the pilcon unit 1A and the 19mm vane.
3. Set of three HSV tests undertaken at 0.80m gave average apparent undrained shear strength of 123 kPa, with residual reading of 32 kPa.
4. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 3.00m, then by rotary coring techniques from 3.00m to base of the borehole, with a mist flush.
5. Groundwater entry recorded at 15.00m (not sealed) remaining level after 20 minutes.
6. Borehole backfilled with sodium bentonite (pellets) on completion.

BOREHOLE RECORD - BH G202 B

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site	M1 J23a to J25 Ground Investigation
Client	Costain Galliford Try
Boring diameter:	120 mm to 13.50m 100 mm to 19.50m
Casing diameter:	120 mm to 13.50m
Project No.:	G17057
Logged by:	SS
Ground Level:	
Date:	19/04/2017-21/04/2017
Location:	-
Scale:	1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
B1	0.00-1.00				0.40	MADE GROUND - Reddish brown slightly clayey slightly silty gravelly fine to coarse SAND with occasional rootlets. Gravel is angular to rounded fine to medium quartz, chert and sandstone.
					0.80	MADE GROUND - Orangeish brown silty fine to coarse SAND and angular to rounded fine to medium quartz limestone and sandstone GRAVEL.
S	1.20	N=22				MADE GROUND - Stiff friable reddish brown silty CLAY with occasional gravel sized sub-angular mudstone lithorelicts.
D2	1.20-1.65					
D3	1.20-2.00					
S	2.00	50/160mm				
D4	2.00-2.45				2.40	
						MADE GROUND - Very dense reddish brown locally orangeish brown fine to coarse SAND and sub-angular to rounded fine to coarse quartz and chert GRAVEL.
S	3.00	50/175mm				
D5	3.00-3.45				3.40	
						Very dense reddish brown slightly silty fine to coarse SAND and sub-rounded to rounded fine to coarse quartz and chert GRAVEL.
S	4.00	50/235mm				
S	7.00	N=43				. . . becoming dense between 7.00m and 8.00m.
C	8.00	50/285mm				
C	9.00	50/170mm			9.00	

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 3.00m, then open hole / driving casing from 3.00m to 9.00m (due to dense gravels). Borehole advanced from 9.00m to borehole base by rotary coring techniques, with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G202 B

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation			
Client Costain Galliford Try	Boring diameter: 120 mm to 13.50m 100 mm to 19.50m	Casing diameter: 120 mm to 13.50m	Project No.: G17057
Logged by: SS	Ground Level:	Date: 19/04/2017-21/04/2017	Location: -
			Scale: 1:50

Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	9.00-10.50	0 0 0					Extremely weak reddish brown MUDSTONE. (Description based on limited returned arisings from rotary coring as no sample recovery from 9.00m to 12.00m. Not possible to identify weathering grade).		
C	10.50	50/255 mm							
CR	10.50-12.00	0 0 0							
C	12.00	50/205 mm				12.00	Very weak to weak thinly laminated reddish brown sandy MUDSTONE with occasional wavy thin to thick laminations of gypsum. Slightly reduced strength. Horizontal fracture, very closely to closely spaced, undulating rough, clean. (Grade I locally Grade II).		
CR	12.00-13.50	33 27 7	0 8						
C	13.50	50/85 mm							
CR	13.50-15.00	100 96 53	17 6			13.75	Weak to medium strong thinly laminated pale green silty fine to medium grained SANDSTONE with occasional thick lamination of gypsum. Horizontal bedding fractures are very closely to closely spaced, undulating slightly rough, partly open, rare soft green clay infill <6mm.		
						14.10	Very weak reddish brown silty MUDSTONE with frequent thin laminations of gypsum. No evidence of weathering. Horizontal fracture are very closely to closely spaced, undulating rough, partly open, clean. (Grade I).		
CR	15.00-16.50	100 97 72	2 3			14.85	Medium strong pale green and brownish red fine to coarse grained silty SANDSTONE with frequent very thin to thin beds of sandy mudstone and occasional thick laminations of gypsum. Horizontal bedding fractures are closely spaced, undulating slightly rough, clean,		
CR	16.50-18.00	100 99 82	2						
		TCR SCR RQD	FI FS				*(continued next sheet)*	Sheet 2 of 3	

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 3.00m, then open hole / driving casing from 3.00m to 9.00m (due to dense gravels). Borehole advanced from 9.00m to borehole base by rotary coring techniques, with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G202 B

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 13.50m, 100 mm to 19.50m	Casing diameter: 120 mm to 13.50m	Project No.: G17057
Logged by: SS / Ground Level:	Date: 19/04/2017-21/04/2017	Location: -	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	18.00-19.50	91 91 88	1 0				Medium strong pale green and brownish red fine to coarse grained silty SANDSTONE with frequent very thin to thin beds of sandy mudstone and occasional thick laminations of gypsum. Horizontal bedding fractures are closely spaced, undulating slightly rough, clean,		
						19.50	*End of Borehole at 19.50 m*		
		TCR SCR RQD	FI FS					Sheet 3 of 3	

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 3.00m, then open hole / driving casing from 3.00m to 9.00m (due to dense gravels). Borehole advanced from 9.00m to borehole base by rotary coring techniques, with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G202A
(Window Sampler)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 2.00m		G17057

Logged by: IG	Ground Level: 33.45 mAOD	Date: 10/04/2017	Location: 328595E - 447330N	Scale: 1:50

Samples & In situ Tests Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
D1 B2	0.15 0.30-1.00			33.25	0.20	MADE GROUND - Topsoil (Soft brown slightly gravelly slightly sandy SILT. Gravel is sub-angular to sub-rounded fine to coarse quartz).		
S	1.20	N=19				MADE GROUND - Orangeish brown gravelly fine to coarse SAND with occasional gravel sized fragments of concrete. Gravel is angular to rounded fine to coarse quartz, granite and sandstone.		
B3	1.50-2.00		▼	31.95	1.50	MADE GROUND - Firm locally stiff reddish brown mottled greenish grey CLAY.		
C	2.00	50/65mm		31.45	2.00	MADE GROUND - Obstruction (concrete).		
						End of Borehole at 2.00 m		

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques from 1.20m to 2.00m (no casing used).
3. Fragment of blue ribbed plastic pipe recovered in base of window sample at 2.00m.
4. Encountered obstruction (thought to be concrete) at 2.00m, unable to continue, borehole terminated at this location and moved 2.0m north.
5. Groundwater recorded at 1.80m at end of drilling.
6. Borehole backfilled with sodium bentonite (pellets) and surface reinstated upon completion.

BOREHOLE RECORD - BH G202AA

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 13.50m	120 mm to 12.70m	G17057

Logged by: IG	Ground Level: 33.45 mAOD	Date: 10/04/2017-19/04/2017	Location: 328595E - 447330N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
D1	0.20-0.60			33.25	0.20	MADE GROUND - Topsoil (soft brown slightly gravelly slightly sandy SILT. Gravel is sub-angular to sub-rounded fine to coarse quartz).
D2	0.60-0.90			32.85	0.60	MADE GROUND - Soft locally firm brown slightly gravelly sandy CLAY. Gravel is sub-angular to sub-rounded fine to coarse quartz, limestone and mudstone.
D3	0.90-1.20			32.55	0.90	MADE GROUND - Grey sandy silty angular fine to coarse limestone GRAVEL (sub-base).
S	1.20	N=15				
D4	1.20-1.65					
D5	1.50-2.00					
C	2.00	50/105mm		31.45	2.00	MADE GROUND - Firm reddish brown mottled grey slightly gravelly CLAY. Gravel is sub-angular to sub-rounded fine to coarse quartz and mudstone.
						Very dense dark brown gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse quartz, mudstone and sandstone. (Description derived from returned arising from open hole drilling, as sands / gravels too dense to dynamic sample).
C	3.00	50/165mm				
C	4.00	50/195mm				
C	5.00	50/125mm				
D6	5.00-5.50					
C	6.00	N=33				
D7	6.00-6.10			27.35	6.10	Stiff locally firm friable reddish brown CLAY.
D8	6.10-7.00					
				26.55	6.90	Stiff friable reddish brown CLAY with frequent thin bands of mudstone (recovered as gravel sized fragments) and occasional gravel sized mudstone lithorelicts. . . . (no sample recovery from 7.00m to 10.00m, descriptions based on returned arisings from rotary coring).
S	7.00	50/160mm				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques from 1.20m to 2.00m, then by open hole / driving casing from 2.00m to 7.00m and 11.50m to 13.50m (due to very dense gravels). Borehole then advanced by rotary coring techniques from 7.00m to 11.50m (no recovery), with a mist flush.
3. No groundwater seepages were encountered during boring operations.
4. Unable to penetrate below 13.50m (advance 0.50m in 4 hour shift), due to casing shoe being worn away by dense quartz cobbles. Borehole therefore terminated.
5. Borehole backfilled with sodium bentonite (pellets) and surface reinstated in completion.

BOREHOLE RECORD - BH G202AA

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try	Boring diameter: 120 mm to 13.50m	Casing diameter: 120 mm to 12.70m	Project No.: G17057	
Logged by: IG	Ground Level: 33.45 mAOD	Date: 10/04/2017-19/04/2017	Location: 328595E - 447330N	Scale: 1:50

Samples & In situ Tests Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
						Stiff friable reddish brown CLAY with frequent thin bands of mudstone (recovered as gravel sized fragments) and occasional gravel sized mudstone lithorelicts.		
S D10 D9	10.00 10.00-11.50 10.00-10.45	50/140mm		23.45	10.00	Very dense yellow fine to coarse SAND and sub-angular to sub-rounded fine to coarse quartz GRAVEL with a high quartz cobble content and probable boulders (unable to determine boulder content due to open hole drilling method) (Description based on returned arisings from open hole drilling, as gravels too dense to dynamic sample). . . . driller noted an increased cobble content below 11.00m.		
D11	11.50-13.00							
C D12	13.00 13.00-13.50	50/120mm						
				19.95	13.50	*End of Borehole at 13.50 m*		

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques from 1.20m to 2.00m, then by open hole / driving casing from 2.00m to 7.00m and 11.50m to 13.50m (due to very dense gravels). Borehole then advanced by rotary coring techniques from 7.00m to 11.50m (no recovery), with a mist flush.
3. No groundwater seepages were encountered during boring operations.
4. Unable to penetrate below 13.50m (advance 0.50m in 4 hour shift), due to casing shoe being worn away by dense quartz cobbles. Borehole therefore terminated.
5. Borehole backfilled with sodium bentonite (pellets) and surface reinstated in completion.

BOREHOLE RECORD - BH G203

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 13.00m; 100 mm to 30.00m	Casing diameter: 120 mm to 13.00m	Project No.: G17057
Logged by: IG / Ground Level:	Date: 24/04/2017-03/05/2017	Location: -	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
D1	0.00-0.30					MADE GROUND - Soft dark brown slightly cobbly slightly gravelly sandy SILT with frequent rootlets, frequent gravel sized fragments of polystyrene and occasional gravel sized fragments of macadam and concrete. Gravel and cobbles are sub-angular to rounded fine to coarse limestone, quartz and sandstone. . . . polystyrene board at 0.30m.
D2	0.30-0.60					
D3	0.60-1.00				0.60	MADE GROUND - Yellowish brown cobbly gravelly silty fine to coarse SAND with occasional gravel sized macadam fragments. Gravel and cobbles are sub-angular to rounded fine to coarse limestone and quartz.
D4	1.00-1.20				1.00	MADE GROUND - Soft locally firm reddish brown slightly gravelly CLAY. Gravel is sub-angular to rounded fine to medium quartz and mudstone.
S	1.20	N=24			1.20	MADE GROUND - Firm locally stiff reddish brown mottled grey slightly sandy gravelly CLAY. Gravel is sub-angular to rounded fine to medium quartz, limestone and mudstone.
D5	1.20-1.65					
B6	1.20-2.00					
S	2.00	50/270mm			1.95	Very dense yellowish brown gravelly silty fine to coarse SAND. Gravel is sub-rounded to rounded fine to coarse quartz. (Description based on limited returned arisings from open hole drilling).
D7	2.00-2.45					
D8	2.00-3.00					
S	3.00	50/275mm				
D9	3.00-4.00					
C	4.50	50/195mm				
B10	4.50-6.00					
C	6.00	50/85mm				
B11	6.00-9.00					
					6.50	Very dense orangeish brown fine to coarse SAND and sub-rounded to rounded fine to coarse quartz GRAVEL. (Description based on limited returned arisings from open hole drilling).
C	7.50	50/285mm				
C	9.00	50/130mm			9.00	

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 2.00m, then open hole / driving casing from 2.00m to 13.00m (due to dense gravels). Borehole advanced from 13.00m to the the borehole base by rotary coring techniques, with a mist flush.
3. No groundwater seepages were encountered during boring operations.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G203

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Client: Costain Galliford Try	Site: M1 J23a to J25 Ground Investigation		
	Boring diameter: 120 mm to 13.00m; 100 mm to 30.00m	Casing diameter: 120 mm to 13.00m	Project No.: G17057
Logged by: IG	Ground Level:	Date: 24/04/2017-03/05/2017	Location: -
			Scale: 1:50

Ref:	Depth (m)	SPT N	TCR / SCR / RQD	FI / FS	Water	Level (mAOD)	Depth (m)	Strata Description
								Stiff reddish brown CLAY with occasional mudstone lithorelicts. (Description based on limited returned arisings from open hole drilling).
S	10.00	50/85mm						
D12	10.00-10.45							
D13	11.00-12.00						11.00	Dark brown sandy sub-rounded to rounded medium to coarse quartz GRAVEL. (Description based on returned arisings from open hole drilling).
D14	12.90-13.00						12.90	Stiff reddish brown friable SILT with occasional sub-angular to sub-rounded fine to medium gravel sized mudstone lithorelicts.
C	13.00	N=5		0			13.00	
				5				
CR	13.00-14.50		75 / 67 / 37	5				Extremely weak reddish brown MUDSTONE thinly interbedded with greenish grey medium grained SANDSTONE with frequent gypsum mineralisation. Discontinuities are horizontal closely spaced smooth planar and rough undulating. (Mudstone weathering grade not possible due to mudstone being interbedded with sandstone).
				4				
CR	14.50-16.00		100 / 93 / 77					
				0				
				0				
CR	16.00-17.50		100 / 100 / 95	3				. . . becoming very weak to weak below 16.70m.
							17.30	Weak to medium strong greenish grey fine to medium grained SANDSTONE with horizontal closely spaced undulating rough clean fractures.
				5				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 2.00m, then open hole / driving casing from 2.00m to 13.00m (due to dense gravels). Borehole advanced from 13.00m to the the borehole base by rotary coring techniques, with a mist flush.
3. No groundwater seepages were encountered during boring operations.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G203

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 13.00m 100 mm to 30.00m	120 mm to 13.00m	G17057
Logged by: IG / Ground Level:	Date: 24/04/2017-03/05/2017	Location: -	Scale: 1:50

Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	17.50-19.00	97 97 57	4				Weak to medium strong greenish grey fine to medium grained SANDSTONE with horizontal closely spaced undulating rough clean fractures.		
C	19.00	50/3mm							
CR	19.00-20.50	100 83 60	6						
			2						
CR	20.50-22.00	97 97 67	3			21.00	Weak to medium strong reddish brown mottled grey MUDSTONE with frequent gypsum mineralisation. Discontinuities are horizontal to sub-horizontal very closely to closely spaced planar smooth and undulating rough. (Grade I locally Grade II).		
			4						
CR	22.00-23.50	97 97 67	2						
CR	23.50-25.00	100 87 80	2						
C	25.00	50/40mm							
CR	25.00-26.50	80 73 67	2						
			3						
CR	26.50-28.00	97 97 60							
		TCR SCR RQD	FI FS				*(continued next sheet)*	Sheet 3 of 4	

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 2.00m, then open hole / driving casing from 2.00m to 13.00m (due to dense gravels). Borehole advanced from 13.00m to the the borehole base by rotary coring techniques, with a mist flush.
3. No groundwater seepages were encountered during boring operations.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G203

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation				
Client Costain Galliford Try	Boring diameter: 120 mm to 13.00m 100 mm to 30.00m	Casing diameter: 120 mm to 13.00m	Project No.: G17057	
Logged by: IG	Ground Level:	Date: 24/04/2017-03/05/2017	Location: -	Scale: 1:50

Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
			4				Weak to medium strong reddish brown mottled grey MUDSTONE with frequent gypsum mineralisation. Discontinuities are horizontal to sub-horizontal very closely to closely spaced planar smooth and undulating rough. (Grade I locally Grade II).		
CR	28.00-29.50	93 93 70	4						
CR	29.50-30.00	80 80 0	1						
C	30.00	50/20mm				30.00	*End of Borehole at 30.00 m*		
		TCR SCR RQD	FI FS					Sheet 4 of 4	

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 2.00m, then open hole / driving casing from 2.00m to 13.00m (due to dense gravels). Borehole advanced from 13.00m to the the borehole base by rotary coring techniques, with a mist flush.
3. No groundwater seepages were encountered during boring operations.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G204

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 18.00m 100 mm to 24.00m	120 mm to 18.00m	G17057

Logged by: SS	Ground Level: 33.53 mAOD	Date: 10/04/2017-18/04/2017	Location: 447237E - 328864N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				33.33	0.20	MADE GROUND - Topsoil (soft light brown organic sandy SILT with frequent rootlets).
D1	0.40					
D2	0.40					MADE GROUND - Orangish brown slightly gravelly slightly cobbly slightly silty fine to coarse SAND with occasional gravel sized fragments of concrete. Gravel and cobbles are angular to rounded fine to coarse quartzite, sandstone and chert.
D3	0.80					
D4	0.80					
D5	1.10-1.50			32.43	1.10	
S	1.20	N=19				
D6	1.20					
D7	1.50-2.00					MADE GROUND - Stiff reddish brown slightly gravelly sandy CLAY. Gravel is angular to rounded fine to medium sandstone, quartzite and chert.
S	2.00	50/275mm				
				31.23	2.30	Dense reddish brown fine to coarse SAND and sub-angular to rounded fine to medium quartzite GRAVEL. . . . no recovery from 2.50 to 4.70m (due to dense sands and gravels)
C	3.00	50/210mm				
C	4.00	N=32				
D8	4.70-4.85			28.83	4.70	
B9	4.85-5.40			28.68	4.85	Dense reddish brown sandy rounded to sub-rounded fine to coarse siltstone, sandstone and quartzite GRAVEL with occasional cobbles of rounded to sub-angular mudstone and quatzite.
S	5.00	N=28	▼			
D10	5.40-6.00		▽			Dense reddish brown slightly gravelly fine to coarse SAND. Gravel is rounded fine quartzite and chert. . . . occasional sub-angular mudstone cobbles from 5.80 to 5.90m.
C	6.00	41/144mm				
C	7.00	50/95mm				
C	8.00	50/95mm				
C	9.00	50/85mm				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Groundwater entry was encountered at 5.90m (sealed off with casing) rising to 5.10m after 20 minutes.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 6.00m, then by driving casing / open hole from 6.00m to 10.50m (due to very dense gravels). Borehole advanced from 10.50m to base by rotary coring techniques, with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G204

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 18.00m 100 mm to 24.00m	120 mm to 18.00m	G17057

Logged by: SS | Ground Level: 33.53 mAOD | Date: 10/04/2017-18/04/2017 | Location: 447237E - 328864N | Scale: 1:50

Samples & In situ Tests Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
						Dense reddish brown slightly gravelly fine to coarse SAND. Gravel is rounded fine quartzite and chert.
C D11	10.50 10.50-10.83	50/180 mm		23.03	10.50	Extremely weak reddish brown MUDSTONE (no sample recovery, description based on limited arisings returned from rotary coring, not possible to identify weathering grade).
CR	10.50-12.00	0 0 0				
C D12	12.00 12.00-12.37	50/245 mm				
CR	12.00-13.50	0 0 0				
D11	13.00					
C D12	13.50 13.50-13.95	N=46				
CR	13.50-15.00	0 0 0				
C D12	15.00 15.00	50/180 mm				
CR	15.00-16.50	0 0 0				
C D13	16.50 16.50-16.80	50/150 mm				
CR	16.50-18.00	0 0 0				
				15.53	18.00	
		TCR SCR RQD FI FS				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Groundwater entry was encountered at 5.90m (sealed off with casing) rising to 5.10m after 20 minutes.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 6.00m, then by driving casing / open hole from 6.00m to 10.50m (due to very dense gravels). Borehole advanced from 10.50m to base by rotary coring techniques, with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G204

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 18.00m; 100 mm to 24.00m	Casing diameter: 120 mm to 18.00m	Project No.: G17057
Logged by: SS / Ground Level: 33.53 mAOD	Date: 10/04/2017-18/04/2017	Location: 447237E - 328864N	Scale: 1:50

Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description
CR	18.00-19.50	95 82 50	9, 5, 7		14.78	18.75	Very weak to weak reddish brown mottled green silty MUDSTONE with frequent irregular thin to thick laminations of gypsum and rare very thin beds of siltstone. Evidence of weathering as slightly reduced strength and mottled discoluration. Fractures are horizontal to sub-horizontal very closely to closely spaced, undulating, rough, partly open and clean. (Grade II to Grade I).
					14.26	19.27	Weak to medium strong thinly laminated pale green fine grained SILTSTONE with frequent thin and rare thick lamination of gypsum. Fractures are horizontal to sub-horizontal, closely spaced, undulating and planar, smooth, tight to partly open, clean.
CR	19.50-21.00	100 98 73	6		13.43	20.10	Very weak to weak brownish red locally green silty MUDSTONE with frequent irregular thin laminations of gypsum. Fractures are sub-horizontal, undulating, rough, very closely spaced, tight to partly open, clean. (Grade I locally Grade II).
CR	21.00-22.50	100 100 76	8, 5, 0		12.43	21.10	Weak to medium strong thinly laminated pale green fine grained SILTSTONE with frequent thin to thick lamiantion of gypsum and rare thin mudstone beds. Fractures are sub-horizontal, very closely to closely spaced, undulating and planar, smooth and rough, tight to partly open, clean.
					11.63	21.90	Weak locally medium strong thinly laminated brownish red silty MUDSTONE with rare beds of siltstone and irregular thin to thick lamination of gypsum. Fractures are horizontal to sub-horizontal, very closely to closely spaced, undulating, slightly rough to smooth, tight to partly open, clean. (Grade I to Grade II).
CR	22.50-24.00	89 73 63	6, 8		10.38	23.15	Medium strong thinly laminated pale green fine grained SILTSTONE with rare thin to thick lamination of gypsum. Fractures are horizontal to sub-horizontal, undulating and planar, slightly rough and smooth, partly open, clean.
					9.53	24.00	Very weak to weak thinly laminated brownish red locally green silty MUDSTONE with irregular thin lamination of gypsum. Evidence of weathering as slightly reduced strength and mottled discolouration. Fractures are sub-horizontal, very closely to closely spaced, undulating and planar, smooth to slightly rough, partly open to open, clean. (Grade II).

End of Borehole at 24.00 m

TCR SCR RQD | FI FS

Sheet 3 of 3

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Groundwater entry was encountered at 5.90m (sealed off with casing) rising to 5.10m after 20 minutes.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 6.00m, then by driving casing / open hole from 6.00m to 10.50m (due to very dense gravels). Borehole advanced from 10.50m to base by rotary coring techniques, with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G301A

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site	M1 J23a to J25 Ground Investigation
Client	Costain Galliford Try
Boring diameter:	120 mm to 16.50m 100 mm to 22.00m
Casing diameter:	120 mm to 16.50m
Project No.:	G17057
Logged by:	JP
Ground Level:	36.30 mAOD
Date:	10/04/2017-12/04/2017
Location:	329167E - 447138N
Scale:	1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				36.20	0.10	MADE GROUND - Topsoil (soft light brown organic sandy SILT with occasional rootlets).
B1	0.40-0.60					MADE GROUND - Brown slightly organic slightly silty fine to coarse SAND and sub-angular to sub-rounded fine to coarse quartz GRAVEL. . . . with some sub-rounded quartz cobbles and partings of clay below 0.90m.
B2	0.90-1.20					
S	1.20	N=6	▼			
D3	1.20-1.60			35.00	1.30	MADE GROUND - Soft locally very soft and locally firm reddish brown and occasionally light grey silty CLAY with frequent gravel sized fragments of mudstone and siltstone and rare quartz gravels.
D4	1.60-2.00			34.70	1.60	MADE GROUND - Soft locally firm reddish brown and occasionally light grey silty CLAY with frequent gravel to cobble sized fragments of mudstone and siltstone.
S	2.00	N=12				
D5	2.00-2.50					
D6	2.50-3.00					
S	3.00	N=10				
D7	3.00-3.40					
D8	3.40-3.80			32.90	3.40	POSSIBLE MADE GROUND - Stiff reddish brown and occasional light grey slightly sandy slightly gravelly CLAY. Gravel is angular to sub-rounded fine to coarse mudstone and siltstone.
S	4.00	N=31				
D9	4.20-4.60					
				31.40	4.90	Very dense brown fine to coarse SAND and sub-angular to sub-rounded fine to coarse quartz GRAVEL.
S	5.00	50/85mm				
D10	5.00-5.17					
S	6.00	N=15		30.30	6.00	Firm brown slightly sandy slightly gravelly silty CLAY. Gravel is sub-angular to sub-rounded fine to coarse quartz.
D10	6.00-6.40					
D11	6.40-7.00			29.90	6.40	Dense orangeish brown slightly gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse quartz.
S	7.00	N=38				
D12	7.50-8.50					
S	8.50	N=29				
D13	9.00-10.00					

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Slight groundwater seepage noted at 1.20m (sealed off with casing) rising to 1.10m after 15 minutes.
3. No recovery from 5.30m to 6.00m, cased off.
4. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 12.00m, then rotary coring techniques from 12.00m to the borehole base, with a mist flush.
5. Borehole backfilled with sodium bentonite (pellets) upon completion.

BOREHOLE RECORD - BH G301A

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 16.50m, 100 mm to 22.00m	Casing diameter: 120 mm to 16.50m	Project No.: G17057
Logged by: JP / Ground Level: 36.30 mAOD	Date: 10/04/2017-12/04/2017	Location: 329167E - 447138N	Scale: 1:50

Ref:	Depth (m)	SPT N / TCR SCR RQD	FI FS	Water	Level (mAOD)	Depth (m)	Strata Description
							Dense orangeish brown slightly gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse quartz.
S	10.00	50/225mm					
D14	10.50-11.00						
D15	11.00-11.50				25.30	11.00	Very stiff friable reddish brown and occasional light grey silty CLAY with occasional gravel sized mudstone lithorelicts.
S	11.50	N=31					
					24.30	12.00	Extremely weak red mottled pale green sandy MUDSTONE. Destructured to residually weathered. (Grade IVa to Grade IVb). . . . reamed out hole from 12.00m to 12.50m.
CR	12.00-12.50	60 0 0					
CR	12.50-13.50	100 0 0					. . . very thin bed of medium strong siltstone at 13.25m.
S	13.50	50/105mm					
CR	13.50-15.00	27 0 0					. . . non-intact between 14.60m and 15.00m (recovered as gravel).
S	15.00	50/225mm					
CR	15.00-16.50	13 0 0					
CR	16.50-17.50	0 0 0	0				
			15		18.80	17.50	Very weak to weak reddish brown locally green silty MUDSTONE with frequent irregular thin laminations of

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Slight groundwater seepage noted at 1.20m (sealed off with casing) rising to 1.10m after 15 minutes.
3. No recovery from 5.30m to 6.00m, cased off.
4. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 12.00m, then rotary coring techniques from 12.00m to the borehole base, with a mist flush.
5. Borehole backfilled with sodium bentonite (pellets) upon completion.

BOREHOLE RECORD - BH G301A

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 16.50m; 100 mm to 22.00m	Casing diameter: 120 mm to 16.50m	Project No.: G17057
Logged by: JP / Ground Level: 36.30 mAOD	Date: 10/04/2017-12/04/2017	Location: 329167E - 447138N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	17.50-19.00	87 75 31	7				gypsum. Evidence of weathering as slightly reduced strength. Fractures are horizontal to sub-horizontal locally sub-vertical, very closely to closely spaced, undulating, rough, partly open, rare infill of gypsum. Grade I to Grade II).		
CR	19.00-20.50	99 96 66	10		16.61	19.69	Weak to medium strong thinly laminated green mottled red SILTSTONE with occasional thin and thick laminations of gypsum. Fractures are horizontal to sub-horizontal locally sub-vertical, very closely to closely spaced, undulating, slightly rough, tight to partly open, clean.		
CR	20.50-22.00	95 89 74	7, 2		15.90	20.40	Weak thinly laminated reddish brown silty MUDSTONE with rare irregular thin to thick laminations of gypsum. Fractures are horizontal to sub-horizontal, undulating, smooth to slightly rough, partly open to open, clean. (Grade I locally Grade II).		
					14.30	22.00	*End of Borehole at 22.00 m*		

TCR SCR RQD FI FS

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Slight groundwater seepage noted at 1.20m (sealed off with casing) rising to 1.10m after 15 minutes.
3. No recovery from 5.30m to 6.00m, cased off.
4. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 12.00m, then rotary coring techniques from 12.00m to the borehole base, with a mist flush.
5. Borehole backfilled with sodium bentonite (pellets) upon completion.

BOREHOLE RECORD - BH G301B
(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 18.50m 100 mm to 21.00m	120 mm to 18.00m	G17057

Logged by: SS	Ground Level: 36.33 mAOD	Date: 21/04/2017-25/04/2017	Location: 329181E - 447188N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
D1	0.30-0.50					MADE GROUND - Greyish brown slightly cobbly gravelly silty fine to coarse SAND with occasional gravel sized fragments of concrete. Gravel is sub-rounded to rounded fine to coarse quartz and chert. Cobbles are sub-rounded quartz.
				35.73	0.60	
D2	0.70-1.10					
				35.23	1.10	MADE GROUND - Reddish brown slightly silty fine to coarse SAND and angular to rounded fine to coarse quartz, mudstone and chert GRAVEL with occasional sub-rounded quartz cobbles.
D3	1.20-2.00					
S	2.00	N=15		34.33	2.00	MADE GROUND - Reddish brown slighty silty sandy sub-rounded fine to coarse quartz GRAVEL with occasional sub-angular mudstone cobbles.
D4	2.00-2.45					
B5	2.00-3.00					MADE GROUND - Firm reddish brown slightly sandy slightly gravelly clayey SILT. Gravel is sub-angular to sub-rounded fine to coarse mudstone and siltstone.
S	3.00	N=15				
D6	3.00-3.45					
B7	3.00-4.00					
S	4.00	N=11				
D8	4.00-4.45					
B9	4.20-5.00			32.13	4.20	MADE GROUND - Firm locally stiff reddish brown slightly gravelly silty CLAY with occasional sub-rounded siltstone cobbles. Gravel is angular fine to coarse mudstone and siltstone.
S	5.00	50/230mm				
D10	5.00-5.45					
				30.93	5.40	Very dense orangeish brown slightly silty fine to coarse SAND and sub-rounded to rounded fine to coarse quartz, chert and mudstone GRAVEL.
C	6.00	50/235mm				
C	7.00	50/235mm	▼ ▽			
C	8.00	50/265mm				
C	9.00	50/210mm				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit exposed warning tape at 0.80m. Starter pit moved 0.30m to avoid fibre optic cable at 1.00m.
2. Second hand dug starter pit to 1.20m, to check for services.
3. Groundwater entry recorded at 7.30m (sealed off with casing) rising to 6.90m after 20 minutes.
4. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 5.00m, then driving casing / open hole from 5.00m to 13.50m (due to very dense gravels). Borehole advanced from 13.50m to base by rotary coring techniques, with a mist flush.
5. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G301B

(Window Sampler plus Rotary Core)

Client Costain Galliford Try	Site M1 J23a to J25 Ground Investigation		
	Boring diameter: 120 mm to 18.50m 100 mm to 21.00m	Casing diameter: 120 mm to 18.00m	Project No.: G17057
Logged by: SS / Ground Level: 36.33 mAOD	Date: 21/04/2017-25/04/2017	Location: 329181E - 447188N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
						Very dense orangeish brown slightly silty fine to coarse SAND and sub-rounded to rounded fine to coarse quartz, chert and mudstone GRAVEL.
C	10.00	50/85mm				
				23.33	13.00	Extremely weak reddish brown MUDSTONE (no sample recovery, description based on limited arising returns from rotary drilling, no possible to identify weathering grade).
C D11	13.50 13.50-13.95	50/285mm				
CR	13.50-15.00	0 0 0				
CR	15.00-16.50	0 0 0				
C D12	16.50 16.50-16.95	50/2 mm				
CR	16.50-18.00	0 0 0				
C D13	18.00 18.00-18.35	50/20 mm				
		TCR SCR RQD FI FS				*(continued next sheet)*

Sheet 2 of 3

Remarks and Water Observations

1. Hand dug starter pit exposed warning tape at 0.80m. Starter pit moved 0.30m to avoid fibre optic cable at 1.00m.
2. Second hand dug starter pit to 1.20m, to check for services.
3. Groundwater entry recorded at 7.30m (sealed off with casing) rising to 6.90m after 20 minutes.
4. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 5.00m, then driving casing / open hole from 5.00m to 13.50m (due to very dense gravels). Borehole advanced from 13.50m to base by rotary coring techniques, with a mist flush.
5. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G301B
(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation				
Client Costain Galliford Try	Boring diameter: 120 mm to 18.50m 100 mm to 21.00m	Casing diameter: 120 mm to 18.00m	Project No.: G17057	
Logged by: SS	Ground Level: 36.33 mAOD	Date: 21/04/2017-25/04/2017	Location: 329181E - 447188N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
					17.83	18.50	Extremely weak reddish brown MUDSTONE (no sample recovery, description based on limited arising returns from rotary drilling, no possible to identify weathering grade).		
CR	18.50-19.50	85 80 36	6				Moderately weak reddish brown thinly interbedded MUDSTONE and SILTSTONE with occasional gypsum mineralisation. (Grade I). . . . with occasional angular medium to coarse gravel sized gypsum fragments at 19.85m. (Drilling disturbed) . . . thick lamination of gypsum at 20.40m. . . . inclinced thick lamination of gypsum noted at 20.49m. . . . thick lamination of gypsum noted at 20.55m.		
CR	19.50-21.00	93 88 83	2 0		15.33	21.00			
							End of Borehole at 21.00 m		

TCR SCR RQD FI FS

Remarks and Water Observations

1. Hand dug starter pit exposed warning tape at 0.80m. Starter pit moved 0.30m to avoid fibre optic cable at 1.00m.
2. Second hand dug starter pit to 1.20m, to check for services.
3. Groundwater entry recorded at 7.30m (sealed off with casing) rising to 6.90m after 20 minutes.
4. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 5.00m, then driving casing / open hole from 5.00m to 13.50m (due to very dense gravels). Borehole advanced from 13.50m to base by rotary coring techniques, with a mist flush.
5. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G303

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 9.00m; 120 mm to 24.50m	Casing diameter: 120 mm to 12.00m	Project No.: G17057
Logged by: IG / Ground Level: 33.52 mAOD	Date: 12/05/2017-18/07/2017	Location: 329905E - 446938N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
D1	0.15-0.70			33.37	0.15	MADE GROUND - Topsoil (light brown slightly gravelly silty fine SAND with frequent rootlets. Gravel is sub-rounded to rounded fine to medium quartz, flint and mudstone).
D2	0.70-1.00			32.82	0.70	MADE GROUND - Dark brown gravelly silty fine to medium SAND with a medium sub-angular limestone cobble content. Gravel is sub-angular to rounded fine to coarse quartz, flint, mudstone and limestone.
D3	1.00-1.10			32.52	1.00	MADE GROUND - Firm locally soft reddish brown slightly gravelly slightly sandy CLAY. Gravel is sub-angular to rounded fine to medium quartz, flint and mudstone.
S	1.20	N=20		32.42	1.10	MADE GROUND - Greyish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse limestone.
D4	1.20-1.65					
D5	1.20-2.00					
S	2.00	50/200mm				
D6	2.00-2.45			31.32	2.20	MADE GROUND - Firm reddish brown slightly sandy gravelly CLAY. Gravel is sub-angular to rounded fine to coarse quartz, mudstone and sandstone.
						Very dense yellowish brown fine to coarse SAND and sub-angular to rounded fine to coarse quartz, flint and mudstone GRAVEL. (Description based on returned arisings from open hole drilling).
S	3.00	N=47				. . . becoming dense between 3.00m and 4.50m.
D7	3.00-3.45					
D8	3.00-4.50					
S	4.50	50/225mm				
D9	4.50-6.00					
S	6.00	N=44				. . . becoming dense between 6.00m to 7.50m.
D10	6.00-6.45					
D11	6.00-7.50					
S	7.50	50/65mm				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques through overburden then by open-hole / driving casing to 12.00, through dense coarse grained soils, then rotary coring through rock to base.
4. Borehole backfilled with bentonite pellets to ground level upon completion.

BOREHOLE RECORD - BH G303

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try

Boring diameter: 120 mm to 9.00m; 120 mm to 24.50m

Casing diameter: 120 mm to 12.00m

Project No.: G17057

Logged by: IG | Ground Level: 33.52 mAOD | Date: 12/05/2017-18/07/2017 | Location: 329905E - 446938N | Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
						Very dense yellowish brown fine to coarse SAND and sub-angular to rounded fine to coarse quartz, flint and mudstone GRAVEL. (Description based on returned arisings from open hole drilling).
				21.52	12.00	Very weak structureless fine grained SANDSTONE. Discontinuities are sub-horizontal closely spaced smooth planar smooth undulating clean.
CR	12.50-14.00	73 50 40				
				20.22	13.30	Extremely weak medium interbedded reddish brown MUDSTONE and grey SILTSTONE with frequent gypsum mineralisation. Discontinuities are horizontal sub-horizontal and vertical closely spaced rough planar smooth planar rough undulating smooth undulating and rough stepped closely spaced clean and gypsum coated.
CR	14.00-15.50	100 83 43				
CR	15.50-17.00	100 70 33				
CR	17.00-18.50	100 57 28				
		TCR SCR RQD / FI FS				*(continued next sheet)*

Sheet 2 of 3

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques through overburden then by open-hole / driving casing to 12.00, through dense coarse grained soils, then rotary coring through rock to base.
4. Borehole backfilled with bentonite pellets to ground level upon completion.

NICHOLLS COLTON GROUP

BOREHOLE RECORD - BH G303
(Window Sampler plus Rotary Core)

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 9.00m 120 mm to 24.50m	120 mm to 12.00m	G17057

Logged by: IG	Ground Level: 33.52 mAOD	Date: 12/05/2017-18/07/2017	Location: 329905E - 446938N	Scale: 1:50

Core Data Ref:	Core Data Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	18.50-20.00	100 63 43					Extremely weak medium interbedded reddish brown MUDSTONE and grey SILTSTONE with frequent gypsum mineralisation. Discontinuities are horizontal sub-horizontal and vertical closely spaced rough planar smooth planar rough undulating smooth undulating and rough stepped closely spaced clean and gypsum coated. . . . becoming weak locally very weak below 19.75m.		
CR	20.00-21.50	100 73 51							
CR	21.50-23.00	100 65 52							
CR	23.00-24.50	100 43 17							
					9.02	24.50	*End of Borehole at 24.50 m*		
		TCR SCR RQD	FI FS					Sheet 3 of 3	

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques through overburden then by open-hole / driving casing to 12.00, through dense coarse grained soils, then rotary coring through rock to base.
4. Borehole backfilled with bentonite pellets to ground level upon completion.

BOREHOLE RECORD - BH G304

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 10.50m 100 mm to 18.00m	120 mm to 10.50m	G17057

Logged by: PM | Ground Level: 33.64 mAOD | Date: 20/04/2017-25/04/2017 | Location: 329934E - 446891N | Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
B1	0.00-1.10					MADE GROUND - Brown slightly gravelly slightly clayey medium to coarse SAND with frequent gravel sized concrete fragments. Gravel is sub-rounded fine to medium quartz.
S D2	1.20 1.20-2.00	N=15		32.54	1.10	MADE GROUND - Stiff brown mottled grey CLAY with frequent gravel sized sub-angular mudstone lithorelicts. . . . sub-rounded fine to medium siltstone gravel and coal fragments below 1.50m. . . . rounded medium to coarse quartz gravel at 1.90m.
S	2.00	50/125mm		31.64	2.00	Very dense brownish grey cobbly sub-rounded to rounded coarse quartz GRAVEL. Cobbles are rounded to sub-rounded fine to coarse quartz.
S	3.00	N=50				
D3	3.40-4.00			30.24	3.40	Brown fine to coarse SAND.
S B4	4.00 4.00-5.00	N=41		29.64	4.00	Dense brown gravelly medium to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse quartz and siltstone.
			▼			
S D5	5.00 5.00-5.27	50/115mm				. . . becoming very dense below 5.00m.
S D5	6.00 6.00-6.50	N=33		27.64	6.00	Dense brown medium to coarse SAND and sub-angular to rounded fine to coarse quartz and siltstone GRAVEL (based on limited returned arisings from open hole drilling).
S	7.50	50/245mm				. . . becoming very dense below 7.50m.
S	9.00	50/230mm				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Groundwater entry encountered at 4.50m (sealed off with casing) remaining level after 20 minutes.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques 1.20m to 5.00m, then open hole / driving casing from 5.00m to 10.50m (due to very dense gravels). Borehole then advanced by rotary coring techniques from 10.50m to the borehole base, with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G304

(Window Sampler plus Rotary Core)

Site	M1 J23a to J25 Ground Investigation
Client	Costain Galliford Try
Boring diameter:	120 mm to 10.50m 100 mm to 18.00m
Casing diameter:	120 mm to 10.50m
Project No.:	G17057
Logged by:	PM
Ground Level:	33.64 mAOD
Date:	20/04/2017-25/04/2017
Location:	329934E - 446891N
Scale:	1:50

Samples & In situ Tests

Ref:	Depth (m)	SPT N / TCR SCR RQD
S	10.50	50/85 mm
CR	10.50-12.00	90 87 47
CR	12.00-13.50	100 97 71
CR	13.50-15.00	97 97 93
CR	15.00-16.50	90 90 60
CR	16.50-18.00	93 93 56

FI / FS: 2, 4, 8, 0, 0, 7, 1, 3, 3, 0, 6, 0

Water	Level (mAOD)	Depth (m)	Strata Description
			Dense brown medium to coarse SAND and sub-angular to rounded fine to coarse quartz and siltstone GRAVEL (based on limited returned arisings from open hole drilling).
	23.14	10.50	Medium strong pale green sandy SILTSTONE with frequent thin and thick laminations of gypsum. Bedding fractures are horizontal, closely spaced, undulating and planar, smooth, very tight, clean.
	22.69	10.95	Very weak to weak brownish red silty MUDSTONE with frequent thin laminations of gypsum. Bedding fractures are horizontal, closely spaced, undulating, rough, tight, clean.
	22.14	11.50	Medium strong pale green fine to medium grained silty SANDSTONE with occasional thick laminations and very thin beds of gypsum. Horizontal fractures are very closely to closely spaced, undulating, rough, tight, clean.
	21.64	12.00	Very weak to weak thinly laminated brownish red silty MUDSTONE.
	21.34	12.30	Medium strong pale green fine to medium grained silty SANDSTONE with occasional thin to thick laminations of gypsum. Fractures are horizontal, closely spaced, undulating and planar, rough and smooth, tight, clean.
	20.84	12.80	Very weak to weak brownish red silty MUDSTONE with occasional thin and thick laminations of gypsum. Fractures are horizontal, very closely to closely spaced, undulating, rough, tight, clean.
	20.44	13.20	Medium strong pale green to greyish-white fine to medium grained silty SANDSTONE. Fractures are horizontal, medium spaced, undulating, rough, tight, clean.
	20.14	13.50	Very weak to weak brownish red silty MUDSTONE with frequent thin and thick laminations of gypsum. Fractures are sub-horizontal, closely spaced, undulating, smooth, tight, clean.
	19.44	14.20	Medium strong pale green to greyish-white fine to medium grained silty SANDSTONE with occasional thick laminations to very thin beds of gypsum. Fractures are
	18.04	15.60	
	15.64	18.00	

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Groundwater entry encountered at 4.50m (sealed off with casing) remaining level after 20 minutes.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques 1.20m to 5.00m, then open hole / driving casing from 5.00m to 10.50m (due to very dense gravels). Borehole then advanced by rotary coring techniques from 10.50m to the borehole base, with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G304

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP	Site M1 J23a to J25 Ground Investigation			
Client Costain Galliford Try	Boring diameter: 120 mm to 10.50m 100 mm to 18.00m	Casing diameter: 120 mm to 10.50m	Project No.: G17057	
Logged by: PM	Ground Level: 33.64 mAOD	Date: 20/04/2017-25/04/2017	Location: 329934E - 446891N	Scale: 1:50

Core Data: Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
							14.20m - 15.60m : horizontal, medium spaced, undulating, rough, tight, clean.		
							15.60m - 18.00m : Very weak to weak locally medium strong brownish red and green silty MUDSTONE with frequent thin to thick laminations of gypsum. Fractures are sub-horizontal to sub-vertical, very closely to closely spaced, undulating, rough, partly open, clean.		
							End of Borehole at 18.00 m		
		TCR SCR RQD	FI FS					Sheet 2+ of 2	

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Groundwater entry encountered at 4.50m (sealed off with casing) remaining level after 20 minutes.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques 1.20m to 5.00m, then open hole / driving casing from 5.00m to 10.50m (due to very dense gravels). Borehole then advanced by rotary coring techniques from 10.50m to the borehole base, with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G305

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 12.50m 100 mm to 17.00m	120 mm to 12.50m	G17057

Logged by: SS	Ground Level: 34.31 mAOD	Date: 06/05/2017-09/05/2017	Location: 330107E - 446872N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				34.16	0.15	MADE GROUND - Soft greyish brown slightly sandy slightly gravelly clayey SILT. Gravel is angular to rounded fine to coarse quartz.
D1	0.50-0.70			33.86	0.45	MADE GROUND - Reddish brown and greyish brown gravelly silty fine to coarse SAND. Gravel is angular to rounded fine to coarse quartz, siltstone and mudstone.
				33.61	0.70	MADE GROUND - Reddish brown slightly cobbly slightly gravelly silty clayey fine to coarse SAND. Gravel is sub-angular fine to coarse mudstone and siltstone. Cobbles are sub-rounded siltstone and mudstone.
D2	0.90-1.10			33.31	1.00	MADE GROUND - Greyish and reddish brown silty fine to coarse SAND and angular fine to coarse limestone GRAVEL.
S	1.30	N=10				
D3	1.30-1.75					
B4	1.30-2.10					
S	2.00	N=19				
D5	2.00-2.45					
B6	2.00-2.90					
D7	2.90-3.00			31.46	2.85	MADE GROUND - Firm reddish brown gravelly silty CLAY with a low sub-angular siltstone cobble content. Gravel is angular fine to medium mudstone and siltstone.
C	3.00	N=30				
D8	3.00-3.50					
D9	3.50-3.60			30.81	3.50	MADE GROUND - Firm to stiff greyish brown and reddish brown gravelly sandy CLAY. Gravel is rounded to sub-rounded fine to medium quartz and chert.
C	4.00	50/255mm		30.31	4.00	Reddish brown fine to coarse SAND and sub-angular to rounded fine to coarse quartz, chert and mudstone GRAVEL.
B10	4.00-5.00					Very dense reddish brown to orangeish brown gravelly fine to coarse SAND. Gravel is rounded fine to coarse quartz and chert.
C	5.00	50/210mm				
B11	5.00-6.00					
C	6.00	50/285mm				
B12	6.00-7.50					
C	7.00	50/160mm				
B13	7.50-9.00					

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.30m, to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.30m to 3.60m, then open hole / driving casing from 3.60m to 12.50m (due to very dense gravels). Borehole advanced from 12.50m to the base by rotary coring techniques, with a mist flush.
4. Borehole was backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G305

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client Costain Galliford Try	Boring diameter: 120 mm to 12.50m 100 mm to 17.00m	Casing diameter: 120 mm to 12.50m	Project No.: G17057
Logged by: SS / Ground Level: 34.31 mAOD	Date: 06/05/2017-09/05/2017	Location: 330107E - 446872N	Scale: 1:50

Samples & In situ Tests Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
						Very dense reddish brown to orangeish brown gravelly fine to coarse SAND. Gravel is rounded fine to coarse quartz and chert.
C	10.50	50/170mm				
C	12.00	50/210mm				
C	12.50	(75/0)mm		21.81	12.50	Medium strong greyish green fine to medium grained silty SANDSTONE with occasional thin laminations of gypsum. Fractures are subhorizontal very closely to closely spaced, undulating, slightly rough, tight to partly open, clean.
CR	12.50-14.00	50 50 30 / 4				
		6		20.61	13.70	Weak to medium strong brownish red and pale grey sandy MUDSTONE with frequent irregular thin and thick laminations of gypsum. Fractures are mainly horizontal, closely spaced, undulating and planar, slightly rough and smooth, tight to partly open, clean. (Grade I locally Grade II).
C	14.00	14/30mm				
CR	14.00-15.50	90 80 57 / 3				
CR	15.50-17.00	96 96 63 / 4, 2				
				17.31	17.00	*End of Borehole at 17.00 m*
		TCR SCR RQD / FI FS				

Remarks and Water Observations

1. Hand dug starter pit to 1.30m, to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.30m to 3.60m, then open hole / driving casing from 3.60m to 12.50m (due to very dense gravels). Borehole advanced from 12.50m to the base by rotary coring techniques, with a mist flush.
4. Borehole was backfilled with sodium bentonite (pellets) to ground level upon completion.

NICHOLLS COLTON GROUP	**BOREHOLE RECORD - BH G307** (Window Sampler plus Rotary Core)		
	Site M1 J23a to J25 Ground Investigation		
Client Costain Galliford Try	Boring diameter: 120 mm to 18.00m 100 mm to 21.50m	Casing diameter: 120 mm to 18.00m	Project No.: G17057
Logged by: SS / Ground Level: 38.85 mAOD	Date: 22/05/2017-30/05/2017	Location: 330771E - 446616N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
				38.65	0.20	MADE GROUND - Topsoil (greyish-brown gravelly clayey organic fine to coarse SAND/SILT with many roots).		
B1	0.30-0.60							
				38.25	0.60	MADE GROUND - Dark greyish-brown to brown gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse mixed lithology including quartz, siltstone, limestone and mudstone.		
B2	0.80-1.00							
				37.85	1.00	MADE GROUND - Reddish-brown and light brown slightly clayey slightly silty fine to coarse SAND and angular to rounded fine to coarse quartz, siltstone, sandstone and mudstone GRAVEL with occasional pockets of sandy gravelly Clay.		
S	1.20	N=13						
B3	1.20-2.00							
S	2.00	N=13						
B4	2.00-2.50					MADE GROUND - Medium dense reddish-brown gravelly slightly clayey fine to coarse SAND/SILT with a low angular mudstone and siltstone cobble content. Gravel is angular fine to coarse mudstone and siltstone.		
B5	2.60-3.00							
S	3.00	N=27		35.85	3.00	MADE GROUND - Stiff reddish-brown slightly gravelly sandy CLAY. Gravel is angular fine to coarse mudstone and siltstone.		
B6	3.00-3.50							
				35.25	3.60	MADE GROUND - Very dense reddish-brown gravelly silty fine to coarse SAND. Gravel is angular fine to coarse mudstone and siltstone.		
B7	3.70-3.90							
S	4.00	50/215mm						
S	6.00	50/250mm						
S	7.50	50/220mm		31.35	7.50	Very dense reddish-brown gravelly fine to coarse SAND. Gravel is sub rounded to rounded fine to medium quartz and chert.		
B8	7.60-9.00							
S	9.00	N=46						
						(continued next sheet)	Sheet 1 of 3	

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 5.00m, then by open-hole / driving casing from 5.00m to 18.00m (due to dense gravels). Borehole then advanced by rotary core techniques to 21.50m, with a mist flush.
3. No groundwater entries were observed during boring operations, however, minor inflows may have been masked by drilling techniques.
4. Not possible to measure fracture index in mudstone below 17.50m due to highly fragmented rock cores and poor sample recovery.
5. Borehole backfilled with sodium bentonite (pellets), and surface reinstated upon completion.

BOREHOLE RECORD - BH G307

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client
Costain Galliford Try

Boring diameter:
120 mm to 18.00m
100 mm to 21.50m

Casing diameter:
120 mm to 18.00m

Project No.:
G17057

Logged by: SS | Ground Level: 38.85 mAOD | Date: 22/05/2017-30/05/2017 | Location: 330771E - 446616N | Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
						Remaining Detail : 9.00m - 9.00m : . . . becoming dense below 9.00m.
C	10.50	22/90mm		28.35	10.50	Medium dense reddish-brown slightly gravelly fine to coarse SAND. Gravel is sub-rounded fine to medium quartz.
				27.15	11.70	Very dense reddish-brown fine to coarse SAND and sub-rounded to rounded fine to medium quartz and chert GRAVEL.
C B9	12.00 12.00-13.50	19/75mm				
C	13.50	N=29				. . . becoming medium dense below 13.50m.
				24.35	14.50	Very dense multi-coloured sandy sub-rounded to rounded fine to coarse quartz and chert GRAVEL.
S SD10	15.00 15.00-15.40	50/270mm				
C	16.50	50/85mm				
				21.35	17.50	Extremely weak reddish-brown locally light grey thinly laminated MUDSTONE. (Grade IVa to III, locally Grade
CR S	17.50-18.50 18.00	0 0 50/165 mm				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 5.00m, then by open-hole / driving casing from 5.00m to 18.00m (due to dense gravels). Borehole then advanced by rotary core techniques to 21.50m, with a mist flush.
3. No groundwater entries were observed during boring operations, however, minor inflows may have been masked by drilling techniques.
4. Not possible to measure fracture index in mudstone below 17.50m due to highly fragmented rock cores and poor sample recovery.
5. Borehole backfilled with sodium bentonite (pellets), and surface reinstated upon completion.

BOREHOLE RECORD - BH G307

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation				
Client Costain Galliford Try	Boring diameter: 120 mm to 18.00m 100 mm to 21.50m	Casing diameter: 120 mm to 18.00m	Project No.: G17057	
Logged by: SS	Ground Level: 38.85 mAOD	Date: 22/05/2017-30/05/2017	Location: 330771E - 446616N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
							II).		
CR	18.50-20.00	33 20 17							
CR	20.00-21.50	47 40 10							
C	21.50	50/70mm			17.35	21.50	*End of Borehole at 21.50 m*		

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 5.00m, then by open-hole / driving casing from 5.00m to 18.00m (due to dense gravels). Borehole then advanced by rotary core techniques to 21.50m, with a mist flush.
3. No groundwater entries were observed during boring operations, however, minor inflows may have been masked by drilling techniques.
4. Not possible to measure fracture index in mudstone below 17.50m due to highly fragmented rock cores and poor sample recovery.
5. Borehole backfilled with sodium bentonite (pellets), and surface reinstated upon completion.

BOREHOLE RECORD - BH G308

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client
Costain Galliford Try

Boring diameter: 120 mm to 31.00m

Casing diameter: 120 mm to 19.50m

Project No.: G17057

Logged by: SS | Ground Level: | Date: 10/05/2017-17/05/2017 | Location: - | Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
					0.20	MADE GROUND - Topsoil (greyish brown gravelly silty fine to coarse SAND with frequent rootlets. Gravel is angular to rounded fine to coarse quartz and sandstone.)
B1	0.30-0.60					
					0.45	MADE GROUND - reddish brown to greyish brown gravelly silty fine to coarse SAND. Gravel is angular to rounded fine to coarse quartz, siltstone and mudstone.
B2	0.70-1.00					
					1.10	MADE GROUND - Light grey sandy angular fine to coarse sandstone GRAVEL.
S	1.30	N=37				
B3	1.30-2.00					
D4	1.30-1.75					
S	2.00	50/190mm			2.00	MADE GROUND - Firm reddish brown slightly sandy slightly gravelly silty CLAY. Gravel is angular fine to medium mudstone and siltstone.
D5	2.00-2.45					
D6	2.00-2.50					MADE GROUND - Very dense reddish brown slightly gravelly clayey silty fine SAND. Gravel is angular fine to coarse mudstone and siltstone.
S	3.00	50/219mm				
D7	3.00-3.45					
					3.50	MADE GROUND - Reddish brown slightly sandy slightly clayey silty angular fine to medium mudstone and siltstone GRAVEL. (Description based on returned arisings from open hole drilling).
S	4.50	50/285mm				
D8	4.50-4.95					
					4.80	Very dense reddish brown fine to coarse SAND and rounded fine to coarse quartz and chert GRAVEL. (Description based on returned arisings from open hole drilling).
B9	5.00-6.00					
S	6.00	50/140mm				
B10	6.00-7.50					
S	7.50	50/145mm				
S	9.00	50/235mm				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.30m to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques from 1.20m to 2.50m, then by open hole / driving casing from 2.50m to 19.50m (due to dense gravels). Borehole then rotary cored to 31.00m, with a mist flush.
4. Borehole collapsing below 25.00m, preventing completion of SPT/CPT's.
5. Borehole backfilled with sodium bentonite (pellets) on completion.

BOREHOLE RECORD - BH G308

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client Costain Galliford Try	Boring diameter: 120 mm to 31.00m	Casing diameter: 120 mm to 19.50m	Project No.: G17057
Logged by: SS — Ground Level:	Date: 10/05/2017-17/05/2017	Location: -	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
						Very dense reddish brown fine to coarse SAND and rounded fine to coarse quartz and chert GRAVEL. (Description based on returned arisings from open hole drilling).		
S	10.50	N=48				. . . becoming dense below 10.50m.		
S	12.00	50/225mm			12.00	Stiff reddish brown SILT/CLAY. (Description based on limited returned arisings from open hole drilling).		
					13.00	Very dense reddish brown fine to coarse SAND and rounded fine to coarse quartz and chert GRAVEL. (Descriptions based on returned arisings from open hole drilling).		
S	13.50	50/235mm						
S	15.00	(75/0mm						
S	16.50	50/210mm						
S	18.00	50/235mm						
						(continued next sheet)	Sheet 2 of 4	

Remarks and Water Observations

1. Hand dug starter pit to 1.30m to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques from 1.20m to 2.50m, then by open hole / driving casing from 2.50m to 19.50m (due to dense gravels). Borehole then rotary cored to 31.00m, with a mist flush.
4. Borehole collapsing below 25.00m, preventing completion of SPT/CPT's.
5. Borehole backfilled with sodium bentonite (pellets) on completion.

BOREHOLE RECORD - BH G308

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation				
Client: Costain Galliford Try	Boring diameter: 120 mm to 31.00m	Casing diameter: 120 mm to 19.50m	Project No.: G17057	
Logged by: SS	Ground Level:	Date: 10/05/2017-17/05/2017	Location: -	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
						Very dense reddish brown fine to coarse SAND and rounded fine to coarse quartz and chert GRAVEL. (Descriptions based on returned arisings from open hole drilling).
S	19.50	50/141 mm			19.50	Hard reddish brown slightly gravelly silty CLAY with a medium sub-angular sandstone cobble content. Gravel is sub-angular to sub-rounded fine to coarse limestone, sandstone and quartz.
CR	19.50-21.00	83 / 0 / 0				
CR	21.00-22.50	87 / 0 / 0				
C	22.50	50/85 mm				
D11	22.50-22.70					
CR	22.50-24.00	97 / 0 / 0				
						. . . No core sample recovery 24.00m to 25.50m.
CR	24.00-25.50	0 / 0 / 0				
S	25.50	N=6				
CR	25.50-27.00	77 / 0 / 0				

TCR SCR RQD FI FS

(continued next sheet)

Sheet 3 of 4

Remarks and Water Observations

1. Hand dug starter pit to 1.30m to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques from 1.20m to 2.50m, then by open hole / driving casing from 2.50m to 19.50m (due to dense gravels). Borehole then rotary cored to 31.00m, with a mist flush.
4. Borehole collapsing below 25.00m, preventing completion of SPT/CPT's.
5. Borehole backfilled with sodium bentonite (pellets) on completion.

BOREHOLE RECORD - BH G308

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation				
Client: Costain Galliford Try	Boring diameter: 120 mm to 31.00m	Casing diameter: 120 mm to 19.50m		Project No.: G17057
Logged by: SS	Ground Level:	Date: 10/05/2017-17/05/2017	Location: -	Scale: 1:50

Core Data Ref:	Core Data Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	27.00-28.50	33 0 0					Hard reddish brown slightly gravelly silty CLAY with a medium sub-angular sandstone cobble content. Gravel is sub-angular to sub-rounded fine to coarse limestone, sandstone and quartz.		
CR	28.50-30.00	63 0 0							
CR	30.00-31.00	0 0 0							
						31.00	*End of Borehole at 31.00 m*		
		TCR SCR RQD	FI FS						

Sheet 4 of 4

Remarks and Water Observations

1. Hand dug starter pit to 1.30m to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques from 1.20m to 2.50m, then by open hole / driving casing from 2.50m to 19.50m (due to dense gravels). Borehole then rotary cored to 31.00m, with a mist flush.
4. Borehole collapsing below 25.00m, preventing completion of SPT/CPT's.
5. Borehole backfilled with sodium bentonite (pellets) on completion.

BOREHOLE RECORD - BH G309

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try

Boring diameter: 120 mm to 21.45m

Casing diameter: 120 mm to 19.60m

Project No.: G17057

Logged by: IG | Ground Level: | Date: 04/05/2017-10/05/2017 | Location: - | Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
B1	0.00-0.50					MADE GROUND - Topsoil (soft friable light brown organic slightly gravelly sandy silt with frequent rootlets. Gravel is sub-angular to rounded fine to medium quartz and flint.)
B2	0.50-0.70				0.50	MADE GROUND - Greyish white gravelly silty fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse limestone.
B3	0.70-1.20				0.70	MADE GROUND - Soft reddish brown gravelly SILT with occasional mudstone cobbles. Gravel is sub-angular to sub-rounded fine to coarse quartz and mudstone.
S	1.20	N=4				
D4	1.20-1.65					
D5	1.50-2.00					
					1.80	MADE GROUND - Soft reddish brown slightly sandy gravelly CLAY with occasional mudstone cobbles. Gravel is sub-angular to sub-rounded fine to coarse mudstone. . . . becoming firm at and below 2.60m.
S	2.00	N=14				
D6	2.00-2.45					
D7	2.00-3.00					
S	3.00	N=26				
D8	3.00-3.45					
D9	3.00-4.00					
S	4.00	50/195mm				
D10	4.00-4.45					
					4.50	Dense brown silty fine to coarse SAND and sub-angular to rounded fine to coarse quartz GRAVEL.
C	5.00	N=48				
D11	5.00-6.00					
S	6.00	N=10			6.00	Medium dense dark brown clayey fine to medium SAND.
D12	6.00-6.45					
					6.50	Dense brown silty fine to coarse SAND and sub-angular to rounded fine to coarse quartz, siltstone GRAVEL.
S	7.50	N=46				
S	9.00	50/165mm				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Borehole advanced using Commachio 205 combination rig AR01 using dynamic sampling techniques from 1.20m to 4.00m and 10.50m to 12.00m, borehole advanced by driving casing / open hole 4.00m to 10.50m and then by rotary coring techniques 12.00m to the base, with a mist flush.
3. No groundwater seepages were encountered during boring operations.
4. Borehole backfilled with sodium bentonite (pellets) upon completion.

NICHOLLS COLTON GROUP

BOREHOLE RECORD - BH G309

(Window Sampler plus Rotary Core)

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 21.45m	Casing diameter: 120 mm to 19.60m	Project No.: G17057
Logged by: IG / Ground Level:	Date: 04/05/2017-10/05/2017	Location: -	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
D13	9.00-10.50					Remaining Detail : 9.00m - 9.00m : . . . becoming very dense below 9.00m.
S	10.50	50/125mm			10.50	Stiff reddish brown sandy SILT.
D14	10.50-10.95					
S	12.00	50/270 mm			12.00	Very stiff reddish brown mottled grey slightly gravelly CLAY. Gravel is sub-angular to rounded fine to medium quartz, flint and mudstone.
D15	12.00-12.45					
D16	12.00-13.50					
CR	12.00-13.50	30 / 0 / 0				
S	13.50	50/230 mm				. . . becoming very stiff at and below 13.50m.
D17	13.50-13.95					
CR	13.50-15.00	0 / 0 / 0				
S	15.00	50/200 mm			15.00	Stiff reddish brown mottled grey friable CLAY with occasional mudstone bands.
CR	15.00-16.50	100 / 0 / 0				
S	16.50	63/230 mm				(description based on limited arising return from rotary coring below 16.50m).
D18	16.50-16.95					
CR	16.50-18.00	0 / 0 / 0				
D19	18.00-19.50				18.00	
		TCR SCR RQD / FI FS				*(continued next sheet)*

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Borehole advanced using Commachio 205 combination rig AR01 using dynamic sampling techniques from 1.20m to 4.00m and 10.50m to 12.00m, borehole advanced by driving casing / open hole 4.00m to 10.50m and then by rotary coring techniques 12.00m to the base, with a mist flush.
3. No groundwater seepages were encountered during boring operations.
4. Borehole backfilled with sodium bentonite (pellets) upon completion.

BOREHOLE RECORD - BH G309

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try	Boring diameter: 120 mm to 21.45m	Casing diameter: 120 mm to 19.60m	Project No.: G17057	
Logged by: IG	Ground Level:	Date: 04/05/2017-10/05/2017	Location: -	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description
CR	18.00-19.50	0 0 0					Yellowish brown slightly sandy sub-angular to rounded fine to coarse quartz, various igneous and mudstone GRAVEL. (description based on limited arising returns from rotary coring).
S D20	19.50 19.50-19.95	50/14 mm				19.50	Very stiff reddish brown mottled grey friable CLAY with occasional mudstone bands. (description based on limited arising returns from rotary coring)
CR	19.50-21.00	0 0 0					
S D21	21.00 21.00-21.45	50/45mm					
						21.45	*End of Borehole at 21.45 m*

TCR SCR RQD FI FS

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Borehole advanced using Commachio 205 combination rig AR01 using dynamic sampling techniques from 1.20m to 4.00m and 10.50m to 12.00m, borehole advanced by driving casing / open hole 4.00m to 10.50m and then by rotary coring techniques 12.00m to the base, with a mist flush.
3. No groundwater seepages were encountered during boring operations.
4. Borehole backfilled with sodium bentonite (pellets) upon completion.

BOREHOLE RECORD - BH G310
(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 11.00m	120 mm to 11.00m	G17057

Logged by: IG	Ground Level:	Date: 10/05/2017-12/05/2017	Location: -	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
B1	0.20-0.60				0.15	MADE GROUND - Topsoil (soft light brown organic slightly gravelly sandy SILT with frequent rootlets. Gravel is sub-angular to rounded fine to medium quartz and flint).		
B2	0.60-1.00				0.60	MADE GROUND - Yellowish brown gravelly silty fine to medium SAND with frequent gravel sized concrete fragments. Gravel is sub-angular to sub-rounded fine to coarse quartz, flint, mudstone and limestone.		
B3	1.00-1.20				1.00	MADE GROUND - Greyish white gravelly silty fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse limestone.		
S	1.20	N=8						
D4	1.20-1.65							
D5	1.20-2.00							
S	2.00	N=12				MADE GROUND - Soft locally firm reddish brown slightly sandy gravelly CLAY. Gravel is sub-angular to sub-rounded fine to coarse quartz, mudstone and sandstone. . . . becoming sandy below 2.50m.		
D6	2.00-2.45							
D7	2.00-3.00							
S	3.00	N=22			3.00	Medium dense reddish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse quartz, flint and mudstone. (Sample description based on returned arisings from open hole drilling). . . . becoming very dense below 4.00m.		
D8	3.00-3.45							
D9	3.00-4.00							
S	4.00	50/205mm						
D10	4.00-4.45							
D11	4.50-6.00							
S	6.00	N=47			6.00	Dense yellowish brown fine to coarse SAND and sub-angular to rounded fine to coarse quartz, flint and mudstone GRAVEL. (Description based on returned arisings from open hole drilling).		
D12	6.00-6.45							
D13	6.00-7.50							
S	7.50	50/250mm				. . . becoming very dense below 7.50m.		
D14	7.50-9.00							
S	9.00	50/80mm						

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques from 1.20m to 3.00m, then by open hole / driving casing from 3.00m to the base of the borehole, using a mist flush.
3. No groundwater seepages were encountered during boring operations.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G310

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation				
Client Costain Galliford Try	Boring diameter: 120 mm to 11.00m	Casing diameter: 120 mm to 11.00m	Project No.: G17057	
Logged by: IG	Ground Level:	Date: 10/05/2017-12/05/2017	Location: -	Scale: 1:50

Samples & In situ Tests			Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
Ref:	Depth (m)	SPT N						
D15	9.00-10.50					Dense yellowish brown fine to coarse SAND and sub-angular to rounded fine to coarse quartz, flint and mudstone GRAVEL. (Description based on returned arisings from open hole drilling).		
C	10.50	50/90mm						
D16	10.50-11.00							
C	11.00	50/130mm			11.00	*End of Borehole at 11.00 m*		

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques from 1.20m to 3.00m, then by open hole / driving casing from 3.00m to the base of the borehole, using a mist flush.
3. No groundwater seepages were encountered during boring operations.
4. Borehole backfilled with sodium bentonite (pellets) to ground level upon completion.

BOREHOLE RECORD - BH G311A

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client Costain Galliford Try	Boring diameter: 120 mm to 13.50m 100 mm to 21.00m	Casing diameter: 120 mm to 13.50m	Project No.: G17057
Logged by: JP — Ground Level: 36.04 mAOD	Date: 24/05/2017-30/05/2017	Location: 331983E - 446553N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				35.84	0.20	MADE GROUND - Topsoil (soft brown very organic sandy SILT).
D1	0.40-0.50			35.74	0.30	MADE GROUND - Stiff friable reddish-brown slightly gravelly silty CLAY. Gravel is sub-angular fine to coarse siltstone.
D2	0.70-0.80			35.34	0.70	MADE GROUND - Brown slightly gravelly silty fine to coarse SAND. Gravel is angular to sub-rounded fine to coarse siltstone.
D3	0.90-1.00			35.24	0.80	MADE GROUND - Grey gravelly fine to coarse SAND. Gravel is angular fine to coarse siltstone.
S	1.20	N=23				
D4	1.50-1.75			34.59	1.45	MADE GROUND - Reddish-brown slightly gravelly silty fine SAND. Gravel is angular to sub-rounded fine to coarse quartz. . . . becoming medium dense below 1.20m.
D5	1.75-2.00					MADE GROUND - Stiff reddish brown locally grey silty CLAY with occasional gravel to cobble sized fragments of sub-angular mudstone and siltstone.
S	2.00	N=16				
D6	2.00-2.50					
D7	2.50-3.00					
S	3.00	N=24				
D8	3.00-3.50					
D9	3.50-4.00					
S	4.00	N=22				
D10	4.00-4.50					
D11	4.50-5.00					
S	5.00	N=35		31.04	5.00	Medium dense orangeish-brown fine to coarse SAND and sub-angular to rounded fine to coarse quartz and flint GRAVEL. (Description based off returned arisings from open hole drilling).
C	6.00	50/285mm				. . . becoming very dense below 6.00m.
C	7.00	N=45				. . . becoming dense between 7.00m to 8.00m.
C	8.00	50/275mm				
C	9.00	50/210mm				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Groundwater seepage was encountered at 16.50m during boring operations.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 5.00m, then by open-hole / driving casing from 5.00m to 12.00m (due to dense gravels). Then advanced to borehole base by rotary coring techniques, with a mist flush.
4. No core sample recovery from 12.00m to 13.50m and then 13.50m to 15.00m.
5. Rotary core run attempted at 12.00m, however no recovery possible due to coring in sands and gravels.
6. Borehole backfilled with sodium bentonite (pellets), and surface reinstated upon completion.

BOREHOLE RECORD - BH G311A

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP	Site M1 J23a to J25 Ground Investigation
Client Costain Galliford Try	Boring diameter: 120 mm to 13.50m, 100 mm to 21.00m; Casing diameter: 120 mm to 13.50m; Project No.: G17057
Logged by: JP; Ground Level: 36.04 mAOD	Date: 24/05/2017-30/05/2017; Location: 331983E - 446553N; Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
						Medium dense orangeish-brown fine to coarse SAND and sub-angular to rounded fine to coarse quartz and flint GRAVEL. (Description based off returned arisings from open hole drilling).
C	10.00	50/160mm				
C	11.00	50/210mm				
C	12.00	50/135mm				
				23.54	12.50	Extremely weak reddish brown MUDSTONE. (Description based off limited returned arisings from rotary coring. Not possible to identify weathering grade due to no core sample recovery). . . . no core recovery between 12.50m to 15.00m.
CR	12.00-13.50	0 0 0				
C	13.50	50/115mm				
CR	13.50-15.00	0 0 0				
C	15.00	50/215mm		21.04	15.00	Weak to medium strong reddish brown to brownish red silty MUDSTONE with occasional very thin beds of gypsum. Weathering evidence as slightly reduced strength and locally mottled discolouration. Bedding fractures are horizontal to sub-horizontal, very closely spaced, planar smooth to planar rough, local clay infill. (Grade II).
CR	15.00-16.50	90 87 25 / 12				
		12	▼			
CR	16.50-18.00	93 88 44				
				18.59	17.45	Medium strong thinly laminated greyish green SILTSTONE with occasional very thin beds of red mudstone. No
C	18.00	50/60mm				
		TCR SCR RQD / FI FS				*(continued next sheet)*

Legend | Backfill

Sheet 2 of 3

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Groundwater seepage was encountered at 16.50m during boring operations.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 5.00m, then by open-hole / driving casing from 5.00m to 12.00m (due to dense gravels). Then advanced to borehole base by rotary coring techniques, with a mist flush.
4. No core sample recovery from 12.00m to 13.50m and then 13.50m to 15.00m.
5. Rotary core run attempted at 12.00m, however no recovery possible due to coring in sands and gravels.
6. Borehole backfilled with sodium bentonite (pellets), and surface reinstated upon completion.

BOREHOLE RECORD - BH G311A

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Client Costain Galliford Try	Site M1 J23a to J25 Ground Investigation			
	Boring diameter: 120 mm to 13.50m 100 mm to 21.00m	Casing diameter: 120 mm to 13.50m	Project No.: G17057	
Logged by: JP	Ground Level: 36.04 mAOD	Date: 24/05/2017-30/05/2017	Location: 331983E - 446553N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	18.00-19.50	87 87 41	8				evidence of weathering. Fractures are horizontal to sub-horizontal, closely spaced, planar smooth to planar rough, clean.		
			12		16.84	19.20	Weak to medium strong reddish brown to brownish red silty MUDSTONE with occasional very thin beds of gypsum. Weathering evidence as slightly reduced strength and locally mottled discolouration. Bedding fractures are horizontal to sub-horizontal, very closely spaced, planar smooth to planar rough, local clay infill. (Grade II).		
CR	19.50-21.00	90 89 17	11						
C	21.00	50/45mm			15.04	21.00	*End of Borehole at 21.00 m*		
		TCR SCR RQD	FI FS					Sheet 3 of 3	

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Groundwater seepage was encountered at 16.50m during boring operations.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 5.00m, then by open-hole / driving casing from 5.00m to 12.00m (due to dense gravels). Then advanced to borehole base by rotary coring techniques, with a mist flush.
4. No core sample recovery from 12.00m to 13.50m and then 13.50m to 15.00m.
5. Rotary core run attempted at 12.00m, however no recovery possible due to coring in sands and gravels.
6. Borehole backfilled with sodium bentonite (pellets), and surface reinstated upon completion.

BOREHOLE RECORD - BH G321

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 14.00m; 100 mm to 23.00m	Casing diameter: 120 mm to 14.00m	Project No.: G17057
Logged by: SS/IG; Ground Level: 45.53 mAOD	Date: 07/06/2017-12/06/2017	Location: 334505E - 447142N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				45.38	0.15	MADE GROUND - Topsoil (soft brown sandy very organic SILT).
B1	0.30-0.40					
				45.03	0.50	MADE GROUND - Brown and orangish-brown slightly gravelly silty fine to coarse SAND. Gravel is angular fine to coarse siltstone and quartz.
B2	0.60-0.80					
S	1.20	N=11		44.33	1.20	MADE GROUND - Light grey roadstone / sub-base (fine to coarse SAND and angular fine to coarse siltstone GRAVEL).
B3	1.40-2.00					
S	2.00	N=11				MADE GROUND - Firm reddish-brown slightly sandy slightly gravelly silty CLAY with a low sub-angular silstone cobble content. Gravel is angular fine to coarse mudstone and siltstone.
B4	2.10-3.00					
S	3.00	N=7				. . . noted as being locally dark grey below 3.00m with a medium sub-angular siltstone cobble content.
B5	3.30-4.00					
S	4.00	N=20				
B6	4.50-5.00					
S	5.00	N=36				
B7	5.00-5.50					
S	6.00	N=42				
D8	6.00-6.45					
C	7.00	N=47		38.53	7.00	Dense reddish-brown gravelly fine to coarse SAND. Gravel is sub-rounded to rounded fine to coarse quartz and chert. (Description based on returned arisings from open hole drilling).
C	8.00	N=49				
C	9.00	N=44				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 5.00m then by open-hole / driving casing from 5.00m to 14.00m, (due to dense gravels). Borehole then advanced to base using rotary coring techniques, with a mist flush.
3. Groundwater entry recorded at 16.30m rising to 14.10m after 20 minutes.
4. Borehole backfilled with sodium bentonite (pellets), and surface reinstated upon completion.

BOREHOLE RECORD - BH G321

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 14.00m 100 mm to 23.00m	120 mm to 14.00m	G17057
Logged by: SS/IG — Ground Level: 45.53 mAOD	Date: 07/06/2017-12/06/2017	Location: 334505E - 447142N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				36.03	9.50	Dense reddish-brown gravelly fine to coarse SAND. Gravel is sub-rounded to rounded fine to coarse quartz and chert. (Description based on returned arisings from open hole drilling).
C	10.50	N=50				Dense reddish-brown fine to coarse SAND and sub-rounded to rounded fine to coarse quartz and chert GRAVEL with occasional quartz cobbles. (Description based on returned arisings from open hole drilling). . . . becoming very dense below 10.50m.
				34.03	11.50	Stiff reddish-brown locally greyish-brown slightly gravelly CLAY. Gravel is sub-rounded to rounded fine to coarse quartz, limestone and igneous lithologies. (Description based on returned arisings from open hole drilling).
C	12.00	N=46				
C	14.00	N=4				
CR	14.00-15.50	20 0 0				
C	15.50	50/140 mm		30.03	15.50	Very stiff locally firm reddish brown sandy CLAY with rare gravel sized sub-angular mudstone lithorelicts. (Grade IVa).
CR	15.50-17.00	23 0 0				
C	17.00	N=43		28.53	17.00	Stiff locally firm reddish brown silty CLAY interbedded with extremely weak reddish-brown MUDSTONE. (Grade III).
CR	17.00-18.50	63 33 32				
		TCR SCR RQD / FI FS				*(continued next sheet)*

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 5.00m then by open-hole / driving casing from 5.00m to 14.00m, (due to dense gravels). Borehole then advanced to base using rotary coring techniques, with a mist flush.
3. Groundwater entry recorded at 16.30m rising to 14.10m after 20 minutes.
4. Borehole backfilled with sodium bentonite (pellets), and surface reinstated upon completion.

BOREHOLE RECORD - BH G321

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation				
Client: Costain Galliford Try	Boring diameter: 120 mm to 14.00m, 100 mm to 23.00m	Casing diameter: 120 mm to 14.00m		Project No.: G17057
Logged by: SS/IG	Ground Level: 45.53 mAOD	Date: 07/06/2017-12/06/2017	Location: 334505E - 447142N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description
					27.23	18.30	Stiff locally firm reddish brown silty CLAY interbedded with extremely weak reddish-brown MUDSTONE. (Grade III).
					27.13	18.40	Stiff grey sandy SILT.
CR	18.50-20.00	0 0 0	NI		27.03	18.50	Extremely weak grey silty fine SANDSTONE. Bedding fractures are horizontal, very closely spaced, planar rough, clean.
C	20.00	50/160 mm			25.53	20.00	Extremely weak reddish brown MUDSTONE. (Description based on limited returned arisings from rotary coring due to no core sample recovery, weathering grade not possible to determine).
CR	20.00-21.50	67 41 25	6		25.38	20.15	Extremely weak reddish brown heavily weathered silty MUDSTONE recovered as fine to medium sub-angular gravel sized fragments. (Grade III to Grade IVa).
					24.28	21.25	Stiff friable reddish brown CLAY/SILT. (Grade IVb).
CR	21.50-23.00	90 67 53	17 3		23.18	22.35	Extremely weak thinly laminated fissile reddish brown MUDSTONE. Bedding fractures are sub-horizontal to horizontal, medium to closely spaced, planar smooth, clean. (Grade II).
					23.03	22.50	Extremely weak locally very weak thinly laminated grey SILTSTONE with occasional gypsum mineralisation. Bedding fractures are horizontal to sub-horizontal, very closely spaced, smooth planar to smooth stepped, clean.
C	23.00	50/30mm			22.53	23.00	Extremely weak locally very weak thinly laminated reddish brown MUDSTONE interbedded with very weak grey SILTSTONE. Bedding fractures are sub-horizontal, closely spaced, smooth undulating, clean. (Grade II to Grade I).
							End of Borehole at 23.00 m

TCR SCR RQD FI FS

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 5.00m then by open-hole / driving casing from 5.00m to 14.00m, (due to dense gravels). Borehole then advanced to base using rotary coring techniques, with a mist flush.
3. Groundwater entry recorded at 16.30m rising to 14.10m after 20 minutes.
4. Borehole backfilled with sodium bentonite (pellets), and surface reinstated upon completion.

NICHOLLS COLTON GROUP

BOREHOLE RECORD - BH G324

(Window Sampler plus Rotary Core)

Site	M1 J23a to J25 Ground Investigation		
Client: Costain Galliford Try	Boring diameter: 120 mm to 2.00m, 92 mm to 12.00m	Casing diameter: 120 mm to 2.00m	Project No.: G17057
Logged by: PM/IG; Ground Level: 49.46 mAOD	Date: 07/06/2017-12/06/2017	Location: 335371E - 447167N	Scale: 1:50

Ref:	Depth (m)	SPT N / TCR SCR RQD	FI FS	Water	Level (mAOD)	Depth (m)	Strata Description
					49.16	0.30	MADE GROUND - Topsoil (soft brown organic slightly gravelly slightly clayey fine to medium SAND. Gravel is sub-rounded to rounded medium to coarse quartz).
B1	0.50-1.00						
S	1.20	N=50					Soft locally firm friable reddish-brown mottled grey CLAY with frequent gravel sized sub-angular mudstone lithorelicts. . . . becoming very stiff below 1.20m. . . . no sample recovery between 1.20m and 2.00m.
D2	1.20-1.65						
					47.46	2.00	Extremely weak reddish brown locally grey MUDSTONE locally weathered to gravel sized fragments. Bedding fractures are horizontal to sub-horizontal locally vertical, closely spaced, planar smooth to planar undulating with local clay infill (Grade II to Grade III).
CR	2.00-3.50	80 60 22	9				
S	3.50	50/260mm	NI				
			3				
			NI				
CR	3.50-5.00	87 53 53	8				
					44.46	5.00	Very stiff friable thinly laminated reddish brown locally grey silty CLAY interbedded with bands of extremely weak MUDSTONE (Grade III).
			6				
CR	5.00-6.50	100 89 87					
S	6.50	50/7 mm					
CR	6.50-8.00	97 74 73					
					41.26	8.20	Very stiff friable reddish brown locally grey silty CLAY with frequent gravel sized sub-angular mudstone lithorelicts and occasional mudstone bands (Grade III
CR	8.00-9.50	98 59 43					

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. No groundwater seepages were encountered during boring operations, however entries may have been masked due to drilling technique.
3. Borehole advanced using P60 (slope climbing) combination rig P60C, using dynamic sampling techniques from 1.20m to 2.00m then rotary coring techniques from 1.20m to the borehole base, with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) on completion.

BOREHOLE RECORD - BH G324

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try

Boring diameter: 120 mm to 2.00m; 92 mm to 12.00m

Casing diameter: 120 mm to 2.00m

Project No.: G17057

Logged by: PM/IG | Ground Level: 49.46 mAOD | Date: 07/06/2017-12/06/2017 | Location: 335371E - 447167N | Scale: 1:50

Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description
							to Grade IVa).
C	9.50	50/250mm					
			NI		39.46	10.00	
CR	9.50-11.00	96 47 27			39.21	10.25	Very weak thinly laminated grey SILTSTONE. Bedding fractures are horizontal, very closely spaced, planar smooth, clean.
							Very stiff friable reddish brown locally grey silty CLAY with frequent gravel sized sub-angular mudstone lithorelicts (Grade III to Grade IVa).
C	11.00	50/165mm					
CR	11.00-12.00	27 13 0					
C	12.00	50/150mm			37.46	12.00	
D3	12.00-12.30						*End of Borehole at 12.00 m*

Sheet 2 of 2

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. No groundwater seepages were encountered during boring operations, however entries may have been masked due to drilling technique.
3. Borehole advanced using P60 (slope climbing) combination rig P60C, using dynamic sampling techniques from 1.20m to 2.00m then rotary coring techniques from 1.20m to the borehole base, with a mist flush.
4. Borehole backfilled with sodium bentonite (pellets) on completion.

BOREHOLE RECORD - BH G326

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 16.50m 100 mm to 22.50m	120 mm to 16.50m	G17057

Logged by: JP	Ground Level: 37.05 mAOD	Date: 03/05/2017-09/05/2017	Location: 329612E - 447034N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				36.85	0.20	MADE GROUND - Topsoil (soft brown organic sandy SILT with frequent rootlets).
				36.65	0.40	MADE GROUND - Orangish-brown fine to coarse SAND and sub-angular to sub-rounded fine to coarse quartz GRAVEL.
B1	0.60-0.70					
				36.25	0.80	MADE GROUND - Stiff friable reddish brown locally light grey silty CLAY with many gravel sized fragments of sub-angular granite roadstone and pockets and partings of sand and gravel.
D2	1.00-1.10			36.05	1.00	MADE GROUND - Roadstone with pockets of sand and gravel.
S	1.20	N=6				Stiff friable reddish brown and light grey slightly gravelly silty CLAY. Gravel is angular coarse siltstone. . . . noted as being firm between 1.50m and 2.40m.
D3	1.50-2.00					
S	2.00	N=7				
D4	2.00-2.50					
D5	2.50-3.00					
S	3.00	N=18				
D6	3.00-3.50					
D7	3.50-4.00					
S	4.00	N=11				
D8	4.00-4.50					
D9	4.50-5.00					
S	5.00	N=19				
D10	5.00-5.50					
				31.35	5.70	Very dense brown fine to coarse SAND and sub-angular to sub-rounded fine to coarse quartz GRAVEL. (Description based on returned arisings from open hole drilling). . . . advanced from 6.00m to 12.00m using open hole techniques.
C	6.00	50/140mm				
C	7.50	50/80mm				
C	9.00	50/230mm				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 6.00m, then by open hole / driving casing from 6.00m to 13.50m (due to dense gravels). Borehole advanced by rotary coring techniques to base, with a mist flush.
4. Borehole backfilled to ground level with sodium bentonite pellets upon completion.

BOREHOLE RECORD - BH G326

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site	M1 J23a to J25 Ground Investigation
Client	Costain Galliford Try
Boring diameter:	120 mm to 16.50m 100 mm to 22.50m
Casing diameter:	120 mm to 16.50m
Project No.:	G17057
Logged by:	JP
Ground Level:	37.05 mAOD
Date:	03/05/2017-09/05/2017
Location:	329612E - 447034N
Scale:	1:50

Ref:	Depth (m)	SPT N / TCR SCR RQD	FI FS	Water	Level (mAOD)	Depth (m)	Strata Description
							Very dense brown fine to coarse SAND and sub-angular to sub-rounded fine to coarse quartz GRAVEL. (Description based on returned arisings from open hole drilling).
C	10.50	N=40					. . . becoming dense below 10.50m.
C	12.00	50/175mm					
C	13.50	50/230 mm			23.55	13.50	Extremely weak reddish brown MUDSTONE. (Description based on limited returned arisings due to no core sample recovery. No recovery of core samples preventing identification of weathering grade).
CR	13.50-15.00	0 0 0					
C	15.00	50/230 mm					
CR	15.00-16.50	0 0 0					
C	16.50	50/205 mm			20.55	16.50	Weak reddish brown MUDSTONE with frequent thin to thick veins of gypsum and occasional beds of grey sandstone. No evidence of weathering. Fractures are horizontal, closely spaced, undulating and planar, rough and smooth, clean. (Grade I).
CR	16.50-18.00	0 0 0					
C	18.00	50/80 mm	6				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 6.00m, then by open hole / driving casing from 6.00m to 13.50m (due to dense gravels). Borehole advanced by rotary coring techniques to base, with a mist flush.
4. Borehole backfilled to ground level with sodium bentonite pellets upon completion.

BOREHOLE RECORD - BH G326

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try

Boring diameter: 120 mm to 16.50m; 100 mm to 22.50m

Casing diameter: 120 mm to 16.50m

Project No.: G17057

Logged by: JP | Ground Level: 37.05 mAOD | Date: 03/05/2017-09/05/2017 | Location: 329612E - 447034N | Scale: 1:50

Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description
CR	18.00-19.50	100 97 87	2				Weak reddish brown MUDSTONE with frequent thin to thick veins of gypsum and occasional beds of grey sandstone. No evidence of weathering. Fractures are horizontal, closely spaced, undulating and planar, rough and smooth, clean. (Grade I).
C	19.50	50/40	m				
			2				
CR	19.50-21.00	87 87 60					
			3				
C	21.00	50/15	mm				
CR	21.00-22.50	100 97 90	3				
C	22.50	50/25mm			14.55	22.50	*End of Borehole at 22.50 m*

TCR SCR RQD | FI FS

Remarks and Water Observations

1. Hand dug starter pit to 1.20m, to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques from 1.20m to 6.00m, then by open hole / driving casing from 6.00m to 13.50m (due to dense gravels). Borehole advanced by rotary coring techniques to base, with a mist flush.
4. Borehole backfilled to ground level with sodium bentonite pellets upon completion.

BOREHOLE RECORD - E3-A1

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation			
Client Costain Galliford Try	Boring diameter: 120 mm to 12.00m	Casing diameter: 120 mm to 11.00m	Project No.: G17057
Logged by: PM / Ground Level: 35.83 mAOD	Date: 22/05/2017-23/05/2017	Location: 331084E - 446517N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				35.63	0.20	MADE GROUND - Topsoil (brown slightly gravelly silty medium to coarse SAND with frequent rootlets).
D1	0.40-0.60					
				35.13	0.70	MADE GROUND - Brown slightly gravelly clayey medium to coarse SAND. Gravel is angular to sub-rounded fine to coarse granite, quartz and sandstone.
B2	1.00-2.00			34.83	1.00	MADE GROUND - Reddish brown gravelly medium to coarse SAND with a medium sub-rounded sandstone boulder content. Gravel is angular to sub-rounded medium to coarse sandstone.
S	1.20	N=26				
				34.43	1.40	MADE GROUND - Reddish brown gravelly silty medium to coarse SAND. Gravel is angular to sub-angular fine to coarse sandstone. . . . becoming medium dense below 1.20m.
B3	1.50-2.00					
S	2.00	N=19				
B4	2.00-3.00					
S	3.00	N=28				MADE GROUND - Firm reddish brown mottled yellow and grey friable slightly sandy slightly gravelly CLAY with frequent sand lenses. Gravel is angular to sub-angular fine to coarse sandstone.
B5	3.00-4.00					
S	4.00	N=49				
S	5.00	50/145mm				
S	6.00	50/105mm		29.83	6.00	Very dense reddish brown fine to coarse SAND and sub-angular to rounded quartz and sandstone GRAVEL. (Description based on arisings returned from open hole drilling).
S	7.00	50/160mm				
S	8.00	50/220mm				
C	9.00	50/280mm				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using using Commachio 205 combination rig GC01, using dynamic sampling techniques 1.20m to 4.00m and 11.00m to 12.00m, then by rotary open hole techniques from 4.00m to 11.00m with a mist flush.
4. Borehole backfilled with bentonite pellets to ground level upon completion.

BOREHOLE RECORD - E3-A1

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation				
Client Costain Galliford Try	Boring diameter: 120 mm to 12.00m	Casing diameter: 120 mm to 11.00m	Project No.: G17057	
Logged by: PM	Ground Level: 35.83 mAOD	Date: 22/05/2017-23/05/2017	Location: 331084E - 446517N	Scale: 1:50

Samples & In situ Tests			Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
Ref:	Depth (m)	SPT N						
						Very dense reddish brown fine to coarse SAND and sub-angular to rounded quartz and sandstone GRAVEL. (Description based on arisings returned from open hole drilling).		
C	10.00	50/200mm						
C	11.00	N=17				. . . becoming medium dense below 11.00m.		
D6	11.00-11.50							
B7	11.50-12.00			24.33	11.50	Soft grey slightly gravelly sandy CLAY. Gravel is sub-angular fine to medium quartz.		
				23.83	12.00	*End of Borehole at 12.00 m*		

Sheet 2 of 2

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using using Commachio 205 combination rig GC01, using dynamic sampling techniques 1.20m to 4.00m and 11.00m to 12.00m, then by rotary open hole techniques from 4.00m to 11.00m with a mist flush.
4. Borehole backfilled with bentonite pellets to ground level upon completion.

BOREHOLE RECORD - CPT01

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client Costain Galliford Try	Boring diameter: 120 mm to 1.50m 100 mm to 6.45m	Casing diameter: 120 mm to 1.50m	Project No.: G17057
Logged by: SS — Ground Level: 274.10 mAOD	Date: 14/06/2017	Location: 447358E - 326274N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				273.94	0.16	MADE GROUND - Macadam road surfacing.
B1	0.30-0.50					
				273.40	0.70	MADE GROUND - Light brown angular to sub-angular medium to coarse limestone GRAVEL.
C	1.00	50/40mm				MADE GROUND - Very dense light brown sandy angular coarse limestone GRAVEL.
C	2.00	50/95mm		272.10	2.00	
CR	2.00-3.00	65 30 25				Very weak to weak reddish brown highly fractured MUDSTONE in a clayey matrix. Locally sandy clay with numerous gravel sized mudstone lithorelicts (Grade III).
C	3.00	N=48		271.10	3.00	
CR	3.00-4.50	83 37 33				Weak to moderately weak reddish brown thinly laminated MUDSTONE thickly interbedded with weak SILTSTONE. Discontinuities are sub-horizontal closely spaced, smooth planar rough undulating, clean. (Grade II).
C	4.50	50/90mm				
CR	4.50-6.00	100 47 13				
C	6.00	50/25mm				
				267.65	6.45	*End of Borehole at 6.45 m*

TCR SCR RQD FI FS

Sheet 1 of 1

Remarks and Water Observations

1. Borehole advanced through road surfacing using road coring attachment.
2. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 3.00m techniques, then advanced to the borehole base using rotary coring techniques, with a mist flush.
3. No groundwater seepages were encountered during drilling operations.
4. Borehole backfilled with sodium bentonite (pellets) upon completion and surface reinstated.

BOREHOLE RECORD - CPT02
(Window Sampler)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation				
Client: Costain Galliford Try	Boring diameter: 120 mm to 5.00m; 120 mm to 10.00m	Casing diameter: 120 mm to 5.00m	Project No.: G17057	
Logged by: PM	Ground Level: 37.48 mAOD	Date: 03/07/2017	Location: 328684E - 447304N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				37.28	0.20	MADE GROUND - Bituminous macadam (carriageway surfacing).
				37.26	0.22	MADE GROUND - Macadam.
				37.18	0.30	MADE GROUND - Crushed rock sub-base.
D1	0.60-1.00			36.88	0.60	MADE GROUND - Concrete.
				36.58	0.90	MADE GROUND - Sub-base.
D2	1.30-1.50			36.18	1.30	MADE GROUND - Brown angular to sub-rounded fine to coarse siltstone, sandstone and quartzite GRAVEL.
C	1.50	N=17				
B3	1.50-2.30					
				35.68	1.80	MADE GROUND - Stiff reddish brown mottled grey slightly gravelly CLAY with a medium sub-rounded siltstone cobble content. Gravel is sub-angular to sub-rounded fine to coarse siltstone and mudstone.
D4	2.30-2.40			35.18	2.30	MADE GROUND - Stiff reddish brown mottled grey slightly gravelly CLAY. Gravel is sub-angular fine siltstone and mudstone.
C	2.50	N=25				Medium dense brown medium to coarse SAND and sub-angular to sub-rounded fine to coarse siltstone sandstone and quartzite GRAVEL. . . . becoming very dense below 3.50m.
C	3.50	50/295mm				
D5	4.00-5.00					
C	4.50	50/285mm				
C	5.00	50/255mm		32.48	5.00	*End of Borehole at 5.00 m*

Sheet 1 of 1

Remarks and Water Observations

1. Carriageway surfacing cored for borehole access.
2. No groundwater seepages were encountered during boring operations (entries may have been masked by water added to aid drilling operations).
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 2.50m, then by rotary open hole / driving casing to the borehole base, with a mist flush.
4. Borehole backfilled with sodium bentonite pellets to 2.00m then to ground level with granular material by CGT.

BOREHOLE RECORD - SP01
(Window Sampler)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation			
Client Costain Galliford Try	Boring diameter: 120 mm to 10.00m	Casing diameter: 120 mm to 10.00m	Project No.: G17057
Logged by: PM / Ground Level: 33.49 mAOD	Date: 04/07/2017	Location: 328421E - 447388N	Scale: 1:50

Samples & In situ Tests			Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
Ref:	Depth (m)	SPT N						
				33.27	0.22	MADE GROUND - Macadam.		
				32.89	0.60	MADE GROUND - Concrete.		
D1	0.90-1.50			32.59	0.90	MADE GROUND - Reddish brown angular to sub-angular fine to coarse granite GRAVEL (Sub-base).		
C	1.50	N=39						
D2	1.50-1.80			31.69	1.80	MADE GROUND - Firm reddish brown mottled grey slightly gravelly CLAY with a medium sub-angular siltstone cobble content. Gravel is sub-angular to sub-rounded fine to coarse siltstone and mudstone.		
						MADE GROUND - Brown medium to coarse SAND and sub-angular to sub-rounded fine to medium siltstone, sandstone and quartzite GRAVEL. . . . becoming very dense below 3.00m.		
C	3.00	50/140mm						
B3	3.30-6.00							
C	4.50	50/130mm						
C	6.00	50/60mm						
B4	7.00-10.00							
C	7.50	N=44				. . . becoming dense between 7.50m to 10.00m.		
C	9.00	N=43						
						(continued next sheet)	Sheet 1 of 2	

Remarks and Water Observations

1. Carriageway surfacing cored for borehole access.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 3.00m, then by open hole / driving casing (due to dense gravels) to the borehole base, with a mist flush.
4. Borehole backfilled with sodium bentonite pellets to ground level upon completion.

BOREHOLE RECORD - SP01
(Window Sampler)

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 10.00m	120 mm to 10.00m	G17057

Logged by: PM	Ground Level: 33.49 mAOD	Date: 04/07/2017	Location: 328421E - 447388N	Scale: 1:50

Samples & In situ Tests			Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
Ref:	Depth (m)	SPT N						
						MADE GROUND - Brown medium to coarse SAND and sub-angular to sub-rounded fine to medium siltstone, sandstone and quartzite GRAVEL.		
C	10.00	50/285mm		23.49	10.00	*End of Borehole at 10.00 m*		

Remarks and Water Observations

1. Carriageway surfacing cored for borehole access.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig GC01, using dynamic sampling techniques from 1.20m to 3.00m, then by open hole / driving casing (due to dense gravels) to the borehole base, with a mist flush.
4. Borehole backfilled with sodium bentonite pellets to ground level upon completion.

BOREHOLE RECORD - G112

(Window Sampler plus Rotary Core)

Site	M1 J23a to J25 Ground Investigation
Client	Costain Galliford Try
Boring diameter:	120 mm to 32.50m
Casing diameter:	120 mm to 20.00m
Project No.:	G17057
Logged by:	IG
Ground Level:	37.87 mAOD
Date:	13/06/2017-19/06/2017
Location:	327569E - 447563N
Scale:	1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
B1	0.10-0.40					MADE GROUND - TOPSOIL (dark brown slightly gravelly silty fine SAND with frequent rootlets. Gravel is sub-angular to rounded fine to coarse quartz).
B2	0.50-1.00			37.47	0.40	Orangeish brown gravelly silty fine to coarse SAND with frequent quartz cobbles. Gravel is sub-angular to rounded fine to coarse quartz, sandstone and mudstone.
S	1.20	N=29				
D3	1.20-1.65					
D4	1.50-2.00			36.37	1.50	Firm reddish brown slightly gravelly sandy CLAY. Gravel is sub-angular to rounded fine to coarse quartz, flint, mudstone and sandstone.
S	2.00	N=25				
D5	2.00-2.45					
D6	2.40-3.00			35.47	2.40	Firm reddish brown sandy CLAY.
S	3.00	N=8				. . . locally soft from 3.00m to 3.60m.
D7	3.00-3.45					
D8	3.00-3.40					
D9	3.40-4.00			34.47	3.40	Firm friable reddish brown SILT.
S	4.00	N=17				
D10	4.00-4.45					
B11	4.00-4.75					
D12	4.75-5.00			33.12	4.75	Firm medium interbedded reddish brown slightly sandy CLAY and grey sandy SILT.
S	5.00	N=10				
D13	5.00-5.45					
D14	5.00-5.30					
D15	5.30-6.00					
S	6.10	50/100mm		31.77	6.10	Extremely weak reddish brown with some light grey MUDSTONE. Fractures are horizontal, close to medium spaced, undulating, striated, clean and very tight (All drilling induced). (Grade I).
D16	6.10-6.50					
CR	6.10-7.00	74 42 42				. . . band of light grey SILTSTONE from 7.20m to 7.40m.
CR	7.00-8.50	97 55 37				. . . drilling induced non-intact zone from 7.25m to 7.35m. . . . band of light grey SILTSTONE from 7.80m to 8.20m.
C	8.50	N=36		29.37	8.50	. . . drilling induced non-intact zone from 8.25m to 8.30m.
		TCR SCR RQD FI FS				*(continued next sheet)*

Sheet 1 of 4

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Groundwater seepage was encountered at 14.50m during boring operations.
3. Borehole advanced using Borehole advanced using P60 (slope climbing) combination rig P60C, using dynamic sampling techniques through overburden then by rotary coring techniques in rock from 6.10m to base, with a mist flush.
4. Borehole backfilled with bentonite pellets to ground level upon completion.

BOREHOLE RECORD - G112

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 32.50m	120 mm to 20.00m	G17057

Logged by: IG	Ground Level: 37.87 mAOD	Date: 13/06/2017-19/06/2017	Location: 327569E - 447563N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description
CR	8.50-10.00	95 0 0					Stiff reddish brown and occasional light grey silty CLAY.
					28.27	9.60	. . . band of firm friable light grey silt noted from 9.15m to 9.30m.
							Extremely weak fissile light grey SILTSTONE.
CR	10.00-11.50	90 50 44			27.27	10.60	. . . band of very weak reddish brown MUDSTONE noted from 10.35m to 10.40m.
							Extremely weak fissile reddish brown with some light grey MUDSTONE. Fractures are horizontal, close to medium spaced, undulating, striated, clean and very tight (Mostly being drilling induced). (Grade I).
C	11.50	50/180mm					
							. . . light grey only between 11.70m and 12.30m.
CR	11.50-13.00	90 40 27					
CR	13.00-14.50	93 65 41					. . . light grey only between 13.80m and 14.00m.
C	14.50	50/270mm		▼			. . . grading to very stiff CLAY between 14.50m and 15.05m.
CR	14.50-16.00	91 45 44					
CR	16.00-17.50	80 59 46					
C	17.50	50/175mm					. . . becoming very weak below 17.50m.

Legend | Backfill

TCR SCR RQD FI FS

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Groundwater seepage was encountered at 14.50m during boring operations.
3. Borehole advanced using Borehole advanced using P60 (slope climbing) combination rig P60C, using dynamic sampling techniques through overburden then by rotary coring techniques in rock from 6.10m to base, with a mist flush.
4. Borehole backfilled with bentonite pellets to ground level upon completion.

BOREHOLE RECORD - G112

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 32.50m	120 mm to 20.00m	G17057

Logged by: IG	Ground Level: 37.87 mAOD	Date: 13/06/2017-19/06/2017	Location: 327569E - 447563N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description
CR	17.50-19.00	87 30 27					Extremely weak fissile reddish brown with some light grey MUDSTONE. Fractures are horizontal, close to medium spaced, undulating, striated, clean and very tight (Mostly being drilling induced). (Grade I). . . . sandy between 18.60m and 19.00m.
CR	19.00-20.50	97 60 47					
C	20.50	50/85mm					. . . numerous (drilling induced) fractures noted between 20.5m and 23.50m.
CR	20.50-22.00	100 51 23					
CR	22.00-23.50	100 75 47					
C	23.50	50/130mm					. . . some (drilling induced) fractures noted between 23.50m and 25.00m.
CR	23.50-25.00	100 63 55					
							. . . sub-vertical fracture (naturally occurring) noted from 25.05m to 25.15m.
CR	25.00-26.50	100 91 80					
C	26.50	50/65mm					
CR	26.50-28.00	95 67 59					. . . 30mm band of siltstone noted at 26.80m.

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Groundwater seepage was encountered at 14.50m during boring operations.
3. Borehole advanced using Borehole advanced using P60 (slope climbing) combination rig P60C, using dynamic sampling techniques through overburden then by rotary coring techniques in rock from 6.10m to base, with a mist flush.
4. Borehole backfilled with bentonite pellets to ground level upon completion.

BOREHOLE RECORD - G112

(Window Sampler plus Rotary Core)

Site: M1 J23a to J25 Ground Investigation

Client Costain Galliford Try	Boring diameter: 120 mm to 32.50m	Casing diameter: 120 mm to 20.00m	Project No.: G17057	
Logged by: IG	Ground Level: 37.87 mAOD	Date: 13/06/2017-19/06/2017	Location: 327569E - 447563N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description
							Extremely weak fissile reddish brown with some light grey MUDSTONE. Fractures are horizontal, close to medium spaced, undulating, striated, clean and very tight (Mostly being drilling induced). (Grade I). . . . 70mm band of siltstone noted at 27.40m. . . . 50mm band of siltstone noted at 27.75m. . . . 30mm band of siltstone noted at 28.00m. . . . 50mm band of siltstone noted at 28.50m.
CR	28.00-29.50	93 63 37					
C	29.50	50/16 mm					
CR	29.50-31.00	83 53 49					. . . sub-vertical fracture (naturally occurring) noted from 30.10m to 30.20m.
CR	31.00-32.50	100 55 33					. . . 30mm band of siltstone noted at 31.50m.
C	32.50	50/75mm			5.37	32.50	*End of Borehole at 32.50 m*

TCR SCR RQD FI FS

Sheet 4 of 4

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. Groundwater seepage was encountered at 14.50m during boring operations.
3. Borehole advanced using Borehole advanced using P60 (slope climbing) combination rig P60C, using dynamic sampling techniques through overburden then by rotary coring techniques in rock from 6.10m to base, with a mist flush.
4. Borehole backfilled with bentonite pellets to ground level upon completion.

BOREHOLE RECORD - G302

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try	Boring diameter: 120 mm to 26.50m	Casing diameter: 120 mm to 14.50m	Project No.: G17057
Logged by: JP — Ground Level: 38.76 mAOD	Date: 19/07/2017-21/07/2017	Location: 447102E - 330395N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				38.51	0.25	MADE GROUND - Macadam road construction.
				38.36	0.40	MADE GROUND - Concrete road construction.
D1	0.60-0.70	(0)		37.86	0.90	MADE GROUND - Light grey fine to coarse SAND and angular fine to coarse siltstone GRAVEL. (Road stone sub-base).
S	1.00	140 kPa N=7				
D2	1.10-1.20	(0)				
D3	1.20-1.60	(0)				
D4	1.60-2.00	(0)				
S	2.00	N=3				
D5	2.00-2.50	(0)				
D6	2.50-3.00	(0)				
S	3.00	N=4				
D7	3.00-3.50	(0)				
D8	3.50-4.00	(0)		35.26	3.50	MADE GROUND - Stiff reddish brown and occasionally light grey silty CLAY with many angular gravel sized fragments of siltstone.
S	4.00	N=22		34.66	4.10	MADE GROUND - Soft brown with occasional black speckles slightly gravelly slightly clayey sandy (fine) SILT with occasional rootlets. Gravel is sub-angular to sub-rounded fine to coarse quartz.
D9	4.20-4.60	(0)				
S	5.00	N=12		33.86	4.90	MADE GROUND - Firm reddish brown and light grey slightly gravelly silty CLAY. Gravel is angular to sub-rounded quartz, siltstone and mudstone.
D10	5.30-5.70	(0)				MADE GROUND - Stiff grey and occasional reddish brown slightly gravelly silty CLAY. Gravel is angular to sub-rounded fine to coarse quartz, siltstone and mudstone.
						. . . becoming reddish brown with occasional light grey below 6.00m.
D11	6.40-6.90	(0)				
S	7.00	N=33				
D12	7.30-7.50	(0)		31.26	7.50	MADE GROUND - Stiff grey and occasional reddish brown slightly gravelly silty CLAY (stratum above ends).
C	8.00	50/230mm				MADE GROUND - Brown fine to coarse SAND and sub-angular to sub-rounded fine to coarse quartz GRAVEL. (Determined from open hole arisings only).
C	9.00	50/155mm				

(continued next sheet)

Remarks and Water Observations

1. Advanced through road construction using coring attachment, then hand dug starter pit to 1.20m, to check for services.
2. Set of three Hand Shear Vane (HSV) tests undertaken at 0.90m all reached maximum capacity of unit (140kPa), using the pilcon unit (HSV3) and the 19mm vane. Attempted HSV test at 1.20m, ground too hard for vane (19mm) to penetrate.
3. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques through overburden (to 7.50m) then by open-hole / driving casing from through dense coarse grained soils (to 14.00m), then rotary coring through rock to base (26.50m).
4. Borehole backfilled with sodium bentonite (pellets) to 1.50m below surface, rapid setting concrete to 0.10m then surface reinstated upon completion.

BOREHOLE RECORD - G302

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation					
Client Costain Galliford Try		Boring diameter: 120 mm to 26.50m	Casing diameter: 120 mm to 14.50m	Project No.: G17057	
Logged by: JP	Ground Level: 38.76 mAOD	Date: 19/07/2017-21/07/2017	Location: 447102E - 330395N	Scale: 1:50	

Samples & In situ Tests Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
						MADE GROUND - Brown fine to coarse SAND and sub-angular to sub-rounded fine to coarse quartz GRAVEL. (Determined from open hole arisings only).		
C	10.50	50/80mm						
C	12.00	50/65mm						
C	13.50	50/65mm		25.26	13.50	Stiff reddish brown slightly gravelly silty CLAY. Gravel is angular to sub-rounded fine to coarse quartz, siltstone and mudstone. (no sample recovery, description determined from arisings and SPT sample only).		
C	14.50	50/160mm						
				21.26	17.50	Extremely weak, locally very weak reddish brown MUDSTONE with many thin bands of gypsum (2mm).		

(continued next sheet)

Remarks and Water Observations

1. Advanced through road construction using coring attachment, then hand dug starter pit to 1.20m, to check for services.
2. Set of three Hand Shear Vane (HSV) tests undertaken at 0.90m all reached maximum capacity of unit (140kPa), using the pilcon unit (HSV3) and the 19mm vane. Attempted HSV test at 1.20m, ground too hard for vane (19mm) to penetrate.
3. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques through overburden (to 7.50m) then by open-hole / driving casing from through dense coarse grained soils (to 14.00m), then rotary coring through rock to base (26.50m).
4. Borehole backfilled with sodium bentonite (pellets) to 1.50m below surface, rapid setting concrete to 0.10m then surface reinstated upon completion.

BOREHOLE RECORD - G302

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation				
Client: Costain Galliford Try	Boring diameter: 120 mm to 26.50m	Casing diameter: 120 mm to 14.50m	Project No.: G17057	
Logged by: JP	Ground Level: 38.76 mAOD	Date: 19/07/2017-21/07/2017	Location: 447102E - 330395N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	17.50-19.00	33 11 0					Discontinuities are horizontal closely spaced smooth planar with local clay infill. (Grade I-II).		
CR	19.00-20.50	84 40 25					. . . sub-vertical frature noted from 19.70m to 19.75m. . . . 15mm thick band of sub-horizontal gypsum noted from 19.95m to 20.00m.		
CR	20.50-22.00	85 79 75			17.96	20.80	Weak locally very weak grey SILTSTONE with rare thin bands of gypsum (2-3mm). Discontinuities are sub-horizontal closely spaced smooth planar and clean.		
CR	22.00-23.50	93 52 32			16.76	22.00	Weak locally very weak reddish brown SILTSTONE locally grading to mudstone (in bands up to 50mm) with occasional thin bands of gypsum (2-3mm). Discontinuities are sub-horizontal closely spaced smooth planar with local clay infill.		
CR	23.50-25.00	93 55 33			14.46	24.30	Weak light grey fine grained SANDSTONE. No fractures.		
					14.11	24.65	Weak locally very weak reddish brown SILTSTONE locally grading to mudstone (in bands up to 50mm) with occasional thin bands of gypsum (2-3mm). Discontinuities are sub-horizontal closely spaced smooth planar with local clay infill.		
CR	25.00-26.50	95 60 44			13.56	25.20	Weak light grey fine grained SANDSTONE with rare gypsum bands (10mm). Discontinuities are sub-horizontal closely spaced to medium spaced rough planar and clean. . . . Band of very weak reddish brown SILTSTONE noted from 25.75m to 25.90m.		
					12.26	26.50	*End of Borehole at 26.50 m*		
		TCR SCR RQD	FI FS					Sheet 3 of 3	

Remarks and Water Observations

1. Advanced through road construction using coring attachment, then hand dug starter pit to 1.20m, to check for services.
2. Set of three Hand Shear Vane (HSV) tests undertaken at 0.90m all reached maximum capacity of unit (140kPa), using the pilcon unit (HSV3) and the 19mm vane. Attempted HSV test at 1.20m, ground too hard for vane (19mm) to penetrate.
3. Borehole advanced using Commachio 205 combination rig AR01, using dynamic sampling techniques through overburden (to 7.50m) then by open-hole / driving casing from through dense coarse grained soils (to 14.00m), then rotary coring through rock to base (26.50m).
4. Borehole backfilled with sodium bentonite (pellets) to 1.50m below surface, rapid setting concrete to 0.10m then surface reinstated upon completion.

BOREHOLE RECORD - G311B

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site	M1 J23a to J25 Ground Investigation
Client	Costain Galliford Try
Boring diameter:	120 mm to 13.50m 100 mm to 21.50m
Casing diameter:	120 mm to 13.50m
Project No.:	G17057
Logged by:	IG
Ground Level:	33.80 mAOD
Date:	09/10/2017-11/10/2017
Location:	446589E - 331987N
Scale:	1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				33.65	0.15	MADE GROUND - Macadam.
				33.30	0.50	MADE GROUND - Concrete.
D1	0.85-1.00			32.95	0.85	MADE GROUND - Whitish grey sandy silty sub-angular to sub-rounded fine to coarse limestone GRAVEL (sub-base).
S	1.00	N=18				
E2	1.00					
D3	1.00-1.45					
B4	1.00-2.00					MADE GROUND - Firm reddish brown slightly sandy slightly gravelly clayey SILT. Gravel is sub-angular to rounded fine to coarse sandstone, mudstone and quartz.
S	2.00	N=17	▼			
D5	2.00-2.45					
B6	2.30-3.00			31.50	2.30	Firm locally stiff reddish brown slightly sandy slightly gravelly silty CLAY. Gravel is sub-angular to rounded fine to coarse sandstone, mudstone and quartz.
S	3.00	N=27				
D7	3.00-3.45					
D8	3.50-3.90					
D9	3.90-4.45			29.90	3.90	Medium dense dark brown gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse sandstone, mudstone and quartz.
S	4.00	N=21				
S	6.00	N=12				
D10	6.00-6.45			27.70	6.10	Medium dense orangish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse quartz, flint, mudstone and sandstone.
D11	6.00-7.00					
S	7.00	N=10		26.80	7.00	Loose orangish brown silty fine to coarse SAND and sub-angular to rounded fine to coarse quartz, flint, mudstone and sandstone GRAVEL.
D12	7.00-7.45					
B13	7.00-8.00					
S	9.00	N=34				

(continued next sheet)

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 6.00m, then by open-hole driving casing from 6.00m to 13.50m (through the dense coarse grained soils). Borehole then advanced to 21.50m using rotary coring techniques with a mist flush.
3. Groundwater entry encountered at 2.00m (sealed off with casing) remaining level after 20 minutes.
4. SPT's at 5.00m and 8.00m not possible due to granular soils collapsing into the borehole and blowing up the casing.
5. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
6. All arisings removed and work area cleaned.

BOREHOLE RECORD - G311B

(Window Sampler plus Rotary Core)

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 13.50m; 100 mm to 21.50m	Casing diameter: 120 mm to 13.50m	Project No.: G17057
Logged by: IG	Ground Level: 33.80 mAOD	Date: 09/10/2017-11/10/2017	Location: 446589E - 331987N
Scale: 1:50			

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
						Remaining Detail : 9.00m - 9.00m : . . . becoming dense below 9.00m.
S	10.50	50/200mm				. . . becoming very dense below 10.50m.
S	12.00	50/225mm		21.80	12.00	Stiff friable reddish brown SILT.
D14	12.00-12.45					
S	13.50	50/225mm				
CR	13.50-14.00	20 / 0 / 0				
D15	14.00-15.50			19.80	14.00	Extremely weak weathered grey SILTSTONE with gypsum bands recovered as gravel sized fragments (Grade II).
CR	14.00-15.50	13 / 0 / 0				
				18.30	15.50	Weak reddish brown MUDSTONE interbedded with grey SILTSTONE with occasional gypsum veins. Bedding fractures are horizontal closely spaced, planar smooth to undulating smooth and clean (Grade I).
CR	15.50-17.00	87 / 52 / 36; FI 10		17.55	16.25	Extremely weak reddish brown MUDSTONE (recovered as stiff sandy clay with frequent mudstone lithorelicts) (Grade III).
				17.40	16.40	Weak reddish brown MUDSTONE interbedded with grey SILTSTONE with occasional gypsum veins. Bedding fractures are horizontal closely spaced, planar smooth to undulating smooth and clean (Grade I).
C	17.00	50/35m				
CR	17.00-18.50	97 / 69 / 66; FI 8				
		TCR SCR RQD / FI FS				*(continued next sheet)*

Sheet 2 of 3

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 6.00m, then by open-hole / driving casing from 6.00m to 13.50m (through the dense coarse grained soils). Borehole then advanced to 21.50m using rotary coring techniques with a mist flush.
3. Groundwater entry encountered at 2.00m (sealed off with casing) remaining level after 20 minutes.
4. SPT's at 5.00m and 8.00m not possible due to granular soils collapsing into the borehole and blowing up the casing.
5. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
6. All arisings removed and work area cleaned.

BOREHOLE RECORD - G311B

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation				
Client: Costain Galliford Try	Boring diameter: 120 mm to 13.50m, 100 mm to 21.50m	Casing diameter: 120 mm to 13.50m		Project No.: G17057
Logged by: IG	Ground Level: 33.80 mAOD	Date: 09/10/2017-11/10/2017	Location: 446589E - 331987N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
							Remaining Detail : 17.00m - 17.00m : . . . weathered to firm clay between 17.00m to 17.10m. Detail 17.30m - 17.30m : . . . with a 30mm gypsum band at 17.30m. . . . bedding fractures are medium spaced below 18.40m. . . . with frequent gypsum veins below 18.80m. . . . weathered to firm clay between 19.40m to 19.50m.		
CR	18.50-20.00	100 85 80	3						
C	20.00	50/75	m						
					13.65	20.15	. . . weathered to firm clay between 20.00m to 20.15m.		
							Weak reddish brown MUDSTONE with occasional gypsum veins. Bedding fractures are horizontal, medium spaced, planar smooth and clean. (Grade I).		
CR	20.00-21.50	93 73 51							
C	21.50	50/35mm			12.30	21.50	*End of Borehole at 21.50 m*		

TCR SCR RQD FI FS

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 6.00m, then by open-hole / driving casing from 6.00m to 13.50m (through the dense coarse grained soils). Borehole then advanced to 21.50m using rotary coring techniques with a mist flush.
3. Groundwater entry encountered at 2.00m (sealed off with casing) remaining level after 20 minutes.
4. SPT's at 5.00m and 8.00m not possible due to granular soils collapsing into the borehole and blowing up the casing.
5. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
6. All arisings removed and work area cleaned.

BOREHOLE RECORD - G312

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 16.00m; 100 mm to 21.00m	Casing diameter: 120 mm to 16.00m	Project No.: G17057
Logged by: IG / Ground Level: 35.15 mAOD	Date: 05/10/2017-09/10/2017	Location: 446981E - 332717N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				35.05	0.10	MADE GROUND - Bituminous road construction.
				34.65	0.50	MADE GROUND - Concrete road construction.
				34.50	0.65	MADE GROUND - Light grey fine to coarse SAND and angular fine to coarse siltstone GRAVEL. (Roadstone).
E1	0.70					MADE GROUND - Firm reddish brown slightly gravelly sandy SILT. Gravel is sub-angular to rounded fine to coarse sandstone, siltstone, mudstone and quartz.
D2	0.70-1.00					
S	1.00	N=17				
D3	1.00-1.45					
D4	1.00-2.00					
C	1.20	N=21				
S	2.00	N=24				
D5	2.00-2.45			33.05	2.10	MADE GROUND - Stiff reddish brown slightly gravelly silty CLAY. Gravel is sub-angular to rounded fine to coarse quartz, mudstone, sandstone and siltstone. . . . sandstone cobble encountered at 2.50m.
D6	2.50-3.00					
S	3.00	N=19				
D7	3.00-3.45					
D8	3.00-4.00					
S	4.00	N=20				
D9	4.00-4.45					
D10	4.00-5.00					
S	5.00	N=18				. . . siltstone cobble encountered at 4.90m.
D11	5.00-5.45					
D12	5.00-6.00					
S	6.00	N=37				
D13	6.00-6.45					
			▼	28.15	7.00	Soft orangish brown mottled light grey slightly sandy silty CLAY.
S	7.50	N=37				
D14	7.50-7.95			27.35	7.80	Dense yellowish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse quartz and mudstone.
S	9.00	N=23				

(continued next sheet)

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core from 0.50m to 6.00m and 13.50m to 14.50m, and by open-hole / driving casing from 6.00m to 13.50m (through the dense coarse grained soils) then to 15.00m. Borehole then advanced from 15.00m to 21.00m using rotary coring techniques with a mist flush.
3. Groundwater entry encountered at 7.00m (sealed off with casing) remaining level after 20 minutes.
4. Groundwater entry encountered at 16.00m (not sealed) remaining level after 20 minutes.
5. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
6. All arisings removed and work area cleaned.

BOREHOLE RECORD - G312

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try

Boring diameter: 120 mm to 16.00m, 100 mm to 21.00m

Casing diameter: 120 mm to 16.00m

Project No.: G17057

Logged by: IG | Ground Level: 35.15 mAOD | Date: 05/10/2017-09/10/2017 | Location: 446981E - 332717N | Scale: 1:50

Ref	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
D15	9.00-9.45					Remaining Detail : 9.00m - 9.00m : . . . becoming medium dense below 9.00m.
				25.35	9.80	Medium dense orangish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse quartz, flint and mudstone.
S D16	10.50 10.50-10.95	N=23				
				23.65	11.50	Orangish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse quartz, flint and mudstone. . . . becoming very dense below 12.00m.
S D17	12.00 12.00-12.45	50/155mm				
				22.15	13.00	Firm friable reddish brown locally grey slightly sandy silty CLAY with frequent sand bands (50mm thick).
S D18 D19	13.50 13.50-13.95 13.50-14.50	N=26				
S D20	14.50 14.50-14.95	N=47		20.65	14.50	Stiff locally firm friable grey silty CLAY.
C	15.00	50/35 m		20.15	15.00	Stiff friable grey locally reddish brown silty CLAY.
				19.80	15.35	Weak greenish grey fine SANDSTONE with occasional gypsum veins. Bedding fractures are horizontal closely spaced, undulating smooth and clean. . . . gypsum band (30mm) at 16.05m.
CR	15.00-16.50	73 / 56 / 50	▼			
				18.75	16.40	Weak dark grey fine SANDSTONE with occasional gypsum veins. Bedding fractures are horizontal closely spaced, planar smooth and clean.
				18.50	16.65	Weak greenish grey fine SANDSTONE with frequent gypsum veins (10mm to 50mm thick). Bedding fractures are horizontal closely spaced, planar smooth with clay infill.
CR	16.50-18.00	100 / 66 / 59; FI 3, 30				
				17.60	17.55	
C	18.00	50/20 m		17.15	18.00	
		TCR SCR RQD / FI FS				*(continued next sheet)*

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core from 0.50m to 6.00m and 13.50m to 14.50m, and by open-hole / driving casing from 6.00m to 13.50m (through the dense coarse grained soils) then to 15.00m. Borehole then advanced from 15.00m to 21.00m using rotary coring techniques with a mist flush.
3. Groundwater entry encountered at 7.00m (sealed off with casing) remaining level after 20 minutes.
4. Groundwater entry encountered at 16.00m (not sealed) remaining level after 20 minutes.
5. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
6. All arisings removed and work area cleaned.

BOREHOLE RECORD - G312

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try	Boring diameter: 120 mm to 16.00m 100 mm to 21.00m	Casing diameter: 120 mm to 16.00m	Project No.: G17057
Logged by: IG	Ground Level: 35.15 mAOD	Date: 05/10/2017-09/10/2017	Location: 446981E - 332717N
Scale: 1:50			

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description
							17.55m - 18.00m : Weak greenish grey SILTSTONE with frequent gypsum veins. Bedding fractures are horizontal to sub-horizontal, extremely closely spaced, planar smooth with clay infill.
CR	18.00-19.50	83 57 36	5				18.00m - 19.50m : Weak reddish brown locally grey MUDSTONE. Bedding fractures are horizontal closely spaced, undulating smooth and clean. (Grade I locally Grade II). Detail 18.15m - 18.15m : . . . gypsum band (10mm) at 18.15m.
					15.65	19.50	
CR	19.50-21.00	100 65 57					Weak reddish brown MUDSTONE with frequent gypsum veins. Bedding fractures are horizontal to sub-horizontal, closely spaced, planar smooth to undulating rough, clean with local gypsum infill. (Grade I locally Grade III). . . . locally weathered and recovered as gravel sized fragments between 20.15m to 20.30m.
					14.35	20.80	Extremely weak weathered grey SILTSTONE locally recovered as gravel sized fragments and with occasional gypsum veins. Bedding fractures are sub-horizontal very closely spaced, undulating smooth with gypsum infill.
C	21.00	50/30mm			14.15	21.00	*End of Borehole at 21.00 m*

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core from 0.50m to 6.00m and 13.50m to 14.50m, and by open-hole / driving casing from 6.00m to 13.50m (through the dense coarse grained soils) then to 15.00m. Borehole then advanced from 15.00m to 21.00m using rotary coring techniques with a mist flush.
3. Groundwater entry encountered at 7.00m (sealed off with casing) remaining level after 20 minutes.
4. Groundwater entry encountered at 16.00m (not sealed) remaining level after 20 minutes.
5. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
6. All arisings removed and work area cleaned.

BOREHOLE RECORD - G313

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 13.00m	Casing diameter: 120 mm to 3.00m	Project No.: G17057
Logged by: IG / Ground Level: 34.40 mAOD	Date: 17/05/2017-13/06/2017	Location: 447040E - 332872N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
D1	0.30-0.40			34.25	0.15	MADE GROUND - Topsoil (soft brown sandy gravelly SILT with frequent rootlets. Gravel is sub-angular to sub-rounded fine to coarse quartz).
D2	0.70-0.80			34.00	0.40	MADE GROUND - Brown gravelly fine to coarse SAND. Gravel is angular to sub-rounded fine to coarse quartz and limestone.
S	1.20	N=22		33.30	1.10	MADE GROUND - Firm reddish brown slightly gravelly CLAY. Gravel is sub-angular to sub-rounded fine to coarse limestone and quartz.
D3	1.20-1.65					MADE GROUND - Soft locally firm reddish brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is sub-angular to sub-rounded fine to coarse mudstone, quartz and sandstone. . . . becoming firm below 1.50m.
B4	1.20-2.00					
S	2.00	N=25				
D5	2.00-2.45					
D6	2.00-3.00					
S	3.00	N=14				
D7	3.00-3.45					
B8	3.00-4.00					
S	4.00	N=22		30.40	4.00	Medium dense yellowish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse quartz, flint and mudstone.
D10	4.00-4.30					
D9	4.00-4.45			30.10	4.30	Firm dark brown mottled orangish brown CLAY with frequent black organic material.
D11	4.30-5.00					
S	5.00	50/195mm		29.40	5.00	Very dense yellowish brown fine to coarse SAND and sub-angular to rounded fine to coarse quartz, mudstone, flint, sandstone GRAVEL. (Description based on returned arisings from open hole drilling). . . . becoming dense between 6.00m and 7.50m.
D12	5.00-5.45					
D13	5.00-9.00					
C	6.00	N=48				
C	7.50	50/285mm				
C	9.00	N=46				

(continued next sheet)

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig AR01 (G. L to 10.50m) and GC01 (10.50m to 13.00m), using dynamic sampling techniques from 1.20m to 5.00m, then by open hole / driving casing to the borehole base, with a mist flush.
4. Borehole backfilled with sodium bentonite pellets to ground level upon completion.

BOREHOLE RECORD - G313

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 13.00m	Casing diameter: 120 mm to 3.00m	Project No.: G17057
Logged by: IG / Ground Level: 34.40 mAOD	Date: 17/05/2017-13/06/2017	Location: 447040E - 332872N	Scale: 1:50

Samples & In situ Tests			Water	Level (mAOD)	Depth (m)	Strata Description
Ref:	Depth (m)	SPT N				
D14	9.00-10.50					Remaining Detail : 9.00m - 9.00m : . . . becoming dense below 9.00m.
C	10.50	N=48		23.90	10.50	Dense light brown fine to medium SAND. (Description based on returned arisings from open hole drilling).
C	13.00	50/135mm		21.40	13.00	*End of Borehole at 13.00 m*

Remarks and Water Observations

1. Hand dug starter pit to 1.20m to check for services.
2. No groundwater seepages were encountered during boring operations.
3. Borehole advanced using Commachio 205 combination rig AR01 (G. L to 10.50m) and GC01 (10.50m to 13.00m), using dynamic sampling techniques from 1.20m to 5.00m, then by open hole / driving casing to the borehole base, with a mist flush.
4. Borehole backfilled with sodium bentonite pellets to ground level upon completion.

BOREHOLE RECORD - G314

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 16.00m 110 mm to 19.00m	120 mm to 16.00m	G17057
Logged by: JP / Ground Level:	Date: 26/09/2017-28/09/2017	Location: 447173E - 333163N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
					0.20	MADE GROUND - Bituminous road construction.		
D1	0.50-0.80				0.50	MADE GROUND - Concrete road construction.		
E2 D3	0.80-0.90 0.90-1.20	140 kPa			0.80	MADE GROUND - Light grey fine to coarse SAND and angular fine to coarse siltstone GRAVEL. (Roadstone).		
D4	1.20-1.50					MADE GROUND - Very stiff reddish brown, brown and occasional light grey slightly gravelly CLAY . Gravel is angular to sub-rounded fine to coarse siltstone, mudstone and quartz.		
S D5	1.50 1.50-2.00	N=17			1.50			
D6	2.00-2.50					MADE GROUND - Very stiff reddish brown and occasional light grey slightly gravelly silty CLAY. Gravel is angular fine to coarse siltstone and mudstone.		
S	2.50	N=50						
					2.70	Very dense brown gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse quartz, mudstone and sandstone. (Description derived from returned arising from open hole drilling, as sands / gravels too dense to dynamic sample).		
S	4.50	N=20				. . . becoming medium dense between 4.50m and 6.00m.		
S	6.00	50/245mm	▽					
C	7.50	N=41			7.50	Stiff locally firm friable reddish brown and occasional light grey silty CLAY.		
D7	8.00-8.50							
C	8.50	N=18						
D8	9.00-9.50				9.00			

(continued next sheet)

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques through overburden then by open-hole / driving casing from 2.70m to 7.50m, through the dense coarse grained soils, then rotary coring to base.
3. Hand Shear Vane (HSV) test undertaken at 0.90m (in sample tube) gave apparent undrained shear strength of greater than 140 kPa, using the pilcon unit (HSV1A) and the 19mm vane. Attempted HSV tests at 1.40m and 2.50m, soils too stiff / friable.
4. Groundwater entry encountered at 6.00m during drilling, however minor flows may have been masked by mist flush.
5. Borehole backfilled with sodium bentonite (pellets) to 1.20m below surface then rapid setting concrete to surface upon completion.
6. All arisings removed and work area cleaned.

BOREHOLE RECORD - G314

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP	Site M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 16.00m 110 mm to 19.00m	120 mm to 16.00m	G17057

Logged by: JP	Ground Level:	Date: 26/09/2017-28/09/2017	Location: 447173E - 333163N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
C	9.50	50/120mm				Stiff friable light grey silty CLAY.
D9	10.00-11.50				10.00	Extremely weak light grey sandy SILTSTONE. (Recovered as sandy Silt, sample scrubbed away, description based on limited recovery and arisings).
CR	10.00-11.50	6 0 0				
D10	11.50-13.00					
CR	11.50-13.00	23 0 0				
C D11	13.00 13.00-14.50	50/95mm			13.00	Very weak, locally weak fissile reddish brown and occasional light grey MUDSTONE with some thin bands of siltstone. (Poor recovery, description based on limited recovery and arisings). (Grade III-IV).
CR	13.00-14.50	5 0 0				
CR	14.50-16.00	17 0 0				
C	16.00	50/30mm				
CR	16.00-17.50	40 2 0				
		TCR SCR RQD FI FS				*(continued next sheet)*

Sheet 2 of 3

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques through overburden then by open-hole / driving casing from 2.70m to 7.50m, through the dense coarse grained soils, then rotary coring to base.
3. Hand Shear Vane (HSV) test undertaken at 0.90m (in sample tube) gave apparent undrained shear strength of greater than 140 kPa, using the pilcon unit (HSV1A) and the 19mm vane. Attempted HSV tests at 1.40m and 2.50m, soils too stiff / friable.
4. Groundwater entry encountered at 6.00m during drilling, however minor flows may have been masked by mist flush.
5. Borehole backfilled with sodium bentonite (pellets) to 1.20m below surface then rapid setting concrete to surface upon completion.
6. All arisings removed and work area cleaned.

BOREHOLE RECORD - G314

(Window Sampler plus Rotary Core)

Site
M1 J23a to J25 Ground Investigation

Client Costain Galliford Try	Boring diameter: 120 mm to 16.00m 110 mm to 19.00m	Casing diameter: 120 mm to 16.00m	Project No.: G17057	
Logged by: JP	Ground Level:	Date: 26/09/2017-28/09/2017	Location: 447173E - 333163N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	17.50-19.00	41 6 0					Very weak, locally weak fissile reddish brown and occasional light grey MUDSTONE with some thin bands of siltstone. (Poor recovery, description based on limited recovery and arisings). (Grade III-IV).		
C	19.00	50/40mm				19.00	*End of Borehole at 19.00 m*		
		TCR SCR RQD	FI FS					Sheet 3 of 3	

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques through overburden then by open-hole / driving casing from 2.70m to 7.50m, through the dense coarse grained soils, then rotary coring to base.
3. Hand Shear Vane (HSV) test undertaken at 0.90m (in sample tube) gave apparent undrained shear strength of greater than 140 kPa, using the pilcon unit (HSV1A) and the 19mm vane. Attempted HSV tests at 1.40m and 2.50m, soils too stiff / friable.
4. Groundwater entry encountered at 6.00m during drilling, however minor flows may have been masked by mist flush.
5. Borehole backfilled with sodium bentonite (pellets) to 1.20m below surface then rapid setting concrete to surface upon completion.
6. All arisings removed and work area cleaned.

BOREHOLE RECORD - G315
(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 12.00m 100 mm to 30.00m	120 mm to 12.00m	G17057

Logged by: IG	Ground Level: 32.92 mAOD	Date: 12/10/2017-17/10/2017	Location: 447231E - 333353N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				32.77	0.15	MADE GROUND - Macadam.
				32.42	0.50	MADE GROUND - Concrete.
D2	0.60-1.00			32.32	0.60	MADE GROUND - Black sandy sub-angular to sub-rounded fine to coarse limestone GRAVEL (sub-base).
E1	0.70					
S	1.00	N=14				
D3	1.00-1.45					
D4	1.50-2.00			31.42	1.50	MADE GROUND - Soft reddish brown locally orangish grey slightly gravelly sandy SILT. Gravel is angular to sub-rounded fine to coarse mudstone, sandstone and siltstone.
S	2.00	N=34	▼			
D5	2.00-2.45					
D6	2.00-2.40					
D7	2.40-2.50			30.52	2.40	MADE GROUND - Firm reddish brown slightly gravelly silty CLAY. Gravel is sub-angular to sub-rounded fine to coarse mudstone, siltstone and sandstone. . . . becoming stiff below 2.00m.
S	2.50	N=43				
D8	2.50-2.95					
S	3.00	N=9		29.92	3.00	MADE GROUND - Dense orangish brown gravelly silty fine to coarse SAND. Gravel is angular to rounded fine to coarse quartz, sandstone, limestone and mudstone. . . . limestone cobble encountered at 2.50m (SPT bouncing on the cobble).
D9	3.00-3.45					
D10	3.00-4.00					
S	4.00	N=14				Soft grey CLAY with occasional organic matter.
D11	4.00-4.45					
S	4.50	N=18		28.42	4.50	Medium dense greyish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse flint, quartz and mudstone. (Description based on returned arisings from open hole drilling).
D12	4.50-4.95					
D13	4.50-5.50					
S	6.00	N=21				
D14	6.00-6.45					
S	7.50	N=8		25.42	7.50	Firm locally soft grey CLAY.
D15	7.50-7.95					
B16	7.50-8.50					
				24.92	8.00	Firm grey sandy SILT with frequent gravel sized sandstone lithorelicts.
S	8.50	N=33				
D17	8.50-8.95					
S	9.00	50/225mm		23.92	9.00	

(continued next sheet)

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 4.00m, 4.50m to 5.50m and 7.50m to 8.50m, then by open-hole / driving casing from 4.50m to 7.50m and 8.50m to 12.00m (through the dense coarse grained soils). Borehole then advanced from 12.00m to 30.00m using rotary coring techniques with a mist flush.
3. Groundwater entry encountered at 2.00m (sealed off with casing) remaining level after 20 minutes.
4. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
5. All arisings removed and work area cleaned.

BOREHOLE RECORD - G315
(Window Sampler plus Rotary Core)

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 12.00m 100 mm to 30.00m	120 mm to 12.00m	G17057

Logged by: IG	Ground Level: 32.92 mAOD	Date: 12/10/2017-17/10/2017	Location: 447231E - 333353N	Scale: 1:50

Ref:	Depth (m)	SPT N / TCR SCR RQD / FI FS	Water	Level (mAOD)	Depth (m)	Strata Description
D18	9.00-9.45					Very dense whiteish grey silty fine to medium SAND. (Description based on returned arisings from open hole drilling).
S D19	10.50 10.50-10.95	50/270mm		22.42	10.50	Stiff friable reddish brown locally grey slightly sandy SILT with occasional siltstone bands. (Description based on returned arisings from open hole drilling).
S D20 D21	12.00 12.00-12.45 12.00-13.50	50/225mm		20.92	12.00	Weak reddish brown MUDSTONE. (Grade III).
CR	12.00-13.50	13 0 0				
				19.42	13.50	Reddish brown silty fine to coarse SAND with frequent gravel sized mudstone lithorelicts.
				19.02	13.90	Very weak reddish brown MUDSTONE. Bedding fractures are horizontal to vertical, very closely spaced, planar smooth to stepped smooth and clean (Grade II).
CR	13.50-15.00	47 0 0				
C	15.00	50/35mm		17.92	15.00	Very stiff friable reddish brown slightly sandy silty CLAY with occasional mudstone and siltstone lithorelicts (Grade III).
				17.52	15.40	Weak reddish brown MUDSTONE. Bedding fractures are horizontal to sub-vertical closely spaced, planar smooth and clean with local clay infill (Grade I locally Grade II).
CR	15.00-16.50	47 9 9				
CR	16.50-18.00	53 3 0 / 27		15.72	17.20	Weak reddish brown MUDSTONE recovered as gravel sized fragments (Grade III to II).
				15.47	17.45	
				15.12	17.80	Weak reddish brown locally grey MUDSTONE. Bedding
C	18.00	50/105mm				

(continued next sheet)

Sheet 2 of 4

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 4.00m, 4.50m to 5.50m and 7.50m to 8.50m, then by open-hole / driving casing from 4.50m to 7.50m and 8.50m to 12.00m (through the dense coarse grained soils). Borehole then advanced from 12.00m to 30.00m using rotary coring techniques with a mist flush.
3. Groundwater entry encountered at 2.00m (sealed off with casing) remaining level after 20 minutes.
4. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
5. All arisings removed and work area cleaned.

BOREHOLE RECORD - G315

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site	M1 J23a to J25 Ground Investigation
Client	Costain Galliford Try
Boring diameter:	120 mm to 12.00m 100 mm to 30.00m
Casing diameter:	120 mm to 12.00m
Project No.:	G17057
Logged by:	IG
Ground Level:	32.92 mAOD
Date:	12/10/2017-17/10/2017
Location:	447231E - 333353N
Scale:	1:50

Core Data

Ref:	Depth (m)	TCR SCR RQD	FI
CR	18.00-19.50	50 43 17	1
			4
CR	19.50-21.00	53 39 9	
			3
C	21.00	50/65mm	
CR	21.00-22.50	77 17 8	7
			4
CR	22.50-24.00	100 70 66	
C	24.00	50/20mm	
CR	24.00-25.50	100 60 51	5
CR	25.50-27.00	100 69 60	78
C	27.00	50/25mm	

Level (mAOD)	Depth (m)
14.17	18.75
13.62	19.30
12.62	20.30
12.22	20.70
11.52	21.40
11.07	21.85
10.52	22.40
9.27	23.65
8.92	24.00
8.52	24.40
6.72	26.20
6.57	26.35

Strata Description

17.45m - 17.80m : fractures are horizontal to sub-horizontal locally vertical, very closely spaced, planar rough to planar smooth, locally stepped smooth, clean. (Grade I to Grade II).

17.80m - 18.75m : Weak reddish brown MUDSTONE (recovered as slightly sandy SILT with occasional gravel sized mudstone lithorelicts) (Grade I locally III).

Weak reddish brown MUDSTONE (recovered as a slightly sandy CLAY with occasional gravel sized mudstone lithorelicts) (Grade I locally III).

Weak reddish brown locally grey MUDSTONE. Bedding fractures are horizontal to sub-vertical, closely spaced, planar smooth to planar rough and clean. (Grade I to Grade II).

Stiff friable reddish brown locally grey slightly sandy silty CLAY with frequent gravel sized mudstone lithorelicts. (Grade III).

Weak reddish brown MUDSTONE with occasional gypsum veins. Bedding fractures are horizontal, closely spaced, planar smooth to undulating rough and clean with local clay infill.

Firm locally stiff reddish brown slightly sandy SILT with frequent gravel sized mudstone lithorelicts and bands (Grade III)

Weak reddish brown locally grey MUDSTONE. Bedding fractures are horizontal to vertical closely spaced, planar smooth to planar rough, locally stepped smooth, clean.

Weak reddish brown locally grey MUDSTONE with frequent gypsum veins. Bedding fractures are horizontal, closely spaced, planar smooth to planar rough with gypsum infill. (Grade I locally Grade II).

Weak reddish brown locally white MUDSTONE with numerous gypsum veins. No fractures present. (Grade I).

Weak grey weathered SILTSTONE locally recovered as a silty sand.

Water | Legend | Backfill

(continued next sheet)

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 4.00m, 4.50m to 5.50m and 7.50m to 8.50m, then by open-hole / driving casing from 4.50m to 7.50m and 8.50m to 12.00m (through the dense coarse grained soils). Borehole then advanced from 12.00m to 30.00m using rotary coring techniques with a mist flush.
3. Groundwater entry encountered at 2.00m (sealed off with casing) remaining level after 20 minutes.
4. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
5. All arisings removed and work area cleaned.

BOREHOLE RECORD - G315
(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 12.00m, 100 mm to 30.00m	Casing diameter: 120 mm to 12.00m	Project No.: G17057
Logged by: IG / Ground Level: 32.92 mAOD	Date: 12/10/2017-17/10/2017	Location: 447231E - 333353N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	27.00-28.50	97 64 37	28				24.40m - 26.20m : Weak reddish brown locally grey MUDSTONE with frequent gypsum veins and locally recovered as gravel sized fragments. Bedding fractures are horizontal, closely spaced, planar smooth to planar rough, clean. (Grade I locally II).		
							26.20m - 26.35m : Weak thinly laminated greenish grey SILTSTONE.		
CR	28.50-30.00	100 77 53	10				26.35m - 30.00m : Weak reddish brown locally grey MUDSTONE with frequent gypsum veins. Bedding fractures are horizontal to sub-horizontal, extremely closely spaced, planar smooth to stepped rough, clean. (Grade I locally II). Detail 29.00m - 2.50m : . . . fractures becoming closely spaced below 29.00m. . . . fractures becoming closely spaced below 29.00m.		
C	30.00	50/30mm			2.92	30.00	*End of Borehole at 30.00 m*		

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 4.00m, 4.50m to 5.50m and 7.50m to 8.50m, then by open-hole / driving casing from 4.50m to 7.50m and 8.50m to 12.00m (through the dense coarse grained soils). Borehole then advanced from 12.00m to 30.00m using rotary coring techniques with a mist flush.
3. Groundwater entry encountered at 2.00m (sealed off with casing) remaining level after 20 minutes.
4. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
5. All arisings removed and work area cleaned.

BOREHOLE RECORD - G316

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site	M1 J23a to J25 Ground Investigation
Client: Costain Galliford Try	Boring diameter: 120 mm to 9.00m; 110 mm to 16.50m
Casing diameter: 120 mm to 9.00m	Project No.: G17057
Logged by: JP	Ground Level: 31.60 mAOD
Date: 03/10/2017-04/10/2017	Location: 447286E - 333477N
Scale: 1:50	

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				31.40	0.20	MADE GROUND - Bituminous road construction.
				31.10	0.50	MADE GROUND - Concrete road construction.
E1	0.60					
				30.65	0.95	MADE GROUND - Light grey fine to coarse SAND and angular fine to coarse siltstone GRAVEL. (Roadstone).
S	1.00	N=9				MADE GROUND - Firm reddish brown slightly sandy slightly gravelly silty CLAY. Gravel is sub-angular to sub-rounded fine to coarse sandstone, siltstone, mudstone and quartz. . . . slight hydrocarbon odour noted at 1.00m below ground level, (environmental sample taken).
E2	1.00					
D3	1.00-1.45					
B4	1.40-2.00					
S	2.00	N=22				
D5	2.00-2.45					
D6	2.50-3.00					
S	3.00	50/230mm		28.60	3.00	MADE GROUND - Very dense dark brown gravelly silty fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse quartz, mudstone and sandstone.
D7	3.00-3.45					
D8	3.50-4.00			28.10	3.50	MADE GROUND - Dark grey sandy angular to sub-rounded fine to coarse quartz, mudstone and granite GRAVEL.
				27.60	4.00	POSSIBLE MADE GROUND - Loose grey silty fine to coarse SAND.
S	4.50	N=2				
D9	4.50-4.95					
D10	4.50-5.50					
S	5.50	N=7				
D11	5.50-5.95					
B12	6.00-8.00			25.60	6.00	(Dense) orangish brown silty fine to coarse SAND and sub-angular to rounded fine to coarse quartz, mudstone and flint GRAVEL. (Density assessed from ease of excavation (slow)). . . . unable to undertake SPT at 7.50m as sand and gravel 'blowing' up into casing.
D13	9.00-9.45			22.60	9.00	

(continued next sheet)

Remarks and Water Observations

1. Advanced through road construction using road coring techniques.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques through overburden then by open-hole / driving casing from 3.00m to 9.00m, through the dense coarse grained soils, then rotary coring techniques to base.
3. Unable to undertake SPT at 7.50m as sand and gravel 'blowing' up into casing.
4. No groundwater entries were observed during drilling, however use of water flush may have masked minor inflows.
5. Borehole backfilled with sodium bentonite (pellets) to 1.20m below surface then rapid setting concrete to surface upon completion.
6. All arisings removed and work area cleaned.

BOREHOLE RECORD - G316

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 9.00m, 110 mm to 16.50m	Casing diameter: 120 mm to 9.00m	Project No.: G17057
Logged by: JP / Ground Level: 31.60 mAOD	Date: 03/10/2017-04/10/2017	Location: 447286E - 333477N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
D14	9.00-10.50				22.10	9.50	Stiff reddish brown friable silty CLAY.		
CR	9.00-10.50	27 15 8					Very weak, locally weak thinly laminated fissile reddish brown and occasional light grey MUDSTONE with some bands of stiff reddish brown silty CLAY. (Grade I locally Grade III).		
CR	10.50-12.00	40 11 7							
S	12.00	50/50mm							
D15	12.00-12.45								
D16	12.00-13.50								
CR	12.00-13.50	33 0 0							
CR	13.50-15.00	50 20 13							
C	15.00	50/85mm							
CR	15.00-16.50	57 11 11							
C	16.50	50/220mm			15.10	16.50	*End of Borehole at 16.50 m*		

TCR SCR RQD | FI FS

Sheet 2 of 2

Remarks and Water Observations

1. Advanced through road construction using road coring techniques.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques through overburden then by open-hole / driving casing from 3.00m to 9.00m, through the dense coarse grained soils, then rotary coring techniques to base.
3. Unable to undertake SPT at 7.50m as sand and gravel 'blowing' up into casing.
4. No groundwater entries were observed during drilling, however use of water flush may have masked minor inflows.
5. Borehole backfilled with sodium bentonite (pellets) to 1.20m below surface then rapid setting concrete to surface upon completion.
6. All arisings removed and work area cleaned.

BOREHOLE RECORD - G318

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation				
Client: Costain Galliford Try	Boring diameter: 120 mm to 21.00m	Casing diameter: 120 mm to 4.50m	Project No.: G17057	
Logged by: IG	Ground Level: 31.52 mAOD	Date: 18/10/2017-20/10/2017	Location: 447272E - 333854N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				31.37	0.15	MADE GROUND - Bituminous road construction.
				31.02	0.50	MADE GROUND - Concrete road construction.
				30.82	0.70	MADE GROUND - Dark grey fine to coarse SAND and sub-angular to sub-rounded fine to coarse limestone GRAVEL.
B2 E1 C	0.90-1.50 1.00 1.20	N=21		30.62	0.90	MADE GROUND - Dark grey limestone COBBLE.
						Medium dense orangish-brown silty fine to coarse SAND and sub-angular to sub-rounded fine to coarse quartz, mudstone sandstone and flint GRAVEL.
S D3 D4	3.00 3.00-3.45 3.10-3.75	N=28		28.42	3.10	Firm locally stiff reddish brown slightly sandy CLAY.
D5 S D6	3.75-4.00 4.00 4.00-4.45	50/175mm		27.77	3.75	Firm grey slightly sandy silty CLAY with occasional gravel sized mudstone lithorelicts.
				27.22	4.30	Extremely weak thinly laminated grey SILTSTONE. Bedding fractures are sub-horizontal very closely spaced, undulating smooth.
D7 S D8 D9	4.50-6.00 6.00 6.00-6.45 6.60-7.50	N=44		27.02	4.50	Stiff locally very stiff friable grey clayey SILT with frequent bands of extremely weak thinly laminated Mudstone.
D10	7.50-9.00			24.52	7.00	Stiff friable reddish brown silty CLAY with frequent bands of extremely weak thinly laminated Mudstone and siltstone.
C	9.00	50/75mm		22.52	9.00	

(continued next sheet)

Remarks and Water Observations

1. Advanced through road construction by coring.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 1.00m, then by open-hole / driving casing to 4.50m (through the dense coarse grained soils), borehole then advanced from 4.50m to 18.00m using rotary coring techniques with a mist flush.
3. No groundwater recorded during drilling; however, minor flows may have been masked by drilling flush.
4. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
5. All arisings removed and work area cleaned.

BOREHOLE RECORD - G318

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP	Site: M1 J23a to J25 Ground Investigation		
Client: Costain Galliford Try	Boring diameter: 120 mm to 21.00m	Casing diameter: 120 mm to 4.50m	Project No.: G17057
Logged by: IG	Ground Level: 31.52 mAOD	Date: 18/10/2017-20/10/2017	Location: 447272E - 333854N
			Scale: 1:50

Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
D11	9.00-10.50						Extremely weak thinly laminated reddish brown MUDSTONE. Bedding fractures are horizontal to sub-horizontal, closely spaced, planar smooth to undulating rough, clean. (Grade I-II).		
CR	9.00-10.50	23 1 0							
D12	10.50-12.00				21.02	10.50	Very stiff reddish brown slightly sandy SILT with frequent mudstone bands (lithorelicts).		
CR	10.50-12.00	0 0 0							
C	12.00	50/60mm			19.52	12.00	Weak fissile thinly laminated reddish brown MUDSTONE with some thin (2mm) bands of gypsum. Bedding fractures are horizontal to sub-horizontal, closely spaced, planar smooth to undulating rough, clean. (Grade I-II).		
CR	12.00-13.50	0 0 0					. . . band 50mm of gypsum recorded at 13.80m.		
CR	13.50-15.00	93 63 50					. . . band 50mm of gypsum recorded at 14.20m.		
C	15.00	50/35mm							
CR	15.00-16.50	73 30 0					. . . band 50mm of gypsum recorded at 15.80m. . . . band 50mm of gypsum recorded at 16.40m.		
CR	16.50-18.00	47 7 7							
C	18.00	50/25mm			13.52	18.00	*End of Borehole at 18.00 m*		

Remarks and Water Observations

1. Advanced through road construction by coring.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 1.00m, then by open-hole / driving casing to 4.50m (through the dense coarse grained soils), borehole then advanced from 4.50m to 18.00m using rotary coring techniques with a mist flush.
3. No groundwater recorded during drilling; however, minor flows may have been masked by drilling flush.
4. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
5. All arisings removed and work area cleaned.

BOREHOLE RECORD - G319

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation				
Client: Costain Galliford Try	Boring diameter: 120 mm to 9.00m, 100 mm to 30.00m		Casing diameter: 120 mm to 9.00m	Project No.: G17057
Logged by: IG	Ground Level: 37.86 mAOD	Date: 23/10/2017-27/10/2017	Location: 447221E - 334141N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				37.66	0.20	MADE GROUND - Macadam.
				37.36	0.50	MADE GROUND - Concrete.
				37.16	0.70	MADE GROUND - Dark grey silty fine to coarse SAND and sub-angular to sub-rounded fine to coarse limestone GRAVEL (sub-base).
E1	0.80					
D2	0.80-1.20					
S	1.00	N=17				
D3	1.00-1.45					
B4	1.00-2.00					
				35.71	2.15	MADE GROUND - Firm locally stiff reddish brown slightly gravelly silty CLAY. Gravel is sub-angular to sub-rounded fine to coarse siltstone, mudstone sandstone and quartz.
S	2.00	N=17				
D5	2.00-2.45					
D6	2.00-2.45			35.61	2.25	MADE GROUND - Firm dark yellowish brown slightly sandy slightly gravelly SILT. Gravel is sub-angular to rounded fine to medium sandstone, siltstone, mudstone and quartz.
D7	2.45-2.85			35.41	2.45	MADE GROUND - Firm reddish brown slightly gravelly silty CLAY. Gravel is sub-angular to sub-rounded fine to medium mudstone, siltstone and sandstone.
D8	2.85-3.00			35.01	2.85	MADE GROUND - Firm dark yellowish brown slightly gravelly sandy CLAY with rare gravel size fragments of slag. Gravel is sub-angular to rounded fine to medium quartz, mudstone and gypsum.
S	3.00	N=17		34.86	3.00	Firm yellowish brown slightly gravelly sandy CLAY. Gravel is sub-angular to rounded fine to coarse flint, quartz and sandstone.
D9	3.00-3.45					
D10	3.00-4.00					
S	4.00	50/260mm	▼			
D11	4.00-4.45					
B12	4.50-6.00					
				32.86	5.00	Medium dense orangeish brown gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse flint, quartz and sandstone. . . . becoming very dense below 4.00m.
S	6.00	N=28				
D13	6.00-6.20					
D14	6.20-6.50			31.66	6.20	Medium dense orangeish brown fine to coarse SAND and sub-angular to rounded fine to coarse quartz, flint, sandstone and mudstone GRAVEL.
				30.86	7.00	Firm locally stiff grey slightly sandy silty CLAY with occasional mudstone bands.
S	7.50	N=24				Firm locally stiff reddish brown mottled grey silty CLAY. . . . occasional sand lenses below 8.00m.
D15	7.50-7.95					
D16	7.50-8.50					
S	8.50	N=23				
D17	8.50-8.95					
S	9.00	N=34				

(continued next sheet)

Remarks and Water Observations

1. Advanced through road construction by coring.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 10.00m. Borehole then advanced to 30.00m using rotary coring techniques with a mist flush.
3. Groundwater was recorded at 4.20m during drilling.
4. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
5. All arisings removed and work area cleaned.

BOREHOLE RECORD - G319

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 9.00m 100 mm to 30.00m	120 mm to 9.00m	G17057
Logged by: IG / Ground Level: 37.86 mAOD	Date: 23/10/2017-27/10/2017	Location: 447221E - 334141N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
D18	9.00-10.00			28.66	9.20	Firm locally stiff reddish brown mottled grey silty CLAY.
S D19	9.70 9.70-10.15	N=45				Stiff reddish brown silty CLAY with frequent gravel size mudstone lithorelics.
CR	10.00-11.50	30 3 0				
				26.51	11.35	Extremely weak thinly laminated fissile reddish brown MUDSTONE. Bedding fractures are horizontal very closely spaced rough planar and rough stepped clean and clay coated (Grade I locally Grade III).
CR	11.50-13.00	53 0 0		25.66	12.20	. . . recovered as firm silty clay with frequent gravel size lithorelics from 11.40m to 11.55m.
				25.11	12.75	Stiff friable reddish brown silty CLAY with frequent mudstone bands.
C	13.00	50/260mm				Extremely weak thinly laminated fissile reddish brown MUDSTONE. Bedding fractures are horizontal very closely spaced rough planar and rough stepped clean and clay coated (Grade I).
CR	13.00-14.50	60 23 13				
				23.81	14.05	Extremely weak thinly laminated fissile grey MUDSTONE. Bedding fractures are horizontal closely spaced rough planar clay coated (Grade I).
				23.61	14.25	Extremely weak thinly laminated fissile reddish brown MUDSTONE. Bedding fractures are horizontal and vertical very closely spaced smooth planar to rough planar and smooth stepped clean and clay coated (Grade I locally Grade II).
CR	14.50-16.00	30 1 0				. . . recovered as sandy clayey angular to sub-rounded fine to coarse mudstone gravel from 14.80m to 15.00m.
C	16.00	50/135mm				. . . recovered as sandy clayey angular to sub-rounded fine to coarse mudstone gravel from 15.60m to 16.00m.
CR	16.00-17.50	27 8 0				
						. . . recovered as angular to sub-rounded fine to coarse mudstone gravel from 17.20m to 17.35m.
		TCR SCR RQD FI FS				*(continued next sheet)*

Remarks and Water Observations

1. Advanced through road construction by coring.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 10.00m. Borehole then advanced to 30.00m using rotary coring techniques with a mist flush.
3. Groundwater was recorded at 4.20m during drilling.
4. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
5. All arisings removed and work area cleaned.

NICHOLLS COLTON GROUP

BOREHOLE RECORD - G319

(Window Sampler plus Rotary Core)

Site
M1 J23a to J25 Ground Investigation

Client Costain Galliford Try	Boring diameter: 120 mm to 9.00m 100 mm to 30.00m	Casing diameter: 120 mm to 9.00m	Project No.: G17057
Logged by: IG / Ground Level: 37.86 mAOD	Date: 23/10/2017-27/10/2017	Location: 447221E - 334141N	Scale: 1:50

Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description
CR	17.50-19.00	47 / 3 / 0					Extremely weak thinly laminated fissile reddish brown MUDSTONE. Bedding fractures are horizontal and vertical very closely spaced smooth planar to rough planar and smooth stepped clean and clay coated (Grade I locally Grade II).
					19.21	18.65	Stiff friable reddish brown silty CLAY with frequent mudstone bands and gravel size mudstone lithorelics.
S	19.00	50/135mm					
CR	19.00-20.50	60 / 23 / 21			18.26	19.60	Weak locally extremely weak thinly laminated fissile reddish brown locally grey MUDSTONE with occasional gypyum mineralisation. Bedding fractures are horizontal, sub-vertical and vertical very close to closely spaced smooth planar to rough planar and rough undulating clean and gypsum filled (Grade I locally Grade II).
CR	20.50-22.00	67 / 12 / 12					
C	22.00	50/25mm					
CR	22.00-23.50	93 / 53 / 36			15.21	22.65	Weak thinly laminated thinly interbedded reddish brown and grey MUDSTONE with occasional gypsum mineralisation. Bedding fractures are horizontal and vertical closely spaced smooth planar to rough planar and clean (Grade I).
					14.46	23.40	Weak thinly laminated reddish brown MUDSTONE with frequent gypsum mineralisation. Bedding fractures are horizontal, sub-horizontal and vertical closely spaced smooth planar to rough planar smooth undulating clean and gypsum filled (Grade I).
CR	23.50-25.00	100 / 67 / 53					
C	25.00	50/20mm					
CR	25.00-26.50	93 / 57 / 42					
CR	26.50-28.00	90 / 60 / 33					

(continued next sheet)

Remarks and Water Observations

1. Advanced through road construction by coring.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 10.00m. Borehole then advanced to 30.00m using rotary coring techniques with a mist flush.
3. Groundwater was recorded at 4.20m during drilling.
4. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
5. All arisings removed and work area cleaned.

BOREHOLE RECORD - G319

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site	M1 J23a to J25 Ground Investigation
Client	Costain Galliford Try
Boring diameter:	120 mm to 9.00m 100 mm to 30.00m
Casing diameter:	120 mm to 9.00m
Project No.:	G17057
Logged by:	IG
Ground Level:	37.86 mAOD
Date:	23/10/2017-27/10/2017
Location:	447221E - 334141N
Scale:	1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
							Weak thinly laminated reddish brown MUDSTONE with frequent gypsum mineralisation. Bedding fractures are horizontal, sub-horizontal and vertical closely spaced smooth planar to rough planar smooth undulating clean and gypsum filled (Grade I).		
C	28.00	50/2 mm							
CR	28.00-28.50	100 40 22							
CR	28.50-30.00	80 29 17					. . . recovered as angular to sub-rounded fine to coarse mudstone gravel from 29.05m to 29.50m.		
C	30.00	50/15mm			7.86	30.00	*End of Borehole at 30.00 m*		

TCR SCR RQD FI FS

Sheet 4 of 4

Remarks and Water Observations

1. Advanced through road construction by coring.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 10.00m. Borehole then advanced to 30.00m using rotary coring techniques with a mist flush.
3. Groundwater was recorded at 4.20m during drilling.
4. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
5. All arisings removed and work area cleaned.

BOREHOLE RECORD - G320

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 13.50m; 110 mm to 18.00m	Casing diameter: 120 mm to 13.50m	Project No.: G17057
Logged by: JP; Ground Level: 42.35 mAOD	Date: 26/09/2017	Location: 447215E - 334330N	Scale: 1:50

Samples & In situ Tests Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				42.10	0.25	MADE GROUND - Bituminous road construction.
				41.85	0.50	MADE GROUND - Concrete road construction.
D1	0.60-0.80			41.45	0.90	MADE GROUND - Light grey fine to coarse SAND and angular fine to coarse siltstone GRAVEL. (Roadstone).
		140 kPa				MADE GROUND - Very stiff reddish brown and occasional light grey slightly gravelly silty CLAY. Gravel is angular fine to coarse siltstone and mudstone.
S	1.20	N=19				
D2	1.20-1.60					
D3	1.60-2.00					
		140 kPa				
S	2.00	N=18				
D4	2.00-2.50					
D5	2.50-3.00					
S	3.00	N=24				. . . becoming stiff below 3.00m.
D6	3.00-3.50					
D7	3.50-4.00					
S	4.00	N=18				
D8	4.20-4.60					
S	5.00	N=30				
D9	5.00-5.60					
				36.60	5.75	Stiff friable dark brown slightly gravelly clayey SILT. Gravel is sub-angular to sub-rounded fine to coarse quartz.
D10	5.80-6.00					
S	6.00	N=27		36.35	6.00	Medium dense orangish-brown fine to coarse SAND and sub-angular to sub-rounded fine to coarse quartz GRAVEL. (Description derived from returned arising from open hole drilling, as sands / gravels too dense to dynamic sample).
C	7.50	50/155mm				. . . becoming very dense below 7.50m.
C	9.00	N=46		33.35	9.00	

(continued next sheet)

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Hand Shear Vane (HSV) test undertaken at 1.00m gave apparent undrained shear strength of greater than 140 kPa, using the pilcon unit (HSV1A) and the 19mm vane.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques through overburden then by open-hole / driving casing from 6.00m to 9.00m, through the dense coarse grained soils, then rotary coring to base.
4. HSV test undertaken at 1.90m gave apparent undrained shear strength of >140kPa. Soils too stiff / friable for HSV at 3.00m and 4.00m.
5. No groundwater recorded during drilling; however, minor flows may have been masked by drilling flush.
6. Borehole backfilled with sodium bentonite (pellets) to 1.20m below surface then rapid setting concrete to surface upon completion.

BOREHOLE RECORD - G320

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation

Client: Costain Galliford Try

Boring diameter: 120 mm to 13.50m; 110 mm to 18.00m

Casing diameter: 120 mm to 13.50m

Project No.: G17057

Logged by: JP | Ground Level: 42.35 mAOD | Date: 26/09/2017 | Location: 447215E - 334330N | Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
						Stiff reddish brown slightly sandy silty CLAY.
S	10.50	N=3				
D11	10.50-12.45					
CR	10.50-12.00	47 0 0				
CR	12.00-13.50	53 0 0		29.55	12.80	Stiff friable reddish brown silty CLAY with occasional very weak mudstone bands.
C	13.50	50/11 mm				
CR	13.50-15.00	27 0 0				
				27.45	14.90	Very stiff grey sandy SILT
				27.35	15.00	Stiff locally very stiff friable reddish brown slightly sandy slightly gravelly silty CLAY. Gravel is sub-angular to sub-rounded fine to coarse siltstone.
CR	15.00-16.50	23 0 0				
S	16.50	N= 3				
D12	16.50					
CR	16.50-18.00	27 5 0				
				24.45	17.90	
S	18.00	50/185mm		24.35	18.00	
D13	18.00-18.45					
		TCR SCR RQD FI FS				*(continued next sheet)*

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Hand Shear Vane (HSV) test undertaken at 1.00m gave apparent undrained shear strength of greater than 140 kPa, using the pilcon unit (HSV1A) and the 19mm vane.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques through overburden then by open-hole / driving casing from 6.00m to 9.00m, through the dense coarse grained soils, then rotary coring to base.
4. HSV test undertaken at 1.90m gave apparent undrained shear strength of >140kPa. Soils too stiff / friable for HSV at 3.00m and 4.00m.
5. No groundwater recorded during drilling; however, minor flows may have been masked by drilling flush.
6. Borehole backfilled with sodium bentonite (pellets) to 1.20m below surface then rapid setting concrete to surface upon completion.

BOREHOLE RECORD - G320

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site M1 J23a to J25 Ground Investigation				
Client Costain Galliford Try	Boring diameter: 120 mm to 13.50m 110 mm to 18.00m	Casing diameter: 120 mm to 13.50m	Project No.: G17057	
Logged by: JP	Ground Level: 42.35 mAOD	Date: 26/09/2017	Location: 447215E - 334330N	Scale: 1:50

Core Data Ref:	Core Data Depth (m)	TCR SCR RQD FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
						Extremely weak thinly laminated fissile grey SILTSTONE. (Recovered as silty sandy fine to coarse gravel sized fragments).		
						End of Borehole at 18.00 m		
		TCR SCR RQD FI FS					Sheet 2+ of 2	

Remarks and Water Observations

1. Advanced through road construction using coring attachment (90 minutes).
2. Hand Shear Vane (HSV) test undertaken at 1.00m gave apparent undrained shear strength of greater than 140 kPa, using the pilcon unit (HSV1A) and the 19mm vane.
3. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques through overburden then by open-hole / driving casing from 6.00m to 9.00m, through the dense coarse grained soils, then rotary coring to base.
4. HSV test undertaken at 1.90m gave apparent undrained shear strength of >140kPa. Soils too stiff / friable for HSV at 3.00m and 4.00m.
5. No groundwater recorded during drilling; however, minor flows may have been masked by drilling flush.
6. Borehole backfilled with sodium bentonite (pellets) to 1.20m below surface then rapid setting concrete to surface upon completion.

BOREHOLE RECORD - G322

(Window Sampler)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	100 mm to 2.65m		G17057

Logged by: IG	Ground Level: 45.50 mAOD	Date: 30/10/2017	Location: 447138E - 334940N	Scale: 1:50

Samples & In situ Tests			Water	Level (mAOD)	Depth (m)	Strata Description
Ref:	Depth (m)	SPT N				
				45.35	0.15	MADE GROUND - Macadam.
				45.10	0.40	
				45.00	0.50	MADE GROUND - Concrete.
D1	0.80					
D2	0.85-1.20			44.65	0.85	MADE GROUND - Whiteish grey sandy silty sub-angular to sub-rounded fine to medium limestone GRAVEL (sub-base).
S	1.20	N=2				
D3	1.20-1.65					
D4	1.50-2.00			44.00	1.50	MADE GROUND - Reddish brown sandy silty angular to rounded fine to coarse flint, slate, mudstone and limestone GRAVEL.
S	2.00	N=0				
D5	2.00-2.45					
D6	2.00-2.65					MADE GROUND - Orangeish brown silty fine to coarse SAND and sub-angular to rounded fine to coarse quartz, flint, mudstone, sandstone GRAVEL.
				42.86	2.64	MADE GROUND - Soft reddish brown locally grey slightly gravelly slightly sandy silty CLAY. Gravel is angular to sub-rounded fine to coarse siltstone and mudstone.
				42.85	2.65	MADE GROUND - Concrete.
						End of Borehole at 2.65 m

Legend | Backfill

Sheet 1 of 1

Remarks and Water Observations

1. Advanced through road construction by coring.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 2.65m.
3. A concrete obstruction was encountered at 2.65m. Borehole was terminated and relocated to G322A.
4. No groundwater recorded during drilling.
5. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
6. All arisings removed and work area cleaned.

BOREHOLE RECORD - G322A

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 21.00m	120 mm to 6.00m	G17057

Logged by: IG	Ground Level: 45.56 mAOD	Date: 30/10/2017-01/11/2017	Location: 447135E - 334939N	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
				45.21	0.35	MADE GROUND - Topsoil.
B1	0.60-0.70			44.86	0.70	MADE GROUND - White silty sub-angular to sub-rounded fine to coarse limestone GRAVEL (Filter drain).
D2	1.00-1.45			44.56	1.00	MADE GROUND - Firm reddish brown slightly sandy silty CLAY.
D3	1.00-2.00					
S	1.20	N=17				
				43.91	1.65	MADE GROUND - Firm orangeish brown sandy SILT.
S	2.00	N=22				
D4	2.00-2.45					
D5	2.00-2.50					
D6	2.50-3.00			43.06	2.50	MADE GROUND - Stiff orangeish brown slightly gravelly slightly sandy silty CLAY. Gravel is sub-angular to sub-rounded fine to coarse sandstone, quartz and mudstone.
			▼	42.66	2.90	MADE GROUND - Firm reddish brown mottled grey slightly sandy silty CLAY.
S	3.00	N=12		42.56	3.00	Firm grey SILT with frequent gravel size siltstone lithorelics.
D7	3.00-3.45					
D8	3.00-4.00					Firm reddish brown mottled grey silty CLAY with frequent gravel size mudstone lithorelics.
S	4.00	N=17				
D10	4.00-5.00					
D9	4.00-4.45					
S	5.00	N=20				
D11	5.00-5.45					
D12	5.00-6.00					
S	6.00	N=4				. . . becoming locally stiff with occcasional mudstone bands below 5.80m.
D13	6.00-6.45					
CR	6.00-7.50	44 / 25 / 20				
CR	7.50-9.00	30 / 13 / 13				
S	9.00	49/26 mm		36.56	9.00	
		TCR SCR RQD FI FS				*(continued next sheet)*

Sheet 1 of 3

Remarks and Water Observations

1. Hand excavated service pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 6.00m. Borehole then advanced to 21.00m using rotary coring techniques with a mist flush.
3. Groundwater recorded at 3.00m during drilling; however minor flows may have been masked by mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to surface upon completion.
5. All arisings removed and work area cleaned.

BOREHOLE RECORD - G322A

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site
M1 J23a to J25 Ground Investigation

Client	Boring diameter:	Casing diameter:	Project No.:
Costain Galliford Try	120 mm to 21.00m	120 mm to 6.00m	G17057

Logged by: IG	Ground Level: 45.56 mAOD	Date: 30/10/2017-01/11/2017	Location: 447135E - 334939N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description
D14	9.00-9.45						Stiff friable reddish brown silty CLAY with occasional mudstone bands.
CR	9.00-10.50	73 33 33					
CR	10.50-12.00	27 0 0					
					33.81	11.75	Extremely weak thinly laminated grey SILTSTONE (recovered as soft gravelly clayey SILT. Gravel is angular to sub-rounded fine to coarse siltstone) (Grade III).
S	12.00	50/220 mm			33.61	11.95	Stiff friable reddish brown silty CLAY with occasional mudstone bands.
CR	12.00-13.50	67 27 27					
					31.66	13.90	Extremely weak thinly laminated grey SILTSTONE (recovered as angular to sub-angular fine to coarse siltstone GRAVEL) (Grade II).
CR	13.50-15.00	73 9 9			31.46	14.10	Stiff friable reddish brown silty CLAY with frequent mudstone bands.
C	15.00	50/45mm			30.56	15.00	Weak thinly laminated greenish grey MUDSTONE (recovered as silty CLAY with frequent gravel size mudstone lithorelics) (Grade III).
					30.06	15.50	Weak locally extremely weak thinly laminated reddish brown MUDSTONE. Bedding fractures are horizontal to sub-vertical close to medium spaced smooth planar to rough planar clean and clay coated (Grade I). . . . from 16.45m to 16.65m recovered as sandy angular to sub-angular fine to coarse mudstone GRAVEL (Grade II).
CR	15.00-16.50	33 3 0					
CR	16.50-18.00	27 0 0					
C	18.00	50/80mm					
		TCR SCR RQD	FI FS				*(continued next sheet)*

Remarks and Water Observations

1. Hand excavated service pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 6.00m. Borehole then advanced to 21.00m using rotary coring techniques with a mist flush.
3. Groundwater recorded at 3.00m during drilling; however minor flows may have been masked by mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to surface upon completion.
5. All arisings removed and work area cleaned.

BOREHOLE RECORD - G322A

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation				
Client: Costain Galliford Try	Boring diameter: 120 mm to 21.00m	Casing diameter: 120 mm to 6.00m	Project No.: G17057	
Logged by: IG	Ground Level: 45.56 mAOD	Date: 30/10/2017-01/11/2017	Location: 447135E - 334939N	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
CR	18.00-19.50	37 0 0					Weak locally extremely weak thinly laminated reddish brown MUDSTONE. Bedding fractures are horizontal to sub-vertical close to medium spaced smooth planar to rough planar clean and clay coated (Grade I).		
CR	19.50-21.00	73 43 27					. . . from 19.95m to 20.00m recovered as angular to sub-rounded fine to coarse mudstone GRAVEL (Grade II). . . . from 20.25m to 20.35m recovered as sandy sub-angular to sub-rounded fine to coarse mudstone GRAVEL (Grade II).		
C	21.00	50/115mm			24.56	21.00	*End of Borehole at 21.00 m*		

TCR SCR RQD FI FS

Sheet 3 of 3

Remarks and Water Observations

1. Hand excavated service pit to 1.20m, to check for services.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 6.00m. Borehole then advanced to 21.00m using rotary coring techniques with a mist flush.
3. Groundwater recorded at 3.00m during drilling; however minor flows may have been masked by mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to surface upon completion.
5. All arisings removed and work area cleaned.

BOREHOLE RECORD - G323

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Site: M1 J23a to J25 Ground Investigation			
Client: Costain Galliford Try	Boring diameter: 120 mm to 12.00m	Casing diameter: 120 mm to 1.50m	Project No.: G17057
Logged by: IG / Ground Level:	Date: 02/11/2017	Location: -	Scale: 1:50

Ref:	Depth (m)	SPT N	Water	Level (mAOD)	Depth (m)	Strata Description
					0.15	MADE GROUND - Macadam.
					0.40	MADE GROUND - Concrete.
D1	0.60-1.00				0.60	MADE GROUND - Dark grey sandy silty sub-angular to sub-rounded fine to medium limestone GRAVEL (sub-base).
E2	0.80					
S	1.00	N=27			1.00	Reddish brown locally yellow slightly gravelly silty fine SAND. Gravel is angular to sub-rounded fine to coarse siltstone and sandstone.
D3	1.00-1.45					
D4	1.20-1.60				1.50	Stiff reddish brown locally grey SILT.
S	1.60	50/85 mm			1.80	Stiff grey SILT with frequent siltstone lithorelics.
D5	1.60-2.05					
D6	1.60-3.00					
CR	1.60-3.00	21 / 0 / 0				Extremely weak thinly laminated grey SILTSTONE (recovered as grey sub-angular to sub-rounded fine to coarse siltstone gravel).
					3.35	Weak locally extremely weak medium bedded thinly laminated reddish brown MUDSTONE and stiff reddish brown silty CLAY with frequent gravel size mudstone lithorelics. Bedding fractures are horizontal and sub-horizontal closely spaced smooth planar to rough planar and smooth stepped clean and clay coated. (Grade I locally Grade II and Grade III) . . . recovered as angular to sub-rounded fine to coarse mudstone GRAVEL from 3.55m to 3.70m (Grade II). . . . recovered as slightly gravelly slightly sandy silty CLAY with frequent mudstone lithorelics from 4.00m to 4.30m (Grade III).
CR	3.00-4.50	73 / 29 / 33				
C	4.50	50/150 mm				
CR	4.50-6.00	47 / 21 / 16				
CR	6.00-7.50	30 / 0 / 0				
C	7.50	50/220 mm				
CR	7.50-9.00	63 / 20 / 20				
		TCR SCR RQD / FI FS				*(continued next sheet)*

Sheet 1 of 2

Remarks and Water Observations

1. Advanced through road construction by coring.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 1.60m. Borehole then advanced to 12.00m using rotary coring techniques with a mist flush.
3. No groundwater recorded during drilling; however, minor flows may have been masked by mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
5. All arisings removed and work area cleaned.

BOREHOLE RECORD - G323

(Window Sampler plus Rotary Core)

NICHOLLS COLTON GROUP

Client Costain Galliford Try	Site M1 J23a to J25 Ground Investigation			
	Boring diameter: 120 mm to 12.00m	Casing diameter: 120 mm to 1.50m	Project No.: G17057	
Logged by: IG	Ground Level:	Date: 02/11/2017	Location: -	Scale: 1:50

Core Data Ref:	Depth (m)	TCR SCR RQD	FI	Water	Level (mAOD)	Depth (m)	Strata Description	Legend	Backfill
							Remaining Detail : 9.00m - 9.40m : . . . recovered as silty angular to sub-rounded fine to coarse mudstone GRAVEL from 9.00m to 9.40m (Grade II).		
CR	9.00-10.50	27 2 0							
C	10.50	50/15	mm			10.50			
							Weak locally extremely weak thinly laminated reddish brown MUDSTONE. Bedding fractures are horizontal, sub-horizontal and vertical closely to very closely spaced smooth planar to rough planar, smooth stepped clean and clay coated (Grade I).		
CR	10.50-12.00	73 36 33							
C	12.00	50/90	mm			12.00			
							End of Borehole at 12.00 m		
		TCR SCR RQD	FI FS					Sheet 2 of 2	

Remarks and Water Observations

1. Advanced through road construction by coring.
2. Borehole advanced using Commachio 205 combination rig NH01, using dynamic sampling techniques below the core to 1.60m. Borehole then advanced to 12.00m using rotary coring techniques with a mist flush.
3. No groundwater recorded during drilling; however, minor flows may have been masked by mist flush.
4. Borehole backfilled with sodium bentonite (pellets) to 1.00m below surface, then rapid setting concrete to surface upon completion.
5. All arisings removed and work area cleaned.

Appendix H Summary of Cross Carriageway Ducts Locations

H.1: Technologies CCD Locations

H.2: Lighting Columns CCD Locations

H.3: Technologies CCD Ground Model

H.1 - Technologies CCD Locations

SMP Reference	Chainage	Carriageway	Length (m)	Depth (m bgl)	Easting (from)	Northing (from)	Easting (to)	Northing (to)
T-CCD-1	181961	A-B	37	2	446835	324433	446872	324431
T-CCD-2	181853	K	13	2	446693	324327	446682	324333
T-CCD-3	182115	K	16	2	446817	324596	446829	324591
T-CCD-4	182194	A-B	38	2	446857	324667	446895	324662
T-CCD-5	182290	M	40	2	446990	324742	447030	324734
T-CCD-6	182658	L	26	2	446999	325111	447025	325108
T-CCD-7	182828	A-B	49	2	447010	325284	447057	325271
T-CCD-8	183296	A-B	44	2	447148	325732	447190	325719
T-CCD-9	183844	A-B	44	2	447309	326256	447352	326243
T-CCD-10	184372	A-B	45	2	447448	326763	447492	326754
T-CCD-11	184931	A-B	37	2	447519	327314	447556	327312
T-CCD-12	184931	M	17	2	447556	327312	447574	327310
T-CCD-13	184931	J	18	2	447502	327310	447519	327314
T-CCD-14	185100	M	16	2	447596	327486	447610	327478
T-CCD-15	185370	K	16	2	447471	327755	447457	327761
T-CCD-16	185500	A-B	40	2	447495	327878	447535	327884
T-CCD-17	186057	A-B	43	2	447378	328420	447420	328431
T-CCD-18	186165	L	11	2	447388	328534	447398	328539
T-CCD-19	186255	A-B	45	2	447321	328607	447364	328621
T-CCD-20	186618	A-B	37	2	447211	328954	447246	328966
T-CCD-21	186618	L	19	2	447246	328966	447263	328972
T-CCD-22	186836	A-B	47	2	447145	329161	447189	329176
T-CCD-23	186842	K	16	2	447127	329161	447112	329162
T-CCD-24	187499	A-B	37	2	446938	329792	446972	329803
T-CCD-26	188510	A-B	37	2	446622	330751	446657	330762
T-CCD-27	188870	A-B	36	2	446515	331097	446550	331105
T-CCD-28	189303	A-B	36	2	446473	331531	446509	331530
T-CCD-29	189769	A-B	38	2	446555	331993	446591	331983
T-CCD-30	190258	A-B	37	2	446763	332441	446794	332423
T-CCD-31	190633	A-B	37	2	446966	332755	446996	332735
T-CCD-32	191068	A-B	37	2	447163	333137	447198	333126
T-CCD-33	191629	A-B	37	2	447270	333679	447306	333679
T-CCD-34	191963	A-B	37	2	447250	334009	447285	334015
T-CCD-35	192344	A-B	38	2	447162	334379	447199	334387
T-CCD-36	192950	A-B	44	2	447140	334988	447184	334984
T-CCD-37	193342	A-B	37	2	447173	335375	447210	335375
T-CCD-38	193342	M	21	2	447210	335375	447231	335375
T-CCD-41	182027	M	11	2	446920	324494	446931	324490
T-CCD-42	185755	M	9	2	447499	328204	447478	328201
T-CCD-43	193485	M	14	2	447226	335521	447241	335521
T-CCD-45	185905	L	90	2	447484	328289	447492	328378
T-CCD-46	186835	K	14	2	446965	328957	446961	328971

Note: Locations where existing CCDs are to be reused are not included

H.2 -Lighting Columns CCD Locations

SMP Reference	Chainage	Carriageway	Length (m)	Depth (m bgl)	Easting (from)	Northing (from)	Easting (to)	Northing (to)
L-CCD-1	181880	K	19	2	446687	324360	446705	324351
L-CCD-2	182130	J	17	2	446789	324609	446807	324610
L-CCD-3	182180	K	13	2	446834	324657	446847	324654
L-CCD-4	182740	L	13	2	447022	325185	447036	325182
L-CCD-5	182815	A-B	47	2	447052	325259	447005	325272
L-CCD-6	184012	A-B	46	2	447402	326402	447357	326416
L-CCD-7	185100	M	18	2	447590	327482	447609	327477
L-CCD-8	185101	A-B	39	2	447519	327482	447559	327483
L-CCD-9	185102	J	20	2	447477	327469	447494	327482
L-CCD-10	185365	L	19	2	447580	327755	447600	327761
L-CCD-11	185445	K	17	2	447459	327828	447478	327827
L-CCD-12	185750	B	16	2	447505	328151	447488	328149
L-CCD-13	186180	B	11	2	447398	328550	447386	328545
L-CCD-14	186440	L	11	2	447322	328816	447327	328806
L-CCD-15	186628	A-B	41	2	447245	328975	447205	328961
L-CCD-16	186860	K	14	2	447126	329185	447112	329185
L-CCD-17	187640	A-B	39	2	446929	329936	446891	329924
L-CCD-18	192502	A-B	39	2	447175	334541	447134	334536
L-CCD-19	192970	A-B	46	2	447141	335004	447185	335002
L-CCD-20	193380	M	24	2	447237	335411	447211	335411
L-CCD-21	193705	K	18	2	447142	335740	447161	335740
L-CCD-22	-	K	14	2	446942	328950	446939	328965
L-CCD-23	186628	L	19	2	447263	328981	447245	328975

H.3 - Technologies CCD Ground Models

SMP Reference	Chainage	Carriageway	Earthwork	Proposed Earthwork Height (m)	Proposed Slope Gradient (°)	Proposed Verge Width (m)	Proposed Earthwork Solution	Anticipated Geology
T-CCD-1	181961	NB (M1)	At Grade	1	11	2	No Solution Required	Mercia Mudstone (fine grained)
		SB (M1)	Embankment	7.5	14	4	No Solution Required	Mercia Mudstone (fine grained)
T-CCD-2	181853	NB (A42 west)	Embankment	As existing	As existing	As existing	As existing	Embankment Fill (fine grained)
		NB (A42 east)	Embankment	As existing	As existing	As existing	As existing	Embankment Fill (fine grained)
T-CCD-3	182115	NB (A42 west)	Embankment	6.4	18	3.8	No Solution Required	Embankment Fill (fine grained)
		NB (A42 east)	Embankment	2.8	51	3.8	No Solution Required	Embankment Fill (fine grained)
T-CCD-4	182194	NB (M1)	At Grade	0.6	21	3.8	Full Regrade 1:2.5	Mercia Mudstone (fine grained)
		SB (M1)	Cutting	6.8	18	3.8	Full Regrade 1:3	Mercia Mudstone (fine grained)
T-CCD-5	182290	SB (A42west)	Cutting	As existing	As existing	As existing	As existing	Mercia Mudstone (fine grained)
		SB (A42east)	Cutting	As existing	As existing	As existing	As existing	Mercia Mudstone (fine grained)
T-CCD-6	182658	SB (M1 offslip west)	At Grade	0.5	2	3.4	No Solution Required	Mercia Mudstone (fine grained)
		SB (M1 offslip east)	Cutting	5	3	2.8	<500mm Fill	Mercia Mudstone (fine grained)
T-CCD-7	182828	NB (M1 onslip west)	Cutting	4.8	27	3.4	Full Regrade 1:2.5	Mercia Mudstone (fine grained)
		SB (M1 offslip east)	At Grade	0	0	4	No Solution Required	Mercia Mudstone (fine grained)
T-CCD-8	183296	NB (M1)	Embankment	3.8	27	4.7	Granular Wedge at Embankment Crest 1:2	Embankment Fill (fine grained)
		SB (M1)	Embankment	5.9	27	4.6	Granular Wedge at Embankment Crest 1:2	Embankment Fill (fine grained)
T-CCD-9	183844	NB (M1)	Cutting	Unknown (>10.8)	18	3.8	Partial Regrade 1:3	Mercia Mudstone (fine grained)
		SB (M1)	Cutting	Unknown (>10.5)	-	4.6	Sheet Pile Retaining Wall	Mercia Mudstone (fine grained)
T-CCD-10	184372	NB (M1)	At Grade	1.5	-	4.8	Sheet Pile Retaining Wall	Embankment Fill (fine grained)
		SB (M1)	Cutting	3.2	18	4.2	<500mm cut	Mercia Mudstone (fine grained)
T-CCD-11	184931	NB (M1)	At Grade	0.7	18	3.2	<500mm Fill	Embankment Fill (fine grained)
		SB (M1)	At Grade	0.7	18	3.2	<500mm Fill	Embankment Fill (fine grained)
T-CCD-12	184931	SB (M1 onslip west)	Embankment	4.4	27	4	Full Regrade 1:2	Embankment Fill (fine grained)
T-CCD-13	184931	NB (M1 offslip east)	Embankment	As existing	As existing	As existing	As existing	Embankment Fill (fine grained)
T-CCD-14	185100	SB (M1 onslip west)	Embankment	As existing	As existing	As existing	As existing	Embankment Fill (fine grained)
		SB (M1 onslip east)	Embankment	As existing	As existing	As existing	As existing	Embankment Fill (fine grained)
T-CCD-15	185370	NB (M1 onslip west)	Embankment	As existing	As existing	As existing	As existing	Glaciofluvial Deposits (coarse grained) of approximately 4m thickness, underlain by weathered Mercia Mudstone (fine grained)
		NB (M1 onslip east)	Embankment	As existing	As existing	As existing	As existing	Glaciofluvial Deposits (coarse grained) of approximately 4m thickness, underlain by weathered Mercia Mudstone (fine grained)
T-CCD-16	185500	NB (M1)	Cutting	3.5	18	4.8	<500mm Cut	Glaciofluvial Deposits or Head Deposits (both coarse grained) of approximately 2m thickness, underlain by weathered Mercia Mudstone (fine grained)
		SB (M1)	Cutting	3.1	18	4	Full Regrade 1:3	Glaciofluvial Deposits or Head Deposits (both coarse grained) of approximately 2m thickness, underlain by weathered Mercia Mudstone (fine grained)
T-CCD-17	186057	NB (M1 onslip west)	Embankment	2.6	-	3	Sheet Pile Retaining Wall	Embankment Fill (fine grained)
		SB (M1)	Embankment	3	27	4	Granular Wedge At Embankment Crest 1:2	Embankment Fill (fine grained)

SMP Reference	Chainage	Carriageway	Earthwork	Proposed Earthwork Height (m)	Proposed Slope Gradient (°)	Proposed Verge Width (m)	Proposed Earthwork Solution	Anticipated Geology
T-CCD-18	186165	SB (M1 offslip west)	Embankment	2.7	27	0	Sheet Pile Retaining Wall	Embankment Fill (fine grained)
		SB (M1 offslip east)	At Grade	0	0	0.8	Granular Wedge At Embankment Crest 1:2	Embankment Fill (fine grained)
T-CCD-19	186255	NB (M1)	At Grade	1.4	18	4	Sheet Pile Retaining Wall	Embankment Fill (fine grained)
		SB (M1 offslip east)	Embankment	2.6	27	4	Full Regrade 1:2	Embankment Fill (fine grained)
T-CCD-20	186618	NB (M1)	Cutting	1.8	27	6.4	No Solution Required	Mercia Mudstone (fine grained)
		SB (M1)	At Grade	0	0	4	<500mm Cut	Embankment Fill (fine grained)
T-CCD-21	186618	SB (M1 offslip east)	At Grade	0	0	3	No Solution Required	Embankment Fill (fine grained)
T-CCD-22	186836	NB (M1)	At Grade	0	0	5.6	No Solution Required	Embankment Fill (fine grained)
		SB (M1 offslip east)	Embankment	5.4	-	3.7	Full Height Embankment Widening 1:2	Embankment Fill (fine grained)
T-CCD-23	186842	NB (M1 onslip west)	Embankment	4.6	30	3.3	Full Height Embankment Widening 1:2	Embankment Fill (fine grained)
		NB (M1 onslip east)	Embankment	5	60	2.3	No Solution Required	Embankment Fill (fine grained)
T-CCD-24	187499	NB (M1)	Embankment	3.1	22	4	No Solution Required	Embankment Fill (fine grained)
		SB (M1)	Embankment	4.4	18	4	Granular Wedge At Embankment Crest 1:2	Embankment Fill (fine grained)
T-CCD-26	188510	NB (M1)	Embankment	8.8	27	3.9	No Solution Required	Embankment Fill (fine grained)
		SB (M1)	Embankment	8.2	-	5.4	Sheet Pile Retaining Wall	Embankment Fill (fine grained)
T-CCD-27	188870	NB (M1)	Embankment	6	-	5.1	No Solution Used	Embankment Fill (fine grained)
		SB (M1)	Embankment	5.3	18	3	<500mm Fill	Embankment Fill (fine grained)
T-CCD-28	189303	NB (M1)	Embankment	5.5	22	1.5	No Solution Required	Embankment Fill (fine grained)
		SB (M1)	Embankment	4.5	-	6.9	Sheet Pile Retaining Wall	Embankment Fill (fine grained)
T-CCD-29	189769	NB (M1)	Embankment	4.3	-	3	<500mm Fill	Embankment Fill (fine grained)
		SB (M1)	Embankment	4	-	9.4	Sheet Pile Retaining Wall	Embankment Fill (fine grained)
T-CCD-30	190258	NB (M1)	Embankment	8.9	22	3	No Solution Required	Embankment Fill (fine grained)
		SB (M1)	Embankment	9.2	27	3.9	Granular Wedge At Embankment Crest 1:2	Embankment Fill (fine grained)
T-CCD-31	190633	NB (M1)	Embankment	6.6	18	3	<500mm Fill	Embankment Fill (fine grained)
		SB (M1)	Embankment	6.3	27	9.3	<500mm Fill	Embankment Fill (fine grained)
T-CCD-32	191068	NB (M1)	At Grade	1.2	18	3.9	<500mm Fill	Embankment Fill (fine grained)
		SB (M1)	Embankment	3.2	27	1.8	<500mm Fill	Embankment Fill (fine grained)

SMP Reference	Chainage	Carriageway	Earthwork	Proposed Earthwork Height (m)	Proposed Slope Gradient (°)	Proposed Verge Width (m)	Proposed Earthwork Solution	Anticipated Geology
T-CCD-33	191629	NB (M1)	Cutting	5.7	20	2.9	<500mm Cut	Glaciofluvial Deposits (coarse grained) of approximately 2.5m thickness, underlain by weathered Mercia Mudstone (fine grained)
		SB (M1)	Cutting	3.1	12	2.2	<500mm Fill	Glaciofluvial Deposits (coarse grained) of approximately 2.5m thickness, underlain by weathered Mercia Mudstone (fine grained)
T-CCD-34	191963	NB (M1)	At Grade	0	0	5.8	No Solution Required	Glaciofluvial Deposits (coarse grained) of approximately 4.5m thickness, underlain by weathered Mercia Mudstone (fine grained)
		SB (M1)	Cutting	2	33	6.9	No Solution Required	Glaciofluvial Deposits (coarse grained) of approximately 4.5m thickness, underlain by weathered Mercia Mudstone (fine grained)
T-CCD-35	192344	NB (M1)	Embankment	7	27	4	Granular Wedge at Embankment Crest 1:2	Embankment Fill (fine grained)
		SB (M1)	Embankment	7	-	8.7	Sheet Pile Retaining Wall	Embankment Fill (fine grained)
T-CCD-36	192950	NB (M1)	At Grade	0.2	6	3.2	<500mm Fill	Mercia Mudstone (fine grained)
		SB (M1)	Cutting	2.8	12	3.2	No Solution Required	Mercia Mudstone (fine grained)
T-CCD-37	193342	NB (M1)	Cutting	2.1	13	8.7	Sheet Pile Retaining Wall	Mercia Mudstone (fine grained)
		SB (M1)	Cutting	2	13	4	Sheet Pile Retaining Wall (plastic)	Mercia Mudstone (fine grained)
T-CCD-38	193342	SB (M1 onslip east)	Cutting	6.1	18	3.8	<500mm Fill	Mercia Mudstone (fine grained)
T-CCD-41	182027	SB (A42 onslip west)	At Grade	As existing	As existing	As existing	As existing	Embankment Fill (fine grained)
		SB (A42 onslip east)	Bund	As existing	As existing	As existing	As existing	Embankment Fill (fine grained)
T-CCD-42	185755	SB (M1 onslip west)	At Grade	0	-	0.5	No Solution Required	Embankment Fill (fine grained) 0.5m thick underlain by Glaciofluvial Deposits (coarse grained) approximately 2.5-3.0m thick, underlain by weathered Mercia Mudstone (fine grained)
		SB (M1 onslip east)	At Grade	0	2	11	<500mm Fill	Embankment Fill (fine grained) 0.5m thick underlain by Glaciofluvial Deposits (coarse grained) approximately 2.5-3.0m thick, underlain by weathered Mercia Mudstone (fine grained)
T-CCD-43	193485	SB (M1 onslip (west)	Embankment	5.8	23	3.5	No Solution Required	Embankment Fill (fine grained)
		SB (M1 onslip east)	At Grade	0.9	10	1.4	No Solution Required	Embankment Fill (fine grained)
T-CCD-45	185905	SB (M1 onslip west)	Embankment	4.6	27	4	Granular Wedge At Embankment Crest 1:2	Glaciofluvial Deposits (coarse grained) approximately 4m thick, underlain by weathered Mercia Mudstone (fine grained)
		SB (M1 onslip east)	Embankment	As existing	As existing	As existing	No Solution Required	Glaciofluvial Deposits (coarse grained) approximately 4m thick
T-CCD-46	186835	NB (M1 onslip west)	At Grade	As existing	As existing	As existing	No Solution Required	Embankment Fill (fine grained)
		NB (M1 onslip east)	Embankment	As existing	As existing	As existing	No Solution Required	Embankment Fill (fine grained)

Note: Locations where existing CCDs are to be reused are not included

Appendix I Photographs

I.1 - List of Photographs - As-Built, Typical Solutions

S/N	List
1	Sheet Pile Wall at SB192520
2	Gantry G 311SB, Sheet Pile Wall at SB188790
3	Gantry G 318, Sheet Pile Wall at NB 191750
4	Gantry G 309 and Sheet Pile Wall at SB188970
5	ERA at SB1887800
6	Gantry 308 and ERA at SB 1887780
7	Sheet Pile Wall at SB188380
8	Embankment Widening at SB 186890
9	Gabion Walls at SB 193460

Sheet Pile Wall at SB192520

Gantry G 311SB, Sheet Pile Wall at SB188790

Gantry G 318, Sheet Pile Wall at NB 191750

Gantry G 309 and Sheet Pile Wall at SB188970

ERA at SB1887800

Gantry 308 and ERA at SB 1887780

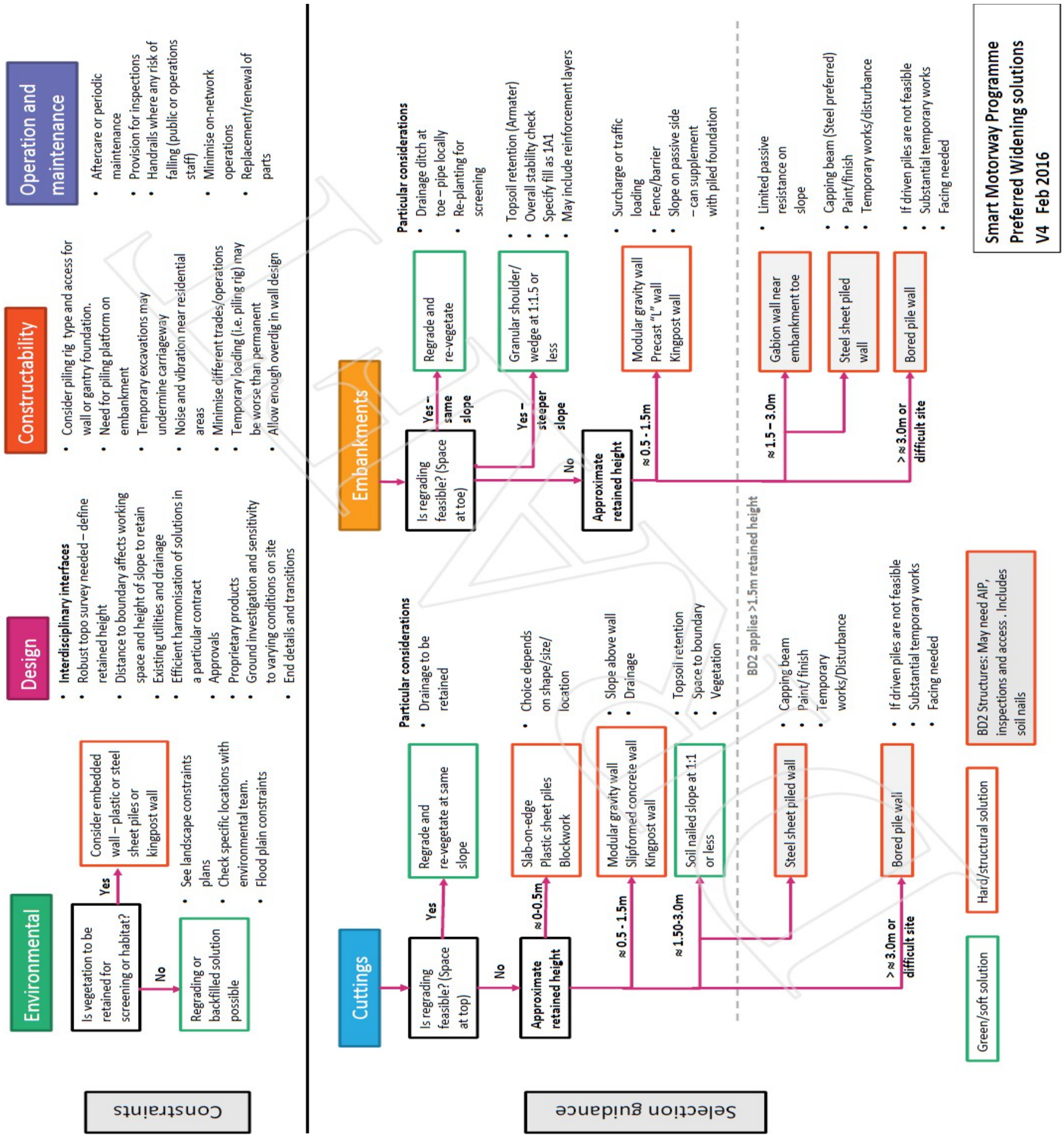
Sheet Pile Wall at SB188380

Embankment Widening at SB 186890

Gabion Walls at SB 193460

Appendix J Preferred Widening Solutions Decision Flow Chart

Ref AmeyArup, "Smart Motorways Programme M1 J23a-25, Gantries and ERAs Lateral Solutions Options Report, Document Ref HA549342-AMAR-SGT-SWI-RP-CB-000001, March 2016 [3]



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See Bookmarks for contents of this report.

NEAR M1 J23A TO J25

COMBINED PSSR-GIR-GDR

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Required Approvals

Name	Signature	Title	Date of Issue	Version

Definitions and Abbreviations

Term	Definition
BGS	British Geological Survey
CBR	California Bearing Ratio
CCTV	Closed Circuit Television
EA	Emergency Area
GDMS	Geotechnical and Drainage Management System
GDS	Geotechnical Design Statement
LIDAR	Light Detection and Ranging
mAOD	Metres Above Ordnance Datum
mbgl	Metres Below Ground Level
MP	Marker Post
NEAR	National Emergency Area Retrofit
NGR	National Grid Reference
PRS	Place of Relative Safety
UXO	Unexploded Ordnance
PPL	Potential Pollution Linkage
CSM	Conceptual Site Model
DEFRA	Department for Environment, Food and Rural Affairs
LCRM	Land Contamination Risk Management
GQRA	Generic Quantitative Risk Assessment
GAC	Generic Assessment Criteria
C4SL	Category 4 Screening Level
CIEH	Chartered Institute of Environmental Health
LQM	Land Quality Management Ltd
S4UL	Suitable for Use Levels
CL:AIRE	Contaminated Land: Applications in Real Environments.
AGAC	Acute Generic Assessment Criteria
SoBRA	Society of Brownfield Risk Assessment
DoWCoP	Definition of Waste: Code of Practice
CEMP	Construction Environmental Management Plan
PPE	Personal Protective Equipment
WEL	Workplace Exposure Limit
MMP	Materials Management Plan

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1 INTRODUCTION

1.1 Background

Following the smart motorways evidence stocktake and action plan, published by the UK Government in March 2020, a new standard for the spacing of Emergency Areas was published by National Highways. National Highways has instructed SMP Alliance to retrofit this standard onto existing "All Lane Running" Smart Motorways.

An Emergency Area (EA), as defined in GD301, includes:

1. Motorway Service Areas (MSAs),
2. Emergency Areas,
3. A new or existing hard shoulder that is a minimum of 3 metres wide and minimum 100 metres long with suitable Emergency Roadside Telephone (ERT).

For the purposes of continuity, EA will apply to all of the above throughout this document.

This report deals with geotechnical aspects of one of the National Emergency Area Retrofit (NEAR) schemes located in National Highways Area 7: M1 Junction 23a-25 Smart Motorway. The scope of the project entails design of the following infrastructure between junctions 23a and 25 along the M1 motorway:

1. Six Emergency Areas (EA),
2. One MS4 Cantilever Gantry,
3. One Closed Circuit Television (CCTV) mast,
4. Five Stopped Vehicle Detection (SVD) systems.
5. One Motorway Incident Detection and Automatic Signalling (MIDAS) mast.

The M1 J23a to 25 scheme (M1 J23a-25) works have been defined as a Geotechnical Category 2 as per the requirements of National Highways Standard CD 622 (Design Manual for Roads and Bridges – Managing Geotechnical Risk) [20] and guidance given in BS EN 1997-1 [12].

1.2 Objectives

This report has been prepared in accordance with the Smart Motorway Programme Design Guide Annex E3.11 [25] and Design Manual for Roads and Bridges CD 622 Managing Geotechnical Risk [20]. This report combines the elements of CD 622 i.e., Preliminary Sources Study Report (PSSR), Geotechnical Investigation Report (GIR) and Geotechnical Design Report (GDR) as agreed with National Highways in the scheme specific Statement of Intent (GDMS No. 47380) [5].

1.3 Site location description

The scheme extends between Junction 23a (Donington Park Junction: NGR 446895, 324788) and 25 (Sandiacre Interchange: NGR 447194, 335613) of the M1 for a length of 11.6 km approximately as shown in Annex E. Of the proposed six EAs, three are located along the northbound carriageway and three along the southbound carriageway, of which two are intra-junction. M1 Junction 23a is located where the M1 and A42 connect, situated approximately 1km south of East Midlands Airport. The M1 then proceeds northwards to Junction 24 at the northern extent of Kegworth, providing access to the A50 for northbound M1 traffic. After approximately 1.25km, Junction 24a allows access to the M1 from eastbound traffic of the A50 and provides access to the A50 from southbound M1 traffic. The M1 continues north for 7km to Junction 25, known as Sandiacre Interchange, where the M1 and the A52 connect. Junction 25 marks the northern extent of this scheme. Road levels generally fall from J23a to J25, from approximately 77m AOD to 47m AOD.

1.4 Proposed works

Summary of the proposed infrastructure works involved in this scheme are presented in Table 1. The proposed works are classified as geotechnical category 2 as defined in BS EN 1997:2004 + A1:2013 [12] and CD622 [20]. The co-ordinates listed in Table 1 for each proposed EAs, CCTV, MS4 Gantry, SVDs and MIDAS are their respective midpoints with respect to the extent of the proposed infrastructure. A detailed plan view of the proposed structures from GDMS extract is shown in Figure 19-15 of Annex F.

Table 1 Summary of Proposed Works

Name	Marker Post	Type	Direction	Existing Earthwork Type	Easting	Northing
M1-J23a-J25-EA-NB-187/8	187/8	EA	NB	Embankment	446861.0	330029.0
M1-J23a-J25-EA-NB-190/2	190/2	EA	NB	Embankment	446685.0	332308.0
M1-J23a-J25-EA-NB-192/0	192/0	EA	NB	Cutting to at grade	447256.0	333972.0
M1-J23a-J25-EA-SB-193/4	193/4	EA	SB	Cutting	447211.0	335436.0
M1-J23a-J25-EA-SB-187/7	187/7	EA	SB	Embankment	446911.0	329995.0
M1-J23a-J25-EA-SB-185/1	185/1	EA	SB	Cutting	447559.0	327409.0
MS4-NB-190/5	190/5	Gantry	NB	Embankment	446884.0	332633.0
CCTV	193/3B+43	CCTV	SB	Cutting	447212.2	335401
SVD	190/2A+34	SVD	NB	Embankment	446717.53	332368.9
SVD	192/0A+19	SVD	NB	Cutting to at grade	447245.11	334008.2
SVD	185/0B+05	SVD	SB	Cutting	447558.61	327347.5
SVD	187/7B+70	SVD	SB	Embankment	446892.57	330048.9
SVD	193/3B+45	SVD	SB	Cutting	447212.3	335403.3
MIDAS	190/5A+61	MIDAS	NB	Embankment	446889.0	332642.0

For programme purposes, including to facilitate geotechnical certification, the construction has been split into Advanced Works and Main Works. The Main Works comprise the construction of the infrastructure such as the EA's, VMS gantry, CCTVs, SVDs and MIDAS infrastructure as detailed in Section 1.1.

Advanced Works comprise the following:

- Installation of NRTS interrupter power & technology ducting and cabling local to each EA. There is no trenching works associated with this. All ducting in the verge is to be surface mounted upon wooden stakes or the fence line.
- Vegetation clearance at each EA
- GPR surveys and trial holes to identify existing services and subsequent identification, cutting and removal from the footprint.
- Preparatory works for TM arrangements, typically around merge and di-verge nosing's with amendments to chevrons
- Testing of electrical circuits and general dilapidation surveys of the existing network

Once TM access has been gained, there will be the setup of the welfare and parking area at each EA location using a standardised general layout as illustrated in Figure 1-1, which is being utilised across the NEAR programme. Of particular note, which will be requiring of geotechnical considerations, is an assessment of the appropriateness of the exact location of the welfare area including site cabin, and any provision for off road parking and the planned areas for material storage – all of which is likely to introduce some loads to the verge. It is possible that such areas are in a location where there is limited space due to either an embankment crest or cutting toe. Consideration to the proximity of any existing earthwork defects on GDMS would be prudent to avoid any unintended exacerbation of an area where the slope is already in an 'at risk' situation.

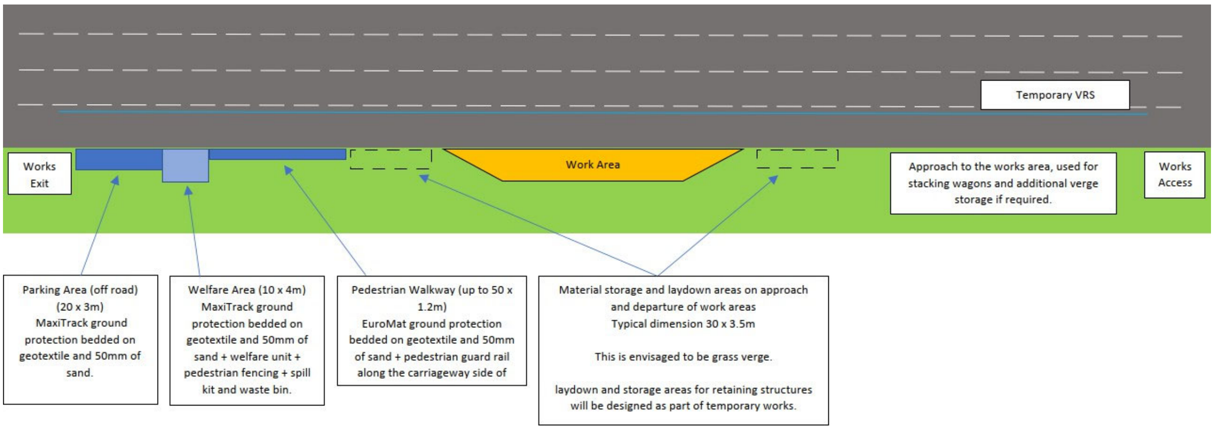


Figure 1-1: Plan showing planned Advance Works

Geotechnically relevant Advanced Works, for example those which have the potential to impact the road user or extend beyond the National Highways boundary are being considered within the scope of this report. At the time of writing the requirement for Temporary Works had not been determined by the Contractor. The Contractor has confirmed that all Temporary Works will be subject to design based on site-specific conditions.

At the time of writing this report the identification, evaluation and management of the geotechnical risks associated with the Advanced Works so that the residual risks are at tolerable levels has been captured in the scheme Geotechnical Risk Register.

2 SOURCES OF INFORMATION, DESK STUDY, SITE RECONAISSANCE, SITE DESCRIPTION AND REVIEW OF FINDINGS

2.1 British Geological Survey (BGS)

2.1.1 Maps

- 1:50,000 and 1:625,000 Scale Geology via BGS Geoindex (2021) [22]. https://mapapps2.bgs.ac.uk/geoindex/home.html#;
- Sheet No. 141 Loughborough Soild and Drift Geology, 1:50,000 Scale (2001) https://largeimages.bgs.ac.uk/iip/mapsportal.html?id=1001634.

2.1.2 Memoirs

- Geology of the country between Loughborough, Burton and Derby: sheet description of the 1:50,000 series sheet 141 (2001). https://pubs.bgs.ac.uk/publications.html?pubID=B06078

2.1.3 Made Ground

The BGS GeoIndex [22] and published geological maps indicate large extents of Made Ground along the M1 J23a-25. This is likely to be associated with construction of the motorway, its associated infrastructure and residential construction in its proximity. The embankments shown on GDMS and descriptions from available boreholes indicate that the embankments are typically constructed of reworked locally won bedrock materials.

2.1.4 Superficial geology

Superficial deposits relevant to the scheme are shown on Figure 19-21 of Annex E. Along the route of the M1 motorway which is followed by Made Ground, Alluvium and River Terrace Deposits which were observed occasionally along the proposed alignment. The presence of Alluvium deposits is associated due to the river Trent in the vicinity. Fluvial incision and floodplain abandonment has resulted in the formation of River Terrace Deposits that flank the river.

2.1.5 Bedrock geology

Geological formations relevant to the scheme are shown on Figure 19-22 of Annex E. Along the extent of the scheme, Mudstones, Siltstones, and Sandstone of various formations namely Gunthorpe member, Diseworth Sandstone, Tarporley Siltstone formation, Helsby Sandstone formation, Edwalton Member, Arden Sandstone formation, Branscombe Mudstone formation and Cotgrave Sandstone member, as indicated in Figure 19-22. Gunthorpe member can be found to be present at both the scheme start and end i.e, J23a and J25. The Edwalton Member is observed to dominate the scheme towards the Northern side.

2.1.6 Boreholes

A review of the BGS Geoindex (2022) [22] has identified approximately 453 boreholes in and around the length of the alignment within the study area as shown in Figure 19-23,Figure 19-24,Figure 19-25,Figure 19-26,Figure 19-27and Figure 19-28. The BGS does not have current contact details for all confidential boreholes deposited with them and the quality of the data is uncertain as no preview is allowed. Therefore, acquisition of these confidential borehole records will not be progressed. Despite the large number of available boreholes, it should be noted that there is no more than one at or near each of the proposed intervention sites from the existing boreholes online in lieu of that ground investigation has been carried out and factual report has been provided to fill that gap in information.
The following previous ground investigation reports were also taken into consideration for the derivation of ground models:

- Smart Motorway Programme M1 Junction 23a – 25, Ground Investigation Report, Amey Arup JV, 2013, GDMS No:28929 [2]

2.2 Environment Agency

2.2.1 Hydrogeology

A review of the Environment Agency's Aquifer Designation Map identifies the M1 (J23a-25) bedrock and superficial geology as Secondary B and Secondary A aquifers respectively. The site does not lie within a groundwater Source Protection Zone.

2.2.2 Hydrology

A review of the Environment Agency (EA) website (https://flood-map-for-planning.service.gov.uk/) indicates:

- Flood Zones 2 & 3, associated with the River Trent catchment, covers most of the study area;
- Flood Zones 2 & 3, associated with River Erewash catchment, are present towards the northern end of J25 approximately 800m East of the study area.

  Flood zones are shown on Figure 19-29.

2.2.3 Landfills

One landfill site is identified in the area adjacent to the proposed works (Figure 19-35). Details of the landfill site and their waste type is detailed in Table 2.

Table 2 Summary of landfill sites

Landfill Site Name	Site reference	Location	Waste Type
Hemington Gravel Pit	EAHLD28397	Adjacent to the carriageway – approximate MP187/3 to 188/3	Industrial

.

2.3 Coal Authority- Engineering and Mining Assessment

A review of the Coal Authority interactive viewer [27] identified no areas where the scheme boundary encroached into the Coalfield Consultation Area. All the geotechnical interventions proposed for the scheme fall outside the Coalfield Consultation Area. There is also no recorded history of mining disturbance affecting the motorway in or near this location.

From the available information and the proposed CCTV location being in the verge of a cutting, the risk from mine workings was deemed insignificant and purchase of further Coal Authority records considered unnecessary.

2.4 GDMS

2.4.1 Reports

Table 3 lists the reports considered most relevant to the scheme. These have been selected after a review of the reports identified in the scheme-specific Statement of Intent and further interrogation of GDMS [21].

Table 3 Scheme related GDMS reports

GDMS No.	Scheme Title	Type	Publication Date	Author
19183	M1 Widening Junctions 21 – 30 [1]	Preliminary Sources Study Report	Nov-2004	Arup
28929	Smart Motorways Programme M1 Junction 23a to 25 [2]	Ground Investigation Report	Feb-2016	Amey Arup JV
29152	Smart Motorways Programme M1 Junction 23a to 25 [3]	Geotechnical Design Report	Jun-2017	Amey Arup JV

GDMS No.	Scheme Title	Type	Publication Date	Author
30523	Super Midland M1 J23a-25 [4]	Feedback Report	2018	Amey Arup

2.4.2 Geotechnical Asset Database

The geotechnical assets, inventory items, condition sets and items have been downloaded from GDMS [21] and are shown in Annex E . Condition set 641780 has been identified as closest to the proposed location EA-SB-185/1, which is 5m westwards from the centre of the EA. The rest of proposed works do not encounter any existing condition sets at or near to the proposed locations. Table 4 summarises the condition sets observed at the proposed EA locations.

Table 4 GDMS Condition Sets

Proposed EA location	National Grid E	National Grid N	SI No.	Defect (Class)	Location	Within EA or Distance from centre of EA	Description	Remediated Slopes in Earthwork	Remarks	Last Inspection Date of Corresponding Earthwork
M1-J23a-J25-EA-NB-187/8	446854	330037	1	None observed	-	-	None observed	N/A	-	27/01/2021
M1-J23a-J25-EA-NB-190/2	446687	332312	1	Class 1D	Near MP 190/0, on the southbound carriageway (opposite side of EA)	120m Southeast	Poorly backfilled excavation behind acoustic barrier - approximately 20m long, max depth 0.3m, max width 0.1m. Foundation to barrier exposed in part.	N/A	Condition ID: 641448, Feature Grade: 3	13/01/2021
MS4-NB-190/5	446860	332593	1	Class 1D	Near MP 190/0, on the southbound carriageway (opposite side of EA)	450m South	Poorly backfilled excavation behind acoustic barrier - approximately 20m long, max depth 0.3m, max width 0.1m. Foundation to barrier exposed in part.	N/A	Condition ID: 641448, Feature Grade : 3	13/01/2021
			2	Not classified	Between MP 190/9 and just beyond MP 191/4, to the northbound carriageway (same side of EA)	390m North	Acoustic barrier	N/A	Set ID 171357	16/04/2021

Proposed EA location	National Grid E	National Grid N	SI No.	Defect (Class)	Location	Within EA or Distance from centre of EA	Description	Remediated Slopes in Earthwork	Remarks	Last Inspection Date of Corresponding Earthwork
M1-J23a-J25-EA-NB-192/0	447255	333980	1	None observed	-	-	None observed	N/A	-	13/01/2021
M1-J23a-J25-EA-SB-193/4	447209	335466	1	Not classified	Near MP 193/5, within the interchange, but close to the northbound carriageway of M1	90m Northwest	Drainage (standing water on the ditch) and vegetation (excessive vegetation on the slope), can't inspect.	N/A	Set ID 478474	11/12/2019
			2	Not classified	Near MP 193/5, within the interchange, but close to the northbound carriageway of M1	113m Northwest	Desiccation cracks at the crest for a length of 31m.	N/A	Set ID 478460	11/12/2019
			3	Not classified	Between MP 193/5 and MP 193/6, approximately 50m away from the northbound carriageway of M1	160m Northwest	Hydrophilic vegetation and high moisture content	N/A	Set ID 411654	09/02/2023
			4	Not classified	Between MP 193/5 and MP 193/6, approximately	170m Northwest	Hydrophilic vegetation and high moisture content	N/A	Set ID 411653	09/02/2023

Proposed EA location	National Grid E	National Grid N	SI No.	Defect (Class)	Location	Within EA or Distance from centre of EA	Description	Remediated Slopes in Earthwork	Remarks	Last Inspection Date of Corresponding Earthwork
					100m away from the northbound carriageway of M1					
			5	Not classified	Between MP 193/5 and MP 193/6, but along A52	220m Northwest	Hydrophilic vegetation and high moisture content	N/A	Set ID 411642	09/02/2023
			6	Class 3	Between MP 193/5 and MP 193/6, but along A53	320m Northwest	-	Retaining wall/concrete slabs 0.5m high. Not seen 2019 due to dense brambles	Set ID 478760	10/02/2023
			7	Not classified	70m from MP 193/5B. i.e., 70m to the west of the southbound carriageway of M1, within the interchange	150m Northeast	Drainage (standing water on the ditch) and vegetation (excessive vegetation on the slope), can't inspect.	N/A	Set ID 478469	11/12/2019
			8	Not classified	Between MP 193/5B and MP 193/6B, approximately 40m from the southbound carriageway of	200m Northeast	Drainage (standing water on the ditch)	N/A	Set ID 411662	09/02/2023

Proposed EA location	National Grid E	National Grid N	SI No.	Defect (Class)	Location	Within EA or Distance from centre of EA	Description	Remediated Slopes in Earthwork	Remarks	Last Inspection Date of Corresponding Earthwork
					M1, within interchange					
			9	Not classified	Near MP 193/6B, approximately 40m from the southbound carriageway, within interchange	225m Northeast	Hydrophilic vegetation	N/A	Set ID 478466	09/02/2023
			10	Class 3	Between MP 193/6B and MP 193/7, along Bostock's Lane	270m Northeast	-	Defect repaired with retaining wall 1 to 1.5m tall with guard rail along top	Set ID 218586	09/02/2023
			11	Class 1A	Between MP 193/6B and MP 193/7, along Bostock's Lane	360m Northeast	Multiple piles of debris at crest of slope. One pile held up by makeshift wooden pallet retaining wall.	N/A	Set ID 653673	09/02/2023
			12	Class 1D	Near MP 193/7, same side of EA	300m North	Slip in mid-slope, back scar has max height of 0.2m and is approximately 22m long. The cutting is also desiccated.	N/A	Set ID 142025	27/01/2021

Proposed EA location	National Grid E	National Grid N	SI No.	Defect (Class)	Location	Within EA or Distance from centre of EA	Description	Remediated Slopes in Earthwork	Remarks	Last Inspection Date of Corresponding Earthwork
			13	Class 1D	Near MP 193/8B, same side of EA	375m North	Comms retaining wall failure/collapse, not repaired by SMP (present 2021)	N/A	Set ID 535991	27/01/2021
M1-J23a-J25-EA-SB-187/7	446908	330003	1	None observed	-	-	None observed	N/A	-	27/01/2021
M1-J23a-J25-EA-SB-185/1	447559	327407	1	Class 2	Between MP 185/0B and MP 185/1B, same side of EA	5m west	Poorly backfilled area of cutting, 8m wide and 8m up slope from toe	N/A	Set ID 641780	28/01/2021
			2	Class 1D	Between MP 185/0A and MP 185/1A, opposite side of EA	39m Southwest	Incipient shallow slope failure, approximately 11m wide, step 0.2m high	N/A	Set ID 641747	28/01/2021
			3	Class 1D	Between MP 185/0A and MP 185/1A, opposite side of EA	39m Southwest	Soil slips in mid-slope, back scar approximately 0.5m high, 9m wide. Desiccation cracking in upper slope.	N/A	Set ID 641748	28/01/2021
			4	Class 1A	Near MP 185/0M, same side of EA, on the slip road next to the main carriage way	77m Southeast	Large embankment failure, full height of embankment and approximately 16.8m long. Back scar is at the crest of the embankment and is 2m high from crest	N/A	Set ID 642019	15/03/2023

Proposed EA location	National Grid E	National Grid N	SI No.	Defect (Class)	Location	Within EA or Distance from centre of EA	Description	Remediated Slopes in Earthwork	Remarks	Last Inspection Date of Corresponding Earthwork
							to top of slope bulge and 3.3m off the back of VRS.			
			5	Class 2	Near MP 184/9B, same side of EA	140m Southeast	Poorly backfilled excavation, no topsoil, and slight seepage	N/A	Set ID 642034	28/01/2021
			6	Not classified	240m to the west of MP 185/3B, along A453	380m Northeast	Drainage (toe). Some ponding and burrows in place within ditch	N/A	Set ID 614079	10/01/2019
			7	Class 1D	260m to the west of MP 185/3B, along A454	400m Northeast	Minor soil slips and subsidence at crest over ~10m long, 3m wide section. Displace ~0.5m vertical	N/A	Set ID 614080	10/01/2019

2.4.3 Structures

The Structures Management Information System structures dataset has been interrogated. Within the study area there are approximately 63 No. structures. The structures consist of:

- 29 No. Bridges and Large Culverts;
- 4 No. Masts;
- 3 No. Retaining Walls;
- 25 No. Signs/Signal Gantries;
- 2 No. Small Span Structures.

The proposed works do not interfere with the existing highway structures.

2.4.4 Historical Land Use

A high-level review of the available historical mapping on GDMS [21] was undertaken along with review of existing PSSR-19183 [1]. The findings are summarised in Table 5.Prior to the construction of the M1 in the early 1970s, the land use of the area was largely rural. Little change has taken place up to Junction 23A except the development of the motorway itself. East Midlands Airport was opened in 1965 on the site of a former Royal Air Force base (Castle Donington). At this time, road access to the airport was from Kegworth village crossing the M1 on an overbridge. Junction 24 was constructed just to the east of Lockington with an exit to the recently improved Derby-Loughborough Road (A6). By 1972, improvements had taken place to the airport access and the Ashby Road diverted around its extended site. The A453 from Nottingham had also been completed as far as Junction 24. By 1982, the A453 link had been built south from Junction 24 to give direct access from the motorway to East Midlands Airport. By 1992, Junction 23A had been completed in its present-day configuration with direct access to East Midlands Airport and slip roads connecting to the newly opened A42/M42.

Junction 24A was opened in 1999 connecting the A50 Derby Southern bypass with the M1 at CH 186+800. Continuing north to Sawley, the motorway route passes over the "Sawley and Weston Railway" at CH 187+ 300. From 1921, a major water main (the "Derwent main") ran parallel and west of the motorway from Sawley to the Warren Lane Bridge at CH 186+800 where a pumping station is still located. By 1972, extensive gravel pits had been developed on both sides of the motorway near Lockington Grounds Fann but were almost entirely infilled by 1995.

The River Trent floodplain was predominantly rural with fields and meadows, and evidence of oxbow lakes and abandoned channels. The M1 was constructed across this area on embankments and viaducts. Between 1971 and 2000, the villages of Sawley and Long Eaten underwent expansion with residential areas extending towards the eastern boundary of the motorway. By 1983, a major reservoir and waterworks (Church Wilne Reservoir) were completed to the west of the motorway just south of the Derby-Nottingham railway. A flood protection lagoon/nature reserve is also shown on the 1983 mapping near the west side of the motorway embankment (CH 191 +500).

Passing north out of the flood plain, the area remains rural. The Derby Canal is shown on the earliest (1889) mapping and crosses the M1 at CH 192+900. The canal was disused by 1973, and partly in filled beneath the motorway and through Long Eaton. Just to the north, a brickyard is shown, disused by 1901. The brickpit is shown as a pond on the line of the motorway, until the construction of the M1, but presumably it was infilled at this time. A small number of properties were demolished to construct the motorway between the settlements of Sandiacre and Risley. Junction 25 gave access to the A52 Derby-Nottingham Road. A slip road to the southeast of the junction was constructed giving access to a motel and hotel completed by 1983.
The historical land uses identified have no adverse impact on the proposed works.

Table 5 Historical mapping review

Year	Observations
Pre 1900	The area is mostly rural
Pre 1910	No significant change
Pre 1920	No significant change
Pre 1930	No significant change
Pre 1940	No significant change
Pre 1950	No significant change
Pre 1960	No significant change
Pre 1970	M1 is present in current configuration J24A not yet constructed. Extension of Swaley and Long Eaton towards the eastern boundary of motorway
Pre 1980	Extension of Swaley and Long Eaton towards the eastern boundary of motorway
Pre 1990	J23A completed in the current day configuration, Extension of Swaley and Long Eaton towards the eastern boundary of motorway
Pre 2000	J24A opened in 1999, Residential and commercial development along the motorway at the existing settlements

2.5 Department for the Environment, Food and Rural Affairs

Searches for statutory undertaker's plant have been undertaken by the project and a composite utilities plan [26] produced. The existing utilities closest to the proposed works are summarised in Table 6. All available utility data will be added to the pre-construction information as required by the Construction Design and Management Regulations (2015). Risks associated with existing services and potential mitigation measures are captured in the scheme designers risk assessment and on the drawings which clearly communicate the residual risk.

Table 6 Utilities identified closest to each site

Proposed work	Marker Post	Utility type	Proximity to works	Drawing reference
M1-J23a-J25-EA-NB-187/8	187/8	BT (Telecom/Cable) – Underground	Within footprint	HE614830-WSP-GEN-P015_AL_ALLGENR-M2-CH-0004
		TELENT - Underground		
M1-J23a-J25-EA-NB-190/2	190/2	BT (Telecom/Cable) – Underground	Within footprint	HE614830-WSP-GEN-P015_AL_ALLGENR-M2-CH-0004
M1-J23a-J25-EA-NB-192/0	192/0	BT (Telecom/Cable) – Underground	Within footprint	HE614830-WSP-GEN-P015_AL_ALLGENR-M2-CH-0004
		TELENT - Underground	Within footprint	
		Western Power Distribution – Electricity Overhead	About 13m west	

Proposed work	Marker Post	Utility type	Proximity to works	Drawing reference
M1-J23a-J25-EA-SB-193/4	193/4	TELENT - Underground	Within footprint	HE614830-WSP-GEN-P015_AL_ALLGENR-M2-CH-0004
		Western Power Distribution – Electricity Underground	About 36m Southeast	
M1-J23a-J25-EA-SB-187/7	187/7	TELENT - Underground	Within footprint	HE614830-WSP-GEN-P015_AL_ALLGENR-M2-CH-0004
M1-J23a-J25-EA-SB-185/1	185/1	TELENT - Underground	Within footprint	HE614830-WSP-GEN-P015_AL_ALLGENR-M2-CH-0004
		Western Power Distribution – Electricity Underground	about 35m north	
MS4-NB-190/5	190/5	BT (Telecom/Cable) – Underground	Within footprint	HE614830-WSP-GEN-P015_AL_ALLGENR-M2-CH-0004

2.6 Utilities

Statutory undertaker searches were undertaken by the project and a composite utilities plan [26] was produced. All available utility data will be added to the pre-construction information as required by the Construction Design and Management Regulations (2015). Risks associated with existing services and potential mitigation measures are captured in the scheme designers risk assessment and on the drawings which clearly communicate the residual risk.

2.7 Unexploded Ordnance (UXO)

The Zetica UXO Ltd regional risk map [28] shows most of the site has a low risk of UXO. No abandoned bombs or UXO finds were identified in the study area. Considering the indicated hazards and the existing motorway construction no further assessment of UXO was deemed necessary.

2.8 Potential Sources of Contamination

In addition to the historical landfill detailed in sub-section 2.2.3, there are two potential off-site sources of contamination within 100m of the proposed EAs and associated structures. These are:

- A historical brick works with associated tramway and tanks, located 30m south of EA-SB-193/4.
- Historical refuse heaps (location of Hemington Gravel Pit historical landfill) located 25m west and 25m east of EA-NB-187/8 and EA-SB-187/7, respectively.

In addition to the above off-site sources, potential on-site sources of contamination could include:

- Contaminated Made Ground and Fill associated with the motorway construction and embankments.
- Fuel and chemical spillages associated with road traffic accidents/incidents.

2.9 Preliminary Conceptual Site Model (CSM) and Risk Assessment

Based on the information in the preceding subsections, a preliminary Conceptual Site Model (CSM) has been developed, and Potential Pollutant Linkages (PPLs) have been identified by a preliminary risk assessment. The PPLs are summarised in Table 7. The risk is based on a consideration of the following:

- The likelihood of an event (probability – considers both the presence of the hazard and receptor and the integrity of the pathway); and,
- The severity of the potential consequence (considers both the potential severity of the hazard and the sensitivity of the receptor).

Further information on the risk assessment methodology is provided in Annex I.

Table 7 Preliminary CSM and Risk Assessment

Source	Identified Contaminant	Pathways to Receptor	Receptor	Consequence	Likelihood	Risk	Comments
On-site sources of contamination, comprising: **- Motorway construction (contaminated Made Ground and Embankment Fill).** **- Motorway fuel/chemical spills.**	Heavy metals, inorganics, polycyclic aromatic hydrocarbons, petroleum hydrocarbons, volatile and semi-volatile organic compounds, asbestos etc.	Leaching and vertical migration of soil contaminants and/or contaminated perched groundwater.	Groundwater: - Secondary A aquifers (superficial deposits). - Secondary B aquifers (Edwalton Member and Gunthorpe Member).	Mild	Unlikely	Very Low	Post-construction, the scheme will primarily comprise hardstanding with limited soft landscaping, therefore leaching of soil contaminants and vertical migration to groundwater is unlikely. During construction, the installation of pile foundations could create preferential pathways for leachable soil contaminants and/or contaminated perched groundwater to enter the aquifers. However, historical ground investigation records within the vicinity (<100m) of the proposed EAs and associated structures do not indicate the presence of widespread visual/olfactory contamination.
Off-site sources of contamination, comprising: **- Historical landfill (Hemington Gravel Pit)** **- Historical refuse heaps.** **- Historical brick works**	Ground gas and vapours.	Inhalation of ground gas/vapours in excavations and confined spaces. Explosion.	Construction and future maintenance workers.	Severe	Unlikely	Moderate/low	Exposure of construction / maintenance workers to ground gas/vapours is possible within excavations and confined spaces. However, historical ground investigation records within the vicinity (<100m) of the proposed EAs and associated structures do not indicate any widespread sources of ground gas or vapours, such as organic/putrescible materials/wastes or odours.
Off-site sources of contamination, comprising: **- Historical landfill (Hemington Gravel Pit).**	Landfill gas.	Inhalation of landfill gas in excavations and confined spaces. Explosion.	Construction and future maintenance workers.	Severe	Low	Moderate	Exposure of construction / maintenance workers to landfill gas is possible within excavations and confined spaces at EA-NB-187/8 and EA-SB-187/7, located within the immediate vicinity (25m) of Hemington Gravel Pit historical landfill.

3 SITE RECONNAISSANCE

Location-specific ground investigation (GI) was carried out between 2nd May and 4th July 2023 at specific areas of interest to determine the geotechnical and geo-environmental information of the substrata. The areas of interest were determined based on the availability of historical substrata information in the proximity of the proposed infrastructure elements. The ground investigation data has been recorded with the proposed field and laboratory tests in the factual report produced by Strata Geotechnics (part of Van Elle) included as Annex J. Along with ground investigation, LiDAR and topographical survey data has also been referred to in the preparation and analysis of the earthwork sections at the specific areas of interest. Cross sections at the proposed EA locations have been developed utilising both LiDAR and topographic data, the worst-case geometry has been considered for final analysis.

4 GROUND CONDITIONS

In addition to publicly available records held by the British Geological Survey, reference has been made to the existing ground investigation data obtained for the M1 J23a - 25 Smart Motorways Programme, which is included in the Ground Investigation Report (GDMS No. 28929) produced by Amey Arup JV in February 2016. The ground conditions and laboratory testing data from this report along with the data from the 2023 ground investigation has been considered in the following assessment. Based on the available ground investigation, the geological conditions along the scheme have been summarised in a series of long sections, which are included in Annex G. The locations of the proposed EAs and their accompanying minor structures have been identified on these sections.

During both Ground Investigations (2016 & 2023), extensive deposits of Made Ground were encountered. Made Ground comprising Engineering Fill associated with the construction of the motorway (road construction materials and embankments) is expected to be present. The composition of the Made Ground is expected to be variable, comprising both granular and cohesive soils. Underlying the Made Ground in several locations, very stiff to occasionally soft cohesive superficial deposits were encountered and in other areas loose to medium dense granular superficial deposits were encountered.

No groundwater strikes were encountered during the ground investigation performed in 2023.

5 PRELIMINARY ENGINEERING ASSESSMENT

The following preliminary engineering assessment forms part of the Preliminary Sources Study Report. These assessments are developed further in the GDR section of the report.

5.1 Earthworks

All the earthwork interventions, both on embankments and in cuttings, will involve regrading of the existing slopes to 1(V):2(H) or 1(V):2.5(H) except one case where retention measure has been adopted. Thus, none of the earthworks will require reinforcement. Slope stability analysis will be undertaken to demonstrate long term stability of earthworks.

Embankments are to be constructed with acceptable engineered fill in accordance with the scheme-specific Series 600. No soft or compressible materials were identified during the 2023 ground investigation, but when localised soft spots are encountered, these should be excavated and replaced with good quality fill material. Standard details will be produced for the earthworks interventions. Annex H shows typical sections of the proposed regrades for this scheme.

5.2 Retaining Structures

Where the proposed EAs cannot be constructed with simple regrades to existing slopes, then retaining structures will be required. There are standard details employed on the Smart Motorway Programme and these include options for slab on edge, modular block walls, and king sheet piles. Detailed geotechnical design will be required for one location where a retention measure in the form of King Sheet Pile Wall has been adopted.

5.3 Minor structures

Posts for signs, CCTV, MIDAS, or gantry bases will be required and shall be designed in accordance with CD 354- Design of minor structures.

In addition to foundations, the drainage of the structures will require to be assessed. For example, the position of Comms chambers will be reviewed to advise on drainage strategy. If feasible soakaway drainage is preferred but this will be assessed against the risk to the earthwork asset or if shallow groundwater has been recorded locally.

6 COMPARISON OF PROJECT OPTIONS AND RISKS

The Overarching SMP design philosophy, which has largely carried through to SMA and NEAR, is "Design Once, use often". This requires creation of a suite of design solutions that can be applied to the likely conditions that will be encountered on site. Each design solution contains a degree of conservatism and has to cover a specific range of conditions. For the NEAR programme the Intervention Decision tree for embankment and cutting respectively show which approach should be selected. The Decision tree was attached in the scheme specific SOI [5] for further information.

7 FIELD AND LABORATORY STUDIES

The scheme-specific ground investigation factual report produced by Strata Geotechnics (2023) is the main reference for the field and laboratory data. The ground conditions and laboratory testing data from this report have been considered in the following assessment. In addition to publicly available records held by the British Geological Survey, reference has been made to previous ground investigation data obtained for the M1 J23a - 25 NEAR scheme in the Ground Investigation Report (GDMS No. 28929) produced by Amey Arup JV in February 2016. The geotechnical parameters derived as part of the M1 J23a - 25 Smart Motorways Programme which is taken from the factual report produced by Strata Geotechnics have been validated using the Ground Investigation Report (GDMS No. 28929) available.

7.1 Geomorphological/Geological Mapping and Topographic Survey

Geomorphological or geological mapping has not been undertaken specifically for this scheme. Reference should be made to Table 4 for information on the current condition of earthwork assets on the scheme. In summary, although minor geomorphological features are present in this section of the network, they are considered not to impose a risk to the proposed scheme and are not planned to be addressed.

7.2 Ground Investigations

A specific ground investigation has been undertaken for the current works. A large existing data set from the previous Managed Motorway works covering Junction 23a to 25 is also available and has been used in conjunction with other historical exploratory hole data accessed via the British Geological Survey and GDMS. The location of the boreholes is identified on the geological long sections provided in Annex G. These boreholes are reasonably sufficient given the proximity and the data filling in the gaps of the ground investigation report [2]. The AGS file for the corresponding ground investigation data can be accessed at this link here: G230600 - 2023-09-04 1020 - AGS to accompany Report Rev 002.ags

7.2.1 Description Of Fieldwork

The ground investigation data available from the Strata Geotechnics factual report (2023) comprises the following:

- 7no. Dynamic (windowless) sample boreholes to a maximum depth of 10m bgl;
- 3no. Window Sample boreholes with rotary follow-on to a maximum depth of 20m bgl.

As noted above, the full dataset, including the new boreholes undertaken between Junction 23a and 25, have been used in the following assessment.

7.2.2 Results of In Situ Tests

Standard Penetration Tests
A total of 94 Standard Penetration Tests (SPT) were undertaken within the boreholes (2023) to determine the in-situ relative density of the ground encountered.

7.3 Drainage Studies

None undertaken.

7.4 Geophysical Surveys

None undertaken.

7.5 Existing Test Pile Results

Working Pile load tests were undertaken at eight gantry base locations constructed as part of the original 'all lane running' (ALR) scheme. This information is recorded in the M1 J23a - 25 Geotechnical Feedback Report (GDMS No. 30523) and summarised below.

Table 8 Static Load Testing Undertaken for M1 J23a-25 All Lane Running Scheme

Gantry	Load (kN)	Results Maximum Displacement (mm)	Residual Displacement (mm)
G:202	Working Load – 849	0.62	0.36
	Max.Test Load –1273.5	1.15	0.69
G:203	Working Load – 713	0.24	0.14
	Max.Test Load –1069.5	0.4	0.2
G:301 P2	Working Load – 1539	1.29	0.64
	Max.Test Load –2308.5	2.43	1.17
G:301	Working Load – 1539	1.12	0.49
	Max.Test Load –2308.5	2.22	1.19
G:303	Working Load – 1033	1.2	0.36
	Max.Test Load –1549.5	1.87	0.64
G:311	Working Load – 590	0.23	0.03
	Max.Test Load –885	0.42	0.11
G:313	Working Load – 412	0.69	0.2
	Max.Test Load –618	1.1	0.37
G:315	Working Load – 1222	0.54	0.13
	Max.Test Load –1833	0.84	0.2
Working Load – Specified Working Load Max.Test Load – Design Verification Load			

7.6 Other Field Work

None undertaken.

7.7 Laboratory Investigation

7.7.1 Description of Tests

The following geotechnical laboratory testing is available:

Geotechnical Test	Test Method	Number of Test Results
Moisture Content	BS1377: Part 2: 1990; Clause 3	31
Liquid / plastic limits	BS1377: Part 2: 1990	51
Particle Size Distribution	BS1377: Part 2: 1990; Clause 9	57
Determination of dry density/moisture content relationship (2.5kg hammer)	BS1377: Part 4: 1990	40
Small Shear Box	BS1377: Part 7: 1990; Clause 4	9
Large Shear Box	BS1377: Part 7: 1990; Clause 4	1
Point Load Index	ISRM 1985	7
Uniaxial Compressive Strength	ISRM, Part 2 1981	1
Consolidated Undrained triaxial total strength (QUT)	BS1377: Part 7: 1990	1

7.7.2 Geoenvironmental Tests

Geoenvironmental sampling and testing was undertaken during the 2023 Strata Geotechnics ground investigation at six EA locations as detailed in Table 9 below. Only testing of soils were undertaken; no leachate testing or testing of water samples were undertaken.

Table 9 Geoenvironmental Testing

Borehole	Sample depth (mbgl)	Strata	Testing (Soils)				
			Asbestos	Inorganics	Metals	TPH	VOCs
BH1877N	0.5	Made ground	Y	Y	Y	Y	Y
	1.0	Hemington Member		Y	Y		
	1.5	Hemington Member		Y	Y	Y	Y
BH1877S	1.8	Hemington Member		Y	Y	Y	Y
BH1896S	1.7	Hemington Member		Y	Y		
BH1912S	1.0	Edwalton Member		Y	Y	Y	Y
BH1920N	0.3	Made ground	Y	Y	Y	Y	Y
BH1933S	0.4	Made ground	Y	Y	Y	Y	Y
	1.0	Made ground	Y	Y	Y	Y	Y
	1.3	Gunthorpe Member		Y	Y		

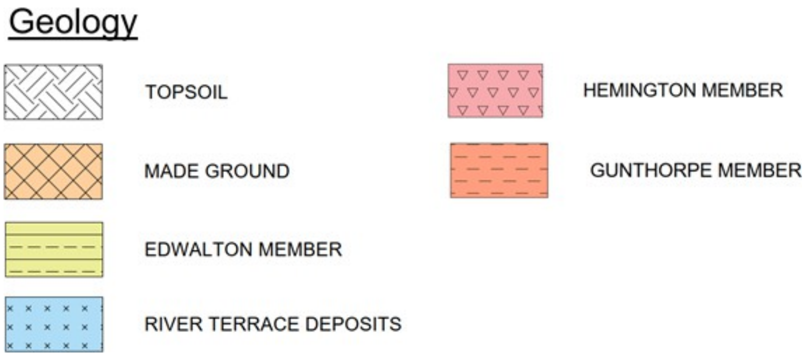
TPH – Total Petroleum Hydrocarbons
VOCs – Volatile Organic Carbons

8 GROUND SUMMARY

8.1 Overview

Based on the ground investigation and historical reports, the geological conditions along the scheme have been summarised in a series of long sections which are included in Annex G. The locations of the individual EAs have been identified on these long sections. The following subsections provide a summary of the ground conditions at each EA and accompanying minor structures using extracts from the geological long sections Annex G. Detailed Geotechnical Data Sheets (GDS) summarising the ground model, characteristic values of geotechnical parameters, risks are included in Annex A and Annex B.

A legend for the geological cross sections is included below.



8.1.1 EA NB-187/8

The approximate location of the EA is shown in the Figure 8-1 which also notes the existing exploratory holes and the GI borehole performed in 2023. An extract of the geological long section indicating the approximate location of the EA is also provided below in Figure 8-2.

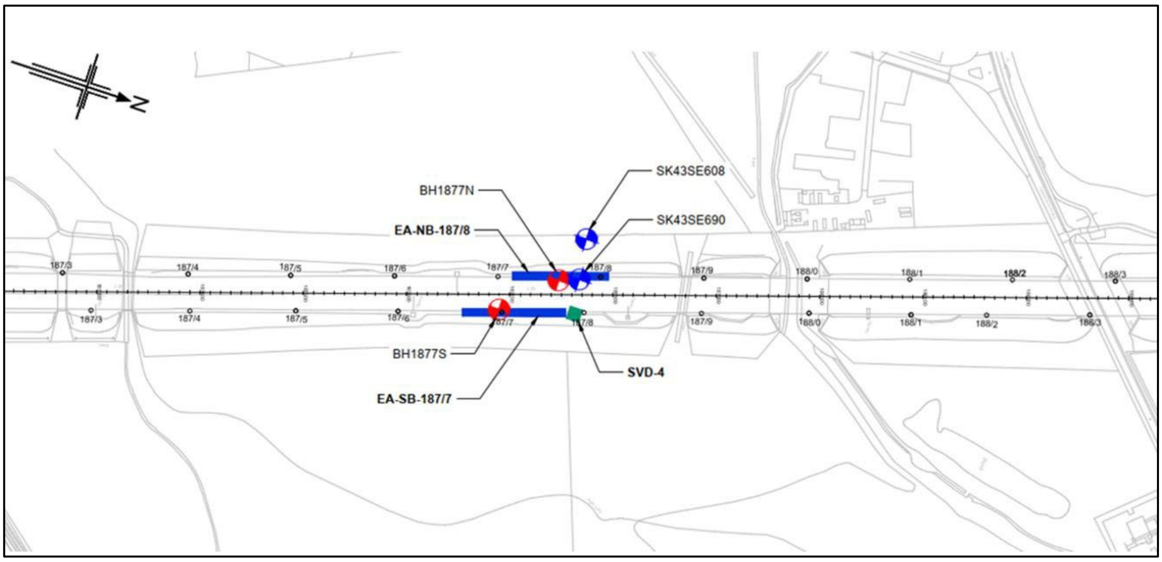


Figure 8-1: Location of EA NB-187/8

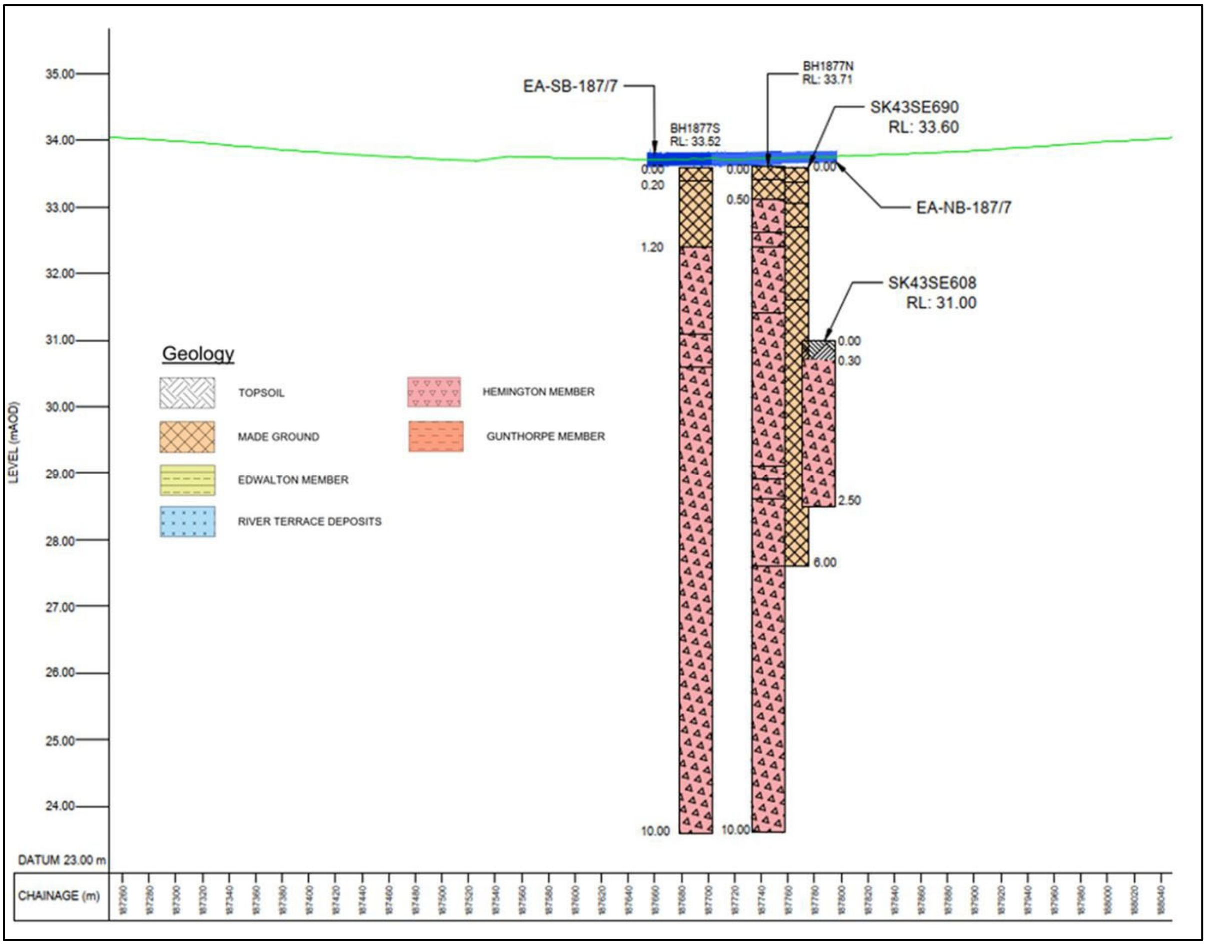


Figure 8-2: Geological long section at EA NB-187/8

There is a difference observed between the strata depicted in the boreholes from the GFR [4] and the 2023 ground investigation data. From the long section in Figure 8-2, field descriptions of Made Ground from the GFR [4] and of the Hemington Member from the 2023 GI data are the same, but these have been classified differently. GDMS [21] depicts superficial data in this region as Hemington Member which is more in line with the 2023 GI data. Therefore, the strata recorded as Made Ground in borehole SK43SE690 is considered an incorrect classification.

8.1.2 EA NB-190/2, SVD-1 and MIDAS-1

The approximate locations of the EA, SVD and MIDAS are noted in Figure 8-3 which also notes the existing exploratory holes and the GI borehole performed in 2023. An extract of the geological long section indicating the approximate location of the EA, SVD and MIDAS is also provided below in Figure 8-4

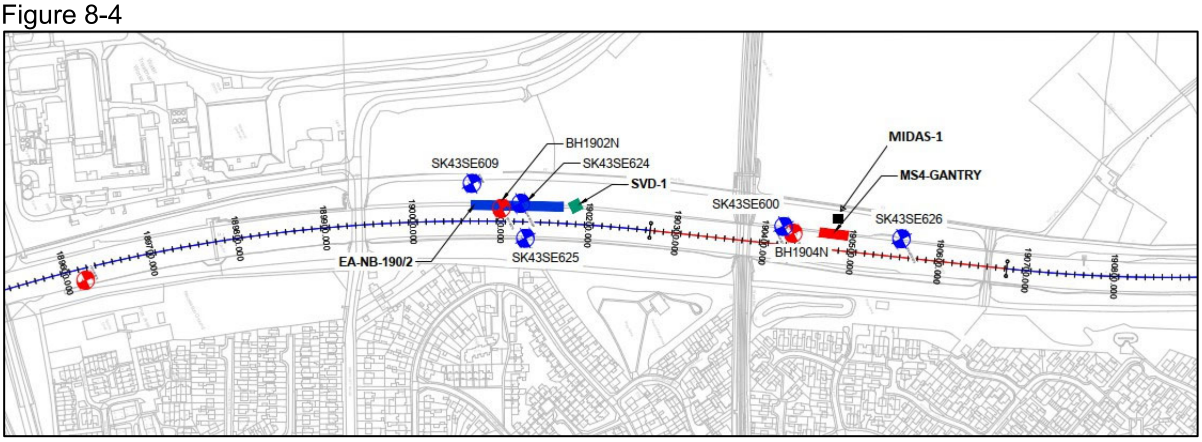


Figure 8-3: Location of EA NB-190/2, SVD-1 and MIDAS-1

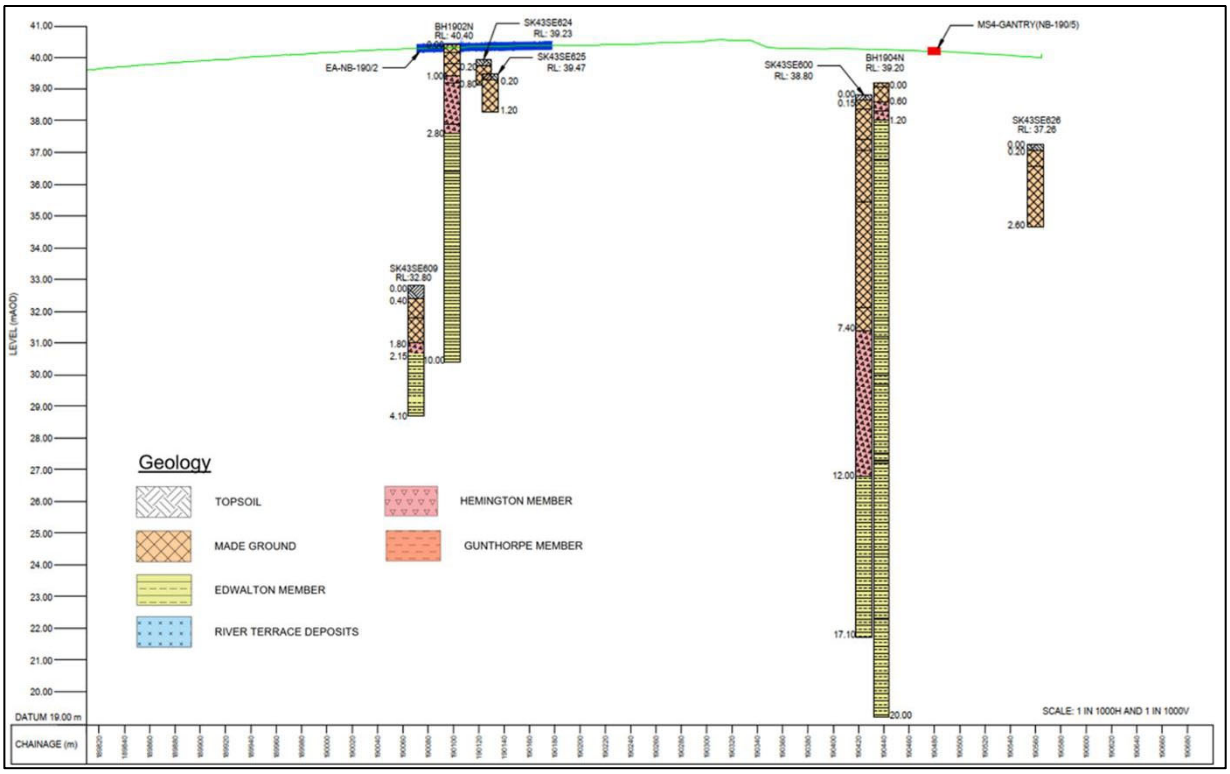


Figure 8-4: Geological long section at EA NB-190/2

On similar lines of section 8.1.1, there is a difference observed between the strata depicted in the boreholes from the GFR [4] and the 2023 GI data. From the long section in Figure 8-4, field descriptions of Made Ground from the GFR [4] and of the Edwalton Member from the 2023 GI data are the same, but these have been identified differently. GDMS [21] depicts superficial data in this region as Hemington Member and bedrock data as Edwalton Member, which is more in line with the 2023 GI data. Therefore, the strata recorded as Made Ground in borehole SK43SE600 is considered an incorrect classification.

8.1.3 EA NB-192/0 and SVD-2

The approximate location of the EA and SVD is noted in Figure 8-5 which also notes the existing exploratory holes and the GI borehole performed in 2023. An extract of the geological long section indicating the approximate ` of the EA and SVD is also provided below in Figure 8-6.

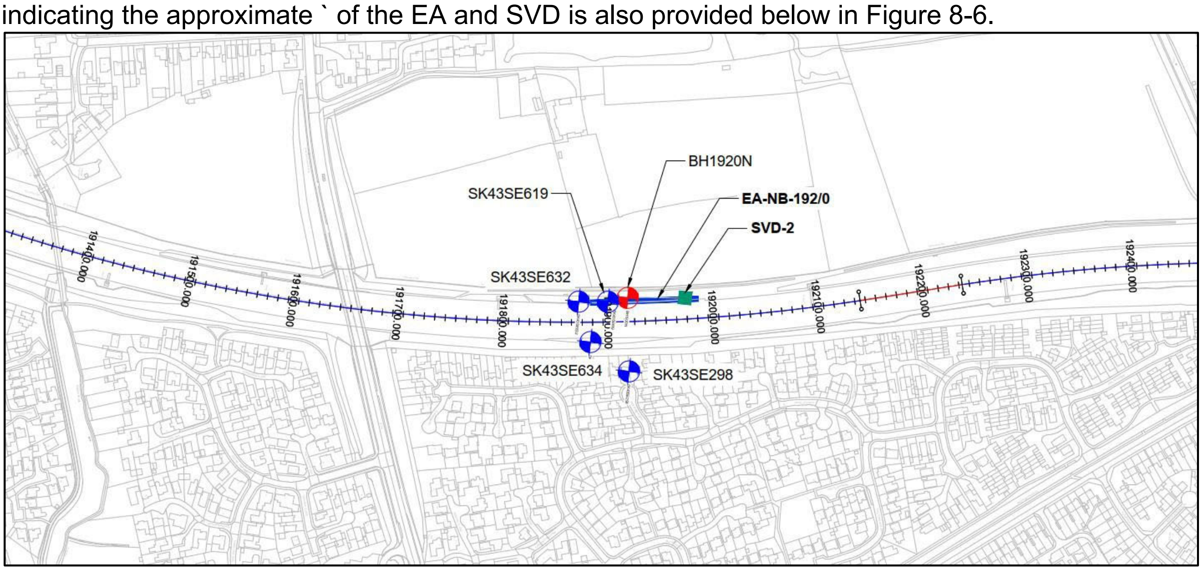


Figure 8-5: Location of EA NB-192/0 and SVD-2

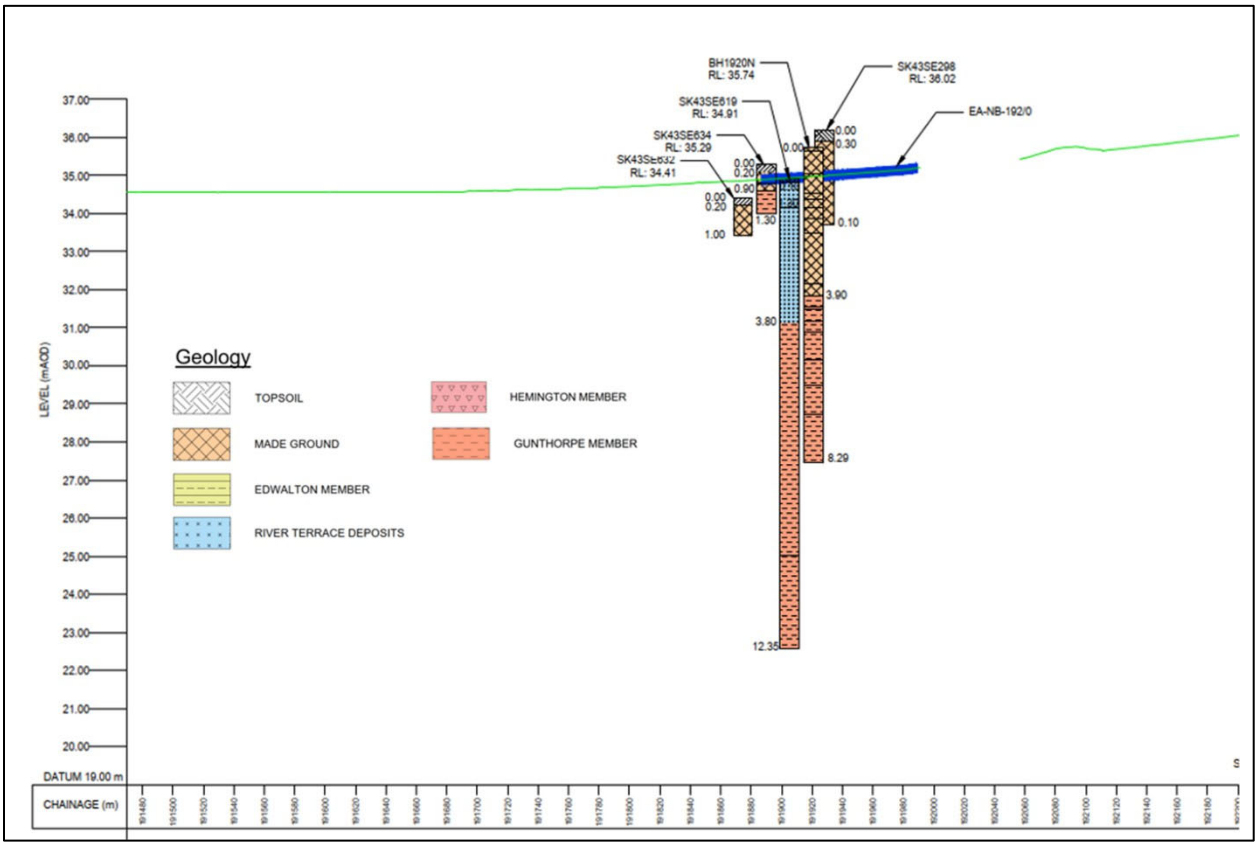


Figure 8-6: Geological long section at EA NB-192/0

8.1.4 EA SB-193/4, CCTV-1 and SVD-5

The approximate location of the EA, CCTV and SVD is noted in Figure 8-7 which also notes the existing exploratory holes and the GI borehole performed in 2023. An extract of the geological long section indicating the approximate location of the EA is shown below in Figure 8-8.

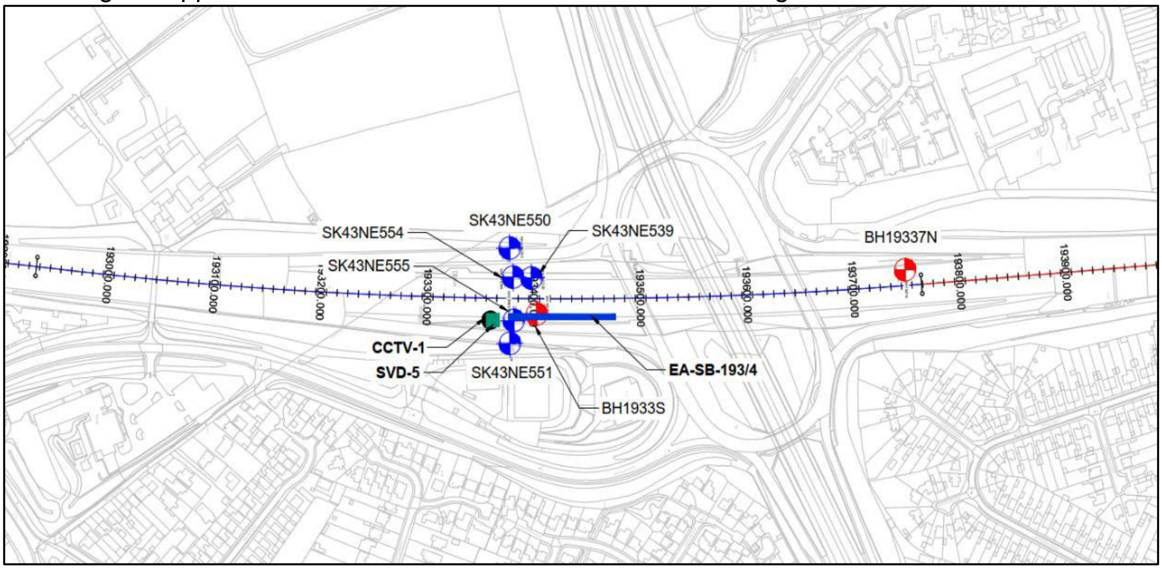


Figure 8-7: Location of EA SB-193/4 and SVD-5

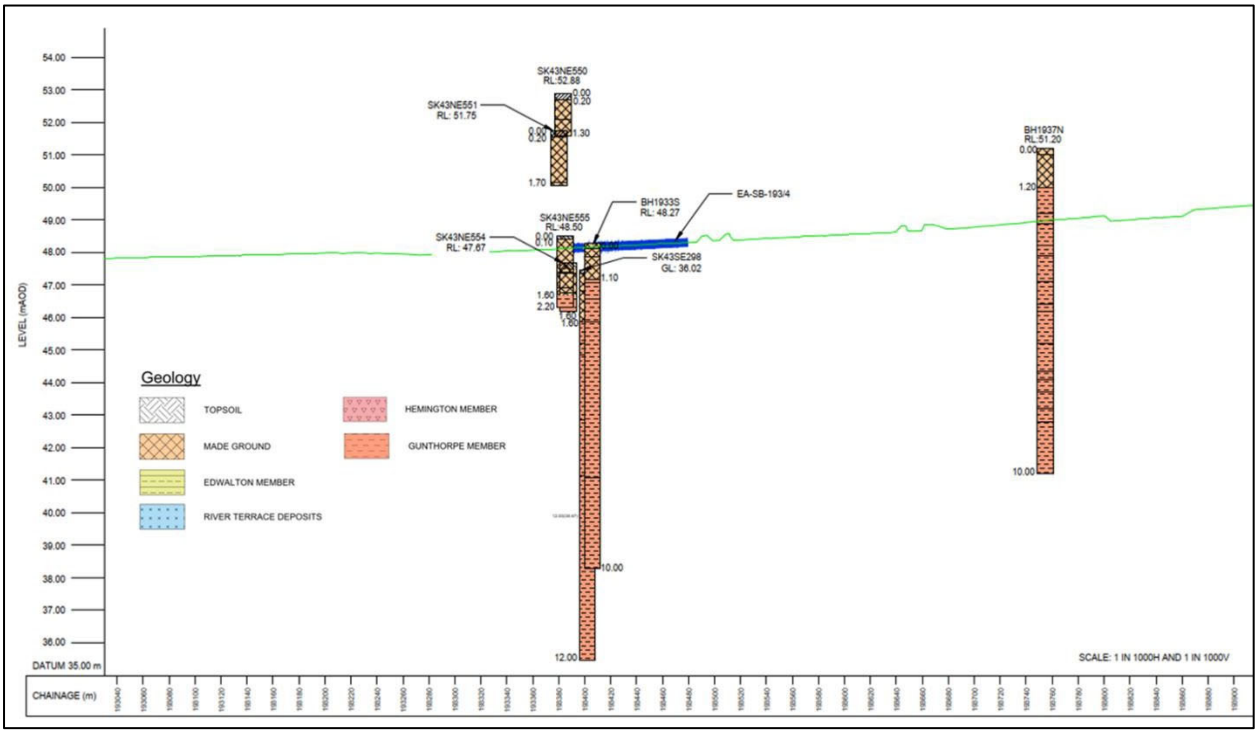


Figure 8-8: Geological long section at EA SB-193/4

8.1.5 EA SB-187/7 and SVD-4

Refer section 8.1.1 for extract of the geological long section indicating the approximate location of the EA and SVD as these are on the southbound carriageway at similar project chainages.

8.1.6 EA SB-185/1 and SVD-3

The approximate location of the EA and SVD is noted in the Figure 8-9 which also notes the existing exploratory holes and the GI borehole performed in 2023. An extract of the geological long section indicating the approximate location of the EA and SVD is also provided below in Figure 8-10.

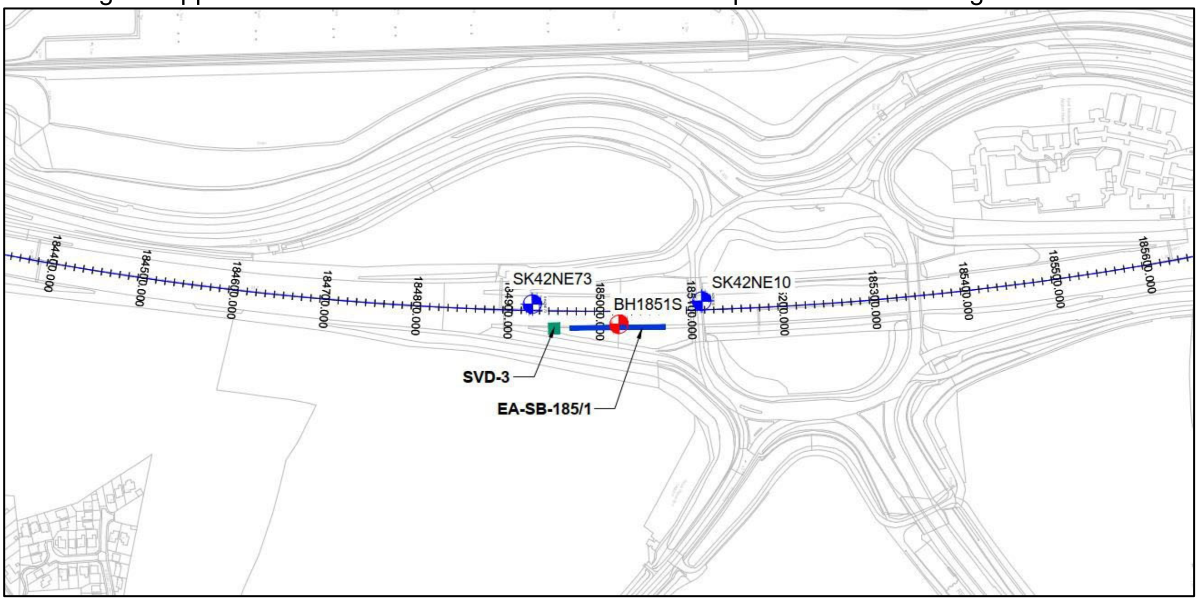


Figure 8-9: Location of EA SB-185/1 and SVD-3

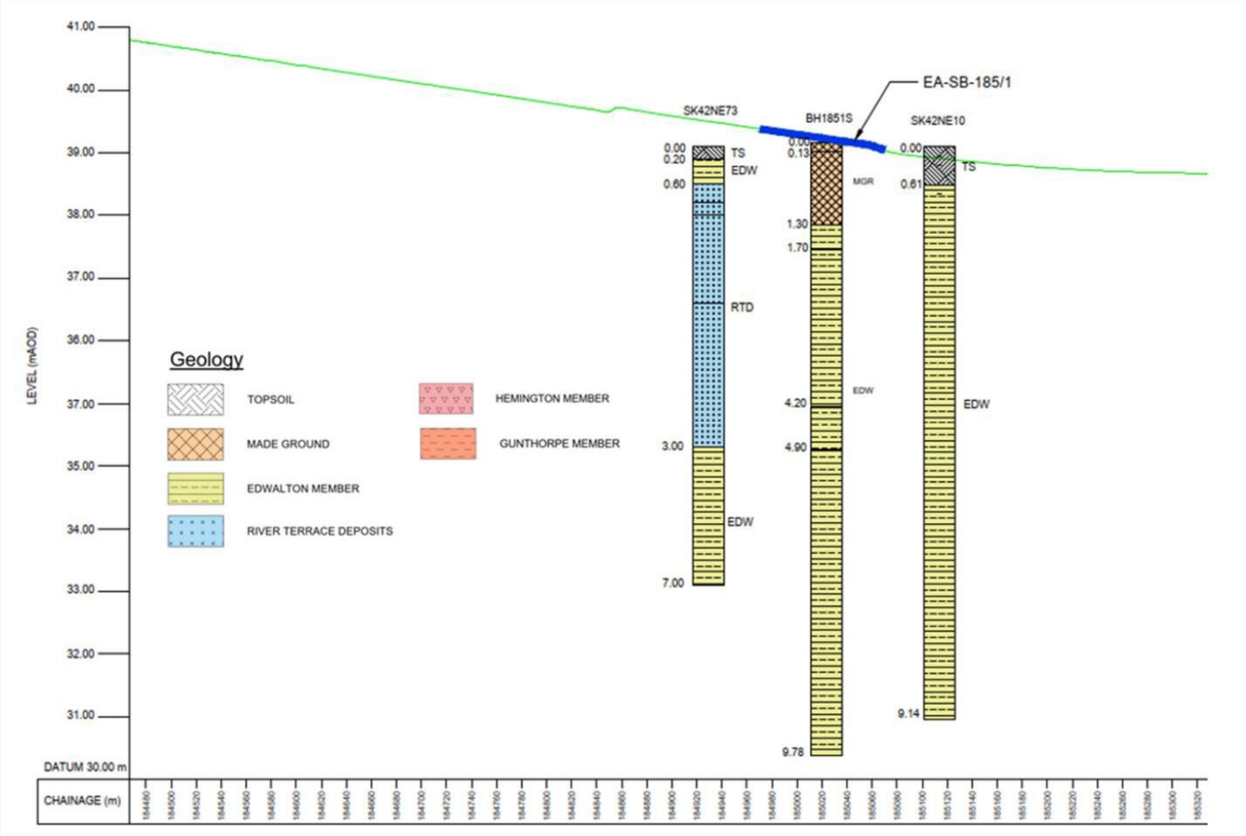


Figure 8-10: Geological long section at EA SB-185/1

8.1.7 MS4 Gantry at NB-190/5

Refer section 8.1.2 for extract of the geological long section indicating the approximate location of the MS4 Gantry.

8.2 Derived Geotechnical Parameters

Characteristic values of unit weights, effective soil parameters and undrained shear strengths have been derived based on scheme-specific ground investigation and the 2017 geotechnical design report for the M1 J23a-25 Smart Motorway upgrade (GDMS report 29152), assuming a moderately conservative approach. A summary of geotechnical parameters is presented in Table 10. Details of characteristic values of geotechnical parameters for each site are provided within the Geotechnical Datasheet in Annex A and Annex B.

Table 10 Derived Geotechnical Parameters

Material (Geological Unit)	Bulk Unit Weight γ (kN/m^3)	Effective Angle of Shearing Resistance ϕ' (°)	Effective Cohesion c′ (kPa)	Undrained Shear Strength C_u (kPa)
Embankment fill (Class 1A)	20	36	0	-
Made Ground (Granular)	19	30	0	-
Made Ground (Cohesive)	19	27	0	100
Hemington Member (Granular)	19-19.5	30	0	-
Hemington Member (Cohesive)	19	27	0	105

Material (Geological Unit)	Bulk Unit Weight γ (kN/m^3)	Effective Angle of Shearing Resistance ϕ′ (˚)	Effective Cohesion c′ (kPa)	Undrained Shear Strength C_u (kPa)
Edwalton Member (Granular)	20	33	0	-
Edwalton Member (Cohesive)	19-20	26-27	0-2	50-167
Gunthorpe Member (Cohesive)	19-20	26-27	0-2	130-192

9 ENGINEERING ASSESSMENT

This document comprises a combined Preliminary Sources Study Report, Ground Investigation Report and Geotechnical Design Report for all sites and minor structures. The strategy for geotechnical works is outlined in the scheme Statement of Intent HE614830-WSP-HGT-P015_AL_ALLGENR-RP-CE-0001.pdf (GDMS No. 47380). On this scheme, the majority of EAs are anticipated to be formed by regrading the existing earthwork slopes, either steepening cuttings or widening embankments. At the time of originating this report, all the EAs categorised under 'green' are anticipated to comprise regrades.

It is proposed to use a series of site-specific ground models to assess the various EAs and minor structures across the scheme. In practice this will mean a moderately conservative ground model is adopted. A detailed geotechnical design of the proposed infrastructure is discussed in the following section. As mentioned in section 7.2 the ground investigation is reasonable sufficient in all aspects of the design considerations.

10 GEOTECHNICAL DESIGN

The following sections comprise the Geotechnical Design Report for the 'Six EA' sites and one MS4 Cantilever Gantry. A summary of these sites and their proposed interventions for EAs and Minor structures are provided in Table 11 and Table 12 respectively. The General Arrangement Drawings of the proposed locations are attached in Annex E of this document.

Table 11 'Green' Category Emergency Areas

Structure Ref.	Structure Type	GDMS Earthwork ID	Earthwork Type	Geotech-nical Solution	Max. Retained Height (m) / Regrade Gradient
M1-J23a-J25-EA-NB-187/8	EA	24434	Embankment	Regrade	1V: 2H
M1-J23a-J25-EA-NB-190/2	EA	24420	Embankment	Regrade	1V: 2H
M1-J23a-J25-EA-NB-192/0	EA	22235	Cutting to at grade	Regrade	1V: 2.5H
M1-J23a-J25-EA-SB-193/4	EA	22232	Cutting	King Sheet Pile Wall	2.0
M1-J23a-J25-EA-SB-187/7	EA	24555	Embankment	Regrade	1V: 2H
M1-J23a-25-EA-SB-185/1	EA	42059	Cutting	Regrade	1V: 2H
MS4 Buildout EA-E3-A2-190/5	Gantry	24388	Embankment	Helical Piles for foundation	1V: 2H*

* The regrade angle is subjected to the installation location of the Helical Piles

Table 12 Minor Structures

Structure Ref.	Structure Type	Earthwork Type	Geotechnical Solution	Foundation Sizes
CCTV SB-193/4	CCTV	Cutting	Planted Foundation	600mm diameter, 3.9m depth
SVD-1 NB-190/2	SVD	Embankment	Pad Foundation	0.9m x 0.9m x0.6m
SVD-2 NB-192/0	SVD	Cutting to At Grade	Pad Foundation	0.9m x 0.9m x0.6m
SVD-3 SB-185/1	SVD	Cutting	Pad Foundation	0.9m x 0.9m x 0.6m
SVD-4 SB-187/7	SVD	Embankment	Pad Foundation	0.9m x 0.9m x0.6m
SVD-5 SB-193/4	SVD	Cutting	Pad Foundation	0.9m x 0.9m x0.6m
MIDAS-1 NB-190/2	MIDAS	Embankment	Planted Foundation	168mm diameter 3.1m depth

10.1 Ground Model and Geotechnical Data Sheets (GDS)

Geotechnical design of the scheme has been progressed in accordance with the Smart Motorways Design Guide, Appendix E3.03. The use of prescriptive measures is maximised using suitably conservative parameter values drawn from the ground investigation undertaken and existing information, as listed in Section 8.2. The details for each design element are summarised in the relevant GDS, which are presented in Annex A for earthworks, retaining wall & MS4 gantry, and Annex B for minor structures.

10.2 Soil Slope Design

10.2.1 General Assumptions

Generic cutting and embankment widening designs have been undertaken for soil slopes. First, the slopes geometry and ground conditions have been reviewed at each EA location, and next, five (5No.) Design Stability Models have been created assigning them to a specific EA. The Design Stability Models represent the worst credible scenarios in terms of geometry and ground conditions, and they are presented in section 10.2.2(for cuttings) and 10.2.3 (for embankments).
Two Design Stability Models have been developed for cuttings and three for embankments. The following information has been taken into account:

- Earthwork type (cutting or embankment);
- Groundwater conditions;
- Regrade type (partial or full);
- Existing slope angle (the steepest one);
- Existing cutting/embankment height (the highest one);
- Proposed regrade height (the highest one);
- Earthwork condition/ recorded defects in the footprint and immediate surroundings of the EA;
- Surcharge loads.

The generic earthwork designs have been applied to all EA earthwork modifications. Commercially available computer software (*Slide2* by Rocscience, 2022, version 9.024), employing limit equilibrium analysis to assess limit state modes of failure, was used to analyse the global stability of embankments and cuttings. Morgenstern and Price analysis for computing Overdesign Factor (ODF) was adopted for all analyses undertaken. The software options of 'slope search' was utilised for confirming the critical slip surface for circular analyses as appropriate.

It has been assumed for the purpose of design that existing earthworks are stable in their current condition unless major earthwork defects were identified during the Principal Inspections of earthworks as recorded in GDMS. Where earthwork defects have been recorded as being remediated, it is assumed that these slopes are stable and no further remedial works are required. Any existing earthwork defects that occur near a slope surface and within the extent of an EA will be remediated as part of the construction process by the creation of benching and the cutting back of existing slope faces. This is to ensure that loose or previously slipped material is removed and replaced.
The minimum depth of slip surfaces considered has been defined as per the default setting in *Slide2*. Drained and undrained conditions have been considered during design; however, for all analysed scenarios, drained conditions are the more onerous.

a) Geotechnical Parameters:
Scheme-wide geotechnical parameters have been assumed in the design of earthworks.
For the purposes of soil slope design, characteristic values of unit weights, effective and total stress soil strength parameters have been prepared from intrusive GI as specified in section 8.2 and historical data (GDMS Report 29152, by Arup for the original M1 J23a-25 Smart Motorway upgrade), adopting a moderately conservative approach.
The EA locations have distinct strata, which are among the six mentioned below and have been used for the respective slope designs. A summary of geotechnical parameters is presented in Table 13.

Table 13 Characteristic Geotechnical Parameters for the slope stability analysis.

Material (Geological Unit)	Bulk Unit Weight, γ (kN/m^3)	Effective Angle of Shearing Resistance, ϕ′ (˚)	Effective Cohesion, c′ (kPa)	Undrained Shear Strength, Cu (kPa)
Embankment fill (Class 1A)	20	36	0	-
Made Ground - Granular (MGG)	19	30	0	-
Made Ground - Cohesive (MGC)	19.0	27	0	100
Hemington Member - Cohesive (HMC)	19	27	0	100
Hemington Member - Granular (HMG)	19.5	30	0	-
Edwalton Member - Cohesive (EDW-C)	19-20*	26-27*	1-2*	75-167*
Gunthorpe Member – Cohesive (GUN-TC)	19-20*	27	2	130-180*

* Characteristic values have been selected from this range at corresponding EA sites.

b) Limit States:

The results of the generic stability analyses both for the cuttings and embankments are summarised in Annex A: Geotechnical Design Summaries – Earthworks.

The methodology for stability analysis is in accordance with BS EN 1997-1 (BSI, 2013), the accompanying National Annex (BSI, 2014) and BS 6031 (BSI, 2010). Both Design Approach 1 Combination 1 (DA1-C1) and Design Approach 1 Combination 2 (DA1-C2) have been considered as part of ultimate limit state (ULS) analysis.

Partial factors on actions and soil parameters for both combinations, used in the slope stability analyses are presented in Table 14 and Table 15 respectively.

Table 14 Partial factors on actions used in the slope stability analysis

Action		Symbol	Set A1	Set A2
Permanent	Unfavourable	γ_G	1.35	1.0
	Favourable		1.0	1.0
Variable	Unfavourable	γ_Q	1.5	1.3
	Favourable		0.0	0.0

Table 15 Partial factors on geotechnical parameters used in the slope stability analysis

Soil Parameter	Symbol	Set A1	Set A2
Effective shearing resistance	$\gamma_{\phi'}$	1.0	1.25
Effective cohesion	$\gamma_{c'}$	1.0	1.25
Undrained shear strength	γ_{cu}	1.0	1.4
Unconfined strength	γ_{qu}	1.0	1.4
Weight density	γ_{γ}	1.0	1.0

For all analysed scenarios, Combination 2 was consistently the critical case due to no extremely high variable actions or extremely low soil strength.

10.2.2 Cuttings

a) General assumptions:
Review of historical ground information has showed that some cutting slopes may be built from Made Ground material. This situation has been encountered at some EAs located around Junctions. This is likely due to the fact that the junction (mainline and slip roads) is located above natural ground levels and supporting earthworks have been built from engineered fills.

b) Loads:
The design of cuttings has included an allowance for potential loading represented as a uniformly distributed S1= 5kN/m^2 nominal surcharge at the top of the cutting.

c) Groundwater:
At all EAs located in cuttings, groundwater levels were deeper than maximum exploration depth; however, for the purpose of design, groundwater has been conservatively assumed to be 1.0m below the carriageway at the toe of cutting slope. Pore water pressure coefficient is not considered for the analysis as the soil above water table is free draining. Also, at EA-NB-192/0 where cohesive material is encountered, pore water pressure coefficient is not considered for the analysis given to the fact that the earthwork involved is at grade and no pore pressure build up is anticipated at this location.

c) Design Stability Models used for cuttings
Two (2No.) different Stability Models have been used in the design of cutting slopes. They have been derived assuming the critical ground conditions and slope geometries i.e., the highest and steepest cutting slopes as well as the highest slope regrades. A regrade of 1(v):2(h) and 1(v):2.5(v) have been proposed for EA locations. The drawings with typical cross-sections are attached in Annex H. A summary of Design Stability Models used for cuttings is presented in Table 16.
The results of slope stability analysis for all Design Stability Models presented in Table 16 indicate the proposed gradients of 1(v):2(h) and 1(v):2.5(h) satisfy the requirements of Eurocode 7.

A schematic cross section of a typical cutting widening is shown in Figure 10-1

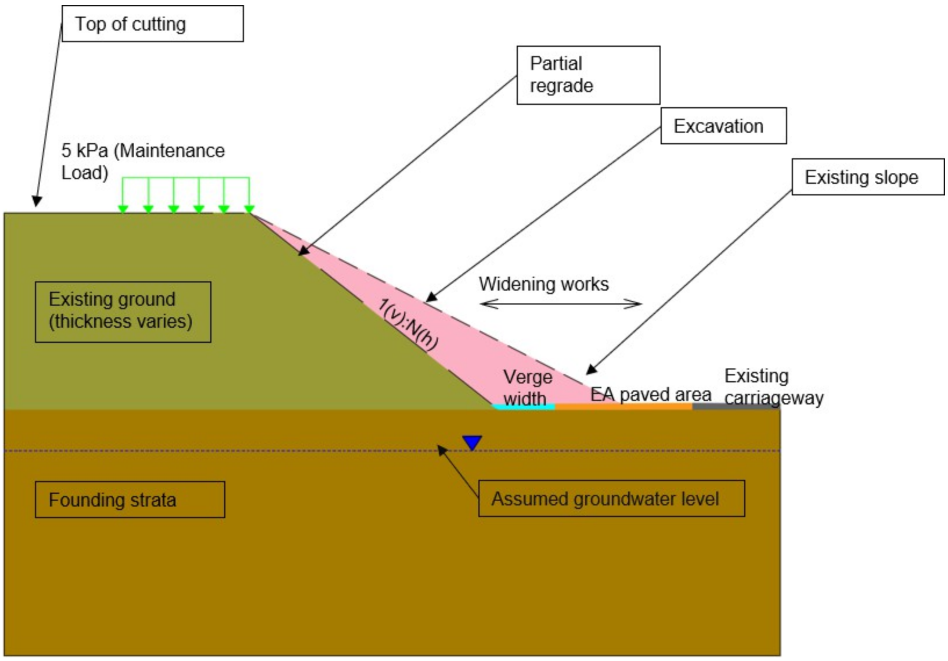


Figure 10-1 Schematic cross section of cutting widening solution.

Table 16 Design Stability Models used in the design of cuttings.

EA location	Existing state				Design State					
	Earthwork Type	Max. Slope Height H (m)	Max. Existing Slope Gradient 1(v): n(h)	Max. Existing Slope Angle α (°)	Regrade Type	Proposed New Slope Gradient	Proposed New Slope Angle β (°)	Max. Slope Regrade Height h(m)	**Surcharge Load S1**	**Ground Model (expressed by layer thickness) (1)**
M1-J23a-J25-EA-NB-192/0	Cutting	3.0	1:2.7	20.0	Partial	1:2.5	21.8	0.75	5kPa	1. MGC: 1.3m, 2. MGG: 2.7m, 3. GUN-C.
M1-J23a-J25-EA-SB-185/1	Cutting	4.9	1:2.0	27.0	Partial	1:2.0	26.5	1.30	5kPa	1. MGG: 2.9m, 2. EDW-C: 0.4m, 3. EDW-C.

(1) Top of cutting / slip road is assumed as the reference level

10.2.3 Embankments

a) General assumptions:
The available historical and new ground information record the presence of Made Ground, both granular and cohesive in nature (MGR and MGC), overlying Hemington Member, Edwalton Member or Cohesive Gunthorpe Member
The Made Ground is clearly associated with motorway embankment construction.
Where localised soft cohesive materials (Cu <40kPa) are encountered beneath the toe of the proposed embankments, it is proposed to be replaced with Class 1A fill if above the water table or Class 6C fill if below.
A 0.5m depth of excavation and replacement of existing soils with Class 1A fill is required for all embankment widening.

b) Loads:
Design of the embankments has included an allowance for normal traffic loads. This is represented as a uniformly distributed S1=20kN/m^2 surcharge which is derived from the load model within NA to BS EN 1991-2:2003 ‘UK National Annex to Eurocode 1: Actions on structures – Part 2: Traffic loads on bridges’ (British Standard Institution, 2010).
Potential temporary construction and maintenance loading on the road verges has been represented by a uniformly distributed S2=10kN/m^2 surcharge in accordance with BS 6031:2009 ‘Code of practice for earthworks’ (British Standards Institution, 2009).

c) Groundwater:
At all EAs located on embankments, groundwater strikes have not been encountered till the maximum depth of exploration; however, for the purpose of design, groundwater has been conservatively assumed to be at 1m below the toe of the embankment. A porewater pressure coefficient (r_u) was not included in the slope stability analysis as the imported fill to form the embankment widening is specified as free-draining Class 1A granular fill (<15% fines) throughout.

A sensitivity check, however, has been carried out to simulate r_u = 0.1 in the upper 1m below slope surface, with the results indicating that slope stability is not compromised. Whilst the risk of localised wash-through of fines is considered feasible, it must be emphasised that this scenario is considered highly unlikely as the granular fill will not change its inherent nature to cohesive over its design life and as such, pore water pressures cannot build up.

c) Design Stability Models used for embankments:
Three (3No.) different Stability Models have been used in the design of embankment slopes. They have been derived assuming the most critical ground conditions and slope geometries i.e., the highest and steepest embankment slopes as well as the highest slope regrades. A regrade of 1(v):2(h) has been proposed for all EA locations. The drawings with typical cross-sections are attached in Annex H.

A summary of Design Stability Models used for embankments is presented in Table 17.
The results of slope stability analysis for all Design Stability Models presented in Table 17 indicate the proposed gradient of 1(v):2(h) satisfies the requirements of Eurocode 7.

A schematic cross section of a typical embankment widening solution is shown in Figure 10-2

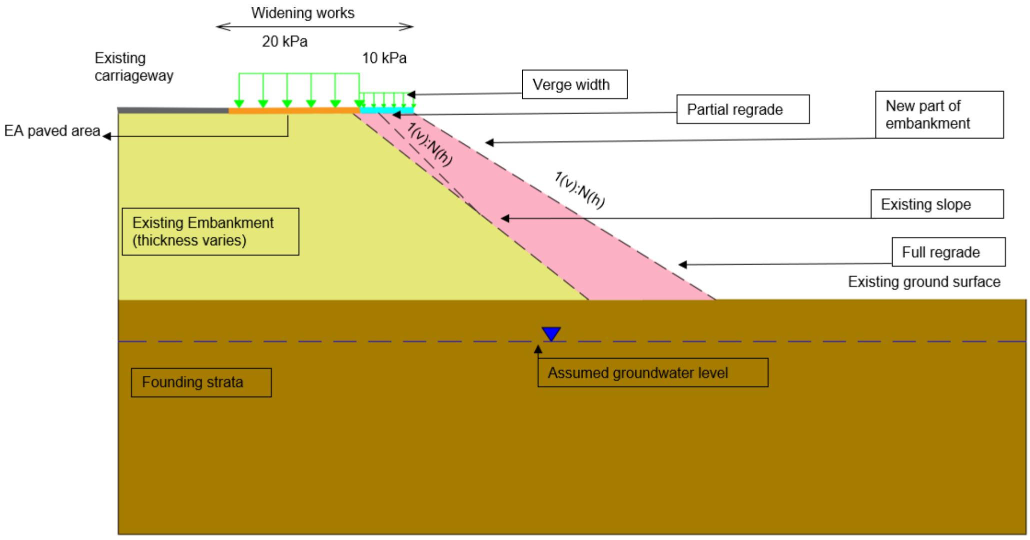


Figure 10-2 Schematic cross section of embankment widening solution.

Table 17 Design Stability Models used in the design of embankments.

Design Stability Model	Existing state				Design State					
	Earthwork Type	Max. Slope Height H (m)	Max. Existing Slope Gradient 1(v):n(h)	Max. Existing Slope Angle α (°)	Regrade Type	Proposed New Slope Gradient	Proposed New Slope Angle β (°)	Max. Slope Regrade Height h (m)	Surcharge Loads S1 & S2	Ground Model (expressed by layer thickness) [(1)]
M1-J23a-J25-EA-NB-187/8	Embankment	5.8	1:2	26.5	Partial	1:2	26.5	2.0	S1=20kPa S2=10kPa	1. MGG: 1.0m 2. HEM-C: 1.2m, 3. HEM-G.
M1-J23a-J25-EA-NB-190/2	Embankment	9.1	1:2	26.5	Partial	1:2	26.5	3.0	S1=20kPa S2=10kPa	1. MGG: 1.3m, 2. HEM-G: 1.6m, 3. EDW-C.
M1-J23a-J25-EA-SB-187/7	Embankment	3.9	1:2	26.5	Partial	1:2	26.5	2.0	S1=20kPa S2=10kPa	1. MGG: 1.2m, 2. HEM-C: 1.8m, 3. HEM-G.

[(1)] Top of embankment is assumed as the reference level

10.2.4 Results

The Overdesign Factor (ODF) against global stability for all the soil slope models is summarised below in Table 18. The ODF in all the cases was observed to be greater than 1.0, hence the provided regrade solutions are found to be satisfactory. The outputs from Slide2 have been appended to Annex C.
The analysis has been checked for sensitivity under maintenance loading on the slope face (a 1m wide vertical surcharge of 5kPa to simulate pedestrian loading moving downslope from the crest). The sensitivity analysis has shown that the ODF is >1.0 in all cases.

Table 18 Slope Stability Analysis Summary

EA	Type of Earthwork	Proposed regrade slope gradient	Overdesign Factor (ODF)			
			DA1C1 Drained	DA1C2 Drained	DA1C1 Undrained	DA1C2 Undrained
M1-J23a-J25-EA-NB-192/0	Cutting	1(v):2.5(h)	1.329	1.050	9.776	8.526
M1-J23a-J25-EA-SB-185/1	Cutting	1(v):2(h)	1.285	1.026	1.656	1.325
M1-J23a-J25-EA-NB-187/8	Embankment	1(v):2(h)	1.486	1.189	3.405	2.854
M1-J23a-J25-EA-NB-190/2	Embankment	1(v):2(h)	1.495	1.228	2.101	1.77
M1-J23a-J25-EA-SB-187/7	Embankment	1(v):2(h)	1.509	1.209	3.338	2.899

10.3 Embedded Retaining Wall

10.3.1 General

The footprint of the proposed EA-SB-193/4 requires removal of the existing gabion wall partially to accommodate the EA. A new embedded retaining structure, a King Sheet Pile (KSP) wall has been recommended as a suitable solution to accommodate the construction of EA-SB-193/4 and retain the soil in the cut slope.

10.3.2 Geometry

The cross-sections for design were obtained from the Highways cross-section models and were verified with 3D-models generated by JET (Jacobs Engineering Tool) software. A KSP wall was identified as a suitable solution for highway widening at SB-193/4 with the proposed wall in a cutting slope. The maximum retained height is 2.0 m. A horizontal berm of 0.6 m width has been considered directly behind (upslope of) the KSP wall for allowance of future maintenance access.

A schematic cross section of an embedded retaining wall solution for cutting widening is shown in Figure 10-3

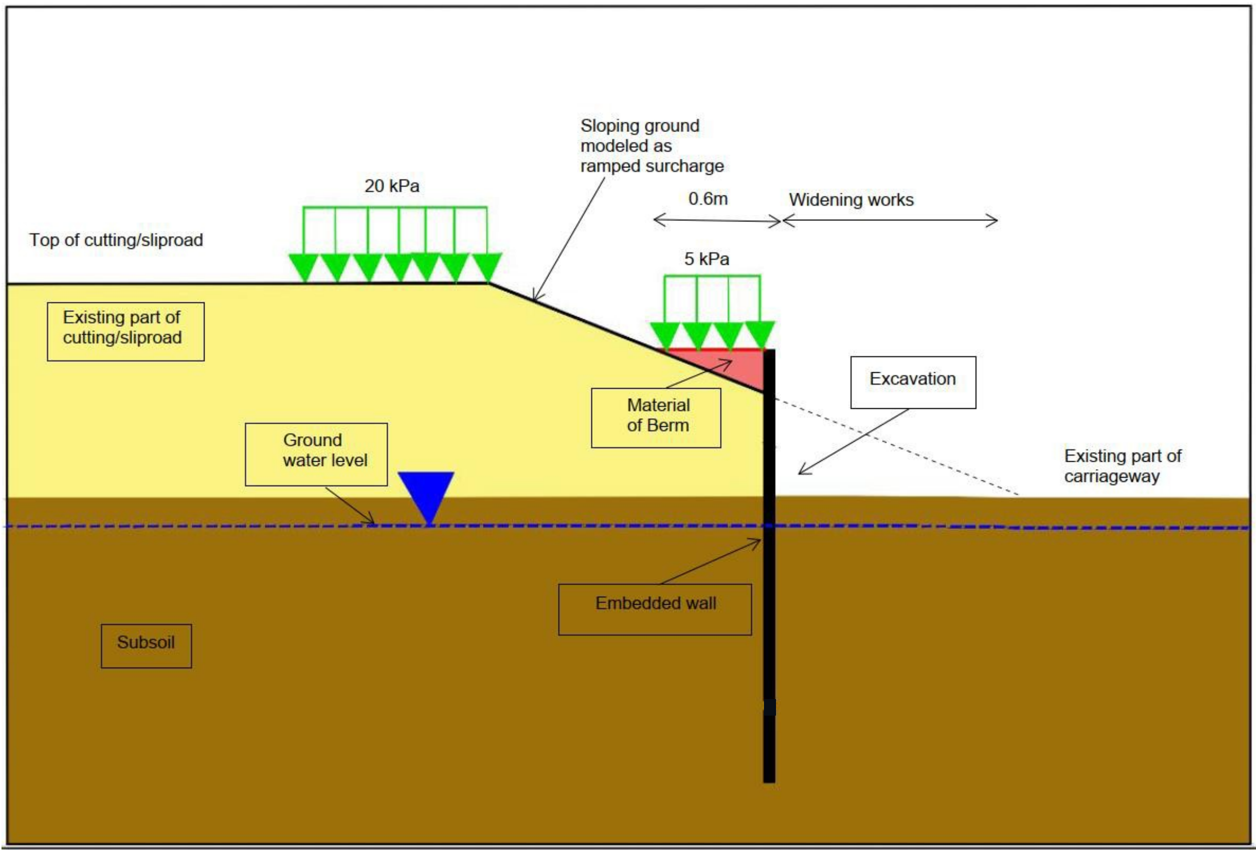


Figure 10-3 Schematic cross section of an embedded retaining wall solution for cutting widening.

10.3.3 Design Section

The design critical sections are identified based on existing ground conditions, maximum retained height and backfill slope angle. The following section profile has been considered during design:

- sheet piles of a Z-section configuration;
- sheet piles of width 700mm (Primary) and 770mm (Intermediate);
- sheet pile with a minimum cold rolled steel grade of S430GP.

A minimum section size of AZ 12-770 or equivalent has been considered for the purposes of drivability, however as this is dependent upon local ground conditions and retained height and pre-augering may be required. No capping beam is required by the design.
The details of wall/slope geometry and design sections are available in the relevant EA GDS appended in Annex A. General arrangement corresponding to King Sheet pile retaining wall is included in Annex H.

10.3.4 Loading

A 20kPa surcharge load representing the imposed load (variable load) from running lanes of the slip road behind the proposed KSP wall was applied in accordance with BS 6031:2009 (British Standard Institution, December 2009). A nominal load of 5kPa was considered behind the wall on the maintenance berm.
Impact loading from vehicles is assumed to be entirely absorbed by the vehicular restraint system within the EA. The sloping ground encountered above the wall was modelled as a tapered surcharge to a height and angle appropriate for the site-specific geometry.

10.3.5 Ground Condition

The ground model for the EA location (SB-193/4) has been presented in the relevant GDS in Annex A. The soil parameters have been extracted from intrusive ground investigation and the existing geotechnical reports. The summary of soil parameters used for analysis is also presented in the GDS.
The groundwater level was assumed to be at 1m below EA ground level.

10.3.6 Drainage

The drainage behind the wall shall be facilitated by the intermediate KSP walls to ensure groundwater levels on the retained side do not exceed the level assumed for design.

10.3.7 Design Working Life

The design working life of the KSP wall is 120 years in accordance with CD 350 (National Highways, 2020). The KSP wall achieves its design working life through an allowance of sacrificial steel. The design assumes that the KSP will not be galvanised, and corrosion rates have been assessed for each face of steel in contact with soil as follows:

- For an embedded wall in cutting, where steel is in contact with soil, the surrounding ground has been taken as "undisturbed natural soils (sand, silt, clay, schist,)" for a 120-year design life. A corrosion rate of 1.44mm per side on contact with soil and 2.0mm on the face area of wall exposed to the atmosphere, to take into account the effects of de-icing salts and other environmental actions in accordance with Table 4.1 of BS EN 1993-5 (BSI, 2012) (BSI, 2009) has been considered for the design.

10.3.8 Geotechnical Design Method

The design of the embedded retaining wall was carried out in accordance with BS EN 1993-5 (BSI, 2009) (BSI, 2009), BS EN 1997-1 (BSI, 2013) (BSI, 2013), their accompanying National Annexes (BSI, 2012) (BSI, 2014), and BS 8002 (BSI, 2015) (BSI, 2015).

The KSP walls were analysed using the commercially available computer software 'WALLAP', version 6.07 (2020), by 'Geosolve'. Earth pressures (active and passive) were derived from EC7 relationships. The friction angle between the wall and the soil has been taken as two-thirds (2/3) the internal friction angle, due to the smooth surface of the wall, as recommended in CIRIA C760 (CIRIA, 2017). In WALLAP, the embedded depth and the retained height were optimised to achieve a factor of safety greater than or equal to 1.0 for limit state design to EC7. The section of sheet pile was then selected based on the maximum bending moment (BM) and shear force (SF) output by WALLAP in accordance with BS EN 1993-5:2007 (BSI, 2009).

The ULS limit states for both types of embedded wall were designed to DA1-C1 and DA1-C2 as per BS EN 1997-1 (BSI, 2013). The SLS condition has been assessed in relation to the deflection at the crest of the wall. Neither the British Standards nor National Highways documentation specifies any limit regarding permissible lateral deflection of the wall or the ground movements; however, a nominal limit of 75 mm was taken as the maximum permissible lateral deflection at the crest of the wall under long term earth pressures and live loading conditions.

The following design approach and assumptions were considered for design and analysis of the KSP wall as per the KSP wall design process document HE614830-JAC-HGT-P001_AL_ALLGENR-TN-GE-0001:

- sloping ground behind the wall in cutting has been modelled as a tapered surcharge;
- the soil in front of the wall has been excavated to the retained height;
- an unplanned excavation (or over-dig) allowance of 10% of retained height (or 0.5 m, whichever is greatest) has been included in the design to allow for unplanned excavation. This is in accordance with BS EN 1997-1 (BSI, 2013) (BSI, 2013), where localised excavation in front of embedded wall is not anticipated;
- soil properties have been changed to drained wherever applicable for modelling long term behaviour;
- wall section properties have been reduced in the long-term to allow for corrosion throughout its design life;
- for embedded walls in cuttings, the design has allowed for the planned excavation required to install the road pavement, or cabinets, in front of the wall. Where site specific information was not available, an allowance of 10% of the retained height (or 1.2m, whichever is greatest) has been included in the design.

The following construction sequence was considered during the 'WALLAP' analysis:

- Installation of KSP wall to the required toe level;

- Excavation in front of the wall including unplanned excavation of 0.5m;
- Excavation in front of the wall allowing for utilities installation to 1.2m below final retention height;
- Filling in front of the wall up to finished road level minus over dig of 0.5m (unplanned);
- Soil properties changed to drained where applicable;
- Sheet pile stiffness reduced as per corroded section thickness for 120-year design life;
- Filling in front of the wall to final retained height.

10.3.9 Design Outcome

The retaining wall sections were chosen to satisfy the lateral deflection and structural capacities. The design results are detailed in the GDS presented in Annex A. A summary of the proposed King Sheet Pile Wall is shown in Table 19.

A sensitivity analysis has been performed to check the possibility of hydrostatic water pressure build-up on the active side of the wall (to a level of 50.23m AOD) and both ULS stability and SLS deflections are found to be within acceptable limits.

Table 19 Summary of proposed King Sheet Pile Wall at EA-SB-193/4

EA	King Pile Type	Inter-mediate Pile Type	King Pile Spacing, (m)	Stiffness of system, EI (kNm^2/m run)			Maximum retained height (m)	Total Embedment of King Pile (m bgl)	Total Embedment of Intermediate Pile (m bgl)
				Before corrosion allowance	After corrosion allowance in exposed length	After corrosion allowance in Buried length			
M1-J23a-J25-EA -SB-193/4	AZ26-700	AZ12-770	2.94	59720	45450	47760	2.0	7.5	3.25

10.4 Highway Structures

10.4.1 MS4 Gantry

Screw Fast foundations (part of Van Elle limited) have been tasked with the preparation of GDR for the proposed MS4 gantry, the same has been attached as Annex D to this GDR.

10.4.2 CCTV Mast Foundation

Foundations for CCTV on long slender masts of 15m height have been designed in accordance with Smart Motorway Programme - Design Guide Annex E3.08 and CD 354 *Design of Minor Structures*.
A plunge pile foundation comprising a 457mm diameter steel circular hollow section 'plunged' into a 750mm diameter bore filled with concrete is proposed for new stand-alone CCTV Mast foundations. Geotechnical design of the foundations has been undertaken in accordance with CD 354 to verify the ultimate and serviceability limit states. WALLAP geotechnical software was used to confirm the pile lengths were sufficient to limit lateral deflections to within acceptable limits. A ground strength factor of 'average' has been assumed for verge locations.
Further details are provided in drawing included in Annex D and in corresponding GDS is included in Annex B.

a) Geometry
A single CCTV mast has been proposed at M1-J23a-J25-EA-SB-193/4, which is on the sloping ground of slope gradient 1(v):2(h). Hence, as per CD 354 sufficient additional depth has been proposed for plunge piles at / near sloping ground.

b) Loading
The loading at the head of each plunge pile foundation to support this mast have been provided by the structures team and presented below in Table 20.

Table 20 Loading on Plunge Pile Foundations

Minor Structure	ULS Bending Moment at Base	ULS Horizontal Force at Base
CCTV	78.6 kNm	9.95 kN

The SLS and ULS were analysed in WALLAP software, with a single pile model. The nominal load was considered for the utilisation calculation for planting depth in accordance with CD 354.

c) Ground condition
The associated ground model for the CCTV structure location has been presented in the GDS in Annex A. An extract of the typical ground conditions is presented in GDS. The ground encountered is broadly divided into two categories:

- Made Ground (cohesionless) underlain by Gunthorpe Member (Cohesive).

Irrespective of the intrusive ground investigation and historical exploratory hole data (with much lower water table), the water table has been conservatively assumed to be 1m below ground level within the analysis.

Geotechnical Design Method

The following design method was applied at the proposed mast location according to Smart Motorway Programme - Design Guide Annex E3.08 and CD 354 Design of minor structures:

- Check cross section at mast from Highways CAD model;
- Assess the location of mast (if at the crest of embankment) to gauge the offset of the mast from the crest of the nearest slope and the gradient of that slope, wherever necessary, include it in the calculation;
- Determine whether the ground conditions are 'Good', 'Average' or 'Poor' as defined by table 12.12 of CD 354;

- Apply loading to foundation and calculate utilisation due to design planting depth in accordance with CD 354;
- To calculate lateral displacements at the head of the pile, undertake WALLAP analysis for a single pile, considering bored pile diameter (750mm) backfilled with concrete, which is then compared with the limiting value.

Displacement Check

The design tolerance of displacement at head of the pile equivalent to 20mm is considered. In WALLAP, the boundary element analysis is carried out. It was necessary to perform a sensitivity analysis on the depth of the plunge pile to limit the deflections at head of the pile within design tolerance.

$$\frac{20\ mm}{4000\ mm} = \frac{X}{4000\ mm\ +\ 15000\ mm}$$

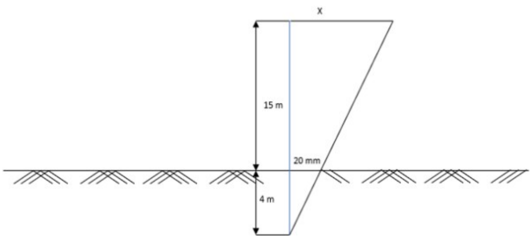


Figure 10-4: Plot showing typical displacement at pile cap.

Design outcome

According to the design checks undertaken for the CCTV plunge pile foundation, a minimum planting depth of 3.9m depth is required for 'average' ground condition. The depth was checked against the required displacement tolerances and was found to be sufficient. Thus, the CCTV foundation is designed as 4.0m long, 750mm diameter bored piles with a plunged 457mm diameter, 10mm thick CHS section. The foundation is connected to the mast via a flange plate.
The foundation drawings for the proposed structure are presented in Annex D.

10.4.3 SVD Foundation

The proposed SVD masts of 4.5m height will be supported on 0.9m long x 0.9m wide x 0.6m thick pad foundations.
Based on ground investigations, the characteristic value of undrained shear strength (C_u) that has been derived for Cohesive Made Ground is 100kPa. However, the design assumes that prior to construction, the formation is to be inspected and, where cohesive material is present, tested by hand shear vane. If low strength cohesive material is encountered, defined as C_u < 70kPa, it shall be excavated and replaced with compacted Class 1 Fill. The minimum depth of excavation shall be to where a minimum C_u of 70kPa is achieved. The granular Made Ground shall be well compacted prior to construction.
Details of the proposed foundation arrangement are included as Annex D. The SVD units are generally mounted on a square concrete foundation, side length 0.9m and thickness 0.6m (see Annex D), which applies a maximum bearing pressure of 70 kPa, including for self-weight of the foundation and wind action. The foundations have been sized for "average ground" conditions as described in the Institute of Highway Engineers (IHE) Sign Structures Guide (2021) Table 5.2, which satisfies ULS requirements of Eurocode 7 and the UK National Annex.
The top of the base will be level with the carriageway to maintain approximate SVD unit height above carriageway. The footing is placed on a 150mm layer of compacted Class 6C material. The SVD units are not sensitive to potential vertical movements that may result from seasonal shrink/swell of cohesive ground.

The foundation has been checked for overturning (EQU), sliding (GEO), and bearing (GEO) failure in accordance with the principles and methods of BS EN 1997 1:2004+A1:2013 using the dimensions and layout detailed below and a set of loads validated by the DED structures team and detailed in Table 21.

Table 21 Loading on Pad Foundations

Minor Structure	ULS Bending Moment at Base	ULS Horizontal Force at Base
SVD	1.32 kNm	0.30 kN

The foundation arrangement for the SVD masts on 0.9m square precast 0.6m deep reinforced concrete spread footing was found to be suitable for the loading and the proposed foundation size has been validated for a set of standardised geometries and ground conditions to be used across multiple sites.

10.4.4 MIDAS Foundation

Foundations for MIDAS on masts of 8m height have been designed in accordance with Smart Motorway Programme - Design Guide Annex E3.08 and CD 354 *Design of Minor Structures*. The proposed MIDAS mast will be supported on planted foundation of depth 3.1m with a pole diameter of 168mm.
Based on ground conditions, the foundations have been sized for “average ground” conditions as described CD354 Table 12.12 and corresponding ground factor G has been used for the depth calculation of planted foundation.
MIDAS mast has been proposed at M1-J23a-J25-EA-NB-190/2, which is on the sloping ground of slope gradient 1(v):2(h). Hence, as per CD 354 sufficient additional depth has been proposed for planted foundation at / near sloping ground.
The loading at the head of planted foundation to support this mast have been provided by the structures team and presented below in Table 22.

Table 22 Loading on Planted Foundations

Minor Structure	ULS Bending Moment at Base	ULS Horizontal Force at Base
MIDAS	3.73 kNm	0.86 kN

10.4.5 Summary

A summary of the various minor structures together with their proposed foundation solution is presented in in the below Table 23. Plunge pile and pad foundation standard detail drawings are included in Annex H.

Table 23 Summary of proposed foundations for Minor Structures

Type	Foundation Type	Foundation Dimensions
CCTV SB-193/4	Plunge Piles	750mm Dia – 3.9m depth
SVD-1 NB-190/2	Pad Foundation	0.9m x 0.9m x0.6m
SVD-2 NB-192/0	Pad Foundation	0.9m x 0.9m x0.6m
SVD-3 SB-185/1	Pad Foundation	0.9m x 0.9m x0.6m
SVD-4 SB-187/7	Pad Foundation	0.9m x 0.9m x0.6m
SVD-5 SB-193/4	Pad Foundation	0.9m x 0.9m x0.6m
MIDAS-1 NB-190/2	Planted Foundation	168mm diameter 3.1m depth

11 SPECIAL GEOTECHNICAL MEASURES

None are proposed for this scheme.

12 PAVEMENT DESIGN, SUBGRADE AND CAPPING

A CBR assessment has been undertaken to provide equilibrium CBR values for pavement design at each of the proposed EA locations. The equilibrium CBR values for pavement design were taken based on the Arup reports (GDMS reports 29152 and 28929) based on the recorded plasticity index values. Also, the DCP test results completed as part of the 2023 GI were considered in arriving at design CBR values. Design CBR has been assessed at 1.2m below existing carriageway level (mbecl), as this is the anticipated pavement subgrade level.

The results of the DCP tests and the CBR values from previous reports (GDMS reports 29152 and 28929), the ground conditions anticipated to be present at each EA and the specific nature of the proposed verge widening works have been taken into consideration in deriving the CBR values for each EA proposed location.

For works on existing Made Ground fill, provided there are no signs of pavement distress, a CBR of 5% (equivalent to a surface modulus E=57MPa) was assumed at subgrade surface level. A target CBR of 5% was specified for newly placed engineered fill. In cuttings, the subgrade will be on native ground which has been identified from the available records. Where subgrade is on Made Ground, a CBR of 5.0% and corresponding surface modulus E obtained as per the correlation given below.

For pavement designs the subgrade modulus is calculated following CD 225 Design for new pavement foundations using the correlation of surface modulus $E=17.6(CBR)^{0.64}$.

The CBR results obtained from the DCP tests are observed to be very high. Hence, the equilibrium CBR obtained from historical reports have been considered relevant for design CBR. Table 24 presents the design CBR values. These values should be validated prior to construction as per HE608071-JAC-HGT-WHL_AL_SCHME-SP-CE-0002.

Table 24 Design CBR Values

Works ID	Direction	Ground model with description (depth mbgl)	Current Earthwork	Likely Formation at 1.2 mbecl	Design CBR (%)	E (MPa)
EA NB-187/8	NB	Made Ground (0-1) Hemington Member (1-10)	Embankment	Made Ground / Engineered Fill	5.0	57
EA NB-190/2	NB	Made Ground (0-1.2) Hemington Member (1.2-2.8) Edwalton Member (2.8-10.0)	Embankment	Made Ground / Engineered Fill	5.0	57
EA NB-192/0	NB	Made Ground (0-3.9) Gunthorpe Member (3.9-8.3)	Cutting to At Grade	Made Ground	5.0	57
EA SB-193/4	SB	Made Ground (0-2.4) Gunthorpe Member (2.4-10.0)	Cutting	Made Ground	5.0	57
EA SB-187/7	SB	Made Ground (0-1.2) Hemington Member (1.2-10.0)	Embankment	Made Ground / Engineered Fill	5.0	57

Works ID	Direction	Ground model with description (depth mbgl)	Current Earthwork	Likely Formation at 1.2 mbecl	Design CBR (%)	E (MPa)
EA SB-185/1	SB	Made Ground (0-1.3) Edwalton Member (1.3-9.8)	Cutting	Made Ground	5.0	57

13 ASSESSMENT OF POTENTIAL CONTAMINATION

13.1 Introduction

The following section presents the methodologies, assessments, and findings with regards to the potential risks posed by identified contaminant sources to human health receptors.
The assessments are primarily based upon the UK DEFRA and Environment Agency 'best practice' in regard to the assessment of potentially contaminated land, which reflects the approach promoted in Land Contamination Risk Management (LCRM) [29] and R&D Publication 66 (National House Building Council and Environment Agency, 2008 [30]) and the supporting guidance referenced within them.
Where one or more PPL has been identified for the scheme at preliminary CSM stage, it is necessary to clarify the risks posed by that PPL to human health and controlled water receptors by comparing soil, soil leachate and groundwater contaminant concentrations with guideline values that represent acceptable values to the land end use.
The 2023 Strata Geotechnics ground investigation was targeted at the proposed EAs. Geo-environmental laboratory testing of soil samples was undertaken six borehole locations. These borehole locations and their respective EAs and the respective boreholes are shown in Table 25 below.

Table 25 Boreholes Conducted for respective EA site

EA	Borehole
EA-NB-187/8	BH1877N
EA-NB-190/2	BH1902N
EA-NB-192/0	BH1920N
EA-SB-193/4	BH1933S
EA-SB-187/7	BH1877S
EA-SB-185/1	BH1851S

In total, four samples of Made Ground and six samples of natural ground were subjected to a suite of geo-environmental laboratory testing, as summarised in Section 7.7.2.

13.2 Visual and Olfactory Contamination

No evidence of visual or olfactory contamination (odours, sheens etc.) was recorded during the ground investigation.

13.3 Human Health Assessment

13.3.1 Methodology

Risks to human health are associated with acute exposure to soils (i.e., construction workers or future maintenance workers) and chronic exposure to soils (i.e. motorway users or adjacent land users). In all cases, the exposure pathways are identified as direct contact, inhalation and ingestion of contaminated soils and/or soil dust.

The proposed scheme will primarily comprise highway infrastructure, with most of the land below hardstanding, but with areas of soft landscaping. To assess chronic exposure risks to highway users or adjacent land users, soil analytical data has been screened against published generic assessment criteria (GAC) based on commercial / industrial land use scenario. GAC are pre-defined concentrations for individual contaminants, below which an actual or potentially unacceptable risk is not considered to be present where a PPL exists. Where contaminants are found to exceed the GAC, they are identified as contaminants of concern and an assessment is then required regarding the viability of the PPL.

The GAC have been selected from a hierarchy of published sources for Tier 2 GAC for contamination in soil. These include DEFRA Category 4 Screening Levels (C4SL) (Department for Environment Food & Rural Affairs (DEFRA), September 2014 [33]), Land Quality Management (LQM) / Chartered Institute of Environmental Health (CIEH) Suitable for Use Levels (S4UL) (Land Quality Management Limited, 2015 [31]), and Environmental Industries Commission/ Association of Geotechnical and Geo-environmental Specialists/CL:AIRE GAC (Contaminated Land: Applications in Real Environments, 2009).

The GAC adopted for chronic human health risk assessment have assumed a soil organic matter (SOM) of 1%, given the heterogenous nature of near surface soils. This is considered a conservative approach. There is no GAC for asbestos. For the purposes of this assessment, detection of asbestos in a sample is considered an exceedance.

In order to assess acute exposure risks to construction workers or future maintenance workers, soil analytical data has been screened against SoBRA Acute Generic Assessment Criteria (SoBRA AGAC) (Society for Brownfield Risk Assessment, 2020 [32]). The AGAC apply to short-term exposure for children and adult receptors based on the risk of oral consumption, inhalation, or dermal contact with soils. Given that the acute exposure risk applies to construction and future maintenance workers, soil analytical data has only been screened against AGAC for adult receptors.

13.3.2 Soil Data Assessment – Acute Exposure

Of the ten soil samples subjected to geo-environmental laboratory analysis, none recorded contaminant concentrations above the AGAC. Therefore, based on the available data, the acute risk to construction workers or and future maintenance workers is negligible.
See Annex K for a complete comparison of soil analytical data against AGAC.

13.3.3 Soil Data Assessment – Chronic Exposure

Of the ten soil samples subjected to geo-environmental laboratory analysis, none recorded contaminant concentrations above the GAC, and no asbestos was recorded. Therefore, based on the available data, the chronic risk to future highway motorway users and adjacent land users is negligible.
See Annex K for a complete comparison of soil analytical data against GAC.

13.4 Controlled Waters Assessment

As no geo-environmental laboratory analysis of soil leachate or groundwater was undertaken as part of the 2023 Strata Geotechnics ground investigation, a GQRA quantitative risk assessment with respect to groundwater has not been undertaken. However, given the ground conditions and nature of Made Ground materials (comprising road construction or reworked natural soils), and the absence of any visual / olfactory contamination at the EA locations, the potential risk to groundwater (Secondary A and B aquifers) is considered to be negligible.

13.5 Ground Gas

As no ground gas monitoring was undertaken during the 2023 Strata Geotechnics ground investigation, an assessment of ground gas with respect to workplace exposure limits (WEL) has not been undertaken. However, based on the borehole logs, potential sources of ground gas such as degradable organic or putrescible materials have not been identified.
Notwithstanding the above, the presence of a historical landfill site (Hemington Gravel Pit) approximately 25m west and 25m east of EA-NB-187/8 and EA-SB-187/7, respectively, presents a potential unquantified risk of landfill gas.

13.6 Updated CSM and Risk Assessment

Based on the findings of the 2023 Strata Geotechnics ground investigation, the preliminary CSM and risk assessment detailed in sub-section 2.20 has been updated. The updated CSM and risk assessment includes confirmed PPLs and/or potential PPLs which cannot be ruled out or discounted.

Table 26 Updated CSM and Risk Assessment

Source	Identified Contaminant	Pathways to Receptor	Receptor	Consequence	Likelihood	Risk	Comments
Off-site sources of contamination, comprising: **- Historical landfill (Hemington Gravel Pit).**	Landfill gas.	Inhalation of landfill gas in excavations and confined spaces. Explosion.	Construction and future maintenance workers.	Severe	Unlikely	Moderate/Low	Exposure of construction / maintenance workers to landfill gas is possible within excavations and confined spaces at EA-NB-187/8 and EA-SB-187/7, located within the immediate vicinity (25m) of Hemington Gravel Pit historical landfill. However, ground investigation records at the locations of EA-NB-187/8 and EA-SB-187/7 (BH1877N and BH1877N, respectively) do not indicate any sources of landfill gas, such as organic or putrescible materials/wastes.

13.7 Conclusions and Recommendations

The 2023 Strata Geotechnics ground investigation has not identified any visual or olfactory evidence in soils, no contaminants have been recorded above the human health GAC or AGAC, and no asbestos has been recorded. Therefore, based on the available data, the risk to human health (construction workers, future maintenance workers, future motorway users and adjacent land users) is considered to be negligible.

The risk to construction and future maintenance workers associated with ground and/or landfill gas has not been fully assessed due to a lack of gas monitoring data. However, based on the existing ground information and the ground investigation borehole logs, potential sources of ground gas such as degradable organic or putrescible materials have not been identified. Based on this information, there is a Moderate/Low risk from landfill gas at EA-NB-187/8 and EA-SB-187/7, associated with a historical landfill site (Hemington Gravel Pit) located approximately 25m to the west and east, respectively. Therefore, where excavations and confined space working is planned during groundworks, gas concentrations should be monitored. Furthermore, continuous gas monitoring should be undertaken during the installation of pile foundations (if any). Should elevated gases be recorded, method statements and risk assessments for exposure to gases, including mitigation measures, should be undertaken by the groundworks and/or piling contractor.

The risk to groundwater has not been quantified due to a lack of geo-environmental soil leachate and groundwater analytical data. However, given the ground conditions, inert nature of Made Ground materials and absence of visual / olfactory contamination at the EA locations, the risk to groundwater (Secondary A and N aquifers) is considered to be negligible. During construction, however, care should be taken to avoid the creation of preferential pollution pathways into groundwater and site drainage. Site won soils, assuming they do not vary from the existing ground information, are likely to be chemically suitable for reuse. Most Made Ground and natural soils are likely to be classified as Non-Hazardous, however, a waste classification assessment in accordance with the Environment Agency Technical Guidance WM3 would need to be undertaken to confirm this.

Given that the proposed works may require the reuse of site won material, It is recommended that this is completed in accordance with the waste management regime and guidance set out within the CL:AIRE Definition of Waste: Development Industry Code of Practice (DoWCoP) (Contaminated Land: Applications in Real Environments, 2011 [33]). As such, it would be necessary for the Contractor to produce a Materials Management Plan (MMP), clearly detailing the proposed materials management scheme for the site.

There are inherent limitations in any ground investigation and sampling exercise, and there remains a potential risk of encountering locally unidentified or unforeseen contamination during groundworks. Therefore, it is recommended that a watching brief is maintained for potential contamination during groundworks. Any suspected contaminated soil, material or groundwater should be segregated to avoid cross-contamination and sampling undertaken to enable further assessment of risks and possible reuse or disposal options.

Suitable working practices, procedures, and mitigation measures, in the form of a Construction Environmental Management Plan (CEMP), should be adopted during construction and future maintenance activities, particularly those associated with excavations and below ground works, to manage residual risks to human health and controlled water receptors from unforeseen contamination. These measures are likely to be limited to the application of appropriate PPE (such as disposable overalls, gloves, and dusk masks), provision of hygiene facilities, damping down of soils, and the provision of cover materials over stockpiles to prevent the release of soil dust or leachable contaminants. All works should be undertaken using the application of appropriate working practices as outlined in CIRIA C741 ‘Environmental good practice on-site’ (4th edition) to prevent risk to human health and controlled waters.

14 GROUND TREATMENT

No such treatment has been undertaken in this scheme as an intervention.

15 SPECIFICATION APPENDICES

Specification appendices are listed in Table 27 and full appendices are included in Annex M and Annex N. Corresponding drawings are included in Annex H

Table 27 Specification Document References.

Specification Series	Document Reference
600	HE614830-WSP-HGT-P015_AL_ALLGENR-SP-CE-0001
1600	HE614830-WSP-HGT-P015_AL_ALLGENR-SP-CE-0002

Class 1A has been assigned a minimum angle of shearing resistance of 36° to maintain long term slope stability where this material is used for embankment widening with slopes formed at 1(v):2.5(h) and 1(v):2(h).

16 INSTRUMENTATION AND MONITORING

Instrumentation is not envisaged for this scheme owing to the difficulties in establishing Traffic Management slots. Monitoring will be required during construction works. It is recommended that a watching brief is maintained for the EAs constructed within.

16.1 Pile testing requirements.

As specified in section 15 of Series 1600 (Specification for Piling and Embedded Retaining Walls).

16.2 Supervision

As specified in section 15 of Series 1600 (Specification for Piling and Embedded Retaining Walls).

.

17 MAINTENANCE AND REPAIR STATEMENT

A scheme specific maintenance strategy and repair statement has been prepared as MRS Annex document HE614830-JAC-HOS-P015_AL_ALLGENR-RP-OS-0005. A summary of engagement between OD Geotechnical Asset Manager and the respective DED Geotechnical team is included in Section 6 of the MRS Annex.

18 GEOTECHNICAL RISK REGISTER

The potential severity of harm occurring, and risk classification are defined in Table 28 and Table 29. The geotechnical risk register is presented in Table 30.

Table 28 Potential severity of harm occurring

Potential severity of harm occurring.		
1	**Minor**	Minor damage or loss (no human injury)
2	**Moderate**	Moderate damage or loss (slight injury or illness)
3	**Serious**	Substantial damage or loss (serious injury or illness)
4	**Major**	Major damage or loss (fatal injury)
5	**Catastrophic**	Catastrophic damage or loss (multiple fatalities)

Table 29 Risk classification

Likelihood		**Severity**				
		1	**2**	**3**	**4**	**5**
		Minor	**Moderate**	**Serious**	**Major**	**Catastrophic**
1	**Extremely unlikely**	1	2	3	4	5
2	**Unlikely**	2	4	6	8	10
3	**Likely**	3	6	9	12	15
4	**Extremely likely**	4	8	12	16	20
5	**Almost certain**	5	10	15	20	25
Low (1-8)		Ensure assumed control measures are maintained and reviewed as necessary				
Medium (9-19)		Additional control measures needed to reduce risk rating to a level that is equivalent to a test of “reasonably required” for				
High (20-25)		Activity not permitted. Hazard to be avoided or risk to be reduced to a tolerable level				

Table 30 Geotechnical Risk Register

Hazard ID	Hazard	Consequence	Likelihood	Severity	Risk	Available Mitigation Measure	Likelihood	Severity	Residual Risk
	Earthworks								
1	**Unknown/variable ground and groundwater conditions**	Disruption to construction. Delay for redesign of permanent and temporary works. Increased costs.	3	2	6	Validation plan through observation on site. Ground Investigation with groundwater observation has been undertaken at each EA and Gantry location.	2	2	4
2	**Existing earthwork defects**	Remediation works required in excess of planned works. Additional cost. Possible delay.	2	2	4	Identified defects are either away from the proposed locations or are not expected to have any significant impact on the works. Current assessment makes risk as low as reasonably practicable. Maintain observation for onset of instability during construction.	2	2	4
3	**Poor construction of engineered fill**	Excessive settlement or slope failure. Damage to structures or carriageway. Cost of repairs/replacement. Programme delays.	2	3	6	Construction in accordance with design drawings and earthwork specification. Unexpected ground conditions should be reported to the Designer.	1	3	3
4	**Unsuitable fill materials imported**	Excessive settlement or slope failure. Damage to structures or carriageway. Cost of	2	3	6	Use of Class 1A fill which impose superior draining properties was proposed as filling material for earthworks.	2	3	6

Hazard ID	Hazard	Consequence	Likelihood	Severity	Risk	Available Mitigation Measure	Likelihood	Severity	Residual Risk
		repairs/replacement. Programme delays.				Construction in accordance with design drawings and earthwork specification.			
5	**Slope instability in cuttings or embankments**	Slope failure leading to damage to structures or carriageway. Cost of repairs. Reputational damage.	2	3	6	Available ground investigation information and ground model and characteristic parameters are selected in accordance with Design Standards. In addition, slope stability analysis was performed to ascertain the safety. Construction shall be in accordance with design drawings and earthwork specification.	1	3	3
6	**Compressible/ collapsible ground**	Settlement/differential settlement of widened embankments and foundation failure of earthworks under traffic loading. Collapse/excessive deformations of shallow foundations. Instability of temporary excavations during construction stage. Deformation of pavements at interface between existing construction and widened embankments.	3	4	12	Ground Investigation has been undertaken to confirm the presence and thickness of Alluvium. Compaction requirements have been captured in Series 600 for embankments to avoid differential settlement issues during and post construction.	2	4	8

Hazard ID	Hazard	Consequence	Likelihood	Severity	Risk	Available Mitigation Measure	Likelihood	Severity	Residual Risk
		Disruption of highway traffic, programme slippage, increased costs and injury to personnel.							
7	**High groundwater due to poor performance of toe/crest drainage systems**	High groundwater or perched water can severely impede construction or result in slope instability. Can lead to long-term instability of the slope, affecting the permanent works. Also, could result in the failure of temporary works	3	3	9	Groundwater monitoring data was taken into account to arrive at design groundwater level. The groundwater level was deep enough to affect the proposed works. As a conservative approach groundwater was considered 1m below the toe level of embankments. Where possible existing highways and toe drains should be regularly inspected and maintained to a good working order. Relevant groundwater control measures (toe and crest drainage) shall be incorporated during any temporary works.	2	3	6
	King Sheet Pile Wall Design								
8	**Driveability of King Sheet-Piles**	Driving through hard ground will result in damage to equipment which in turn could also affect personnel. High costs associated to rectify equipment if	4	4	16	Contractor to assess ground through observations from Ground Investigation GI and determine/consider alternative method of installing king sheet piles.	3	4	12

Hazard ID	Hazard	Consequence	Likelihood	Severity	Risk	Available Mitigation Measure	Likelihood	Severity	Residual Risk
		damaged. Noise generation.							
9	**Surcharge behind the wall**	Failure of system causing damage to highway assets and risk to human life. Cost of repairs. Reputational damage.	2	4	8	Contractor shall allow no surcharge behind the king sheet pile wall on the slope during construction. Machinery required for installation shall be placed front of the wall. Slip road is protected with existing VRS allowing no movement on the slope behind the wall.	1	4	4
10	**Excessive excavation Infront of wall**	Excessive excavation front of the wall shall lead to project delay, damage to assets and risk to human life. Cost of repairs.	2	4	8	Contractor shall follow the design drawings and specifications. Designer shall be notified for any excessive excavation front of the wall.	1	4	4
11	**Soil Slippage at either end, due to improper Tieback of Gabion wall and King Sheet Pile wall.**	Failure of slope due to progressive soil slippage from the gaps created due to improper tieback of the two retaining systems. Cost of	5	4	20	Contractor shall inspect on site and install proper tieback between the two system. A proper wrap around should be provided to arrest the soil slippage and probable slope failure.	2	4	8

Hazard ID	Hazard	Consequence	Likelihood	Severity	Risk	Available Mitigation Measure	Likelihood	Severity	Residual Risk
		repairs. Reputational Damage							
	Structures								
12	**Existing structures**	Obstruction to pilling, increased construction costs and delays.	1	2	2	No records found of previous highway structures. Risk is deemed as low as reasonably practicable.	1	2	2
13	**Non-coal mining hazard**	Risk of mining related subsidence affecting the EA during construction or Operational phase.	4	4	16	Further desk study has been undertaken to collate historic information to assess ground conditions and non-coal mining risk at each EA location. Ground Investigation has been undertaken at required locations and current investigation and assessment makes risk as low as reasonably practicable.	1	4	4
14	**Slope instability including soil slippage**	Risk of slope instability affecting the EA during construction or Operational phase. Damage to structures, carriageway, highway	3	3	9	Assessment was carried out to check whether extent of any existing earthworks instability defect encroaches on the extent of the EA and also on the temporary working space (50m before and	1	3	3

Hazard ID	Hazard	Consequence	Likelihood	Severity	Risk	Available Mitigation Measure	Likelihood	Severity	Residual Risk
		infrastructure and adjoining properties. Disruption of highway traffic, programme slippage, increased works costs.				50m after each EA location) to assess the likelihood of future instability. Carry out essential maintenance/remediation on existing geotechnical assets prior to, or during, the works.			
15	**Unforeseen / unrecorded contamination**	Encountering contaminated material (including asbestos), soil or groundwater, posing risk of harm to construction workers, maintenance staff, motorway users and adjacent land users. Pollution of groundwater. Restriction of disposal routes. Delay to programme as soil/material/groundwater is tested. Additional cost for disposal or treatment or contaminated soil/	2	2	4	Confirmatory ground investigation (including geo-environmental testing of soils) has been undertaken at proposed EA locations. No visual / olfactory contamination or elevated contaminants have been identified which could pose a significant risk to human health or groundwater receptors. Robust site procedures to be documented in Contractor’s MMP and CEMP. Risk associated with asbestos (if present) to be managed by Contractor through the development of working methods and risk assessments in accordance with the Control of Asbestos Regulations (CAR) 2012 and CAR-SOIL guidance.	1	1	1

Hazard ID	Hazard	Consequence	Likelihood	Severity	Risk	Available Mitigation Measure	Likelihood	Severity	Residual Risk
		material/ groundwater.				If contaminated soil/material/groundwater is found or suspected to be present during groundworks, material should be segregated, inspected and tested by a specialist contractor.			
16	**Potential landfill gas**	Health and safety risk to construction and future maintenance workers: Inhalation of landfill gas in excavations and confined spaces. Explosion.	2	4	8	Confirmatory ground investigation has been undertaken at proposed EA locations. Borehole records do not indicate any potential sources of landfill gas, however gas monitoring data is unavailable. Landfill gas risk to be managed by groundworks and/or piling contractor through the development of working methods and risk assessments, including gas monitoring within excavations and confined spaces, continuous gas monitoring during piling, and use of gas alarms.	2	1	2
17	**Excavation of materials**	Exposure of construction workers to contaminated arisings/ made ground associated with historical landfill sites and infilled	4	3	12	Contractor to assess area of excavation and use appropriate safety measures to ensure material is stored or placed away from the running lanes.	2	3	6

Hazard ID	Hazard	Consequence	Likelihood	Severity	Risk	Available Mitigation Measure	Likelihood	Severity	Residual Risk
		mineral extraction pits might impact their health. Project delays undertaking clean-ups if contamination is at levels above acceptable human health screening values. Potential high clean-up costs. Risk of injury to personnel during excavation. Possibility of material being displaced into live carriageway, which can lead to injury to the users of the network.				Excavator operators to have a banksman to prevent the risk of injury to personnel on site. Identified risks to be incorporated in health and safety plan during works.			
18	**Presence of UXO**	Striking unexploded ordnance UXO will lead to destruction of nearby infrastructure, injury and fatality to the personnel involved.	2	5	10	The regional unexploded bomb risk map as downloaded from the Zetica website, identifies that between J23a-J25 there is low risk for encountering unexploded ordnance at the site. Contractor to undertake UXO good practice toolbox talks for excavation works.	1	5	5
19	**Flood events**	Delays to programme caused by flooding (Flood zone 2 & 3).	3	3	9	Works should be scheduled for the dryer months of the year. Flood Risk Review has been undertaken and	1	3	3

Hazard ID	Hazard	Consequence	Likelihood	Severity	Risk	Available Mitigation Measure	Likelihood	Severity	Residual Risk
						determined the surface water flooding risk to be negligible. The proposed works will not impact or exacerbate the existing surface water flood risk. Ground Investigation suggest no surface water flooding risk at site.			
20	**Presence of utilities and 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. Contractor to be supplied with latest utility drawings.	1	5	5
21	**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
22	**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	Chemical testing in accordance with BRE-SD1 during Ground Investigation was undertaken. Use appropriate concrete design in construction.	2	3	6

Hazard ID	Hazard	Consequence	Likelihood	Severity	Risk	Available Mitigation Measure	Likelihood	Severity	Residual Risk
23	**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
24	**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
	Advanced Works (including Mobilisation to Site and Preparation for Main Works)								
25	**Bearing Capacity Failure or Excessive Differential Settlement of temporary foundations for TM infrastructure, Scheme billboard foundation & posts; 'Goal-Posts ' for**	Toppling of temporary CCTV & Temporary Automatic Speed Camera System (TASCAR) +/- Remotely Operated Temporary Traffic Management (ROTTM) signs,	2	5	10	Establish from OSAP any locations of the of temporary CCTV & Temporary Automatic Speed Camera System (TASCAR). Remotely Operated Temporary Traffic Management (ROTTM) signs, Goal-	1	5	5

Hazard ID	Hazard	Consequence	Likelihood	Severity	Risk	Available Mitigation Measure	Likelihood	Severity	Residual Risk
	Avoidance of Danger from Overhead Electric Lines' [GS6 legislation], office cabins, welfare units	GoalPosts ' for Avoidance of Danger from Overhead Electric Lines' [GS6 legislation], into construction workers, or into live traffic, including potential fatalities. Excessive settlement and instability of scheme billboards; 'office cabins, welfare units, either injuring Construction workers or general public. Additional Costs to reinstate				Posts 'for Avoidance of Danger from Overhead Electric Lines'. If any proposed, undertake a review of their likely foundation material, and where appropriate, for example very poor ground is expected, engage to discuss potential alternative locations or provide more detailed geotechnical advice and design in exceptional circumstances.			
26	**Slope instability being triggered by the additional loads induced by of temporary foundations for TM infrastructure, Scheme billboard foundation & posts; 'Goal -Posts ' for Avoidance of Danger from Overhead Electric Lines' [GS6 legislation], office cabins, welfare units**	Toppling of temporary CCTV & Temporary Automatic Speed Camera System (TASCAR) +/- Remotely Operated Temporary Traffic Management (ROTTM) signs, Goal-Posts ' for Avoidance of Danger from Overhead Electric Lines' [GS6 legislation], into construction workers, or into live traffic, including potential fatalities. Exacerbation or worsening of existing earthwork defects	2	5	10	Establish from OSAP all the locations of the of temporary CCTV & Temporary Automatic Speed Camera System (TASCAR), Remotely Operated Temporary Traffic Management (ROTTM) signs, Goal-Posts ' for Avoidance of Danger from Overhead Electric Lines'. Also NRTS trenches, office cabins and welfare units. Undertake a review of GDMS Geotechnical Asset Database and where appropriate, for instance if infrastructure is planned in	1	5	5

Hazard ID	Hazard	Consequence	Likelihood	Severity	Risk	Available Mitigation Measure	Likelihood	Severity	Residual Risk
		from the location of infrastructure directly on top of an existing defect. Positioning of NRTS trenching directly above areas of existing earthwork defects with the potential that they act as unintended French crest drains feeding water into the earthwork and destabilising it.				immediate proximity to a defect and could potentially provide additional load which may de-stabilise it, engage with OSAP to discuss potential alternative locations or provide more detailed geotechnical advice and design in exceptional circumstances			
27	**Hard dig, for example from shallow rockhead**	Difficulties in installing NRTS Open Trenches, or otherwise pegging, ducting, cabling, and crossovers. Inappropriate choice of any trenchless technology.	3	2	6	Establish from OSAP all the NRTS cabling that will be required and understand expectations on how they plan to install it. If there are any below ground trenches (or other means of installation) provide advice on likely amount of hard dig following a review of the design ground model. Provide advice on recommended installation techniques if below ground excavation is necessary. If a trenchless crossing is to be provided provide geotechnical advice on the completion of reporting in accordance with CD 622	3	1	3

Hazard ID	Hazard	Consequence	Likelihood	Severity	Risk	Available Mitigation Measure	Likelihood	Severity	Residual Risk
28	**Geo-Environmental considerations**	Potential health and safety risks arising from contaminated land exposure to construction works from any Advance Works activities. Potential programme delays and costs associated with dealing with any excavations/treatment or disposal of contaminated ground. Potential for topsoil strip and storage is tracked and in accordance with scheme Material Management Plan.	2	4	8	Liaise with OSAP and Geo-Environmental team to ensure that the Materials Management Plan for the scheme is available and understood by the Site Clearance Team.	2	2	4

Note: *Some risks under a particular section heading may also apply under another group heading – This risk register to be considered a holistic overview of the geotechnical risks which apply, and what groups of risks they apply to will be kept under review and updated accordingly. The risks noted above apply whether they are considered as Permanent Works or Temporary Works. Management of Geotechnical Risks in accordance with CD 622 is required for all Permanent Works and Temporary Works that could potentially impact on the road user, or an external party outside the National Highways boundary.*

19 REFERENCES

[1] Ove Arup & Partners. (2005). *M1 Widening: Junctions 21-30, Preliminary Sources Study Report, GDMS Ref: 19183.*

[2] AMAR. (2016). *M1 Junction 23a to 25 Ground Investigation Report, Ref. HA549342-AMAR-HGT-SWI-RP-CE-000002, GDMS Ref: 28929.*

[3] AMAR. (2017). SMP M1 J23a-25 *Geotechnical Design Report, Ref. HA549342-AMAR-HGT-SWI-RP-CE-000003, GDMS Ref: 29152.*

[4] AMAR. (2021). *SMP M1 J23a-25 Geotechnical Feedback Report., Ref. HA549342-AMAR-HGT-SWI-RP-CE-000008, GDMS Ref. 30523*

[5] WSP. (2023). *National Emergency Area Retrofit M1 J23a-25-Statement of Intent, GDMS Ref:* 47380.

[6] BRE Special Digest 1:2005, Concrete in Aggressive Ground.

[7] Geosolve, WALLAP Retaining Wall Anaysis Program.

[8] Highways England, IAN 73/06 Revision 1 – Design Guidance for Road Pavement Foundations (Draft HD25), February 2009.

[9] King Sheet Piling – Technical Guidance, V 1.2/15.4.14, obtained from www.ksp-piling.co.uk.

[10] British Standards Institution. (2009). *BS EN 1993-5:2007 Eurocode 3 – Design of Steel Structures - Part 5: Piling.* London: BSI Standards Limited.

[11] British Standards Institution. (2010). *BS EN 1997-2:2007 Eurocode 7 - Geotechnical Design - Part 2: Ground Investigation and Testing.* London: BSI Standards Limited.

[12] British Standards Institution. (2013). *BS EN 1997-1:2004+A1:2013 Eurocode 7: Geotechnical Design - Part 1: General Rules.* London: BSI Standards Limited.

[13] British Standards Institution. (2015). *BS 5930:2015+A1:2020 Code of practice for ground investigations.* London: BSI Standards Limited.

[14] British Standards Institution. (2018). *BS EN 14688-1:2018 Geotechnical Investigation and Testing - Identification and Classification of Soil.* London: BSI Standards Limited.

[15] British Standards Institution. (2005). *BS 8002 Code of practice for Earth Retaining Structures.* London: BSI Standards Limited.

[16] British Standards Institution. (2010). *BS 8006-1:2010 Code of practice for strengthened/reinforced soils and other fills.* London: BSI Standards Limited.

[17] British Standards Institution. (n.d.). *BS 1377 Methods of test for Soils for civil engineering purposes.* London: BSI Standards Limited.

[18] Design Manual for Roads and Bridges. (2020). *CS 641 Managing the maintenance of highway geotechnical assets.* Design Manual for Roads and Bridges.

[19] Design Manual for Roads and Bridges. (2022). *CD 354 - Design of minor structures.* Design Manual for Roads and Bridges.

[20] Design Manual for Roads and Bridges. (2020). *CD 622- Managing geotechnical risk.* Design Manual for Roads and Bridges.

[21] GDMS. (n.d.). *Geotechnical and Drainage Management Service*. Retrieved 2022, from https://gdms.assetia.cloud/map;tabId=000000.

[22] GeoIndex Onshore. (n.d.). *British Geological Survey.* Retrieved 2020, from GeoIndex - British Geological Survey (bgs.ac.uk).

[23] Guidelines for the safe investigation by drilling of landfills and contaminated land. London: Thomas Telford.

[24] Institute of Highway Engineers. (2021). *Sign Structures Guide-Support design for permanent UK traffic signs to BS EN 12899-1 and Eurocodes.*

[25] Smart Motorway Programme. (2019). *Smart Motorway Programme- Design Guide Annex E3.04.*

[26] Statutory Undertakers Information - HE614830-WSP-GEN-P015_AL_ALLGENR-M2-CH-0004.

[27] The Coal Authority Interactive Viewer. (n.d.). *The Coal Authority*. Retrieved 2023, from Interactive Map Viewer | Coal Authority (bgs.ac.uk).

[28] ZeticaUXO. (n.d.). *Zetica Limited*. Retrieved 2023, from Risk Maps | Zetica UXO.

[29] Land Contamination Risk Management (LCRM), https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm/lcrm-stage-1-risk-assessment#tier-2-generic-quantitative-risk-assessment.

[30] National House Building Council and Environment Agency, 2008, https://webarchive.nationalarchives.gov.uk/ukgwa/20140328084622/http://www.environment-agency.gov.uk/static/documents/Leisure/SR-DPUB66-e-e.pdf

[31] Land Quality Management Limited, 2015, https://www.lqm.co.uk/products/lqm-cieh-suitable-4-use-levels

[32] Society for Brownfield Risk Assessment, 2020, https://sobra.org.uk/acute-gacs-report/development-of-acute-generic-assessment-criteria-for-assessing-risks-to-human-health-from-contaminants-in-soil/

[33] Contaminated Land: Applications in Real Environments, 2011, https://www.claire.co.uk/projects-and-initiatives/category-4-screening-levels

Annex A Geotechnical Data Sheets – Earthworks, King Sheet Pile Wall and MS4 Gantry

Location Name	M1-J23a-J25-EA-NB-187/8	**Location Type**	Emergency Area
Earthwork Type	Embankment	**Earthwork Modification**	Regrade

Carriageway	**Chainage**	**Marker Post Reference**	**National Grid Reference (centre point)**
Northbound	187700-187800	187/8	446861E, 330029N

Description and Proposed Works
Modifications to existing Embankment slope (max. height of regrade 0.8m)

Site Description		
The site is located on the northbound carriageway verge, after Junction 24a.		
Associated Earthworks	GDMS Reference(s)	Type
	24434	Embankment
Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1950s. From the 1970s onward the carriageway in the current alignment we see today is present. The site area is in the designate flood zone 2 and 3 and potential for Groundwater flooding situated below Ground Level. The area falls in recorded flood lines due to exceeding channel capacity. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and Secondary – A Aquifer for the superficial deposits. The site is not with a groundwater Source Protection Zone.	
Geology and Groundwater		
Superficial Deposits	The BGS Geology Viewer depicts: Hemington Member - Silt and Gravel. Superficial deposit formed during the Pre-Quaternary period underlying the entire site.	
Bedrock	The BGS Geology Viewer depicts: Edwalton Member - Mudstone. Sedimentary bedrock formed during the Carnian period.	
Groundwater	No Groundwater encountered during ground investigation performed in 2023.	

Upstream

Downstream

Source: AVIS
Date of Capture 24/03/2023

Figure 19-1 EA-NB-187/8

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Exploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1877N	Midpoint of EA	33.71 (OD)	10m	01/06/2023

Geotechnical Ground Model for Design **Verge Level: 33.71m OD**	**Material**	**Depth (mbgl)**	**Elevation (m OD)**	**Notes**
	Made Ground-Granular	1	32.7	Ground model taken from BH1877N
	Hemington Member – Cohesive	2.2	31.5	
	Hemington Member-Granular	10	23.7	
	Groundwater notes: No Groundwater Encountered			

Design Parameters						
Moderately Conservative Values:						
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)
Made Ground - Granular	19	-	0	30	-	5000
Hemington Member – Cohesive	19	100	0	27	19000	17100
Hemington Member - Granular	19.5	-	1	30	-	25000

Design Section

Minor Regrade of 1V:2H slope has been proposed at this location and slope stability analysis has also been performed. The Slope has been found satisfactory for the proposed conservative ground model.

Contaminated Land Assessment	Potential landfill gas risk associated with Hemington Gravel Pit historical landfill. Method statements and risk assessments for exposure to gases, including mitigation measures, to be undertaken by groundworks and/or piling contractor

Location Specific Risks

ID24: Excavated arisings could be classed as non-hazardous or hazardous waste

Report Extracts and References

GFR

4.3. Details of any problems encountered

No particular embankment construction problems were encountered.

4.4. Instability problems and unusual ground conditions

The materials encountered during construction were broadly similar to the reported ground conditions in the GIR [1]/ GDR [2]. All excavated material was classed as 2A and 2B (unsuitable for embankment widening) and removed from site. No ground instability problems were encountered during the construction.

4.5. Ground water conditions and problems and drainage measures to overcome them

No major drainage or groundwater problems were encountered during widening of the embankments.

4.6. Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

No contamination or hazardous materials were encountered at cutting locations across the scheme.

4.7. Foundation treatment, including drainage measures and treatment of soft areas

No areas of soft foundations were encountered, as the embankment widening did not generally extend into the flood plain areas. New fill was benched into the existing embankment to maintain the integrity of the new slope.

4.8. Settlement of foundation and fill material

The works comprised only localised small scale widening of existing embankments. No new embankments that would be subject to foundation or internal settlement were constructed as part of the works.

Exploratory Hole Log

STRATA GEOTECHNICS	Contract Name: M1 J23A-J25 NEAR		Client: BMJV			Borehole ID: BH1877N
	Contract Number: G230600	Date Started: 01/06/2023	Date Completed: 02/06/2023	Logged: JN/ASH	Checked: JB	Status: FINAL	Sheet 1 of 1
Dynamic Sample Drilling Log	Easting: 446863.5	Northing: 330029.2	Ground Level: 33.71m (OD)	Plant Used: Comacchio 305	Print Date: 04/09/2023	Scale: 1:50
Weather: Fine	Rig Crew: Adrian Foulstone	Termination: Scheduled Depth	SPT Hammer: AR935 Energy Ratio: 63.5%			

Samples & In Situ Testing

Depth	Sample	Test Result	TCR	SCR	RQD	FI/If
0.00 - 1.00	CC1					
0.50	D13					
0.50	ES11					
1.00	ES12					
1.20 - 1.65	D2	SPT(S) 1.20m, N=19 (10,4/4,5,5,5)				
1.40 - 1.50	D14					
1.50 - 1.70	ES15					
2.00 - 3.00	D16					
2.00 - 3.00	ES17					
2.20 - 2.65	D3	SPT(S) 2.20m, N=30 (8,8/9,8,8,5)				
3.00 - 3.41	D4	SPT(S) 3.00m, N=31 (25 for 110mm/14,6,6,5)				
3.00 - 4.00	B19					
3.00 - 4.00	D18					
4.00 - 4.20	D20	SPT(S) 4.00m, N=30 (7,8/2,9,9,10)				
4.00 - 4.45	D5					
4.50 - 4.70	D21					
4.70 - 5.00	D22					
5.00 - 5.45	D6	SPT(S) 5.00m, N=35 (3,8/8,8,8,11)				
5.00 - 6.00	D23					
6.00 - 6.45	D7	SPT(S) 6.00m, N=27 (5,6/6,6,7,8)				
7.00 - 7.45	D8	SPT(S) 7.00m, N=21 (8,9/4,4,6,7)				
7.00 - 8.00	B25					
7.00 - 8.00	D24					
8.00 - 8.45	D9	SPT(S) 8.00m, N=22 (1,4/7,7,5,3)				
8.00 - 9.00	D26					
9.00 - 10.00	D27	SPT(S) 9.00m, N=45 (5,8/9,11,13,12)				
9.00 - 9.45	D10					

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Strata Description
33.51	0.20	MADE GROUND: Black bituminous material. [MADE GROUND]
33.21	(0.30) 0.50	MADE GROUND: Concrete bound material. [MADE GROUND]
32.71	(0.50) 1.00	MADE GROUND: Grey slightly sandy GRAVEL. Sand is fine to coarse. Gravel is angular to sub-angular fine to coarse of quartzite. [MADE GROUND]
32.51	1.20	Firm brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is sub-rounded to rounded fine to medium of quartzite. [Hemmington Member]
31.51	(1.00) 2.20	Stiff reddish brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone. [Hemmington Member]
29.21	(2.30) 4.50	Dense dark brown clayey sandy angular fine to coarse GRAVEL of quartz and siltstone. Sand is fine to coarse. [Hemmington Member]
29.01	4.70	Stiff greyish brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is sub-rounded to rounded fine to coarse of quartz and mudstone. [Hemmington Member]
28.71	(0.30) 5.00	Reddish brown slightly gravelly silty fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse of quartz and sandstone. [Hemmington Member]
27.71	(1.00) 6.00	Dense dark brown clayey gravelly fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse of quartz and sandstone. [Hemmington Member]
23.71	(4.00) 10.00	Medium dense to dense dark brown clayey sandy GRAVEL. Sand is fine to coarse. Gravel is sub-angular to rounded fine to coarse of quartz and sandstone. [Hemmington Member] 7.00 - 8.00 very sandy

End of Borehole at 10.00m

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
01-06-23	20:00			
01-06-23	23:55	0.00		

Flush Return Information

Top	Base	Min %	Max %	Type	Colour

Remarks:
No groundwater encountered during drilling.
Backfilled with bentonite, concrete and bituminous material.

Water Strike

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Borehole Diameter

Depth (m)	Dia (mm)
3.00	101
7.00	87
10.00	77

Casing Diameter

Depth (m)	Dia (mm)
1.20	152

Coring Information

Top (m)	Base (m)	Dia (mm)	Barrel Type

Fracture Index (FI) - Fractures per meter. Fracture Spacing (If) - reported in mm as Min, Average and Max values. TCR, SCR and RQD reported as %. Hand vane (HV) reports Undrained Shear Strength (Cu). Pocket penetrometer (PP) reports Unconfined Compressive Strength (UCS).

Location Name	M1-J23a-J25-EA-NB-190/2	**Location Type**	Emergency Area
Earthwork Type	Embankment	**Earthwork Modification**	Regrade

Carriageway	**Chainage**	**Marker Post Reference**	**National Grid Reference (centre point)**
Southbound	190070 – 190160	190/2	446685E, 332308N

Description and Proposed Works
Modifications to existing Embankment slope (max. height of regrade 1.4m)

Site Description		
The site is located on the northbound carriageway verge, midway between Junction 24a and Junction 25.		
Associated Earthworks	GDMS Reference(s)	Type
	24420	Embankment
Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1960s with Draycot road to the South and Railway Line to the North. From the 1970s onward the carriageway in the current alignment we see today is present. The site area is near to the designate flood zones 2 and 3 and potential for Groundwater flooding situated below Ground Level. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and Secondary – A Aquifer for the superficial deposits. The site is not with a groundwater Source Protection Zone.	
Geology and Groundwater		
Superficial Deposits	The BGS Geology Viewer depicts: Hemington Member - Silt and Gravel. Superficial deposit formed during the Pre-Quaternary period underlying the entire site.	
Bedrock	The BGS Geology Viewer depicts: Edwalton Member - Mudstone. Sedimentary bedrock formed during the Carnian period.	
Groundwater	No Groundwater encountered	

Upstream

Downstream

Source: AVIS
Date of Capture 24/03/2023

Figure 19-2 EA-NB-190/2

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Exploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1902N	Midpoint of EA	40.40 (OD)	10m	30/05/2023

Geotechnical Ground Model for Design **Verge Level: 33.71m OD**	**Material**	**Depth (mbgl)**	**Elevation (m OD)**	**Notes**
	Made Ground-Granular	1.2	39.2	Ground model taken from BH1902N
	Hemington Member – Granular	2.8	37.6	
	Edwalton Member – Cohesive	5.0	35.4	
	Edwalton Member – Cohesive	10.0	30.4	
	Groundwater notes: No Groundwater Encountered			

Design Parameters						
Moderately Conservative Values:						
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)
Made Ground - Granular	19	-	0	30	-	5000
Hemington Member – Granular	19	-	0	30	-	10000
Edwalton Member – Cohesive	19	90	2	26	18000	16200
Edwalton Member – Cohesive	19.5	165	2	27	33000	29700

Design Section

Minor Regrade of 1V:2H slope has been proposed at this location and slope stability analysis has also been performed. The Slope has been found satisfactory for the proposed conservative ground model.

Contaminated Land Assessment	No contamination sources identified based on confirmatory ground investigation data

Location Specific Risks
ID6: Compressible/Collapsible ground hazard

Report Extracts and References
GFR

4.3. Details of any problems encountered

No particular embankment construction problems were encountered.

4.4. Instability problems and unusual ground conditions

The materials encountered during construction were broadly similar to the reported ground conditions in the GIR [1]/ GDR [2]. All excavated material was classed as 2A and 2B (unsuitable for embankment widening) and removed from site. No ground instability problems were encountered during the construction.

4.5. Ground water conditions and problems and drainage measures to overcome them

No major drainage or groundwater problems were encountered during widening of the embankments.

4.6. Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

No contamination or hazardous materials were encountered at cutting locations across the scheme.

4.7. Foundation treatment, including drainage measures and treatment of soft areas

No areas of soft foundations were encountered, as the embankment widening did not generally extend into the flood plain areas. New fill was benched into the existing embankment to maintain the integrity of the new slope.

4.8. Settlement of foundation and fill material

The works comprised only localised small scale widening of existing embankments. No new embankments that would be subject to foundation or internal settlement were constructed as part of the works.

Exploratory Hole Log

STRATA GEOTECHNICS	Contract Name: M1 J23A-J25 NEAR			Client: BMJV			Borehole ID: BH1902N
	Contract Number: G230600	Date Started: 30/05/2023	Date Completed: 31/05/2023	Logged: JN/ASH	Checked: JB	Status: FINAL	Sheet 1 of 1
Dynamic Sample Drilling Log	Easting: 446689.2	Northing: 332306.1	Ground Level: 40.40m (OD)	Plant Used: Comacchio 305		Print Date: 04/09/2023	Scale: 1:50
Weather: Drizzle+Cloudy	Rig Crew: Adrian Foulstone	Termination: Scheduled Depth		SPT Hammer: AR935 Energy Ratio: 63.5%			

Samples & In Situ Testing

Depth	Sample	Test Result	TCR	SCR	RQD	FI/If
0.00 - 1.20	CC1					
1.00	ES11					
1.20 - 1.30	B12	SPT(S) 1.20m, N=11 (1,1/2,3,3,3)				
1.20 - 1.65	D2					
1.40 - 1.50	D13					
1.50 - 1.70	ES14					
2.20 - 2.65	D3	SPT(S) 2.20m, N=10 (2,1/1,2,3,4)				
2.50 - 2.70	ES15					
2.90 - 3.00	D16					
3.00 - 3.45	D4	SPT(S) 3.00m, N=18 (3,3/4,5,4,5)				
3.60 - 3.70	D17					
4.00 - 4.45	D5	SPT(S) 4.00m, N=24 (3,4/5,6,6,7)				
4.50 - 4.70	D18					
5.00 - 5.45	D6	SPT(S) 5.00m, N=25 (2,5/5,6,7,7)				
6.00 - 6.45	D7	SPT(S) 6.00m, N=35 (3,5/8,8,9,10)				
6.50 - 6.70	D19					
7.00 - 7.45	D8	SPT(S) 7.00m, N=33 (5,3/7,8,8,10)				
7.50 - 7.70	D20					
8.00 - 8.45	D9	SPT(S) 8.00m, N=37 (3,6/6,7,11,13)				
8.50 - 8.70	D21					
9.00 - 9.45	D10	SPT(S) 9.00m, N=45 (2,12/10,10,11,14)				
9.50 - 9.70	D22					

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
40.15	0.25		MADE GROUND: Black Bituminous Material. [MADE GROUND]		
39.80	(0.35) 0.60		MADE GROUND: Concrete bound material. [MADE GROUND]		
39.20	(0.60) 1.20		MADE GROUND: Brown clayey sandy GRAVEL. Sand is fine to coarse. Gravel is sub-rounded to rounded fine to medium of quartz and quartzite. [MADE GROUND]		
37.90	(1.30) 2.50		Medium dense reddish brown slightly clayey SAND and GRAVEL. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone. [Hemmington Member]		
37.60	(0.30) 2.80		Loose dark brown slightly sandy angular fine to coarse GRAVEL of quartz and mudstone. Sand is fine to coarse. [Hemmington Member]		
36.40	(1.20) 4.00		Stiff reddish brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone. [Edwalton Member]		
36.20	4.20		Medium dense dark brown silty gravelly fine to coarse SAND. Gravel is angular fine to coarse of quartz and mudstone. [Edwalton Member]		
30.40	(5.80) 10.00		Very stiff reddish brown mottled grey sandy gravelly CLAY. Gravel is angular fine to coarse of mudstone. [Edwalton Member] 8.00 - 9.00: Stiff to very stiff		
			End of Borehole at 10.00m		

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
30-05-23	20:00			
30-05-23	23:55	1.20	1.20	0.00
31-05-23	20:00	1.20	1.20	0.20
31-05-23	23:55	0.00		

Flush Return Information

Top	Base	Min %	Max %	Type	Colour

Remarks:
No groundwater encountered during drilling.
Backfilled with bentonite, concrete and bituminous material.

Water Strike

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Borehole Diameter

Depth (m)	Dia (mm)
3.00	101
10.00	87

Casing Diameter

Depth (m)	Dia (mm)
1.20	152

Coring Information

Top (m)	Base (m)	Dia (mm)	Barrel Type

Fracture Index (FI) - Fractures per meter. Fracture Spacing (If) - reported in mm as Min, Average and Max values. TCR, SCR and RQD reported as %. Hand vane (HV) reports Undrained Shear Strength (Su). Pocket penetrometer (PP) reports Unconfined Compressive Strength (UCS).

Location Name	M1-J23a-J25-EA-NB-192/0	Location Type	Emergency Area
Earthwork Type	Cutting to At Grade	Earthwork Modification	Regrade

Carriageway	Chainage	Marker Post Reference	National Grid Reference (centre point)
Southbound	191880 – 191200	192/0	447256E, 333972N

Description and Proposed Works
Modifications to existing Embankment slope (max. height of regrade 0.72m)

Site Description		
The site is located on the northbound carriageway verge, before Junction 25.		
Associated Earthworks	GDMS Reference(s)	Type
	22235	Cutting
Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1960s with Derby Road to the South and Longmoor Lane to the North. From the 1970s onward the carriageway in the current alignment we see today is present. The site area is designated as potential for Groundwater flooding to Occur at Surface. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and Secondary – A Aquifer for the superficial deposits. The site is not with a groundwater Source Protection Zone.	
Geology and Groundwater		
Superficial Deposits	The BGS Geology Viewer depicts: Beeston Sand and Gravel Member - Sand and Gravel. Superficial deposit formed during the Pleistocene Epoch period underlying the entire site.	
Bedrock	The BGS Geology Viewer depicts: Gunthorpe Member - Mudstone. Sedimentary bedrock formed during the Anisian period.	
Groundwater	No Groundwater encountered	

Upstream

Downstream

Source: AVIS
Date of Capture 24/03/2023

Figure 19-3 EA-NB-192/0

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Exploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1920N	Midpoint of EA	35.74 (OD)	8.29m	02/05/2023

Geotechnical Ground Model for Design	Material	Depth (mbgl)	Elevation (m OD)	Notes
Verge Level: 33.71m OD	Made Ground- Cohesive	1.2	34.5	Ground model taken from BH1920N
	Made Ground- Granular	3.9	31.8	
	Gunthorpe member – Cohesive	7.0	28.7	
	Gunthorpe member – Mudstone	8.29	27.4	
	Groundwater notes: No Groundwater Encountered			

Design Parameters							
Moderately Conservative Values:							
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)	UCS (MPa)
Made Ground- Cohesive	19	100	0	27	7800	6200	-
Made Ground- Granular	19	-	0	32	-	15000	-
Gunthorpe member – Cohesive	20	180	2	27	36000	32400	-
Gunthorpe member – Mudstone	20	-	-		-	50000	0.48

Design Section

Minor Regrade of 1V:2.5H slope has been proposed at this location and slope stability analysis has also been performed. The Slope has been found satisfactory for the proposed conservative ground model.

Contaminated Land Assessment	No contamination sources identified based on confirmatory ground investigation data

Location Specific Risks

ID6: Compressible/Collapsible ground hazard

Report Extracts and References

GFR

3.3. Details of any problems encountered

None encountered.

3.4. Instability problems and unusual ground conditions

The ground conditions and materials encountered during construction were similar to the anticipated ground model in the GIR [1] . All excavated material was classed as 2A and 2B (unsuitable for regrading or fill to structures) and removed from the site. No ground instability problems were encountered during the construction.

3.5. Ground water conditions and problems and drainage measures to overcome them

No major groundwater problems were encountered during regrading of the cutting slopes.

3.6. Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

No contamination or hazardous materials were encountered at cutting locations across the scheme.

Exploratory Hole Log

STRATA GEOTECHNICS	Contract Name: M1 J23A-J25 NEAR		Client: BMJV			Borehole ID: BH1920N
	Contract Number: G230600	Date Started: 02/05/2023	Date Completed: 10/05/2023	Logged: JN/ASH	Checked: JB	Status: FINAL / Sheet 1 of 2
Dynamic Sample Borehole Log	Easting: 447250.8	Northing: 333971.2	Ground Level: 35.74m (OD)	Plant Used: Comacchio 305	Print Date: 04/09/2023	Scale: 1:50
Weather: Dry	Rig Crew: JK&JK	Termination: Scheduled Depth		SPT Hammer: AR3653 Energy Ratio: 63%		

Samples & In Situ Testing

Depth	Sample ID	Test Result
0.30	ES	
0.30	ES1	
0.50	D2	
1.00	ES3	
1.20	D4	SPT(S) 1.20m, N=15 (3,3/4,3,4,4)
1.20 - 1.30	B5	
1.20 - 1.40	ES10	Recovery = 100%
1.20 - 1.65	D26	Recovery = 100%
1.20 - 2.20	L24	
1.60 - 1.70	D11	
1.80 - 1.90	ES12	
2.20 - 2.80	UT22	Recovery = 50%
2.80 - 3.00	ES13	Recovery = 100%
2.80 - 3.80	L23	
3.00 - 3.20	D14	
3.60 - 3.80	D15	
3.80 - 4.80	L25	SPT(S) 3.80m, N=36 (7,8/8,9,9,10)
3.90 - 4.10	ES16	Recovery = 100%
4.10 - 4.20	D17	
4.20 - 4.40	D18	
4.80 - 5.00	UT6	Recovery = 0%
5.00 - 6.00	L7	Recovery = 100%
5.10 - 5.20	D19	
5.60 - 5.70	D20	
6.00 - 7.00	C8	SPT(C) 6.00m, N=44 (10,14/14,16,12,2) Recovery = 30%
7.00 - 7.10	D21	SPT(C) 7.00m, 50 (16,9/17,18,15,)
7.00 - 8.00	L9	Recovery = 100%
8.00	50 (20,5/20,21,9,)	SPT(C) 8.00m, 50 (20,5/20,21,9,)

Fracture | TCR | SCR | RQD

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Strata Description	Progress (Window Run)
35.64	0.10	MADE GROUND: Vegetation over firm dark grey slightly gravelly sandy CLAY, with frequent plants/ rootlets (6x15). Sand is fine to coarse. Gravel is sub-rounded to rounded fine to coarse of quartzite.	
	(0.60)		
35.04	0.70		
	(0.50)		
34.54	1.20	[MADE GROUND]	1.20 - 1.65 100% rec
	(0.40)	MADE GROUND: Firm dark grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is sub-rounded to rounded fine to medium of quartzite.	1.20 - 2.20 100% rec
34.14	1.60		
	(2.00)	[MADE GROUND]	2.20 - 2.80 50% rec
		MADE GROUND: Firm to stiff yellowish brown slightly gravelly sandy CLAY. Sand is fine. Gravel is sub-rounded to rounded of fine to medium of quartzite.	2.80 - 3.80 100% rec
32.14	3.60		
	(0.30)	[MADE GROUND]	
31.84	3.90	MADE GROUND: Medium dense friable dark brown slightly clayey very sandy GRAVEL. Sand is fine to coarse. Gravel is angular to sub-angular fine to coarse of quartz.	3.80 - 4.80 100% rec
	(0.30)	[MADE GROUND]	
31.54	4.20	MADE GROUND: Dark brown slightly clayey very sandy GRAVEL. Sand is fine to coarse. Gravel is sub-angular to rounded fine to coarse of quartz and sandstone.	4.80 - 5.00 0% rec
	(1.40)	[MADE GROUND]	
30.14	5.60	MADE GROUND: Dense orangish brown silty gravelly fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse of quartz and sandstone.	5.00 - 6.00 100% rec
		[MADE GROUND]	
	(1.40)	Stiff reddish brown mottled grey slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is sub-angular to rounded fine to coarse quartz and sandstone.	6.00 - 7.00 30% rec
		[Gunthorpe Member]	
28.74	7.00	Stiff reddish brown mottled grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone and sandstone.	7.00 - 8.00 100% rec
	(1.29)	[Gunthorpe Member]	
		Stiff reddish brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is sub-angular to angular fine to coarse of mudstone.	
27.45	8.29	[Gunthorpe Member]	8.00 - 8.29 AEL
		Very weak reddish brown MUDSTONE. Discontinuities (0-20) are extremely closely spaced planar with clay infill.	
		[Gunthorpe Member]	
		End of Borehole at 8.290m	

Progress by Time

Date	Time	Depth	Casing	Water

Borehole Diameter: Depth	Diameter	Casing Diameter: Depth	Diameter
8.29	140	5.00	150

Remarks:
No groundwater encountered during drilling.
Backfilled with bentonite, concrete and bituminous material.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Location Name	M1-J23a-J25-EA-SB-193/4	Location Type	Emergency Area
Earthwork Type	Cutting	**Earthwork Modification**	King Sheet Pile Wall

Carriageway	Chainage	Marker Post Reference	National Grid Reference (centre point)
Southbound	193480 – 193390	193/4	447211E, 335436N

Description and Proposed Works
Modifications to existing Embankment slope (max. height of retention 1.7m)

Site Description		
The site is located on the southbound carriageway verge before Junction 25.		
Associated Earthworks	GDMS Reference(s)	Type
	22232	Cutting
Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1960s with Longmoor Lane to the South and B5010 Derby Road to the North. From the 1970s onward the carriageway in the current alignment we see today is present. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and absence of Aquifer for the superficial deposits at the site. The site is not with a groundwater Source Protection Zone.	
Geology and Groundwater		
Superficial Deposits	The BGS Geology Viewer depicts: No formation is found underlying the entire site extents.	
Bedrock	The BGS Geology Viewer depicts: Gunthorpe Member - Mudstone. Sedimentary bedrock formed during the Anisian period.	
Groundwater	No Groundwater encountered	

Upstream

Downstream

Source: AVIS
Date of Capture 24/03/2023

Figure 19-4 EA-SB-193/4

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Eploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1933S	Midpoint of EA	48.27 (OD)	10m	24/05/2023

Geotechnical Ground Model for Design **Verge Level: 48.27m OD**	**Material**	**Depth (mbgl)**	**Elevation (m OD)**	**Notes**
	Made Ground-Granular	1.1	47.2	Ground model taken from BH1933S
	Gunthorpe member – Cohesive	2.4	45.9	
	Gunthorpe member – Cohesive	10	38.3	
	Groundwater notes: No Groundwater Encountered			

Design Parameters							
Moderately Conservative Values:							
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)	UCS (MPa)
Made Ground- Granular	19	-	0	30	-	6200	-
Gunthorpe member – Cohesive	19	130	0	27	26000	23400	-
Gunthorpe member – Cohesive	20	192	2	26	32000	28800	-

Design Section

Due to insufficient space due to verge widening with earthworks solution, King Sheet Pile wall of design retention height of 2m has been proposed at this location. Sections have been considered by integrating maximum corrosion rate of 0.012mm/year on the soil side and 0.017mm/year on the exposed side.

Contaminated Land Assessment	No contamination sources identified based on confirmatory ground investigation data

Location Specific Risks

ID6: Compressible/Collapsible ground hazard
ID13: Non-Coal mining Hazard

Report Extracts and References

GFR

5. Retaining Structures

Retaining structures were constructed at the locations where there was insufficient space for verge widening with an earthworks solution, due to the restrictions of the HE boundary, other infrastructure or on embankments crossing flood plains.

The types of retaining walls constructed on the scheme were conventional sheet pile and King Sheet Pile (KSP) walls, gabion walls and slab on edge walls.

5.1. Sheet pile and king sheet pile walls

Locations of sheet pile and KSP wall structures along with the as-built details are shown in Appendix B. The locations of construction phase design changes are summarised in Table 8 and Table 9. The sheet piling subcontractor was Sheet Piling (UK) Ltd.

5.1.1. Record of soil and groundwater conditions encountered

The encountered ground conditions were broadly as expected in the design as described in the GIR [1] and GDR [2]. No significant groundwater seepages were encountered in the temporary excavations or through the sheet pile walls.

5.1.2. Temporary works required

The piling works were carried out from temporary piling platforms designed and constructed by the contractor. Due to the size of the piling rigs, the width of the piling platforms in cuttings was in some cases greater than the available space in the traffic management. In these locations the piling platform was extended past the line of the sheet pile wall, in a temporary cutting, which was subsequently backfilled with Class 6N material with a geotextile drainage layer (Deckdrain) behind the sheet piles.

Exploratory Hole Log

STRATA GEOTECHNICS	Contract Name: M1 J23A-J25 NEAR		Client: BMJV			Borehole ID: BH1933S
	Contract Number: G230600	Date Started: 24/05/2023	Date Completed: 25/05/2023	Logged: JN/ASH	Checked: JB	Status: FINAL / Sheet 1 of 1
Dynamic Sample Drilling Log	Easting: 447207.5	Northing: 335441.9	Ground Level: 48.27m (OD)	Plant Used: Comacchio 305	Print Date: 04/09/2023	Scale: 1:50

Weather: Fine	Rig Crew: Adrian Foulstone	Termination: Scheduled Depth	SPT Hammer: AR935 Energy Ratio: 63.5%

Samples & In Situ Testing

Depth	Sample	Test Result	TCR	SCR	RQD	FI/If
0.00 - 1.20	CC1					
0.40	ES11					
1.00	ES13					
1.20 - 1.30	B12	SPT(S) 1.20m, N=26 (1,5/6,6,7,7)				
1.20 - 1.30	B`1					
1.20 - 1.30	D15					
1.20 - 1.65	D2					
1.30 - 1.40	ES14					
1.70 - 1.90	ES16					
1.90 - 2.00	D17					
2.20 - 2.65	D3	SPT(S) 2.20m, N=28 (3,5/6,8,7,7)				
2.80 - 2.90	D18					
3.10 - 3.20	CSS19					
3.20 - 3.65	D4	SPT(S) 3.20m, N=34 (3,6/8,8,9,9)				
4.00 - 4.10	CSS20					
4.10 - 4.20	D21					
4.20 - 4.65	D5	SPT(S) 4.20m, N=42 (2,8/9,10,10,13)				
5.00 - 5.10	CSS22					
5.10 - 5.20	D23					
5.20 - 5.65	D6	SPT(S) 5.20m, N=32 (3,3/7,7,8,10)				
6.00 - 6.10	CSS24					
6.10 - 6.20	D25					
6.20 - 6.65	D7	SPT(S) 6.20m, N=37 (1,7/8,10,10,9)				
7.00 - 7.10	CSS26					
7.10 - 7.20	D27					
7.20 - 7.60	D8	SPT(S) 7.20m, 50 (1,1/50 for 245mm)				
8.20 - 8.65	D9	SPT(S) 8.20m, N=49 (5,9/10,12,12,15)				
9.20 - 9.65	D10	SPT(S) 9.20m, N=48 (3,10/10,10,13,15)				

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Strata Description
48.12	0.15	MADE GROUND: Black Bituminous Material. [MADE GROUND]
47.87	0.40	MADE GROUND: Concrete bound material. [MADE GROUND]
47.17	(0.70) 1.10	MADE GROUND: Greyish brown slightly sandy GRAVEL, with low cobble content. Sand is fine to coarse. Gravel is sub-angular to rounded fine to coarse quartz and quartzite. Cobbles are angular to sub-angular of quartz. [MADE GROUND]
47.07	1.20	
46.57	(0.50) 1.70	Firm reddish brown slightly sandy very gravelly CLAY. Sand is fine to coarse. Gravel is sub-angular to sub-rounded fine to coarse of quartz and quartzite. [Gunthorpe Member]
45.87	(0.70) 2.40	Firm to stiff reddish brown sandy very gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone and quartz. [Gunthorpe Member]
		Stiff reddish brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone. [Gunthorpe Member]
		3.00 - 3.10 Firm grey
41.07	(4.80) 7.20	Very stiff reddish brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone. [Gunthorpe Member]
38.27	(2.80) 10.00	Firm to stiff reddish brown mottled bluish grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is sub-angular to angular fine to coarse of mudstone. [Gunthorpe Member]
		End of Borehole at 10.00m

Groundwater: Water Strike | Backfill Installation

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
24-05-23	20:00			
24-05-23	23:55	7.20	1.50	3.00
25-05-23	20:00	7.20	1.50	2.00
25-05-23	23:55	0.00		

Flush Return Information

Top	Base	Min %	Max %	Type	Colour

Remarks:
No groundwater encountered during drilling.
Backfilled with bentonite, concrete and bituminous material.

Water Strike

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Borehole Diameter

Depth (m)	Dia (mm)
3.20	101
10.00	87

Casing Diameter

Depth (m)	Dia (mm)
1.50	152

Coring Information

Top (m)	Base (m)	Dia (mm)	Barrel Type

Fracture Index (FI) - Fractures per meter. Fracture Spacing (If) - reported in mm as Min, Average and Max values. TCR, SCR and RQD reported as %. Hand vane (HV) reports Undrained Shear Strength (Su). Pocket penetrometer (PP) reports Unconfined Compressive Strength (UCS).

Location Name	M1-J23a-J25-EA-SB-187/7	**Location Type**	Emergency Area
Earthwork Type	Embankment	**Earthwork Modification**	Regrade

Carriageway	**Chainage**	**Marker Post Reference**	**National Grid Reference (centre point)**
Southbound	187760 – 187650	187/7	446911E, 329995N

Description and Proposed Works
Modifications to existing Embankment slope (max. height of retention 0.91m)

Site Description		
The site is located on the southbound carriageway verge, after Junction 24a.		
Associated Earthworks	GDMS Reference(s)	Type
	24555	Embankment
Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1950s. From the 1970s onward the carriageway in the current alignment we see today is present. The site area is in the designate flood zone 2 and 3 and potential for Groundwater flooding situated below Ground Level. The area falls in recorded flood lines due to exceeding channel capacity. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and Secondary – A Aquifer for the superficial deposits. The site is not with a groundwater Source Protection Zone.	
Geology and Groundwater		
Superficial Deposits	The BGS Geology Viewer depicts: Hemington Member - Silt and Gravel. Superficial deposit formed during the Pre-Quaternary period underlying the entire site.	
Bedrock	The BGS Geology Viewer depicts: Edwalton Member - Mudstone. Sedimentary bedrock formed during the Carnian period.	
Groundwater	No Groundwater encountered	

Upstream

Downstream

Source: AVIS
Date of Capture 24/03/2023

Figure 19-5 EA-SB-187/7

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Exploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1877S	Midpoint of EA	33.52 (OD)	10m	14/06/2023

Geotechnical Ground Model for Design Verge Level: 33.52m OD	Material	Depth (mbgl)	Elevation (m OD)	Notes
	Made Ground-Granular	1.2	32.3	Ground model taken from BH1877S
	Hemington Member – Cohesive	3.0	30.5	
	Hemington Member – Granular	10	23.5	
	Groundwater notes: No Groundwater Encountered			

Design Parameters							
Moderately Conservative Values:							
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)	UCS (MPa)
Made Ground- Granular	19	-	0	30	-	5000	-
Hemington Member – Cohesive	19	100	0	27	19000	17100	-
Hemington Member – Granular	19.5	-	1	30	-	25000	-

Design Section

Minor Regrade of 1V:2H slope has been proposed at this location and slope stability analysis has also been performed. The Slope has been found satisfactory for the proposed conservative ground model.

Contaminated Land Assessment	Potential landfill gas risk associated with Hemington Gravel Pit historical landfill. Method statements and risk assessments for exposure to gases, including mitigation measures, to be undertaken by groundworks and/or piling contractor

Location Specific Risks

ID6: Compressible/Collapsible ground hazard
ID13: Non-Coal mining Hazard
ID24: Excavated arisings could be classed as non-hazardous or hazardous waste

Report Extracts and References

GFR

4.3. Details of any problems encountered

No particular embankment construction problems were encountered.

4.4. Instability problems and unusual ground conditions

The materials encountered during construction were broadly similar to the reported ground conditions in the GIR [1]/ GDR [2]. All excavated material was classed as 2A and 2B (unsuitable for embankment widening) and removed from site. No ground instability problems were encountered during the construction.

4.5. Ground water conditions and problems and drainage measures to overcome them

No major drainage or groundwater problems were encountered during widening of the embankments.

4.6. Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

No contamination or hazardous materials were encountered at cutting locations across the scheme.

4.7. Foundation treatment, including drainage measures and treatment of soft areas

No areas of soft foundations were encountered, as the embankment widening did not generally extend into the flood plain areas. New fill was benched into the existing embankment to maintain the integrity of the new slope.

4.8. Settlement of foundation and fill material

The works comprised only localised small scale widening of existing embankments. No new embankments that would be subject to foundation or internal settlement were constructed as part of the works.

Exploratory Hole Log

STRATA GEOTECHNICS	Contract Name: M1 J23A-J25 NEAR		Client: BMJV			Borehole ID: BH1877S
	Contract Number: G230600	Date Started: 14/06/2023	Date Completed: 15/06/2023	Logged: PB/ASH	Checked: JB	Status: FINAL
						Sheet 1 of 1
Dynamic Sample Drilling Log	Easting: 446908.7	Northing: 329983.3	Ground Level: 33.52m (OD)	Plant Used: Comacchio 305	Print Date: 04/09/2023	Scale: 1:50
Weather: Fine	Rig Crew: Adrian Foulstone	Termination: Scheduled Depth		SPT Hammer: AR935 Energy Ratio: 63.5%		

Samples & In Situ Testing							Strata Details				Groundwater	
Depth	Sample	Test Result	TCR	SCR	RQD	FI/If	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill Installation
0.00 - 1.00	CC1						33.32	0.20		MADE GROUND: Bituminous material. [MADE GROUND]		
								(1.00)		MADE GROUND: Concrete bound material. [MADE GROUND]		
		SPT(C) 1.00m, 50 (2,16/50 for 90mm)					32.32	1.20				
1.50 - 1.60	D2									Very stiff dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of sandstone and mudstone.		
1.80 - 2.00	ES3							(1.30)		[Hemmington Member]		
		SPT(C) 2.00m, 50 (9,13/50 for 150mm)										
2.50 - 2.60	D4						31.02	2.50		Firm to stiff reddish brown sandy gravelly CLAY. Gravel is angular fine to coarse of sandstone and mudstone.		
2.70 - 3.00	ES5							(0.50)		[Hemmington Member]		
		SPT(C) 3.00m, 50 (25 for 75mm/50 for 75mm)					30.52	3.00		Gravels with boulders [Driller's Description] [Hemmington Member]		
		SPT(C) 4.00m, 50 (25 for 145mm/50 for 150mm)										
		SPT(C) 5.00m, 50 (25 for 75mm/50 for 80mm)										
		SPT(C) 6.00m, 50 (25 for 70mm/50 for 75mm)										
								(7.00)				
		SPT(C) 7.00m, 50 (25 for 115mm/50 for 65mm)										
		SPT(C) 8.00m, 50 (25 for 75mm/50 for 75mm)										
		SPT(C) 9.00m, 50 (25 for 75mm/50 for 75mm)										
							23.52	10.00		End of Borehole at 10.00m		

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
14-06-23	20:00			
14-06-23	23:55	5.00	1.00	4.00
15-06-23	20:00	5.00	1.00	4.00
15-06-23	23:55	0.00		

Flush Return Information

Top	Base	Min %	Max %	Type	Colour

Remarks:
No groundwater encountered during drilling.
Backfilled with bentonite, concrete and bituminous material.
Rotary Open Hole from 3.00m BGL to 10m BGL due to very dense strata.

Water Strike

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Borehole Diameter

Depth (m)	Dia (mm)
2.00	101
10.00	87

Casing Diameter

Depth (m)	Dia (mm)
1.00	152
10.00	101

Coring Information

Top (m)	Base (m)	Dia (mm)	Barrel Type

Location Name	M1-J23a-J25-EA-SB-185/1	**Location Type**	Emergency Area
Earthwork Type	Cutting	**Earthwork Modification**	Regrade

Carriageway	**Chainage**	**Marker Post Reference**	**National Grid Reference (centre point)**
Southbound	184970 – 185070	185/1	447559E, 327405N

Description and Proposed Works
Modifications to existing Embankment slope (max. height of retention 1.26m)

Site Description		
The site is located on the southbound carriageway verge, just before Junction 24.		
Associated Earthworks	GDMS Reference(s)	Type
	NA	Cutting
Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1960s with Derby road to the North and Ashby road to the south. From the 1970s onward the carriageway in the current alignment we see today is present. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and Secondary – A Aquifer for the superficial deposits. The site is not with a groundwater Source Protection Zone.	
Geology and Groundwater		
Superficial Deposits	The BGS Geology Viewer depicts: Egginton Common Sand and Gravel Member - Sand and Gravel. Superficial deposit formed during the Mid Pleistocene period underlying the entire site.	
Bedrock	The BGS Geology Viewer depicts: Edwalton Member - Mudstone. Sedimentary bedrock formed during the Carnian period.	
Groundwater	No Groundwater encountered	

Upstream

Downstream

Source: AVIS
Date of Capture 24/03/2023

Figure 19-6 EA-SB-185

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Exploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1851S	Midpoint of EA	39.54 (OD)	9.78m	28/06/2023

Geotechnical Ground Model for Design **Verge Level: 33.52m OD**	**Material**	**Depth (mbgl)**	**Elevation (m OD)**	**Notes**
	Made Ground- Granular	1.3	38.2	Ground model taken from BH1851S
	Edwalton Member – Cohesive	1.7	37.8	
	Edwalton Member – Cohesive	7.0	32.5	
	Edwalton Member – Cohesive	9.8	29.8	
	Groundwater notes: No Groundwater Encountered			

Design Parameters							
Moderately Conservative Values:							
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)	UCS (MPa)
Made Ground- Granular	19	-	0	30	-	6200	-
Edwalton Member – Cohesive	18	50	0	27	7800	6200	-
Edwalton Member – Cohesive	19	86	1	26	19000	17100	-
Edwalton Member – Cohesive	20	167	2	27	37000	33300	-

Design Section

Minor Regrade of 1V:2H slope has been proposed at this location and slope stability analysis has also been performed. The Slope has been found satisfactory for the proposed conservative ground model.

Contaminated Land Assessment	No contamination sources identified based on confirmatory ground investigation data

Location Specific Risks

ID6: Compressible/Collapsible ground hazard
ID13: Non-Coal mining Hazard
ID24: Excavated arisings could be classed as non-hazardous or hazardous waste.

Report Extracts and References

GFR

4.3. Details of any problems encountered

No particular embankment construction problems were encountered.

4.4. Instability problems and unusual ground conditions

The materials encountered during construction were broadly similar to the reported ground conditions in the GIR [1]/ GDR [2]. All excavated material was classed as 2A and 2B (unsuitable for embankment widening) and removed from site. No ground instability problems were encountered during the construction.

4.5. Ground water conditions and problems and drainage measures to overcome them

No major drainage or groundwater problems were encountered during widening of the embankments.

4.6. Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

No contamination or hazardous materials were encountered at cutting locations across the scheme.

4.7. Foundation treatment, including drainage measures and treatment of soft areas

No areas of soft foundations were encountered, as the embankment widening did not generally extend into the flood plain areas. New fill was benched into the existing embankment to maintain the integrity of the new slope.

4.8. Settlement of foundation and fill material

The works comprised only localised small scale widening of existing embankments. No new embankments that would be subject to foundation or internal settlement were constructed as part of the works.

Exploratory Hole Log

STRATA GEOTECHNICS	Contract Name: M1 J23A-J25 NEAR		Client: BMJV			Borehole ID: BH1851S
	Contract Number: G230600	Date Started: 28/06/2023	Date Completed: 30/06/2023	Logged: PB	Checked: JB	Status: FINAL
						Sheet 1 of 1
Dynamic Sample Drilling Log	Easting: 447553.8	Northing: 327409.2	Ground Level: 39.54m (OD)	Plant Used: Comacchio 305	Print Date: 04/09/2023	Scale: 1:50
Weather: Showers+Fine	Rig Crew: Ian Mountain	Termination: Refusal		SPT Hammer: AR666 Energy Ratio: 65%		

Samples & In Situ Testing

Depth	Sample	Test Result	TCR	SCR	RQD	FI/If
0.00 - 0.80	CC6					
		SPT(C) 1.20m, N=31 (8,8/9,7,7,8)				
1.20 - 2.00	L11					
2.00 - 2.45	D1	SPT(S) 2.00m, N=19 (5,5/4,4,6,5)				
2.00 - 2.45	ES20					
2.00 - 3.00	L12					
3.00 - 3.45	D2	SPT(S) 3.00m, N=20 (3,3/4,4,6,6)				
3.00 - 4.00	L13					
4.00 - 4.45	D3	SPT(S) 4.00m, N=21 (4,4/4,4,6,7)				
4.00 - 5.00	L14					
5.00 - 5.45	D4	SPT(S) 5.00m, N=24 (4,4/4,5,7,8)				
5.00 - 6.00	L15					
6.00 - 6.45	D5	SPT(S) 6.00m, N=24 (4,5/5,5,7,7)				
6.00 - 7.00	L16					
7.00 - 7.45	D7	SPT(S) 7.00m, N=37 (10,10/10,10,8,9)				
7.00 - 8.00	B17					
8.00 - 8.45	D8	SPT(S) 8.00m, N=42 (9,9/11,10,10,11)				
8.00 - 9.00	B18					
9.00 - 9.22	D9	SPT(S) 9.00m, 50 (25 for 76mm/50 for 144mm)				
9.00 - 9.60	B19					
9.60 - 9.78	D10	SPT(S) 9.60m, 50 (25 for 79mm/50 for 100mm)				

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description
39.41	0.13		MADE GROUND: Bituminous material. [MADE GROUND]
	(1.17)		MADE GROUND: Concrete bound material. [MADE GROUND]
38.24	1.30 (0.40)		Soft to firm orangish brown slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is fine to coarse angular to sub-rounded quartz, chert and rare sandstone. [Edwalton Member]
37.84	1.70 (2.50)		Firm orangish brown mottled greyish brown sandy CLAY. Sand is fine to medium. [Edwalton Member]
35.34	4.20 (0.70)		Firm greyish brown very sandy friable CLAY. Sand is fine to medium. [Edwalton Member]
34.64	4.90 (4.88)		Stiff orangish brown mottled greyish brown sandy friable CLAY. Sand is fine to medium. [Edwalton Member]
29.76	9.78		End of Borehole at 9.78m

Groundwater: Water Strike | Backfill/Installation

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
28-06-23	20:00			
28-06-23	23:55	7.00	3.00	
29-06-23	20:00	7.00	3.00	
29-06-23	23:55	9.78	3.00	

Flush Return Information

Top	Base	Min %	Max %	Type	Colour

Remarks:
No groundwater encountered during drilling.
Backfilled with bentonite, concrete and bituminous material.

Water Strike

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Borehole Diameter

Depth (m)	Dia (mm)
9.78	101

Casing Diameter

Depth (m)	Dia (mm)

Coring Information

Top (m)	Base (m)	Dia (mm)	Barrel Type

Location Name	EA-E3-A2-190/5	**Location Type**	MS4 Gantry
Earthwork Type	Embankment	**Earthwork Modification**	Helical Piles

Carriageway	**Chainage**	**Marker Post Reference**	**National Grid Reference (centre point)**
Southbound	190475 – 190495	190/5	446884E, 332633N

Description and Proposed Works
Modifications on existing Embankment

Site Description		
The site is located on the southbound carriageway verge, just before Junction 24.		
Associated Earthworks	GDMS Reference(s)	Type
	24388	Embankment

Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1960s with Wilsthorpe Lane-Derby road to the North and Railway Line to the south. From the 1970s onward the carriageway in the current alignment we see today is present. Potential for Groundwater Flooding of Property Situated Below Ground Level at site. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and Secondary – A Aquifer for the superficial deposits. The site is not with a groundwater Source Protection Zone.
Geology and Groundwater	
Superficial Deposits	The BGS Geology Viewer depicts: Hemington Member - Silt and Gravel - Sand and Gravel. Superficial deposit formed during the Mid Pleistocene period underlying the entire site.
Bedrock	The BGS Geology Viewer depicts: Edwalton Member - Mudstone. Sedimentary bedrock formed during the Carnian period.
Groundwater	No Groundwater encountered

Upstream

Downstream

Source: AVIS
Date of Capture 24/03/2023

Figure 19-7 EA-E3-A2-190/4

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Exploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1904N	Midpoint of Gantry	39.20 (OD)	20m	05/05/2023

Geotechnical Ground Model for Design Verge Level: 33.52m OD	Material	Depth (mbgl)	Elevation (m OD)	Notes
	Made Ground- Granular	0.9	38.3	Ground model taken from BH1904N
	Hemington Member- Granular	1.2	38.0	
	Edwalton Member – Cohesive	4.0	35.2	
	Edwalton Member – Cohesive	8.0	31.2	
	Edwalton Member – Cohesive	12.0	27.2	
	Edwalton Member – Granular	14.9	24.4	
	Edwalton Member – Sandstone	20	19.2	
	Groundwater notes: No Groundwater Encountered			

Design Parameters							
Moderately Conservative Values:							
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)	UCS (MPa)
Made Ground- Granular	19	-	0	30	-	6200	-
Hemington Member- Granular	19	-	0	30	-	10000	-
Edwalton Member – Cohesive	19	75	0	26	15000	13500	-
Edwalton Member – Cohesive	19	125	0	26	25000	22500	-
Edwalton Member – Cohesive	19	150	2	26	50000	45000	-
Edwalton Member – Granular	20	-	0	33	-	40000	-
Edwalton Member – Sandstone	21	-	-	-	-	50000	1.5

Design Section
Refer to Annex D

Contaminated Land Assessment	No contamination sources identified based on confirmatory ground investigation data

Location Specific Risks
ID6: Compressible/Collapsible ground hazard

Report Extracts and References
GFR

4.3. Details of any problems encountered

No particular embankment construction problems were encountered.

4.4. Instability problems and unusual ground conditions

The materials encountered during construction were broadly similar to the reported ground conditions in the GIR [1]/ GDR [2]. All excavated material was classed as 2A and 2B (unsuitable for embankment widening) and removed from site. No ground instability problems were encountered during the construction.

4.5. Ground water conditions and problems and drainage measures to overcome them

No major drainage or groundwater problems were encountered during widening of the embankments.

4.6. Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

No contamination or hazardous materials were encountered at cutting locations across the scheme.

4.7. Foundation treatment, including drainage measures and treatment of soft areas

No areas of soft foundations were encountered, as the embankment widening did not generally extend into the flood plain areas. New fill was benched into the existing embankment to maintain the integrity of the new slope.

4.8. Settlement of foundation and fill material

The works comprised only localised small scale widening of existing embankments. No new embankments that would be subject to foundation or internal settlement were constructed as part of the works.

Exploratory Hole Log

STRATA GEOTECHNICS

Contract Name: M1 J23A-J25 NEAR			Client: BMJV			Borehole ID: BH1904N
Contract Number: G230600	Date Started: 02/05/2023	Date Completed: 11/05/2023	Logged: PB/ASH	Checked: JB	Status: FINAL	Sheet 1 of 3
Dynamic Sample Borehole Log	Easting: 446863.9	Northing: 332589.3	Ground Level: 39.20m (OD)	Plant Used: Comacchio 305	Print Date: 04/09/2023	Scale: 1:50
Weather: Fine+Showers	Rig Crew: Adrian Foulstone	Termination: Scheduled Depth		SPT Hammer: AR935 Energy Ratio: 63.5%		

Samples & In Situ Testing

Depth	Sample ID	Test Result
0.00 - 0.60	CC1	
0.60	ES19	
1.00	ES20	
1.00 - 1.10	B21	SPT(S) 1.20m, N=25 (3,13/10,7,4,4)
2.00 - 2.45	D2	SPT(S) 2.00m, N=15 (1,3/3,3,3,6)
3.00 - 3.45	D3	SPT(S) 3.00m, N=17 (2,2/4,4,5,4)
4.00 - 4.45	D4	SPT(S) 4.00m, N=25 (3,6/5,5,5,10)
5.00 - 5.45	D5	SPT(S) 5.00m, N=25 (4,3/5,5,7,8)
6.00 - 6.45	D6	SPT(S) 6.00m, N=28 (3,4/6,7,7,8)
7.00 - 7.45	D7	SPT(S) 7.00m, N=30 (2,6/6,7,7,10)
8.00 - 8.40	D8	Recovery = 88%
8.00	C9	50(12,2/50 for 245mm)
8.00 - 9.50		TCR 33, SCR 20, RQD 0
9.50		N=49 (1,7/9,12,13,15)

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Strata Description
39.05	0.15	MADE GROUND: Bituminous material. [MADE GROUND]
38.60	(0.45) 0.60	MADE GROUND: Concrete. [MADE GROUND]
38.30	(0.30) 0.90	MADE GROUND: Type 1. [MADE GROUND]
38.00	(0.30) 1.20	Reddish brown clayey sandy GRAVEL, with medium cobble content. Sand is fine to coarse. Gravel is sub-angular to rounded fine to coarse mudstone. Cobbles are sub-angular to rounded of mudstone. [Hemmington Member]
31.70	(6.30) 7.50	Very stiff reddish brown mottled grey slightly gravelly silty sandy CLAY. Gravel is angular fine to coarse of mudstone. [Edwalton Member] 4.00 - 4.40: A2C1; 5.00 - 6.35: A2C1; 7.00 - 7.50: A2C1
31.20	(0.50) 8.00	Very stiff reddish brown clayey sandy GRAVEL. Sand is fine to coarse. Gravel is sub-angular to angular fine to coarse of mudstone. [Edwalton Member]
30.00	(1.20) 9.20	Very soft reddish brown mottled grey slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone. [Edwalton Member]
29.70	(0.30) 9.50	Very stiff reddish brown mottled grey slightly sandy slightly gravelly CLAY. Gravel is angular fine to coarse of mudstone. [Edwalton Member]
		Very stiff dark brown sandy gravelly CLAY, with low cobble content. Sand is fine to coarse. Gravel is sub-rounded to rounded fine to coarse quartz. Cobbles are sub-rounded of quartz. [Edwalton Member]

Progress by Time

Date	Time	Depth	Casing	Water
02-05-23	20:30			
02-05-23	23:55	0.00		
03-05-23	20:00	0.00		
03-05-23	23:55	6.00	1.20	2.00
04-05-23	20:30	6.00	1.20	2.00
04-05-23	23:55	8.00	6.00	2.00
09-05-23	20:00	8.00	6.00	2.00
09-05-23	23:55	11.00	6.00	5.00
10-05-23	20:00	11.00	6.00	4.00
10-05-23	23:55	17.00	17.00	0.30
11-05-23	20:00	17.00	17.00	3.00

Borehole Diameter

Depth	Diameter
4.00	101
6.00	87
11.00	146
20.00	146

Casing Diameter

Depth	Diameter
1.20	152
17.00	146

Remarks:
No groundwater encountered during drilling.
Backfilled with bentonite, concrete and bituminous material.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Annex B Geotechnical Datasheets – Minor Structures

Structure Name	CCTV-1	**Structure Type**	Minor Structure
Earthwork Type	Cutting	**Earthwork Modification**	-

Carriageway	**Chainage**	**Marker Post Reference**	**National Grid Reference (centre point)**
Southbound	193364	193/3B+43	447212E, 335401N
The centre of the minor structure is 1.23 m from the verge.			

Description and Proposed Works
Plunge pile foundation

Site Description		
The site is located on the southbound carriageway verge before Junction 25.		
Associated Earthworks	GDMS Reference(s)	Type
	22232	Cutting
Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1960s with Longmoor Lane to the South and B5010 Derby Road to the North. From the 1970s onward the carriageway in the current alignment we see today is present. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and absence of Aquifer for the superficial deposits at the site. The site is not with a groundwater Source Protection Zone.	
Geology and Groundwater		
Superficial Deposits	The BGS Geology Viewer depicts: No formation is found underlying the entire site extents.	
Bedrock	The BGS Geology Viewer depicts: Gunthorpe Member - Mudstone. Sedimentary bedrock formed during the Anisian period.	
Groundwater	No Groundwater encountered	

Upstream   Downstream

Source: AVIS
Date of Capture 24/03/2023

Figure 19-8: Street View of CCTV-1 earthwork location

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Exploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1933S	Midpoint of EA	48.27 (OD)	10m	24/05/2023

Geotechnical Ground Model for Design Verge Level: 48.27m OD	Material	Depth (mbgl)	Elevation (m OD)	Notes
	Made Ground- Granular	1.1	47.2	Ground model taken from BH1933S
	Gunthorpe member – Cohesive	2.4	45.9	
	Gunthorpe member – Cohesive	10	38.3	
	Groundwater notes: No Groundwater Encountered			

Design Parameters							
Moderately Conservative Values:							
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)	UCS (MPa)
Made Ground- Granular	19	-	0	30	-	6200	-
Gunthorpe member – Cohesive	19	130	0	27	26000	23400	-
Gunthorpe member – Cohesive	20	192	2	26	32000	28800	-

Design Section

The CCTV-1 structure is supported on plunge piles of 457mm dia CHS pile planted inside 600mm dia concrete pile of depth 3.9m.

Plunged column Embedment length (m)	4.0m
Anticipated Elastic Deflections	5.1 mm at top of pile 24.85 mm at the top of CCTV mast
Design Utilisation for CD354 planting depth	48.8%

Contaminated Land Assessment	No contamination sources identified based on confirmatory ground investigation data

Location Specific Risks
ID6: Compressible/Collapsible ground hazard
ID13: Non-Coal mining Hazard

Report Extracts and References
GFR

5. Retaining Structures

Retaining structures were constructed at the locations where there was insufficient space for verge widening with an earthworks solution, due to the restrictions of the HE boundary, other infrastructure or on embankments crossing flood plains.

The types of retaining walls constructed on the scheme were conventional sheet pile and King Sheet Pile (KSP) walls, gabion walls and slab on edge walls.

5.1. Sheet pile and king sheet pile walls

Locations of sheet pile and KSP wall structures along with the as-built details are shown in Appendix B. The locations of construction phase design changes are summarised in Table 8 and Table 9. The sheet piling subcontractor was Sheet Piling (UK) Ltd.

5.1.1. Record of soil and groundwater conditions encountered

The encountered ground conditions were broadly as expected in the design as described in the GIR [1] and GDR [2]. No significant groundwater seepages were encountered in the temporary excavations or through the sheet pile walls.

5.1.2. Temporary works required

The piling works were carried out from temporary piling platforms designed and constructed by the contractor. Due to the size of the piling rigs, the width of the piling platforms in cuttings was in some cases greater than the available space in the traffic management. In these locations the piling platform was extended past the line of the sheet pile wall, in a temporary cutting, which was subsequently backfilled with Class 6N material with a geotextile drainage layer (Deckdrain) behind the sheet piles.

Exploratory Hole Log

STRATA GEOTECHNICS

Dynamic Sample Drilling Log

Contract Name:	Client:	Borehole ID:
M1 J23A-J25 NEAR	BMJV	BH1933S

Contract Number:	Date Started:	Date Completed:	Logged:	Checked:	Status:	Sheet 1 of 1
G230600	24/05/2023	25/05/2023	JN/ASH	JB	FINAL	

Easting:	Northing:	Ground Level:	Plant Used:	Print Date:	Scale:
447207.5	335441.9	48.27m (OD)	Comacchio 305	04/09/2023	1:50

Weather: Fine | Rig Crew: Adrian Foulstone | Termination: Scheduled Depth | SPT Hammer: AR935 Energy Ratio: 63.5%

Samples & In Situ Testing

Depth	Sample	Test Result	TCR	SCR	RQD	FI/If
0.00 - 1.20	CC1					
0.40	ES11					
1.00	ES13					
1.20 - 1.30	B12	SPT(S) 1.20m, N=26 (1,5/6,6,7,7)				
1.20 - 1.30	B11					
1.20 - 1.30	D15					
1.20 - 1.65	D2					
1.30 - 1.40	ES14					
1.70 - 1.90	ES16					
1.90 - 2.00	D17					
2.20 - 2.65	D3	SPT(S) 2.20m, N=28 (3,5/6,8,7,7)				
2.80 - 2.90	D18					
3.10 - 3.20	CSS19					
3.20 - 3.65	D4	SPT(S) 3.20m, N=34 (3,6/8,8,9,9)				
4.00 - 4.10	CSS20					
4.10 - 4.20	D21					
4.20 - 4.65	D5	SPT(S) 4.20m, N=42 (2,8/9,10,10,13)				
5.00 - 5.10	CSS22					
5.10 - 5.20	D23					
5.20 - 5.65	D6	SPT(S) 5.20m, N=32 (3,3/7,7,8,10)				
6.00 - 6.10	CSS24					
6.10 - 6.20	D25					
6.20 - 6.65	D7	SPT(S) 6.20m, N=37 (1,7/8,10,10,9)				
7.00 - 7.10	CSS26					
7.10 - 7.20	D27					
7.20 - 7.60	D8	SPT(S) 7.20m, 50 (1,1/50 for 245mm)				
8.20 - 8.65	D9	SPT(S) 8.20m, N=49 (5,9/10,12,12,15)				
9.20 - 9.65	D10	SPT(S) 9.20m, N=48 (3,10/10,10,13,15)				

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Strata Description
48.12	0.15	MADE GROUND: Black Bituminous Material. [MADE GROUND]
47.87	0.40	MADE GROUND: Concrete bound material. [MADE GROUND]
47.17	1.10 (0.70)	MADE GROUND: Greyish brown slightly sandy GRAVEL, with low cobble content. Sand is fine to coarse. Gravel is sub-angular to rounded fine to coarse quartz and quartzite. Cobbles are angular to sub-angular of quartz. [MADE GROUND]
47.07	1.20	Firm reddish brown slightly sandy very gravelly CLAY. Sand is fine to coarse. Gravel is sub-angular to sub-rounded fine to coarse of quartz and quartzite. [Gunthorpe Member]
46.57	1.70 (0.50)	Firm to stiff reddish brown sandy very gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone and quartz. [Gunthorpe Member]
45.87	2.40 (0.70)	Stiff reddish brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone. [Gunthorpe Member] 3.00 - 3.10: Firm grey
	(4.80)	Very stiff reddish brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone. [Gunthorpe Member]
41.07	7.20	Firm to stiff reddish brown mottled bluish grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is sub-angular to angular fine to coarse of mudstone. [Gunthorpe Member]
38.27	10.00 (2.80)	End of Borehole at 10.00m

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
24-05-23	20:00			
24-05-23	23:55	7.20	1.50	3.00
25-05-23	20:00	7.20	1.50	2.00
25-05-23	23:55	0.00		

Flush Return Information

Top	Base	Min %	Max %	Type	Colour

Remarks:
No groundwater encountered during drilling.
Backfilled with bentonite, concrete and bituminous material.

Water Strike

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Borehole Diameter

Depth (m)	Dia (mm)
3.20	101
10.00	87

Casing Diameter

Depth (m)	Dia (mm)
1.50	152

Coring Information

Top (m)	Base (m)	Dia (mm)	Barrel Type

Structure Name	SVD-1	**Structure Type**	Minor Structure
Earthwork Type	Embankment	**Earthwork Modification**	-

Carriageway	**Chainage**	**Marker Post Reference**	**National Grid Reference (centre point)**
Northbound	190188	190/2A+34	446717E, 332368N
The centre of the minor structure is 0.8m from the verge.			

Description and Proposed Works
Pad foundation

Site Description		
The site is located on the northbound carriageway verge, midway between Junction 24a and Junction 25.		
Associated Earthworks	GDMS Reference(s)	Type
	24420	Embankment
Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1960s with Draycot road to the South and Railway Line to the North. From the 1970s onward the carriageway in the current alignment we see today is present. The site area is near to the designate flood zones 2 and 3 and potential for Groundwater flooding situated below Ground Level. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and Secondary – A Aquifer for the superficial deposits. The site is not with a groundwater Source Protection Zone.	
Geology and Groundwater		
Superficial Deposits	The BGS Geology Viewer depicts: Hemington Member - Silt and Gravel. Superficial deposit formed during the Pre-Quaternary period underlying the entire site.	
Bedrock	The BGS Geology Viewer depicts: Edwalton Member - Mudstone. Sedimentary bedrock formed during the Carnian period.	
Groundwater	No Groundwater encountered	

Upstream

Downstream

Source: AVIS
Date of Capture 24/03/2023

Figure 19-9: Street View of SVD 1 earthwork location

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Exploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1902N	Midpoint of EA	40.40 (OD)	10m	30/05/2023

Geotechnical Ground Model for Design **Verge Level: 33.71m OD**	**Material**	**Depth (mbgl)**	**Elevation (m OD)**	**Notes**
	Made Ground- Granular	1.2	39.2	Ground model taken from BH1902N
	Hemington Member – Granular	2.8	37.6	
	Edwalton Member – Cohesive	5.0	35.4	
	Edwalton Member – Cohesive	10.0	30.4	
	Groundwater notes: No Groundwater Encountered			

Design Parameters						
Moderately Conservative Values:						
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)
Made Ground - Granular	19	-	0	30	-	5000
Hemington Member – Granular	19	-	0	30	-	10000
Edwalton Member – Cohesive	19	90	2	26	18000	16200
Edwalton Member – Cohesive	19.5	165	2	27	33000	29700

Design Section
Pad foundation of size 0.9m x 0.9m and thickness of 0.6m is proposed.

Case	**Over Design Factor (ODF)**		
	Overturning	**Sliding**	**Bearing Resistance**
DA1C1	**4**	**21**	**8**
DA1C2	**3**	**14**	**5**
SLS	**4**	**23**	**12**

Contaminated Land Assessment	No contamination sources identified based on confirmatory ground investigation data

Location Specific Risks
ID6: Compressible/Collapsible ground hazard

Report Extracts and References
GFR

4.3. Details of any problems encountered

No particular embankment construction problems were encountered.

4.4. Instability problems and unusual ground conditions

The materials encountered during construction were broadly similar to the reported ground conditions in the GIR [1]/ GDR [2]. All excavated material was classed as 2A and 2B (unsuitable for embankment widening) and removed from site. No ground instability problems were encountered during the construction.

4.5. Ground water conditions and problems and drainage measures to overcome them

No major drainage or groundwater problems were encountered during widening of the embankments.

4.6. Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

No contamination or hazardous materials were encountered at cutting locations across the scheme.

4.7. Foundation treatment, including drainage measures and treatment of soft areas

No areas of soft foundations were encountered, as the embankment widening did not generally extend into the flood plain areas. New fill was benched into the existing embankment to maintain the integrity of the new slope.

4.8. Settlement of foundation and fill material

The works comprised only localised small scale widening of existing embankments. No new embankments that would be subject to foundation or internal settlement were constructed as part of the works.

Exploratory Hole Log

STRATA GEOTECHNICS

Contract Name: M1 J23A-J25 NEAR			Client: BMJV			Borehole ID: BH1902N
Contract Number: G230600	Date Started: 30/05/2023	Date Completed: 31/05/2023	Logged: JN/ASH	Checked: JB	Status: FINAL	Sheet 1 of 1
Dynamic Sample Drilling Log	Easting: 446689.2	Northing: 332306.1	Ground Level: 40.40m (OD)	Plant Used: Comacchio 305	Print Date: 04/09/2023	Scale: 1:50
Weather: Drizzle+Cloudy	Rig Crew: Adrian Foulstone	Termination: Scheduled Depth		SPT Hammer: AR935 Energy Ratio: 63.5%		

Samples & In Situ Testing

Depth	Sample	Test Result	TCR	SCR	RQD	FI/If
0.00 - 1.20	CC1					
1.00	ES11					
1.20 - 1.30	B12	SPT(S) 1.20m, N=11 (1,1/2,3,3,3)				
1.20 - 1.65	D2					
1.40 - 1.50	D13					
1.50 - 1.70	ES14					
2.20 - 2.65	D3	SPT(S) 2.20m, N=10 (2,1/1,2,3,4)				
2.50 - 2.70	ES15					
2.90 - 3.00	D16					
3.00 - 3.45	D4	SPT(S) 3.00m, N=18 (3,3/4,5,4,5)				
3.60 - 3.70	D17					
4.00 - 4.45	D5	SPT(S) 4.00m, N=24 (3,4/5,6,6,7)				
4.50 - 4.70	D18					
5.00 - 5.45	D6	SPT(S) 5.00m, N=25 (2,5/5,6,7,7)				
6.00 - 6.45	D7	SPT(S) 6.00m, N=35 (3,5/8,8,9,10)				
6.50 - 6.70	D19					
7.00 - 7.45	D8	SPT(S) 7.00m, N=33 (5,3/7,8,8,10)				
7.50 - 7.70	D20					
8.00 - 8.45	D9	SPT(S) 8.00m, N=37 (3,6/6,7,11,13)				
8.50 - 8.70	D21					
9.00 - 9.45	D10	SPT(S) 9.00m, N=45 (2,12/10,10,11,14)				
9.50 - 9.70	D22					

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Strata Description
40.15	0.25	MADE GROUND: Black Bituminous Material. [MADE GROUND]
39.80	0.60 (0.35)	MADE GROUND: Concrete bound material. [MADE GROUND]
39.20	1.20 (0.60)	MADE GROUND: Brown clayey sandy GRAVEL. Sand is fine to coarse. Gravel is sub-rounded to rounded fine to medium of quartz and quartzite. [MADE GROUND]
37.90	2.50 (1.30)	Medium dense reddish brown slightly clayey SAND and GRAVEL. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone. [Hemmington Member]
37.60	2.80 (0.30)	Loose dark brown slightly sandy angular fine to coarse GRAVEL of quartz and mudstone. Sand is fine to coarse. [Hemmington Member]
36.40	4.00 (1.20)	Stiff reddish brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone. [Edwalton Member]
36.20	4.20	Medium dense dark brown silty gravelly fine to coarse SAND. Gravel is angular fine to coarse of quartz and mudstone. [Edwalton Member]
30.40	10.00 (5.80)	Very stiff reddish brown mottled grey sandy gravelly CLAY. Gravel is angular fine to coarse of mudstone. [Edwalton Member] 8.00 - 9.00: Stiff to very stiff
		End of Borehole at 10.00m

Groundwater: Water Strike / Backfill Installation

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
30-05-23	20:00			
30-05-23	23:55	1.20	1.20	0.00
31-05-23	20:00	1.20	1.20	0.20
31-05-23	23:55	0.00		

Flush Return Information

Top	Base	Min %	Max %	Type	Colour

Remarks:
No groundwater encountered during drilling.
Backfilled with bentonite, concrete and bituminous material.

Water Strike

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Borehole Diameter

Depth (m)	Dia (mm)
3.00	101
10.00	87

Casing Diameter

Depth (m)	Dia (mm)
1.20	152

Coring Information

Top (m)	Base (m)	Dia (mm)	Barrel Type

Structure Name	SVD-2	Structure Type	Minor Structure
Earthwork Type	Cutting	Earthwork Modification	-

Carriageway	Chainage	Marker Post Reference	National Grid Reference (centre point)
Northbound	191980	192/0A+19	447245E, 334008N
The centre of the minor structure is 0.13 m from the verge.			

Description and Proposed Works
Pad Foundation

Site Description		
The site is located on the northbound carriageway verge, before Junction 25 .		
Associated Earthworks	GDMS Reference(s)	Type
	22235	Cutting
Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1960s with Derby road to the South and Longmoor Lane to the North. From the 1970s onward the carriageway in the current alignment we see today is present. The site area is designated as potential for Groundwater flooding to Occur at Surface. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and Secondary – A Aquifer for the superficial deposits. The site is not with a groundwater Source Protection Zone.	
Geology and Groundwater		
Superficial Deposits	The BGS Geology Viewer depicts: Beeston Sand and Gravel Member - Sand and Gravel. Superficial deposit formed during the Pleistocene Epoch period underlying the entire site.	
Bedrock	The BGS Geology Viewer depicts: Gunthorpe Member - Mudstone. Sedimentary bedrock formed during the Anisian period.	
Groundwater	No Groundwater encountered	

Upstream

Downstream

Source: AVIS
Date of Capture 24/03/2023

Figure 19-10: Street View of SVD 2 earthwork location

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Exploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1920N	Midpoint of EA	35.74 (OD)	8.29m	02/05/2023

Geotechnical Ground Model for Design **Verge Level: 33.71m OD**	**Material**	**Depth (mbgl)**	**Elevation (m OD)**	**Notes**
	Made Ground- Cohesive	1.2	34.5	Ground model taken from BH1920N
	Made Ground- Granular	3.9	31.8	
	Gunthorpe member – Cohesive	7.0	28.7	
	Gunthorpe member – Mudstone	8.29	27.4	
	Groundwater notes: No Groundwater Encountered			

Design Parameters							
Moderately Conservative Values:							
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)	UCS (MPa)
Made Ground- Cohesive	19	100	0	27	7800	6200	-
Made Ground- Granular	19	-	0	32	-	15000	-
Gunthorpe member – Cohesive	20	180	2	27	36000	32400	-
Gunthorpe member – Mudstone	20	-	-	-	-	50000	0.48

Design Section

Pad foundation of size 0.9m x 0.9m and thickness of 0.6m is proposed.

Case	**Over Design Factor (ODF)**		
	Overturning	**Sliding**	**Bearing Resistance**
DA1C1	**4**	**21**	**8**
DA1C2	**3**	**14**	**5**
SLS	**4**	**23**	**12**

Contaminated Land Assessment	No contamination sources identified based on confirmatory ground investigation data

Location Specific Risks
ID6: Compressible/Collapsible ground hazard

Report Extracts and References
GFR

3.3. Details of any problems encountered

None encountered.

3.4. Instability problems and unusual ground conditions

The ground conditions and materials encountered during construction were similar to the anticipated ground model in the GIR [1] . All excavated material was classed as 2A and 2B (unsuitable for regrading or fill to structures) and removed from the site. No ground instability problems were encountered during the construction.

3.5. Ground water conditions and problems and drainage measures to overcome them

No major groundwater problems were encountered during regrading of the cutting slopes.

3.6. Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

No contamination or hazardous materials were encountered at cutting locations across the scheme.

Exploratory Hole Log

STRATA GEOTECHNICS

Contract Name: M1 J23A-J25 NEAR			Client: BMJV			Borehole ID: BH1920N
Contract Number: G230600	Date Started: 02/05/2023	Date Completed: 10/05/2023	Logged: JN/ASH	Checked: JB	Status: FINAL	Sheet 1 of 2
Dynamic Sample Borehole Log	Easting: 447250.8	Northing: 333971.2	Ground Level: 35.74m (OD)	Plant Used: Comacchio 305	Print Date: 04/09/2023	Scale: 1:50
Weather: Dry	Rig Crew: JK&JK	Termination: Scheduled Depth		SPT Hammer: AR3653 Energy Ratio: 63%		

Samples & In Situ Testing

Depth	Sample ID	Test Result
0.30	ES	
0.30	ES1	
0.50	D2	
1.00	ES3	
1.20	D4	SPT(S) 1.20m, N=15 (3,3/4,3,4,4)
1.20 - 1.30	B5	
1.20 - 1.40	ES10	Recovery = 100%
1.20 - 1.65	D26	Recovery = 100%
1.20 - 2.20	L24	
1.60 - 1.70	D11	
1.80 - 1.90	ES12	
2.20 - 2.80	UT22	Recovery = 50%
2.80 - 3.00	ES13	Recovery = 100%
2.80 - 3.80	L23	
3.00 - 3.20	D14	
3.60 - 3.80	D15	
3.80 - 4.80	L25	SPT(S) 3.80m, N=36 (7,8/8,9,9,10)
3.90 - 4.10	ES16	
4.10 - 4.20	D17	Recovery = 100%
4.20 - 4.40	D18	
4.80 - 5.00	UT6	Recovery = 0%
5.00 - 6.00	L7	Recovery = 100%
5.10 - 5.20	D19	
5.60 - 5.70	D20	
6.00 - 7.00	C8	SPT(C) 6.00m, N=44 (10,14/14,16,12,2) Recovery = 30%
7.00 - 7.10	D21	SPT(C) 7.00m, 50 (16,9/17,18,15,)
7.00 - 8.00	L9	Recovery = 100%
8.00	50 (20,5/20,21,9,)	SPT(C) 8.00m, 50 (20,5/20,21,9,)

Fracture	TCR	SCR	RQD

Strata Details

Level (mAOD)	Depth (m) (Thickness)
35.64	0.10
	(0.60)
35.04	0.70
	(0.50)
34.54	1.20
	(0.40)
34.14	1.60
	(2.00)
32.14	3.60
	(0.30)
31.84	3.90
	(0.30)
31.54	4.20
	(1.40)
30.14	5.60
	(1.40)
28.74	7.00
	(1.29)
27.45	8.29

Strata Description

MADE GROUND: Vegetation over firm dark grey slightly gravelly sandy CLAY, with frequent plants/ rootlets (6x15). Sand is fine to coarse. Gravel is sub-rounded to rounded fine to coarse of quartzite.
[MADE GROUND]

MADE GROUND: Firm dark grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is sub-rounded to rounded fine to medium of quartzite.
[MADE GROUND]

MADE GROUND: Firm to stiff yellowish brown slightly gravelly sandy CLAY. Sand is fine. Gravel is sub-rounded to rounded of fine to medium of quartzite.
[MADE GROUND]

MADE GROUND: Medium dense friable dark brown slightly clayey very sandy GRAVEL. Sand is fine to coarse. Gravel is angular to sub-angular fine to coarse of quartz.
[MADE GROUND]

MADE GROUND: Dark brown slightly clayey very sandy GRAVEL. Sand is fine to coarse. Gravel is sub-angular to rounded fine to coarse of quartz and sandstone.
[MADE GROUND]

MADE GROUND: Dense orangish brown silty gravelly fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse of quartz and sandstone.
[MADE GROUND]

Stiff reddish brown mottled grey slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is sub-angular to rounded fine to coarse quartz and sandstone.
[Gunthorpe Member]

Stiff reddish brown mottled grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone and sandstone.
[Gunthorpe Member]

Stiff reddish brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is sub-angular to angular fine to coarse of mudstone.
[Gunthorpe Member]

Very weak reddish brown MUDSTONE. Discontinuities (0-20) are extremely closely spaced planar with clay infill.
[Gunthorpe Member]

End of Borehole at 8.290m

Progress (Window Run)

Window Run
1.20 - 1.60 100% rec
1.20 - 2.20 100% rec
2.20 - 2.80 50% rec
2.80 - 3.80 100% rec
3.80 - 4.80 100% rec
4.80 - 5.00 0% rec
5.00 - 6.00 100% rec
6.00 - 7.00 30% rec
7.00 - 8.00 100% rec

Groundwater: Water Strike | Backfill Installation

Progress by Time

Date	Time	Depth	Casing	Water

Borehole Diameter Depth	Borehole Diameter Diameter	Casing Diameter Depth	Casing Diameter Diameter
8.29	140	5.00	150

Remarks:
No groundwater encountered during drilling.
Backfilled with bentonite, concrete and bituminous material.

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Structure Name	SVD-3	Structure Type	Minor Structure
Earthwork Type	Cutting	Earthwork Modification	-

Carriageway	Chainage	Marker Post Reference	National Grid Reference (centre point)
Southbound	184956	185/0B+05	447558E, 327347N
The centre of the minor structure is 2.3 m from the verge.			

Description and Proposed Works
Pad Foundation

Site Description		
The site is located on the southbound carriageway verge, just before Junction 24.		
Associated Earthworks	GDMS Reference(s)	Type
	NA	Cutting
Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1960s with Derby road to the North and Ashby road to the south. From the 1970s onward the carriageway in the current alignment we see today is present. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and Secondary – A Aquifer for the superficial deposits. The site is not with a groundwater Source Protection Zone.	
Geology and Groundwater		
Superficial Deposits	The BGS Geology Viewer depicts: Egginton Common Sand and Gravel Member - Sand and Gravel. Superficial deposit formed during the Mid Pleistocene period underlying the entire site.	
Bedrock	The BGS Geology Viewer depicts: Edwalton Member - Mudstone. Sedimentary bedrock formed during the Carnian period.	
Groundwater	No Groundwater encountered	

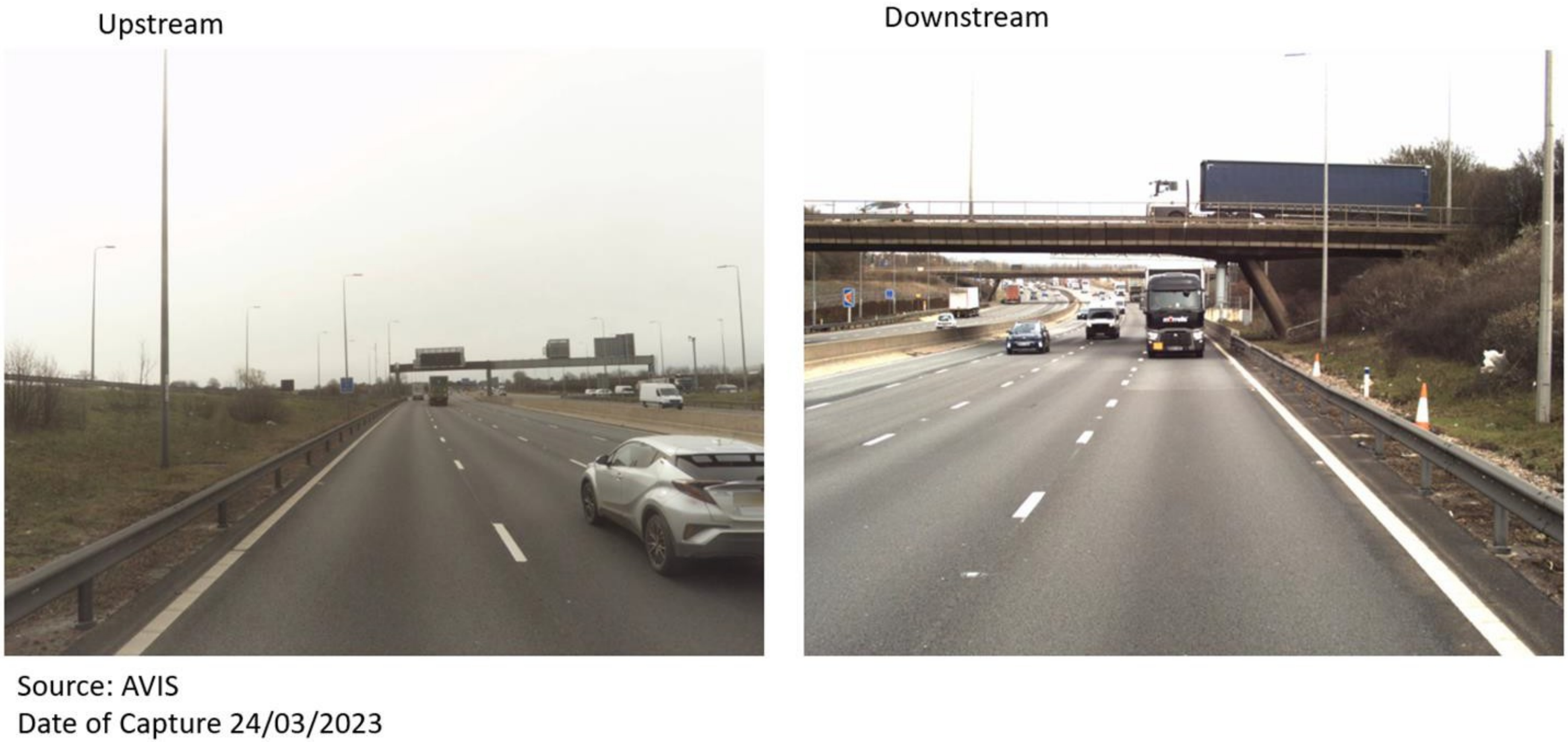


Figure 19-11: Street View of SVD 3 earthwork location

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Exploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1851S	Midpoint of EA	39.54 (OD)	9.78m	28/06/2023

Geotechnical Ground Model for Design **Verge Level: 33.52m OD**	**Material**	**Depth (mbgl)**	**Elevation (m OD)**	**Notes**
	Made Ground- Granular	1.3	38.2	Ground model taken from BH1851S
	Edwalton Member – Cohesive	1.7	37.8	
	Edwalton Member – Cohesive	7.0	32.5	
	Edwalton Member – Cohesive	9.8	29.8	
	Groundwater notes: No Groundwater Encountered			

Design Parameters							
Moderately Conservative Values:							
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)	UCS (MPa)
Made Ground- Granular	19	-	0	30	-	6200	-
Edwalton Member – Cohesive	18	50	0	27	7800	6200	-
Edwalton Member – Cohesive	19	86	1	26	19000	17100	-
Edwalton Member – Cohesive	20	167	2	27	37000	33300	-

Design Section

Pad foundation of size 0.9m x 0.9m and thickness of 0.6m is proposed.

Case	**Over Design Factor (ODF)**		
	Overturning	**Sliding**	**Bearing Resistance**
DA1C1	**4**	**21**	**8**
DA1C2	**3**	**14**	**5**
SLS	**4**	**23**	**12**

Contaminated Land Assessment	No contamination sources identified based on confirmatory ground investigation data

Location Specific Risks
ID6: Compressible/Collapsible ground hazard
ID13: Non-Coal mining Hazard
ID24: Excavated arisings could be classed as non-hazardous or hazardous waste.

Report Extracts and References
GFR

4.3. Details of any problems encountered

No particular embankment construction problems were encountered.

4.4. Instability problems and unusual ground conditions

The materials encountered during construction were broadly similar to the reported ground conditions in the GIR [1]/ GDR [2]. All excavated material was classed as 2A and 2B (unsuitable for embankment widening) and removed from site. No ground instability problems were encountered during the construction.

4.5. Ground water conditions and problems and drainage measures to overcome them

No major drainage or groundwater problems were encountered during widening of the embankments.

4.6. Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

No contamination or hazardous materials were encountered at cutting locations across the scheme.

4.7. Foundation treatment, including drainage measures and treatment of soft areas

No areas of soft foundations were encountered, as the embankment widening did not generally extend into the flood plain areas. New fill was benched into the existing embankment to maintain the integrity of the new slope.

4.8. Settlement of foundation and fill material

The works comprised only localised small scale widening of existing embankments. No new embankments that would be subject to foundation or internal settlement were constructed as part of the works.

Exploratory Hole Log

STRATA GEOTECHNICS	Contract Name: M1 J23A-J25 NEAR		Client: BMJV			Borehole ID: BH1851S
	Contract Number: G230600	Date Started: 28/06/2023	Date Completed: 30/06/2023	Logged: PB	Checked: JB	Status: FINAL
						Sheet 1 of 1
Dynamic Sample Drilling Log	Easting: 447553.8	Northing: 327409.2	Ground Level: 39.54m (OD)	Plant Used: Comacchio 305	Print Date: 04/09/2023	Scale: 1:50

Weather: Showers+Fine | Rig Crew: Ian Mountain | Termination: Refusal | SPT Hammer: AR666 Energy Ratio: 65%

Samples & In Situ Testing

Depth	Sample	Test Result	TCR	SCR	RQD	FI/If
0.00 - 0.80	CC6					
		SPT(C) 1.20m, N=31 (8,8/9,7,7,8)				
1.20 - 2.00	L11					
2.00 - 2.45	D1	SPT(S) 2.00m, N=19 (5,5/4,4,6,5)				
2.00 - 2.45	ES20					
2.00 - 3.00	L12					
3.00 - 3.45	D2	SPT(S) 3.00m, N=20 (3,3/4,4,6,6)				
3.00 - 4.00	L13					
4.00 - 4.45	D3	SPT(S) 4.00m, N=21 (4,4/4,4,6,7)				
4.00 - 5.00	L14					
5.00 - 5.45	D4	SPT(S) 5.00m, N=24 (4,4/4,5,7,8)				
5.00 - 6.00	L15					
6.00 - 6.45	D5	SPT(S) 6.00m, N=24 (4,5/5,5,7,7)				
6.00 - 7.00	L16					
7.00 - 7.45	D7	SPT(S) 7.00m, N=37 (10,10/10,10,8,9)				
7.00 - 8.00	B17					
8.00 - 8.45	D8	SPT(S) 8.00m, N=42 (9,9/11,10,10,11)				
8.00 - 9.00	B18					
9.00 - 9.22	D9	SPT(S) 9.00m, 50 (25 for 76mm/50 for 144mm)				
9.00 - 9.60	B19					
9.60 - 9.78	D10	SPT(S) 9.60m, 50 (25 for 79mm/50 for 100mm)				

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description
39.41	0.13		MADE GROUND: Bituminous material. [MADE GROUND]
	(1.17)		MADE GROUND: Concrete bound material. [MADE GROUND]
38.24	1.30 (0.40)		Soft to firm orangish brown slightly sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is fine to coarse angular to sub-rounded quartz, chert and rare sandstone. [Edwalton Member]
37.84	1.70 (2.50)		Firm orangish brown mottled greyish brown sandy CLAY. Sand is fine to medium. [Edwalton Member]
35.34	4.20 (0.70)		Firm greyish brown very sandy friable CLAY. Sand is fine to medium. [Edwalton Member]
34.64	4.90 (4.88)		Stiff orangish brown mottled greyish brown sandy friable CLAY. Sand is fine to medium. [Edwalton Member]
29.76	9.78		End of Borehole at 9.78m

Groundwater: Water Strike | Backfill/Installation

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
28-06-23	20:00			
28-06-23	23:55	7.00	3.00	
29-06-23	20:00	7.00	3.00	
29-06-23	23:55	9.78	3.00	

Flush Return Information

Top	Base	Min %	Max %	Type	Colour

Remarks:

No groundwater encountered during drilling.
Backfilled with bentonite, concrete and bituminous material.

Water Strike

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Borehole Diameter

Depth (m)	Dia (mm)
9.78	101

Casing Diameter

Depth (m)	Dia (mm)

Coring Information

Top (m)	Base (m)	Dia (mm)	Barrel Type

Fracture Index (FI) - Fractures per meter. Fracture Spacing (If) - reported in mm as Min, Average and Max values. TCR, SCR and RQD reported as %. Hand vane (HV) reports Undrained Shear Strength (Su). Pocket penetrometer (PP) reports Unconfined Compressive Strength (UCS).

Structure Name	SVD-4	Structure Type	Minor Structure
Earthwork Type	Embankment	Earthwork Modification	-

Carriageway	Chainage	Marker Post Reference	National Grid Reference (centre point)
Southbound	187764	187/7B+70	446892E, 330048N
The centre of the minor structure is 3.5 m from the verge.			

Description and Proposed Works
Pad Foundation

Site Description		
The site is located on the southbound carriageway verge, after Junction 24a.		
Associated Earthworks	GDMS Reference(s)	Type
	24555	Embankment

Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1950s. From the 1970s onward the carriageway in the current alignment we see today is present. The site area is in the designate flood zone 2 and 3 and potential for Groundwater flooding situated below Ground Level. The area falls in recorded flood lines due to exceeding channel capacity. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and Secondary – A Aquifer for the superficial deposits. The site is not with a groundwater Source Protection Zone.
Geology and Groundwater	
Superficial Deposits	The BGS Geology Viewer depicts: Hemington Member - Silt and Gravel. Superficial deposit formed during the Pre-Quaternary period underlying the entire site.
Bedrock	The BGS Geology Viewer depicts: Edwalton Member - Mudstone. Sedimentary bedrock formed during the Carnian period.
Groundwater	No Groundwater encountered

Upstream   Downstream

Source: AVIS
Date of Capture 24/03/2023

Figure 19-12: Street View of SVD 4 earthwork location

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Exploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1877S	Midpoint of EA	33.52 (OD)	10m	14/06/2023

Geotechnical Ground Model for Design **Verge Level: 33.52m OD**	**Material**	**Depth (mbgl)**	**Elevation (m OD)**	**Notes**
	Made Ground-Granular	1.2	32.3	Ground model taken from BH1877S
	Hemington Member – Cohesive	3.0	30.5	
	Hemington Member – Granular	10	23.5	
	Groundwater notes: No Groundwater Encountered			

Design Parameters							
Moderately Conservative Values:							
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)	UCS (MPa)
Made Ground- Granular	19	-	0	30	-	5000	-
Hemington Member – Cohesive	19	100	0	27	19000	17100	-
Hemington Member – Granular	19.5	-	0	30	-	25000	-

Design Section
Pad foundation of size 0.9m x 0.9m and thickness of 0.6m is proposed.

Case	**Over Design Factor (ODF)**		
	Overturning	**Sliding**	**Bearing Resistance**
DA1C1	**4**	**21**	**8**
DA1C2	**3**	**14**	**5**
SLS	**4**	**23**	**12**

Contaminated Land Assessment	Potential landfill gas risk associated with Hemington Gravel Pit historical landfill. Method statements and risk assessments for exposure to gases, including mitigation measures, to be undertaken by groundworks contractor.'

Location Specific Risks
ID6: Compressible/Collapsible ground hazard
ID13: Non-Coal mining Hazard
ID24: Excavated arisings could be classed as non-hazardous or hazardous waste.

Report Extracts and References

GFR

4.3. Details of any problems encountered

No particular embankment construction problems were encountered.

4.4. Instability problems and unusual ground conditions

The materials encountered during construction were broadly similar to the reported ground conditions in the GIR [1]/ GDR [2]. All excavated material was classed as 2A and 2B (unsuitable for embankment widening) and removed from site. No ground instability problems were encountered during the construction.

4.5. Ground water conditions and problems and drainage measures to overcome them

No major drainage or groundwater problems were encountered during widening of the embankments.

4.6. Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

No contamination or hazardous materials were encountered at cutting locations across the scheme.

4.7. Foundation treatment, including drainage measures and treatment of soft areas

No areas of soft foundations were encountered, as the embankment widening did not generally extend into the flood plain areas. New fill was benched into the existing embankment to maintain the integrity of the new slope.

4.8. Settlement of foundation and fill material

The works comprised only localised small scale widening of existing embankments. No new embankments that would be subject to foundation or internal settlement were constructed as part of the works.

Exploratory Hole Log

STRATA GEOTECHNICS	Contract Name: M1 J23A-J25 NEAR			Client: BMJV			Borehole ID: BH1877S
	Contract Number: G230600	Date Started: 14/06/2023	Date Completed: 15/06/2023	Logged: PB/ASH	Checked: JB	Status: FINAL	Sheet 1 of 1
Dynamic Sample Drilling Log	Easting: 446908.7	Northing: 329983.3	Ground Level: 33.52m (OD)	Plant Used: Comacchio 305		Print Date: 04/09/2023	Scale: 1:50
Weather: Fine	Rig Crew: Adrian Foulstone	Termination: Scheduled Depth		SPT Hammer: AR935 Energy Ratio: 63.5%			

Samples & In Situ Testing							Strata Details				Groundwater	
Depth	Sample	Test Result	TCR	SCR	RQD	FI/If	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill Installation
0.00 - 1.00	CC1						33.32	0.20		MADE GROUND: Bituminous material. [MADE GROUND]		
								(1.00)		MADE GROUND: Concrete bound material. [MADE GROUND]		
		SPT(C) 1.00m, 50 (2,16/50 for 90mm)					32.32	1.20				
1.50 - 1.60	D2									Very stiff dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of sandstone and mudstone.		
1.80 - 2.00	ES3							(1.30)		[Hemmington Member]		
		SPT(C) 2.00m, 50 (9,13/50 for 150mm)										
2.50 - 2.60	D4						31.02	2.50		Firm to stiff reddish brown sandy gravelly CLAY. Gravel is angular fine to coarse of sandstone and mudstone.		
2.70 - 3.00	ES5							(0.50)		[Hemmington Member]		
		SPT(C) 3.00m, 50 (25 for 75mm/50 for 75mm)					30.52	3.00		Gravels with boulders [Driller's Description] [Hemmington Member]		
		SPT(C) 4.00m, 50 (25 for 145mm/50 for 150mm)										
		SPT(C) 5.00m, 50 (25 for 75mm/50 for 80mm)										
		SPT(C) 6.00m, 50 (25 for 70mm/50 for 75mm)						(7.00)				
		SPT(C) 7.00m, 50 (25 for 115mm/50 for 65mm)										
		SPT(C) 8.00m, 50 (25 for 75mm/50 for 75mm)										
		SPT(C) 9.00m, 50 (25 for 75mm/50 for 75mm)										
							23.52	10.00		End of Borehole at 10.00m		

Scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Start & End of Shift Observations					Flush Return Information					
Date	Time	Depth (m)	Casing (m)	Water (m)	Top	Base	Min %	Max %	Type	Colour
14-06-23	20:00									
14-06-23	23:55	5.00	1.00	4.00						
15-06-23	20:00	5.00	1.00	4.00						
15-06-23	23:55	0.00								

Borehole Diameter		Casing Diameter		Coring Information			
Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	Top (m)	Base (m)	Dia (mm)	Barrel Type
2.00	101	1.00	152				
10.00	87	10.00	101				

Remarks:
No groundwater encountered during drilling.
Backfilled with bentonite, concrete and bituminous material.
Rotary Open Hole from 3.00m BGL to 10m BGL due to very dense strata.

Water Strike					
Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Fracture Index (FI) - Fractures per meter. Fracture Spacing (If) - reported in mm as Min, Average and Max values. TCR, SCR and RQD reported as %. Hand vane (HV) reports Undrained Shear Strength (Su). Pocket penetrometer (PP) reports Unconfined Compressive Strength (UCS).

Structure Name	SVD-5	**Structure Type**	Minor Structure
Earthwork Type	Cutting	**Earthwork Modification**	-

Carriageway	**Chainage**	**Marker Post Reference**	**National Grid Reference (centre point)**
Southbound	193366	193/3B+45	447212E, 335403N
The centre of the minor structure is 1.3 m from the verge.			

Description and Proposed Works
Pad foundation

Site Description		
The site is located on the southbound carriageway verge before Junction 25.		
Associated Earthworks	GDMS Reference(s)	Type
	22232	Cutting
Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1960s with Longmoor Lane to the South and B5010 Derby Road to the North. From the 1970s onward the carriageway in the current alignment we see today is present. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and absence of Aquifer for the superficial deposits at the site. The site is not with a groundwater Source Protection Zone.	
Geology and Groundwater		
Superficial Deposits	The BGS Geology Viewer depicts: No formation is found underlying the entire site extents.	
Bedrock	The BGS Geology Viewer depicts: Gunthorpe Member - Mudstone. Sedimentary bedrock formed during the Anisian period.	
Groundwater	No Groundwater encountered	

Upstream

Downstream

Source: AVIS
Date of Capture 24/03/2023

Figure 19-13: Street View of SVD 5 earthwork location

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Exploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1933S	Midpoint of EA	48.27 (OD)	10m	24/05/2023

Geotechnical Ground Model for Design **Verge Level: 48.27m OD**	**Material**	**Depth (mbgl)**	**Elevation (m OD)**	**Notes**
	Made Ground-Granular	1.1	47.2	Ground model taken from BH1933S
	Gunthorpe member – Cohesive	2.4	45.9	
	Gunthorpe member – Cohesive	10	38.3	
	Groundwater notes: No Groundwater Encountered			

Design Parameters							
Moderately Conservative Values:							
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)	UCS (MPa)
Made Ground- Granular	19	-	0	30	-	6200	-
Gunthorpe member – Cohesive	19	130	0	27	26000	23400	-
Gunthorpe member – Cohesive	20	192	2	26	32000	28800	-

Design Section

Pad foundation of size 0.9m x 0.9m and thickness of 0.6m is proposed.

Case	**Over Design Factor (ODF)**		
	Overturning	**Sliding**	**Bearing Resistance**
DA1C1	**4**	**21**	**8**
DA1C2	**3**	**14**	**5**
SLS	**4**	**23**	**12**

Contaminated Land Assessment	No contamination sources identified based on confirmatory ground investigation data

Location Specific Risks

ID6: Compressible/Collapsible ground hazard
ID13: Non-Coal mining Hazard

Report Extracts and References

GFR

5. Retaining Structures

Retaining structures were constructed at the locations where there was insufficient space for verge widening with an earthworks solution, due to the restrictions of the HE boundary, other infrastructure or on embankments crossing flood plains.

The types of retaining walls constructed on the scheme were conventional sheet pile and King Sheet Pile (KSP) walls, gabion walls and slab on edge walls.

5.1. Sheet pile and king sheet pile walls

Locations of sheet pile and KSP wall structures along with the as-built details are shown in Appendix B. The locations of construction phase design changes are summarised in Table 8 and Table 9. The sheet piling subcontractor was Sheet Piling (UK) Ltd.

5.1.1. Record of soil and groundwater conditions encountered

The encountered ground conditions were broadly as expected in the design as described in the GIR [1] and GDR [2]. No significant groundwater seepages were encountered in the temporary excavations or through the sheet pile walls.

5.1.2. Temporary works required

The piling works were carried out from temporary piling platforms designed and constructed by the contractor. Due to the size of the piling rigs, the width of the piling platforms in cuttings was in some cases greater than the available space in the traffic management. In these locations the piling platform was extended past the line of the sheet pile wall, in a temporary cutting, which was subsequently backfilled with Class 6N material with a geotextile drainage layer (Deckdrain) behind the sheet piles.

Exploratory Hole Log

STRATA GEOTECHNICS	Contract Name: M1 J23A-J25 NEAR		Client: BMJV			Borehole ID: BH1933S
	Contract Number: G230600	Date Started: 24/05/2023	Date Completed: 25/05/2023	Logged: JN/ASH	Checked: JB	Status: FINAL
Dynamic Sample Drilling Log	Easting: 447207.5	Northing: 335441.9	Ground Level: 48.27m (OD)	Plant Used: Comacchio 305	Print Date: 04/09/2023	Sheet 1 of 1; Scale: 1:50
Weather: Fine	Rig Crew: Adrian Foulstone	Termination: Scheduled Depth	SPT Hammer: AR935 Energy Ratio: 63.5%			

Samples & In Situ Testing

Depth	Sample	Test Result	TCR	SCR	RQD	FI/If
0.00 - 1.20	CC1					
0.40	ES11					
1.00	ES13					
1.20 - 1.30	B12	SPT(S) 1.20m, N=26 (1,5/6,6,7,7)				
1.20 - 1.30	B`1					
1.20 - 1.30	D15					
1.20 - 1.65	D2					
1.30 - 1.40	ES14					
1.70 - 1.90	ES16					
1.90 - 2.00	D17					
2.20 - 2.65	D3	SPT(S) 2.20m, N=28 (3,5/6,8,7,7)				
2.80 - 2.90	D18					
3.10 - 3.20	CSS19					
3.20 - 3.65	D4	SPT(S) 3.20m, N=34 (3,6/8,8,9,9)				
4.00 - 4.10	CSS20					
4.10 - 4.20	D21					
4.20 - 4.65	D5	SPT(S) 4.20m, N=42 (2,8/9,10,10,13)				
5.00 - 5.10	CSS22					
5.10 - 5.20	D23					
5.20 - 5.65	D6	SPT(S) 5.20m, N=32 (3,3/7,7,8,10)				
6.00 - 6.10	CSS24					
6.10 - 6.20	D25					
6.20 - 6.65	D7	SPT(S) 6.20m, N=37 (1,7/8,10,10,9)				
7.00 - 7.10	CSS26					
7.10 - 7.20	D27					
7.20 - 7.60	D8	SPT(S) 7.20m, 50 (1,1/50 for 245mm)				
8.20 - 8.65	D9	SPT(S) 8.20m, N=49 (5,9/10,12,12,15)				
9.20 - 9.65	D10	SPT(S) 9.20m, N=48 (3,10/10,10,13,15)				

Strata Details

Level (mAOD)	Depth (m) (Thickness)	Strata Description
48.12	0.15	MADE GROUND: Black Bituminous Material. [MADE GROUND]
47.87	0.40	MADE GROUND: Concrete bound material. [MADE GROUND]
47.17	(0.70) 1.10	MADE GROUND: Greyish brown slightly sandy GRAVEL, with low cobble content. Sand is fine to coarse. Gravel is sub-angular to rounded fine to coarse quartz and quartzite. Cobbles are angular to sub-angular of quartz. [MADE GROUND]
47.07	1.20	
46.57	(0.50) 1.70	Firm reddish brown slightly sandy very gravelly CLAY. Sand is fine to coarse. Gravel is sub-angular to sub-rounded fine to coarse of quartz and quartzite. [Gunthorpe Member]
45.87	(0.70) 2.40	Firm to stiff reddish brown sandy very gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone and quartz. [Gunthorpe Member]
		Stiff reddish brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone. [Gunthorpe Member] 3.00 - 3.10: Firm grey
41.07	(4.80) 7.20	Very stiff reddish brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular fine to coarse of mudstone. [Gunthorpe Member]
38.27	(2.80) 10.00	Firm to stiff reddish brown mottled bluish grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is sub-angular to angular fine to coarse of mudstone. [Gunthorpe Member]

End of Borehole at 10.00m

Groundwater: Water Strike; Backfill Installation

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
24-05-23	20:00			
24-05-23	23:55	7.20	1.50	3.00
25-05-23	20:00	7.20	1.50	2.00
25-05-23	23:55	0.00		

Flush Return Information

Top	Base	Min %	Max %	Type	Colour

Remarks:
No groundwater encountered during drilling.
Backfilled with bentonite, concrete and bituminous material.

Water Strike

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

Borehole Diameter

Depth (m)	Dia (mm)
3.20	101
10.00	87

Casing Diameter

Depth (m)	Dia (mm)
1.50	152

Coring Information

Top (m)	Base (m)	Dia (mm)	Barrel Type

Fracture Index (FI) - Fractures per meter. Fracture Spacing (If) - reported in mm as Min, Average and Max values. TCR, SCR and RQD reported as %. Hand vane (HV) reports Undrained Shear Strength (Cu). Pocket penetrometer (PP) reports Unconfined Compressive Strength (UCS).

Structure Name	MIDAS-1	Structure Type	Minor Structure
Earthwork Type	Embankment	Earthwork Modification	-

Carriageway	Chainage	Marker Post Reference	National Grid Reference (centre point)
Northbound	190494	190/5A+61	446889E, 332642N
The centre of the minor structure is 4.3 m from the verge.			

Description and Proposed Works
Planted foundation

Site Description		
The site is located on the northbound carriageway verge, midway between Junction 24a and Junction 25.		
Associated Earthworks	GDMS Reference(s)	Type
	24420	Embankment
Environmental and Historical Site Information	A review of the historical maps on GDMS shows the site as fields dating up to the 1960s with Draycot road to the South and Railway Line to the North. From the 1970s onward the carriageway in the current alignment we see today is present. The site area is near to the designate flood zones 2 and 3 and potential for Groundwater flooding situated below Ground Level. GDMS indicates that the bedrock at the site area has an aquifer designation as Secondary -B and Secondary – A Aquifer for the superficial deposits. The site is not with a groundwater Source Protection Zone.	
Geology and Groundwater		
Superficial Deposits	The BGS Geology Viewer depicts: Hemington Member - Silt and Gravel. Superficial deposit formed during the Pre-Quaternary period underlying the entire site.	
Bedrock	The BGS Geology Viewer depicts: Edwalton Member - Mudstone. Sedimentary bedrock formed during the Carnian period.	
Groundwater	No Groundwater encountered	

Upstream Downstream

Source: AVIS
Date of Capture 24/03/2023

Figure 19-14: Street View of MIDAS 1 earthwork location

Summary of Applicable Exploratory Holes					
BGS Reference ID	Exploratory Hole Name	Distance and direction from structure to exploratory hole (m)	Exploratory hole Elevation (m)	Exploratory hole Depth (m bgl)	Date of Exploratory Hole Formation
-	BH1902N	Midpoint of EA	40.40 (OD)	10m	30/05/2023

Geotechnical Ground Model for Design Verge Level: 33.71m OD	Material	Depth (mbgl)	Elevation (m OD)	Notes
	Made Ground-Granular	1.2	39.2	Ground model taken from BH1902N
	Hemington Member – Granular	2.8	37.6	
	Edwalton Member – Cohesive	5.0	35.4	
	Edwalton Member – Cohesive	10.0	30.4	
	Groundwater notes: No Groundwater Encountered			

Design Parameters						
Moderately Conservative Values:						
Material	Bulk Density (kN/m3)	Cu (kPa)	c' (kPa)	Φ' (°)	Eu (kPa)	E' (kPa)
Made Ground - Granular	19	-	0	30	-	5000
Hemington Member – Granular	19	-	0	30	-	10000
Edwalton Member – Cohesive	19	90	2	26	18000	16200
Edwalton Member – Cohesive	19.5	165	2	27	33000	29700

Design Section

pole diameter 168mm with Planted foundation of depth 1.2m along with minimum augured depth of 3.0m.

Design Utilisation for CD354 planting depth	63.5%

Contaminated Land Assessment	No contamination sources identified based on confirmatory ground investigation data

Location Specific Risks

ID6: Compressible/Collapsible ground hazard

<u>Report Extracts and References</u>

GFR

4.3. Details of any problems encountered

No particular embankment construction problems were encountered.

4.4. Instability problems and unusual ground conditions

The materials encountered during construction were broadly similar to the reported ground conditions in the GIR [1]/ GDR [2]. All excavated material was classed as 2A and 2B (unsuitable for embankment widening) and removed from site. No ground instability problems were encountered during the construction.

4.5. Ground water conditions and problems and drainage measures to overcome them

No major drainage or groundwater problems were encountered during widening of the embankments.

4.6. Contaminated and hazardous material encountered on site and the location of disposal, both on and off site

No contamination or hazardous materials were encountered at cutting locations across the scheme.

4.7. Foundation treatment, including drainage measures and treatment of soft areas

No areas of soft foundations were encountered, as the embankment widening did not generally extend into the flood plain areas. New fill was benched into the existing embankment to maintain the integrity of the new slope.

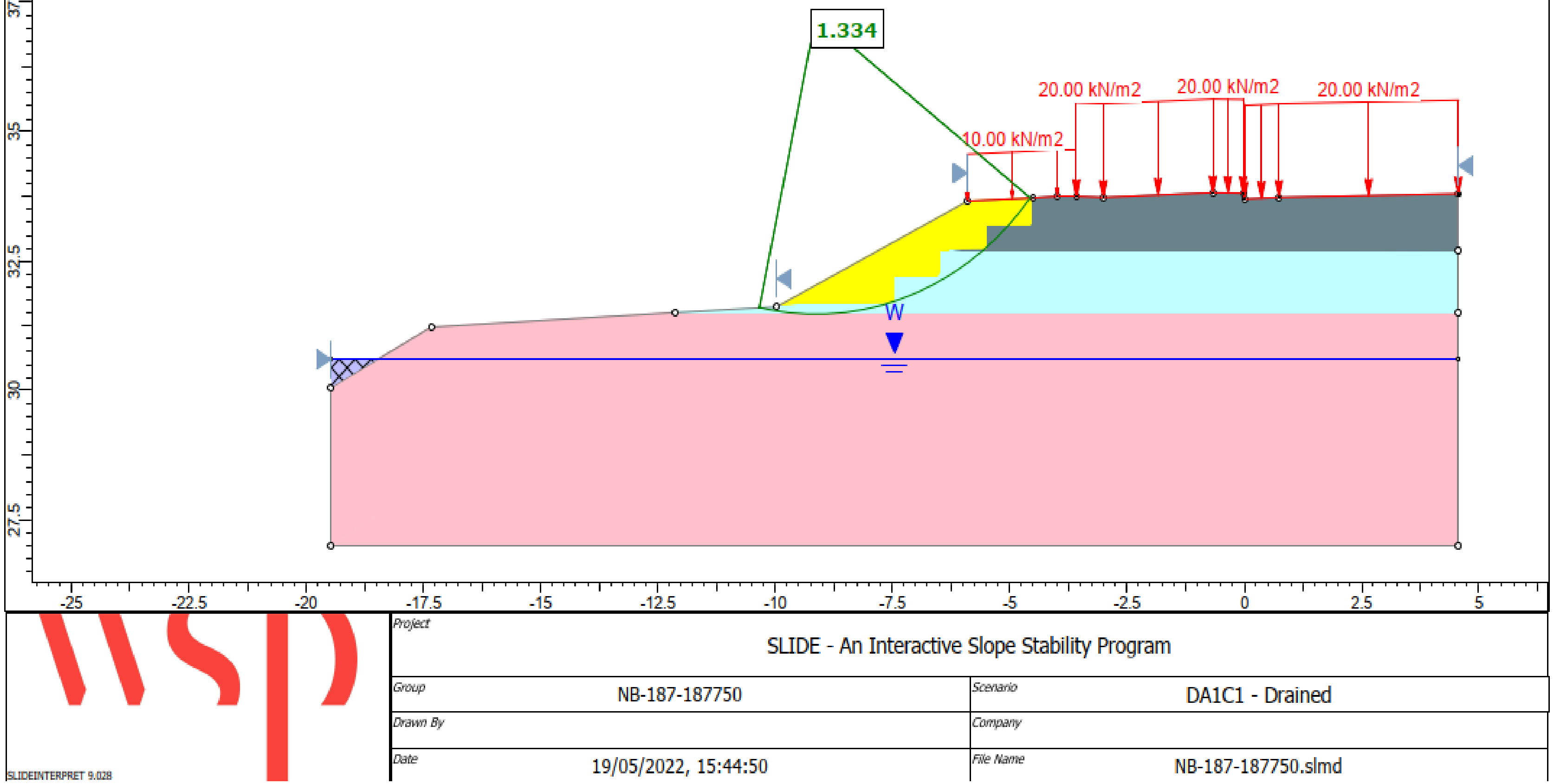
4.8. Settlement of foundation and fill material

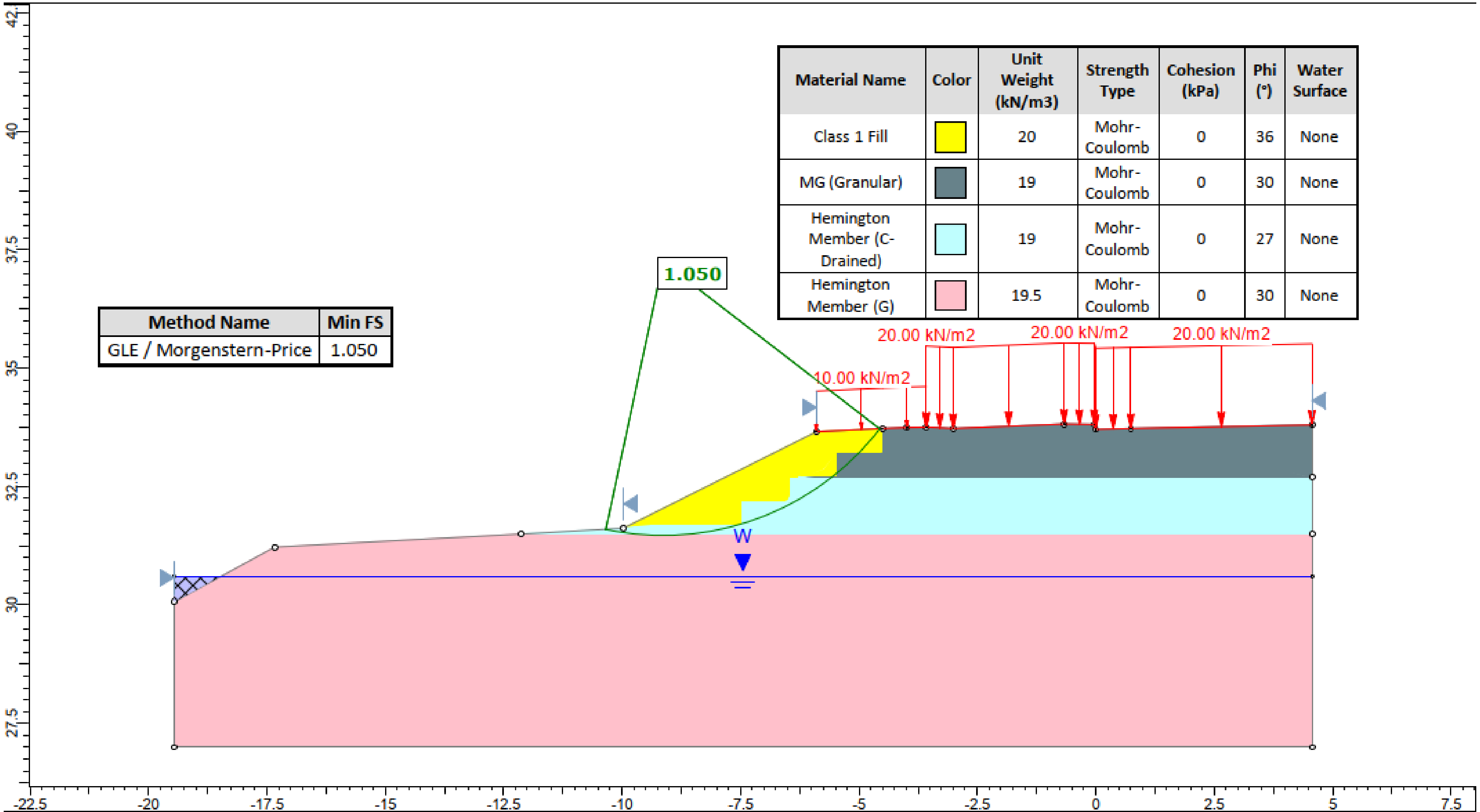
The works comprised only localised small scale widening of existing embankments. No new embankments that would be subject to foundation or internal settlement were constructed as part of the works.

Annex C SLIDE Output

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Class 1 Fill		20	Mohr-Coulomb	0	36	None
MG (Granular)		19	Mohr-Coulomb	0	30	None
Hemington Member (C-Drained)		19	Mohr-Coulomb	0	27	None
Hemington Member (G)		19.5	Mohr-Coulomb	0	30	None

Method Name	Min FS
GLE / Morgenstern-	1.334



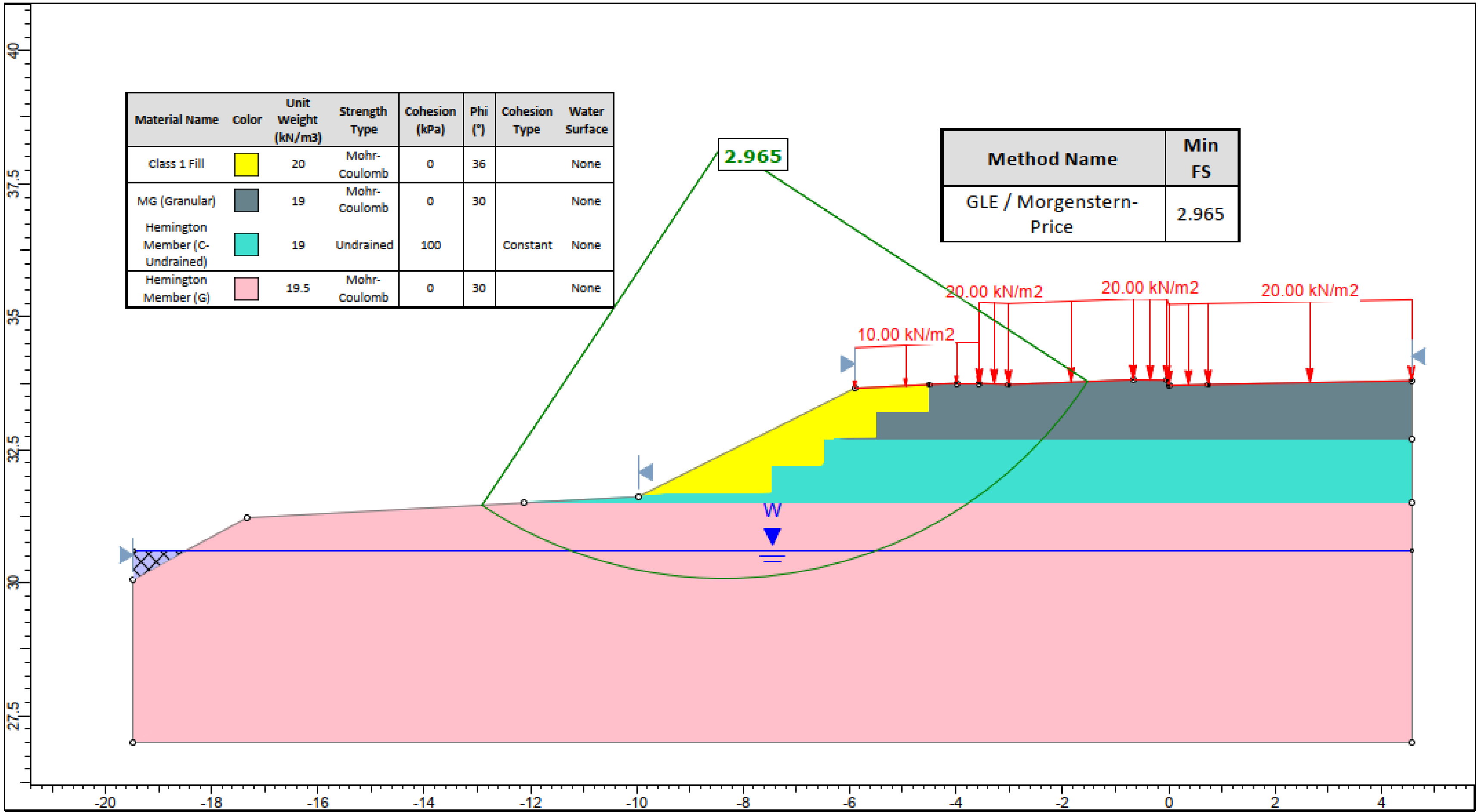


Method Name	Min FS
GLE / Morgenstern-Price	1.050

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Class 1 Fill		20	Mohr-Coulomb	0	36	None
MG (Granular)		19	Mohr-Coulomb	0	30	None
Hemington Member (C-Drained)		19	Mohr-Coulomb	0	27	None
Hemington Member (G)		19.5	Mohr-Coulomb	0	30	None

SLIDEINTERPRET 9.028

Project	SLIDE - An Interactive Slope Stability Program		
Group	NB-187-187750	Scenario	DA1C2 - Drained
Drawn By		Company	
Date	19/05/2022, 15:44:50	File Name	NB-187-187750.slmd

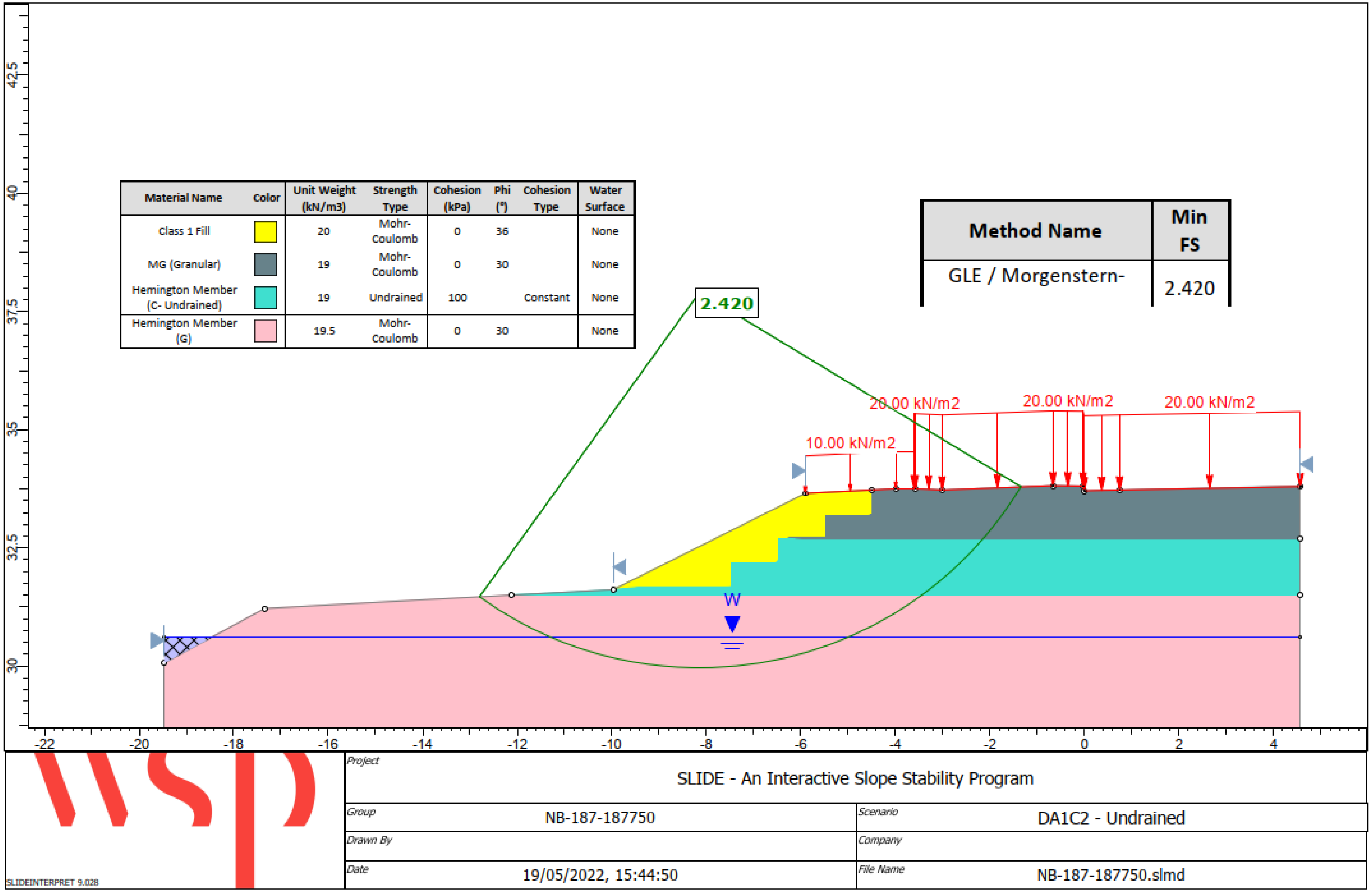


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface
Class 1 Fill		20	Mohr-Coulomb	0	36		None
MG (Granular)		19	Mohr-Coulomb	0	30		None
Hemington Member (C-Undrained)		19	Undrained	100		Constant	None
Hemington Member (G)		19.5	Mohr-Coulomb	0	30		None

Method Name	Min FS
GLE / Morgenstern-Price	2.965

SLIDEINTERPRET 9.028

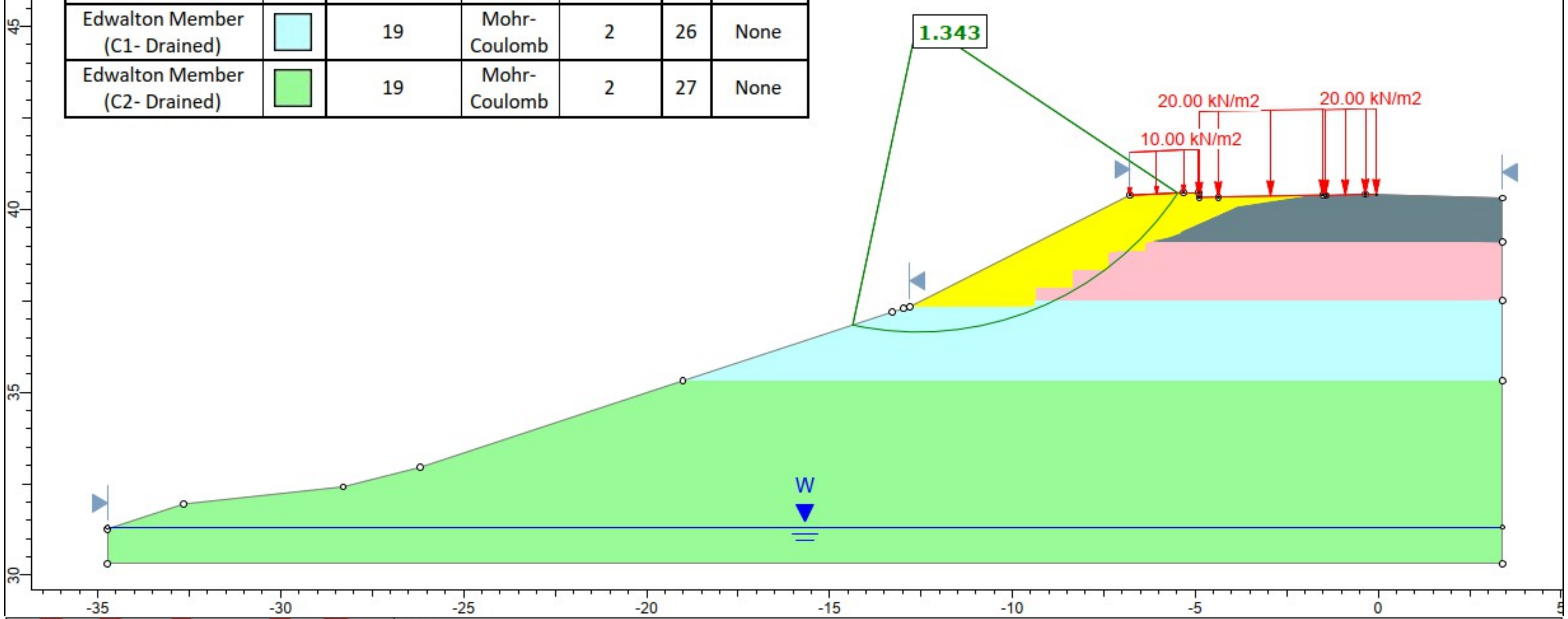
Project	SLIDE - An Interactive Slope Stability Program		
Group	NB-187-187750	Scenario	DA1C1 - Undrained
Drawn By		Company	
Date	19/05/2022, 15:44:50	File Name	NB-187-187750.slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface
Class 1 Fill		20	Mohr-Coulomb	0	36		None
MG (Granular)		19	Mohr-Coulomb	0	30		None
Hemington Member (C- Undrained)		19	Undrained	100		Constant	None
Hemington Member (G)		19.5	Mohr-Coulomb	0	30		None

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Class 1 Fill		20	Mohr-Coulomb	0	36	None
MG (Granular)		19	Mohr-Coulomb	0	30	None
Hemington Member (G)		19	Mohr-Coulomb	0	30	None
Edwalton Member (C1- Drained)		19	Mohr-Coulomb	2	26	None
Edwalton Member (C2- Drained)		19	Mohr-Coulomb	2	27	None

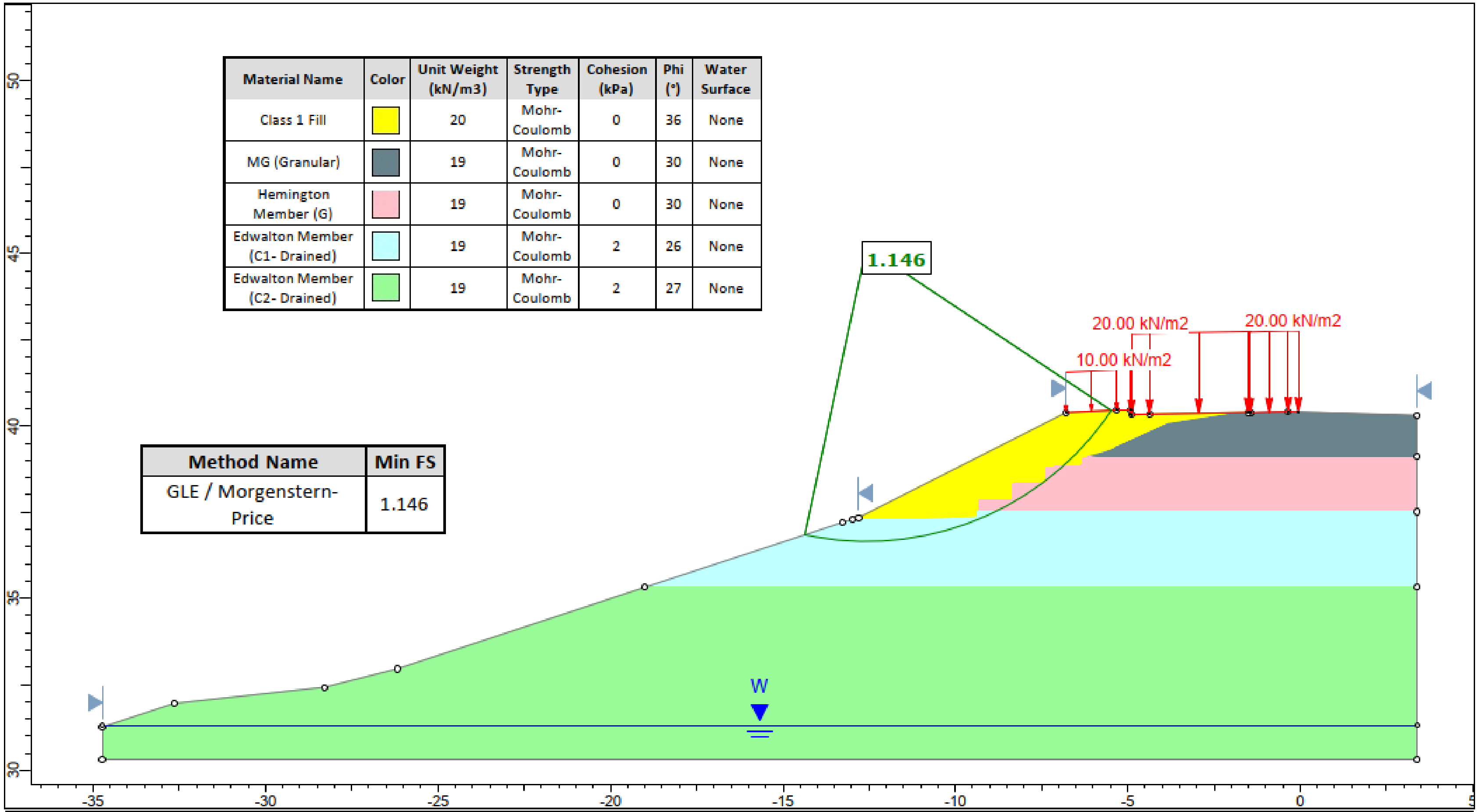
Method Name	Min FS
GLE / Morgenstern-Price	1.343



SLIDEINTERPRET 9.028	Project	SLIDE - An Interactive Slope Stability Program	
Group	NB-190-2+MS4	Scenario	DA1C1 - Drained
Drawn By		Company	
Date	19/05/2022, 15:44:50	File Name	NB-190-2+MS4 -With GWT.slmd

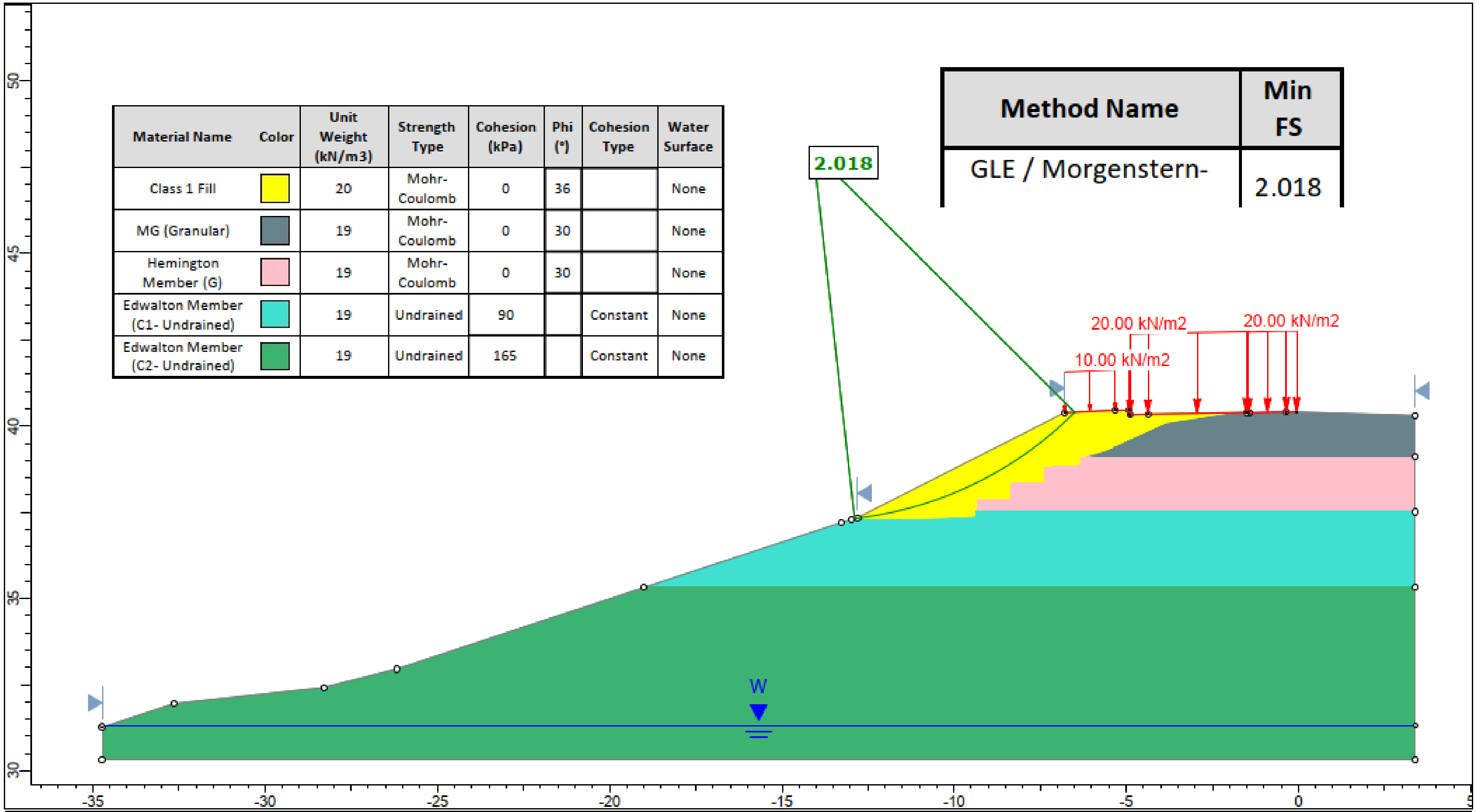
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Class 1 Fill		20	Mohr-Coulomb	0	36	None
MG (Granular)		19	Mohr-Coulomb	0	30	None
Hemington Member (G)		19	Mohr-Coulomb	0	30	None
Edwalton Member (C1- Drained)		19	Mohr-Coulomb	2	26	None
Edwalton Member (C2- Drained)		19	Mohr-Coulomb	2	27	None

Method Name	Min FS
GLE / Morgenstern-Price	1.146



Project	SLIDE - An Interactive Slope Stability Program		
Group	NB-190-2+MS4	Scenario	DA1C2 - Drained
Drawn By		Company	
Date	19/05/2022, 15:44:50	File Name	NB-190-2+MS4 -With GWT.slmd

SLIDEINTERPRET 9.028

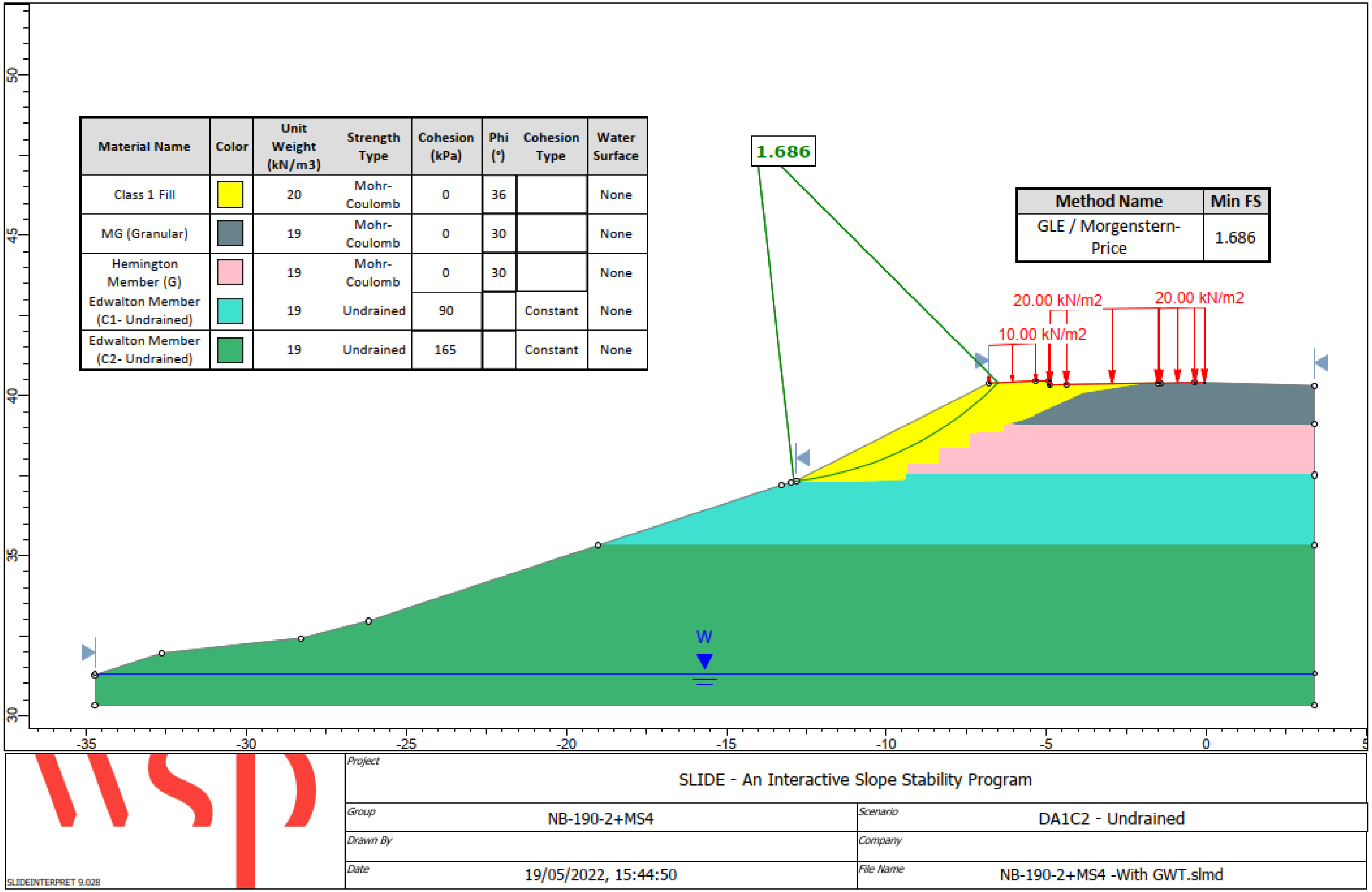


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface
Class 1 Fill		20	Mohr-Coulomb	0	36		None
MG (Granular)		19	Mohr-Coulomb	0	30		None
Hemington Member (G)		19	Mohr-Coulomb	0	30		None
Edwalton Member (C1- Undrained)		19	Undrained	90		Constant	None
Edwalton Member (C2- Undrained)		19	Undrained	165		Constant	None

Method Name	Min FS
GLE / Morgenstern-	2.018

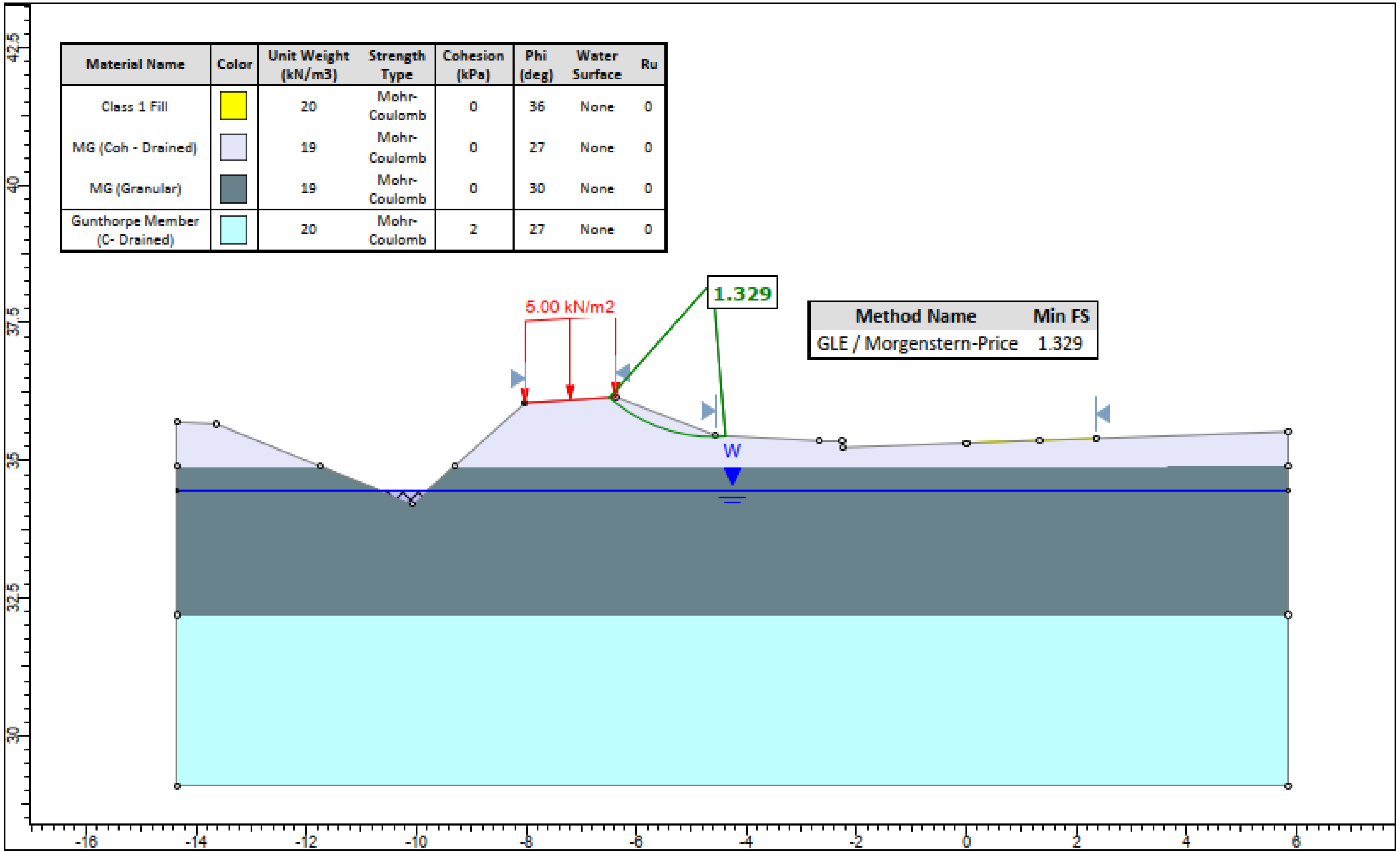
Project	SLIDE - An Interactive Slope Stability Program		
Group	NB-190-2+MS4	Scenario	DA1C1 - Undrained
Drawn By		Company	
Date	19/05/2022, 15:44:50	File Name	NB-190-2+MS4 -With GWT.slmd

SLIDEINTERPRET 9.028



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface
Class 1 Fill		20	Mohr-Coulomb	0	36		None
MG (Granular)		19	Mohr-Coulomb	0	30		None
Hemington Member (G)		19	Mohr-Coulomb	0	30		None
Edwalton Member (C1- Undrained)		19	Undrained	90		Constant	None
Edwalton Member (C2- Undrained)		19	Undrained	165		Constant	None

Method Name	Min FS
GLE / Morgenstern-Price	1.686

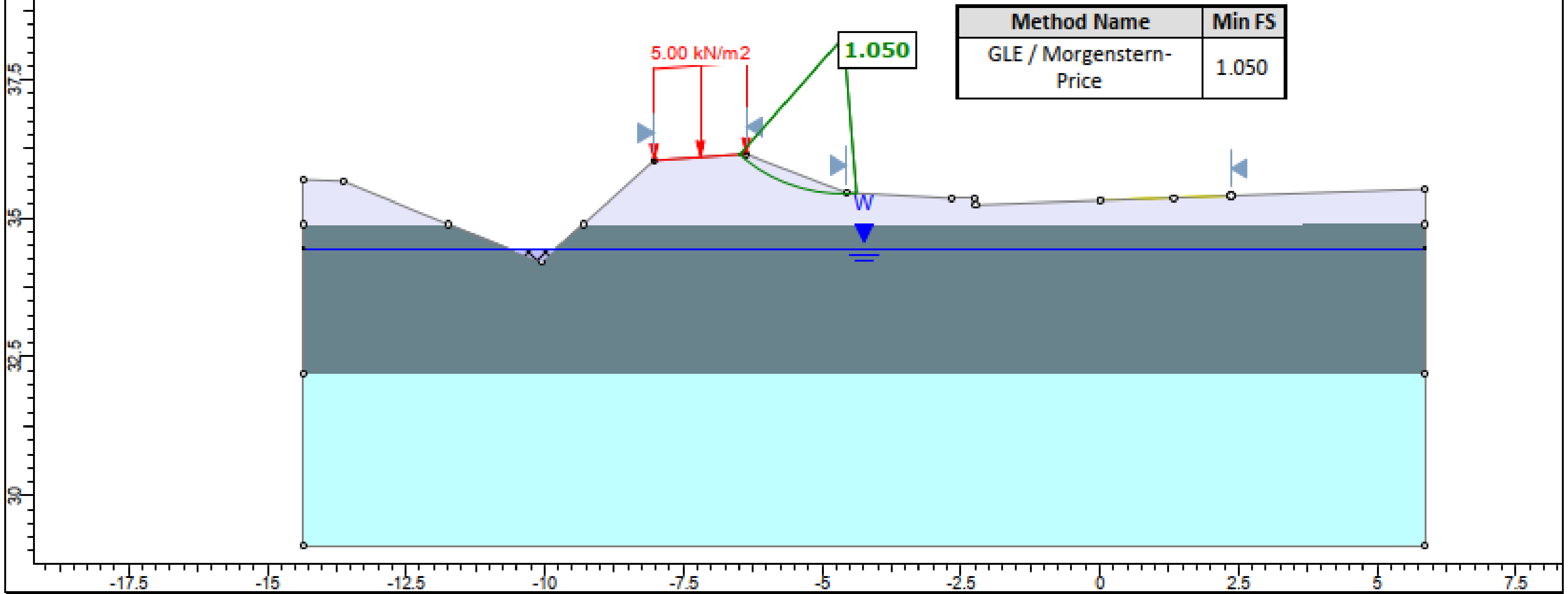


SLIDEINTERPRET 9.019

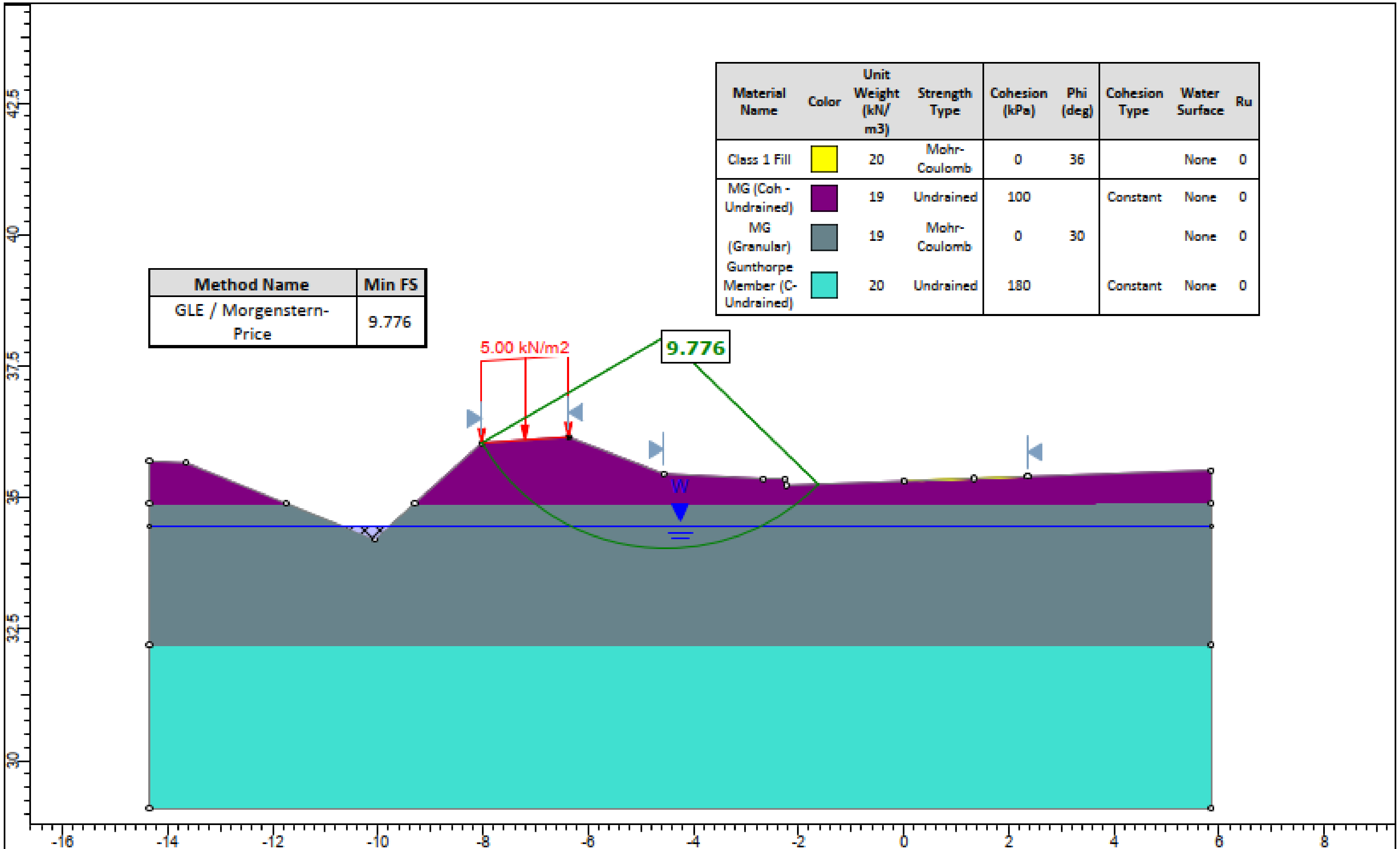
M1-J23a-J25-EA-NB-192-0			
Chainage	191940	Scenario	DA1C1 - Drained
Drawn By	AM	Company	WSP
Date	11-01-2024	File Name	NB-192-0 1 in 2.5.slmd

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
Class 1 Fill		20	Mohr-Coulomb	0	36	None	0
MG (Coh - Drained)		19	Mohr-Coulomb	0	27	None	0
MG (Granular)		19	Mohr-Coulomb	0	30	None	0
Gunthorpe Member (C-Drained)		20	Mohr-Coulomb	2	27	None	0

Method Name	Min FS
GLE / Morgenstern-Price	1.050



SLIDEINTERPRET 9.019	M1-J23a-J25-EA-NB-192-0		
Chainage	191940	Scenario	DA1C2 - Drained
Drawn By	AM	Company	WSP
Date	11-01-2024	File Name	NB-192-0 1 in 2.5.slmd

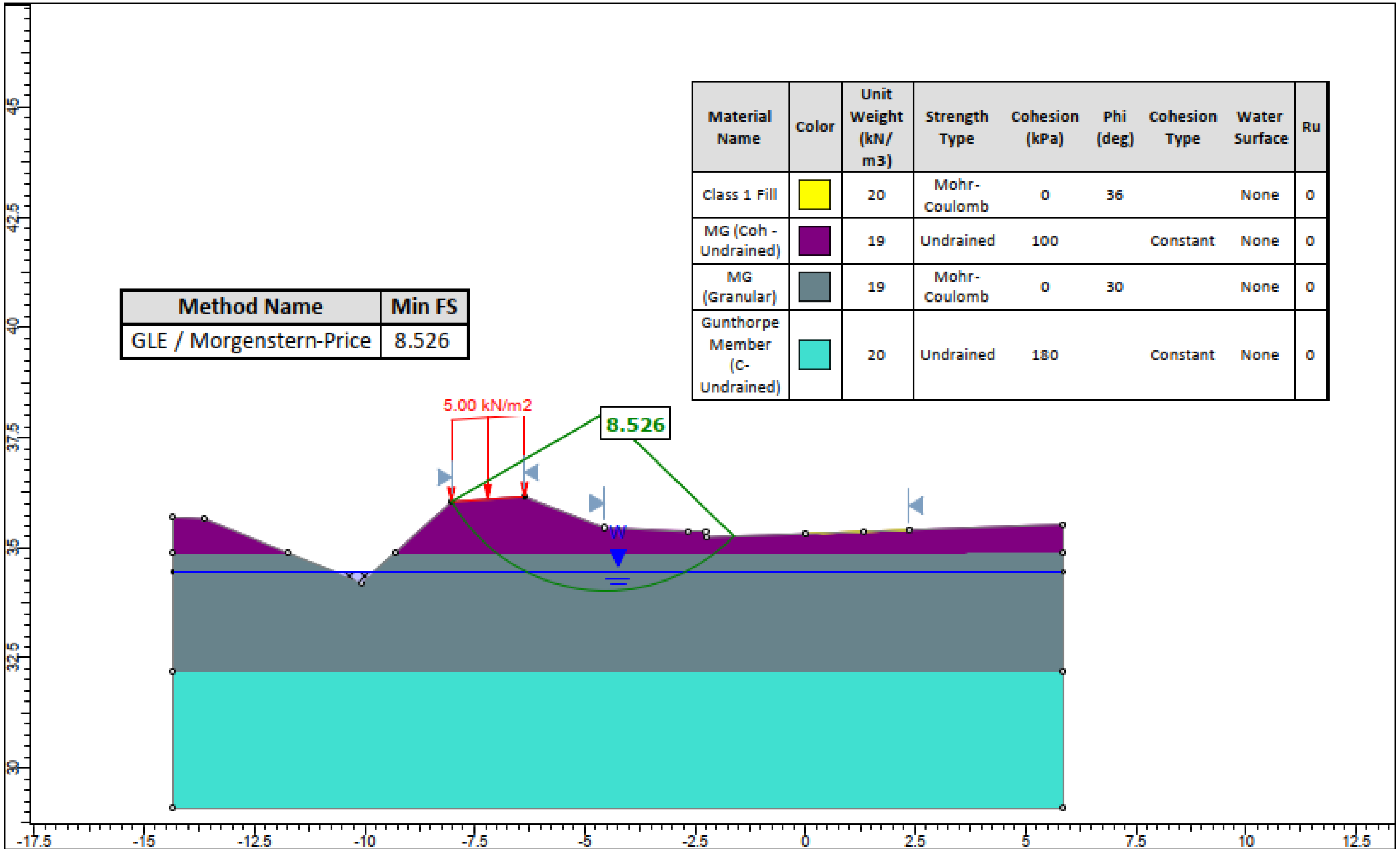


Method Name	Min FS
GLE / Morgenstern-Price	9.776

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Ru
Class 1 Fill		20	Mohr-Coulomb	0	36		None	0
MG (Coh - Undrained)		19	Undrained	100		Constant	None	0
MG (Granular)		19	Mohr-Coulomb	0	30		None	0
Gunthorpe Member (C-Undrained)		20	Undrained	180		Constant	None	0

	M1-J23a-J25-EA-NB-192-0		
Chainage	191940	Scenario	DA1C1 - Undrained
Drawn By	AM	Company	WSP
Date	11-01-2024	File Name	NB-192-0 1 in 2.5.slmd

SLIDEINTERPRET 9.019



Method Name	Min FS
GLE / Morgenstern-Price	8.526

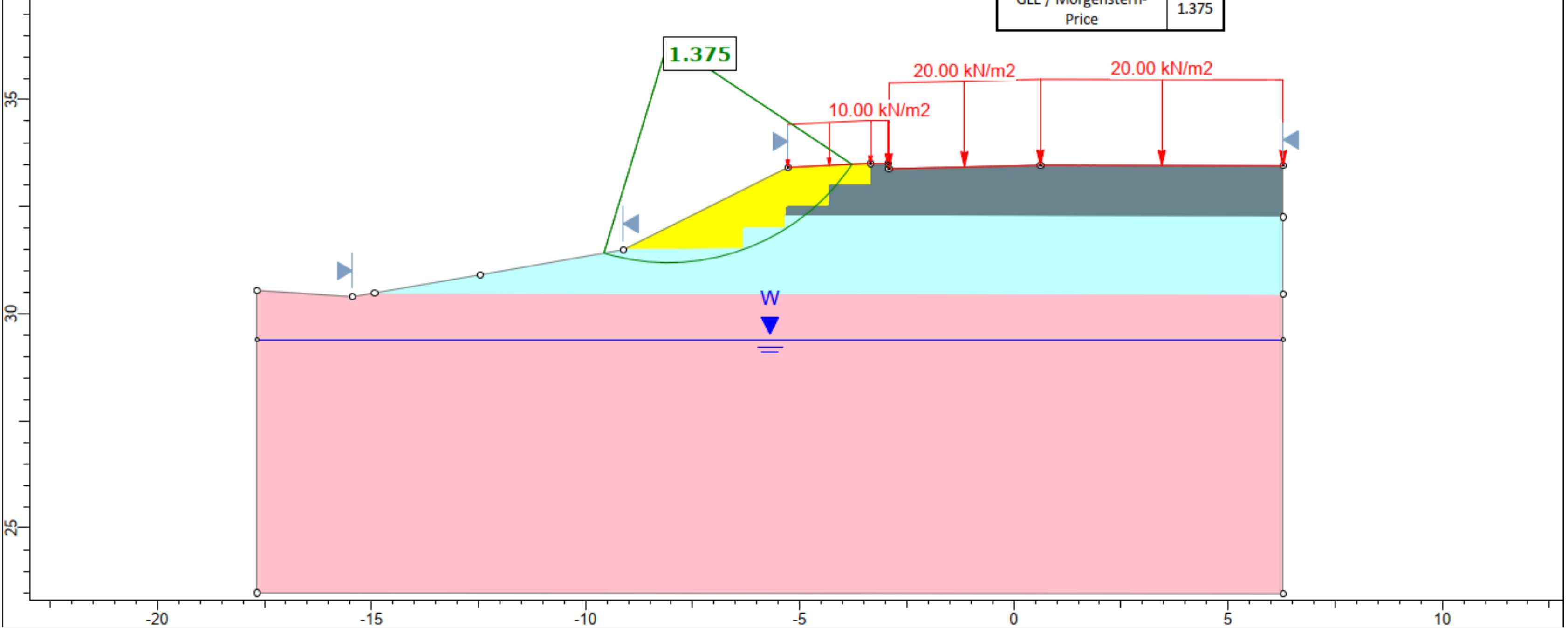
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	Water Surface	Ru
Class 1 Fill		20	Mohr-Coulomb	0	36		None	0
MG (Coh - Undrained)		19	Undrained	100		Constant	None	0
MG (Granular)		19	Mohr-Coulomb	0	30		None	0
Gunthorpe Member (C-Undrained)		20	Undrained	180		Constant	None	0

M1-J23a-J25-EA-NB-192-0			
Chainage	191940	Scenario	DA1C2 - Undrained
Drawn By	AM	Company	WSP
Date	11-01-2024	File Name	NB-192-0 1 in 2.5.slmd

SLIDEINTERPRET 9.019

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Class 1 Fill		20	Mohr-Coulomb	0	36	None
MG (Granular)		19	Mohr-Coulomb	0	30	None
Hemington Member (C-Drained)		19	Mohr-Coulomb	0	27	None
Hemington Member (G)		19.5	Mohr-Coulomb	1	30	None

Method Name	Min FS
GLE / Morgenstern-Price	1.375

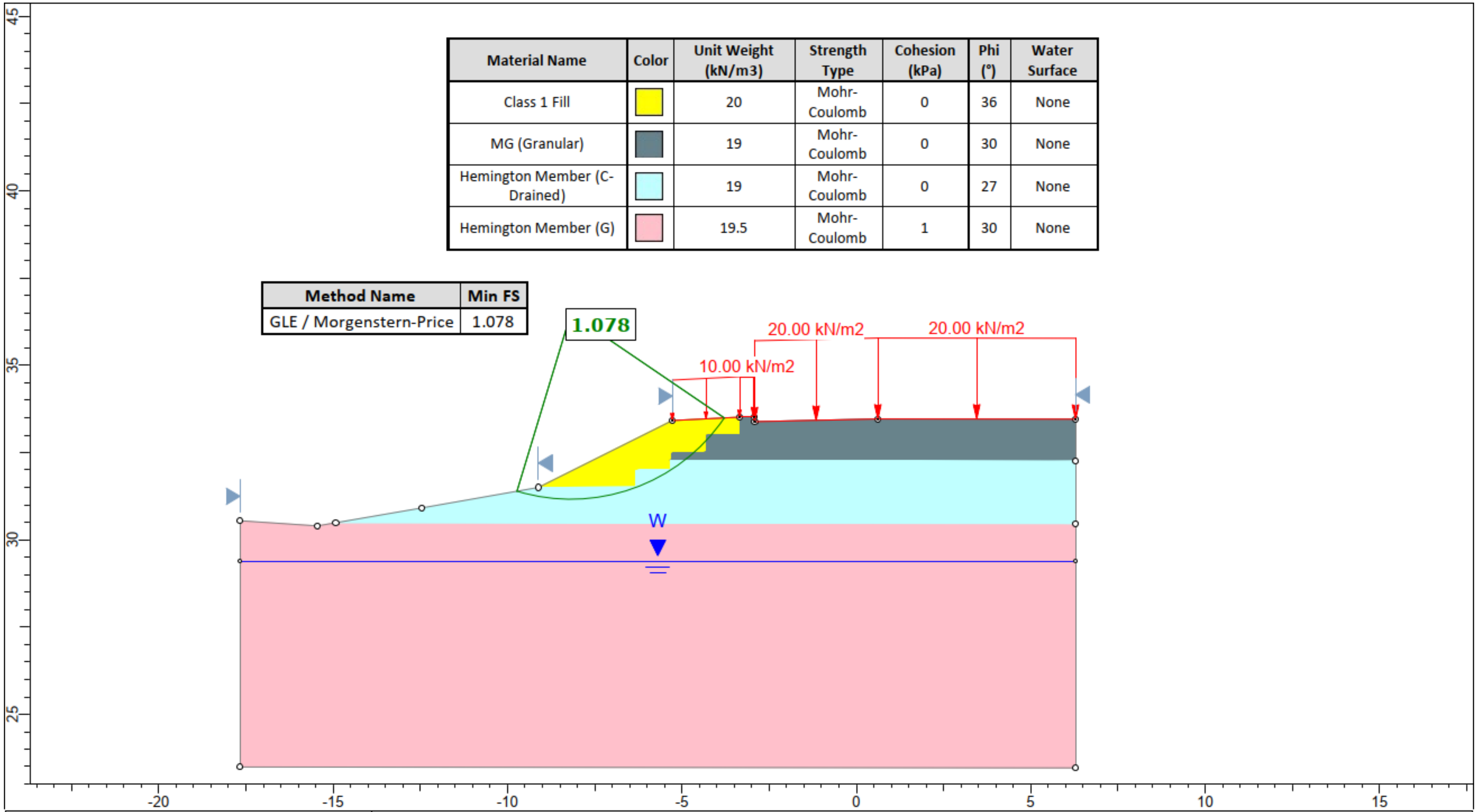


Project	SLIDE - An Interactive Slope Stability Program		
Group	SB 187-7	Scenario	DA1C1 - Drained
Drawn By		Company	
Date	19/05/2022, 15:44:50	File Name	SB187-7 - GWT.slmd

SLIDEINTERPRET 9.028

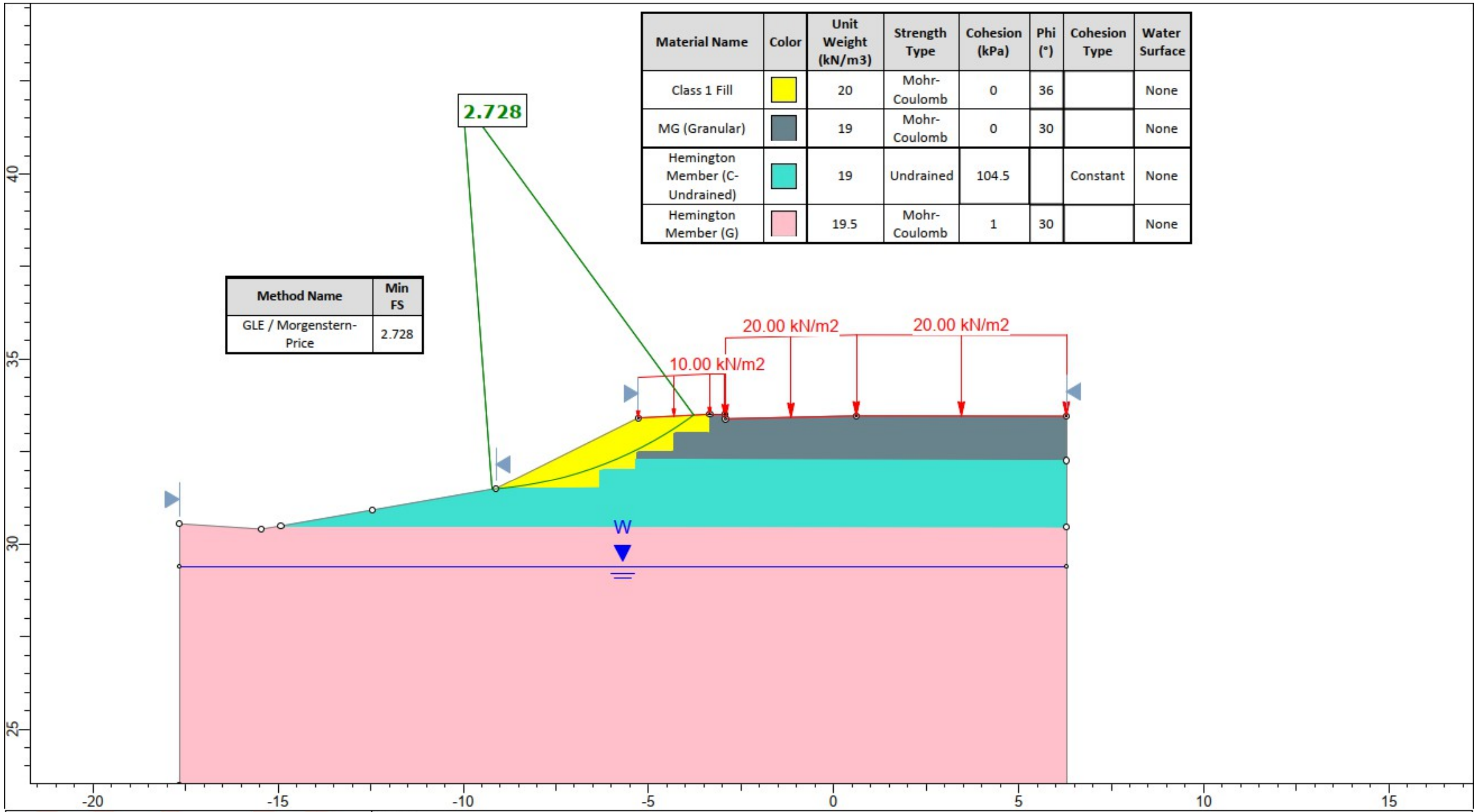
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
Class 1 Fill		20	Mohr-Coulomb	0	36	None
MG (Granular)		19	Mohr-Coulomb	0	30	None
Hemington Member (C-Drained)		19	Mohr-Coulomb	0	27	None
Hemington Member (G)		19.5	Mohr-Coulomb	1	30	None

Method Name	Min FS
GLE / Morgenstern-Price	1.078



Project	SLIDE - An Interactive Slope Stability Program		
Group	SB 187-7	Scenario	DA1C2 - Drained
Drawn By		Company	
Date	19/05/2022, 15:44:50	File Name	SB187-7 - GWT.slmd

SLIDEINTERPRET 9.028



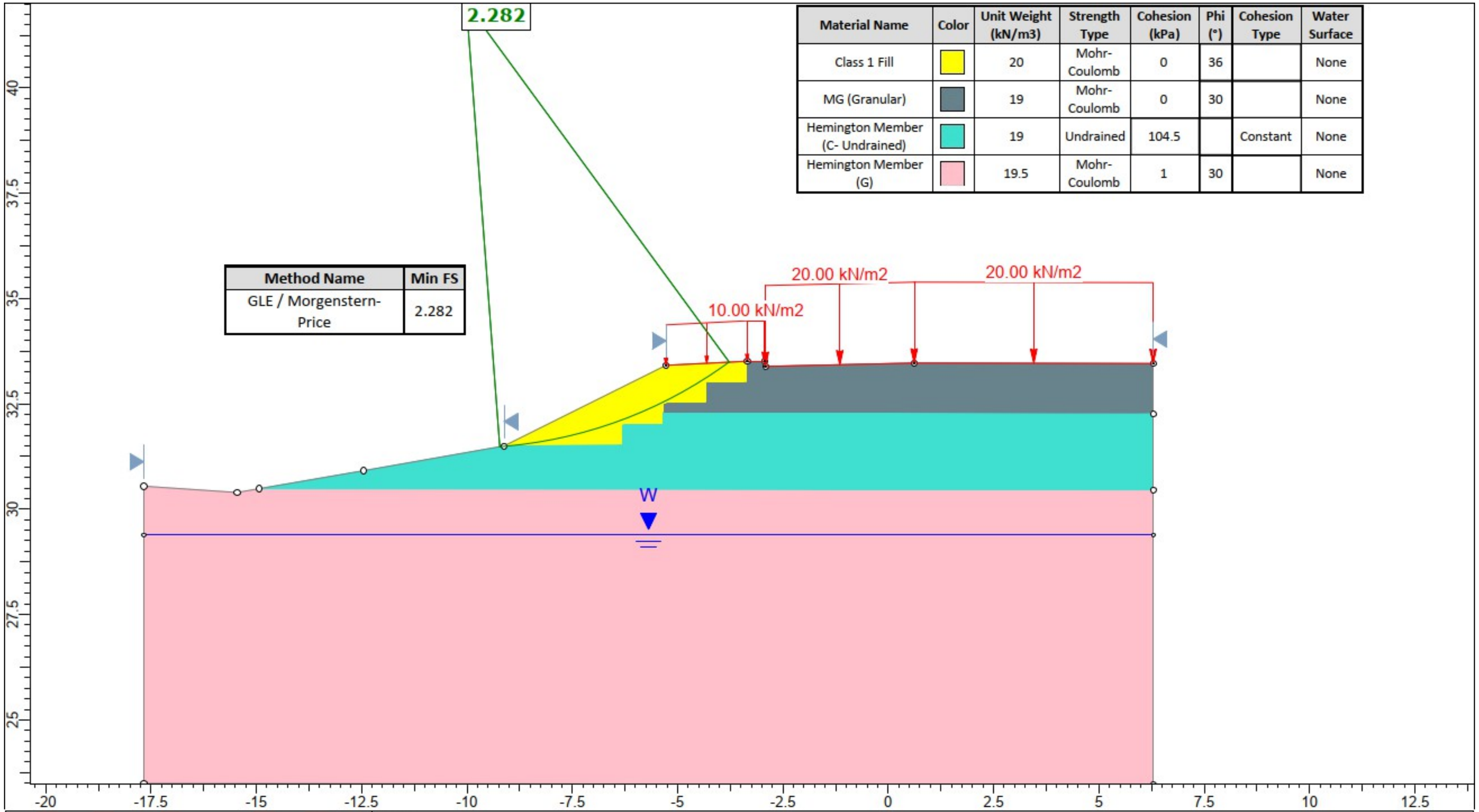
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface
Class 1 Fill		20	Mohr-Coulomb	0	36		None
MG (Granular)		19	Mohr-Coulomb	0	30		None
Hemington Member (C-Undrained)		19	Undrained	104.5		Constant	None
Hemington Member (G)		19.5	Mohr-Coulomb	1	30		None

Method Name	Min FS
GLE / Morgenstern-Price	2.728

SLIDEINTERPRET 9.028	Project	SLIDE - An Interactive Slope Stability Program	
	Group: SB 187-7	Scenario: DA1C1 - Undrained	
	Drawn By	Company	
	Date: 19/05/2022, 15:44:50	File Name: SB187-7 - GWT.slmd	

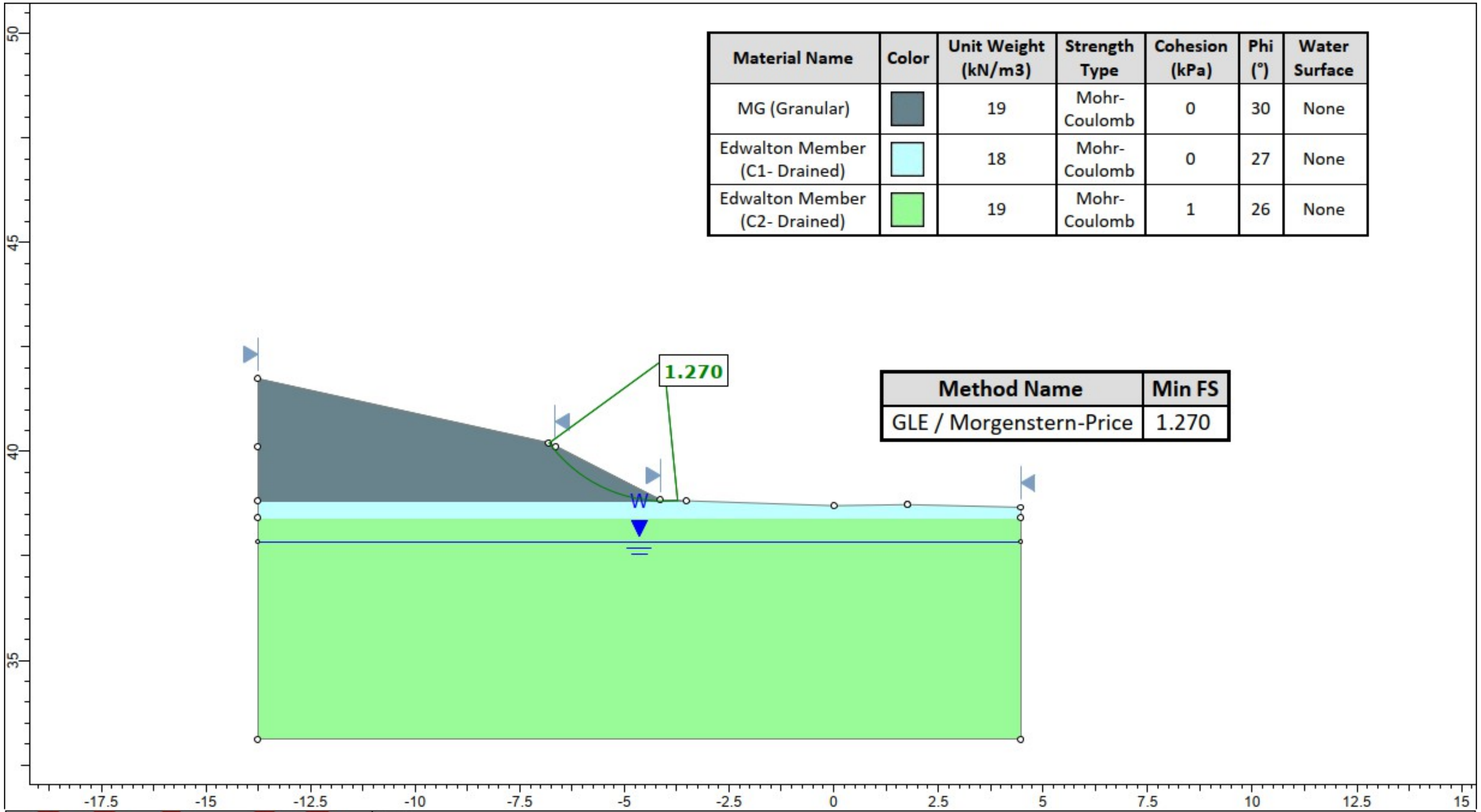
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface
Class 1 Fill		20	Mohr-Coulomb	0	36		None
MG (Granular)		19	Mohr-Coulomb	0	30		None
Hemington Member (C- Undrained)		19	Undrained	104.5		Constant	None
Hemington Member (G)		19.5	Mohr-Coulomb	1	30		None

Method Name	Min FS
GLE / Morgenstern-Price	2.282



SLIDEINTERPRET 9.028

Project	SLIDE - An Interactive Slope Stability Program		
Group	SB 187-7	Scenario	DA1C2 - Undrained
Drawn By		Company	
Date	19/05/2022, 15:44:50	File Name	SB187-7 - GWT.slmd

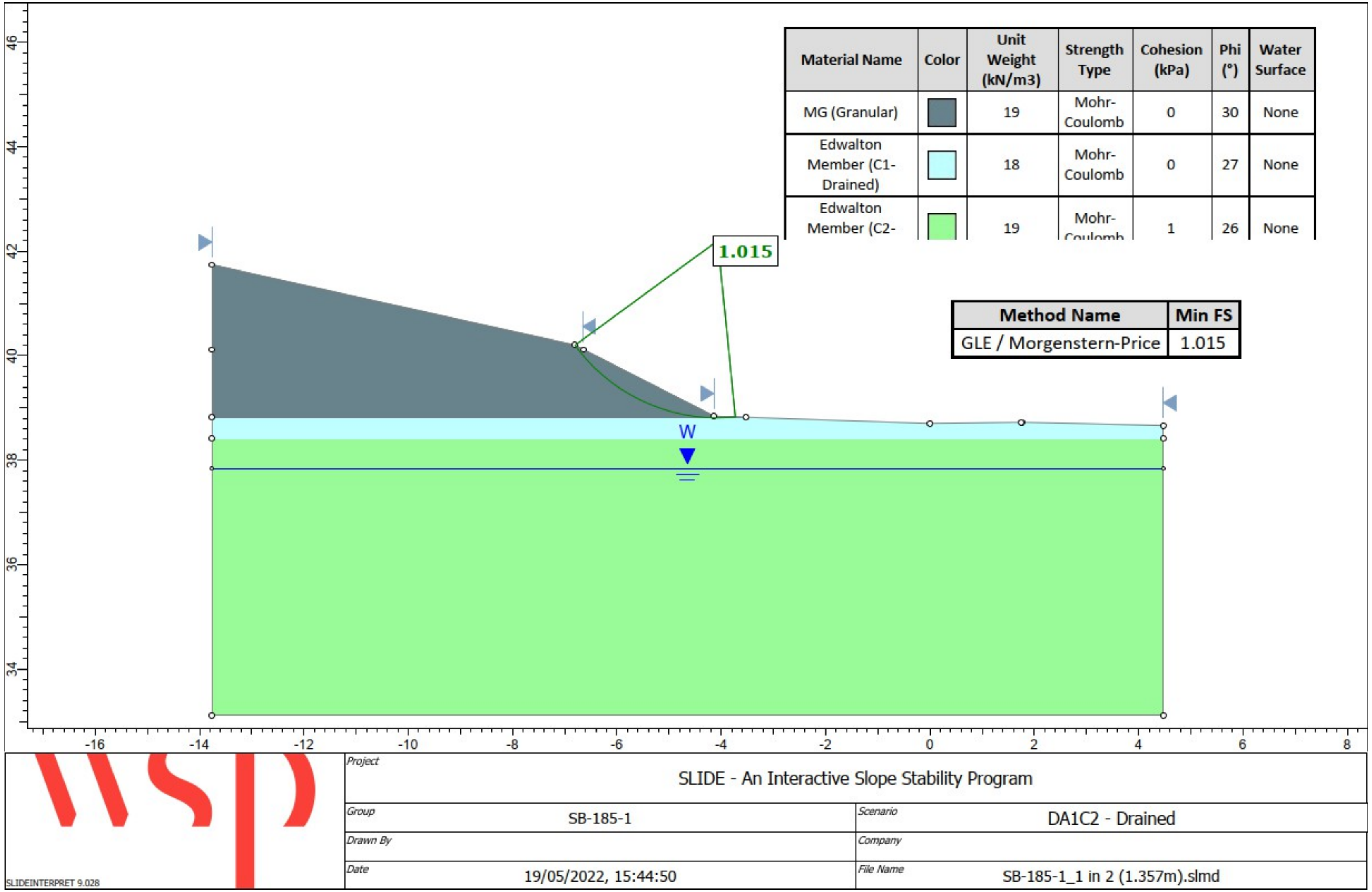


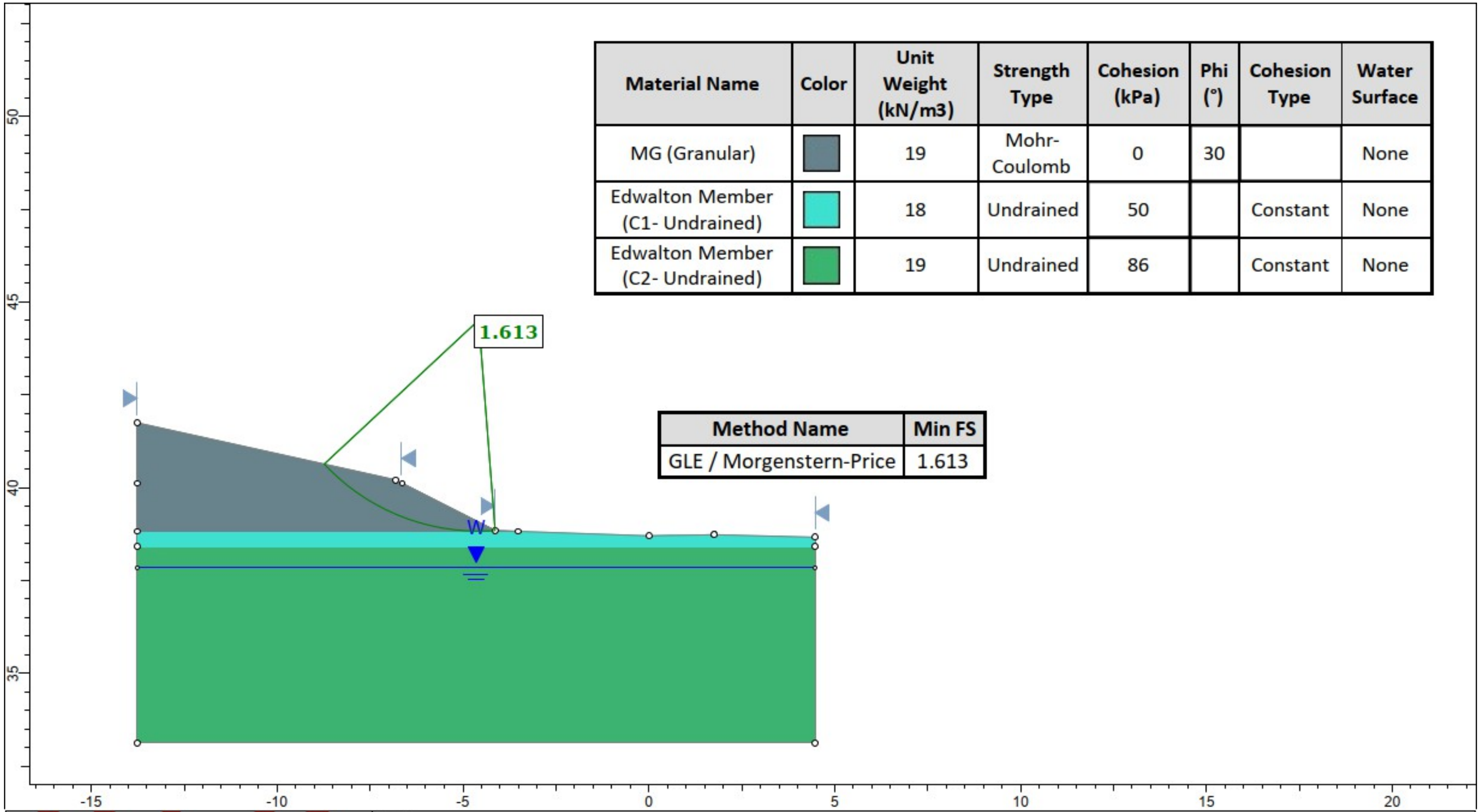
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Water Surface
MG (Granular)		19	Mohr-Coulomb	0	30	None
Edwalton Member (C1- Drained)		18	Mohr-Coulomb	0	27	None
Edwalton Member (C2- Drained)		19	Mohr-Coulomb	1	26	None

Method Name	Min FS
GLE / Morgenstern-Price	1.270

SLIDEINTERPRET 9.028

Project	SLIDE - An Interactive Slope Stability Program		
Group	SB-185-1	Scenario	DA1C1 - Drained
Drawn By		Company	
Date	19/05/2022, 15:44:50	File Name	SB-185-1_1 in 2 (1.357m).slmd


Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (°) | Water Surface
MG (Granular) | 19 | Mohr-Coulomb | 0 | 30 | None
Edwalton Member (C1-Drained) | 18 | Mohr-Coulomb | 0 | 27 | None
Edwalton Member (C2- | 19 | Mohr-Coulomb | 1 | 26 | None
1.015
Method Name | Min FS
GLE / Morgenstern-Price | 1.015
W
46
44
42
40
38
36
34
-16
-14
-12
-10
-8
-6
-4
-2
0
2
4
6
8
Project
SLIDE - An Interactive Slope Stability Program
Group
SB-185-1
Scenario
DA1C2 - Drained
Drawn By
Company
Date
19/05/2022, 15:44:50
File Name
SB-185-1_1 in 2 (1.357m).slmd
SLIDEINTERPRET 9.028

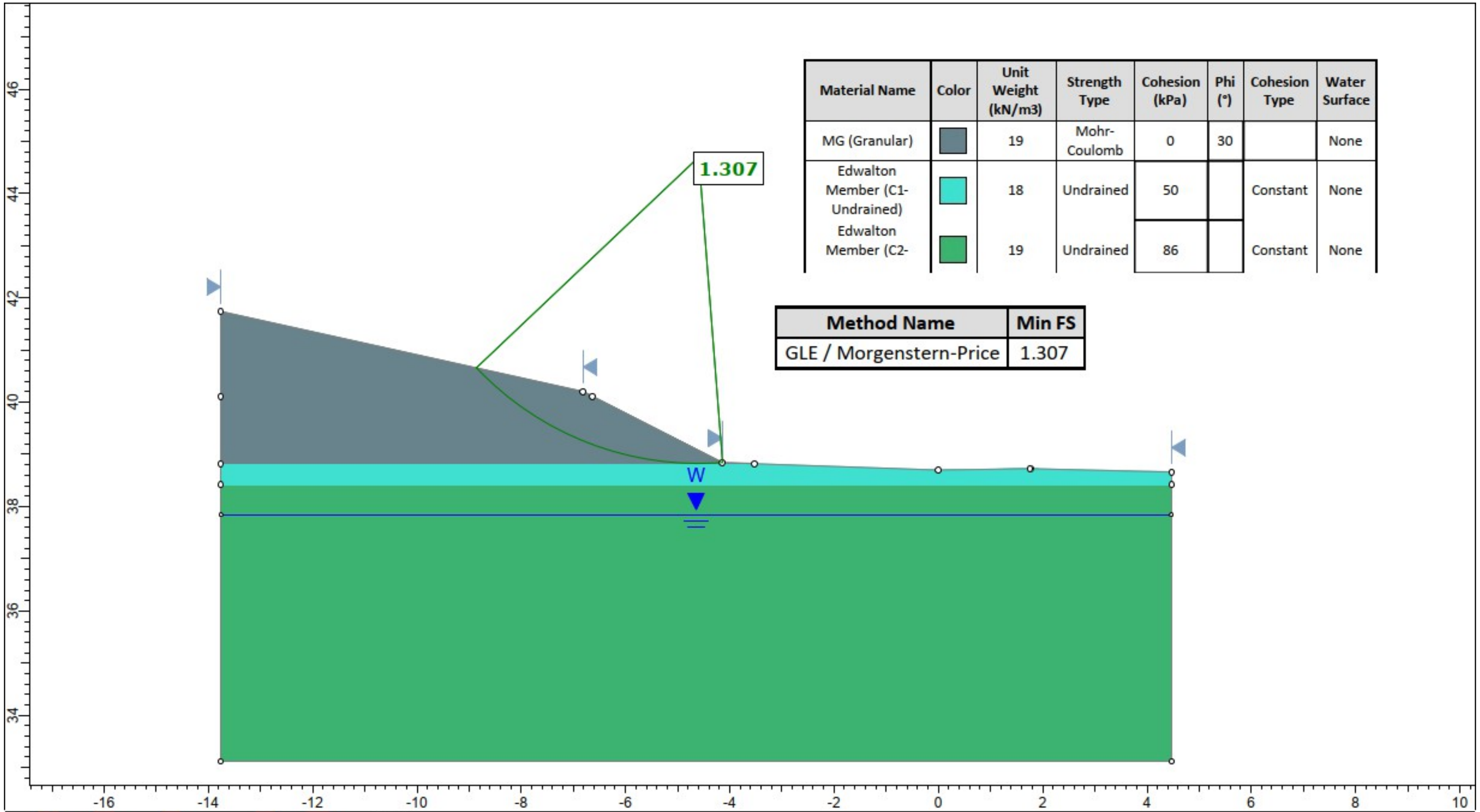


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface
MG (Granular)		19	Mohr-Coulomb	0	30		None
Edwalton Member (C1- Undrained)		18	Undrained	50		Constant	None
Edwalton Member (C2- Undrained)		19	Undrained	86		Constant	None

Method Name	Min FS
GLE / Morgenstern-Price	1.613

SLIDEINTERPRET 9.028

Project	SLIDE - An Interactive Slope Stability Program		
Group	SB-185-1	Scenario	DA1C1 - Undrained
Drawn By		Company	
Date	19/05/2022, 15:44:50	File Name	SB-185-1_1 in 2 (1.357m).slmd



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (°)	Cohesion Type	Water Surface
MG (Granular)		19	Mohr-Coulomb	0	30		None
Edwalton Member (C1-Undrained)		18	Undrained	50		Constant	None
Edwalton Member (C2-		19	Undrained	86		Constant	None

Method Name	Min FS
GLE / Morgenstern-Price	1.307

Project	SLIDE - An Interactive Slope Stability Program		
Group	SB-185-1	Scenario	DA1C2 - Undrained
Drawn By		Company	
Date	19/05/2022, 15:44:50	File Name	SB-185-1_1 in 2 (1.357m).slmd

SLIDEINTERPRET 9.028

Annex D MS4 Cantilever Gantry Geotechnical Design Report

NATIONAL EMERGENCY AREA RETROFIT M1 J23a-25

HE614830

MS4 Chainage 190+485

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* In addition to the mandatory final sign off, some products also require a prior ‘technical’ acceptance by one or more technical specialists (such as SES Transport Planning Group (TPG) or SES Environment Group) or ‘operational’ approval from OD.

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Contents

Introduction

This report forms the Geotechnical Design Report for the gantry foundations of the National Emergency Area Retrofit M1 J23a-25 scheme, which is to be attached to the main Geotechnical Design Report to be drafted by DED. This report concerns the helical pile foundations designed by Screwfast Foundations (part of Van Elle Limited) for the structures on the M1 J23a-25 scheme listed in Table 1 - 1.

This report should be read in conjunction with the AIP document ref; HE614830-WSP-SGY-P015_S2_ALLGENR-AV-CB-0001

Reference should be made to the Factual Ground Investigation Report by Strata Geotechnics, with reference, G230600 and dated 08/08/23.

G1 Cuttings

No major earthworks are necessary for the installation of the gantry foundations.

G2 Embankments

No major earthworks are necessary for the installation of the foundations.

G3 Highway structures

G3.1 *Details of highway structure types*

The structure type that will be supported on Screwfast foundations are given in Table 1 - 1. The structure loads are transferred to the piled foundations at the leg by means of a steel grillage. Details of the relevant highway structure and the site-specific foundation design, including foundation type and soil parameters, are summarised on the datasheets given in Appendix A.

The grillage also has a steel stair for access, which requires helical pile to be installed as part of the stair independent foundation.

The use of helical piles, has been determined using the available ground information for the site. The number of piles beneath the grillage has been determined by the available bearing capacity on the selected pile type and the most efficient combination of pile length and number of piles to restrain the required load.

G3.2 *General design details*

The design life of the structures is 30 years and the foundations have been designed with a corresponding 30-year design life. The structural design considers 30 years' design life plus 10 years for fatigue.

The factual ground report has been referenced for the ground model development. The relevant borehole is shown on the site-specific datasheets (Appendix A). Information from the factual report has been supplemented with data from the nearest borehole and literature such as Tomlinson and Woodward (2008) and Barnes (2010) where necessary to derive the soil parameters and soil mechanics for design for this project.

Table 1 – 1: Structures to be installed by ScrewFast Foundations

Gantry	Structure Type	Chainage	Structure Key	Carriage-way	Pile Type
MS4 190+485	MS4	190+485	STR 43871	NB	Helical

The friction angle of non-cohesive soils has been estimated using different methods for the different soil conditions, again a conservative estimate of phi (see below formulas adopted);

When Grain angularity is unknown:

<u>*Japanese Road Association, 1990*</u>

$\emptyset^{r} = 15 + \sqrt{(15 \times N)}$

When Grain angularity is known:

<u>*Dunham, J.W. Pile foundation for buildings*</u>

$\emptyset^{r} = 25 + \sqrt{(12 \times N)}$ Angular

$\emptyset^{r} = 15 + \sqrt{(12 \times N)}$ Rounded

$\emptyset^{r} = 20 + \sqrt{(12 \times N)}$ Well graded

Occasionally, where applicable, the derived Phi values from the formulas may be reduced to account for variations in the granular material including the potential for variations of cohesive content and grain angularity.

G3.3 *Design of ScrewFast Helical Piles*

ScrewFast's helical piles are designed using conventional pile design methodologies and soil mechanics in accordance with Eurocode 7, BS 8004:2015+A1:2020 and Perko (2009). Helical piles are classed as low displacement piles in the codes, therefore parameters and partial factors relevant to this pile type are used in the design. Minimum, maximum and estimated installation ('design') torque values are also produced as part of ScrewFast's design process to accompany the design for use as a check on the design during installation. The torque values are shown on the design calculation sheets at Appendix B. The maximum torque reflects the structural capacity of the pile steel elements and is used to ensure that the pile is not over-stressed during installation. The minimum and design torque values are calculated using empirical relationships modified from Perko (2009) developed by ScrewFast over many years and are used, if necessary, as described at Section G3.7.

Thedeparture prepared by DED will be submitted to NH for approval proposing use of ICE Specification for Piling and Embedded Retaining Wall 3rd Edition as the basis for installation of the helical piles.

G3.3.1 *Compressive and tensile capacity of a single pile*

The bearing capacity of each helical pile is considered as the sum of the capacities of each helical plate along the shaft. For conservatism, shaft resistance is ignored for the purposes of design. The capacity of each plate is calculated by considering it as an end-bearing face, with the helix plate area net of the shaft diameter. Each helix plate, therefore, acts as an individual base plate supported directly by the ground above and below it for tensile and compressive loads respectively. The shaft-type failure has been checked in the design of the spacing of the helix plates according to Boussinesq's theory. The most likely failure mechanism is the failure of individual helix plates, which is checked during design.

The equations used to calculate end-bearing resistance (q_b) are as follows:

In cohesive soil:	$q_b = 9.c_u$	where: c_u = undrained shear strength
In non-cohesive soil:	q_b = Nq.pd'	Nq = bearing capacity factor in accordance with Brinch Hanson pd' = average effective overburden pressure

These equations are widely used for pile design and are published in a variety of sources including Tomlinson and Woodward (2008) and Barnes (2010).

The strength of the founding stratum for each helix plate is calculated from weighted average ground strengths over one metre above or below the helix for tensile and compressive loads respectively. The ground strength average is weighted according to the distance from the helical plate.

The piles will be subjected cyclic loads as a result of the application and removal of the variable actions on the structure throughout its design life. To account for possible soil disturbance resulting from the cyclic loading, reference is made to section 5.6 of Perko (2009). This summarises work undertaken by Ghaly and Clemence (1998) which showed that upwards creep is almost 100 percent recoverable where the cyclic load is less than 25 percent of the ultimate static resistance, which was then confirmed by test results presented by Victor and Cerato (2008). Further, there is suggestion that the cyclical nature of the loads can cause stiffening of the soils and therefore increase pile resistance. As such, piles have been designed in accordance with this criteria.

Appropriate partial factors are applied, and the design resistance is checked against the factored actions in accordance with EC7 and CD365. These are all shown on the design calculation sheets given at Appendix B. Checks on the anticipated settlement performance against the required settlement forms part of the helical pile design checks.

As shown on the design calculation sheets in Appendix B, the design utilisation for the ULS DA1-1(STR) and DA1-2 (GEO) is 32% and 70% respectively. The design to Eurocode is considered acceptable when the pile utilisation is less than 100%. As discussed, the potential creep associated with cyclical loading is considered almost 100% recoverable where the cyclical load is less than 25% of the ultimate static resistance which will be maintained. The substructure deflection and rotation falls within the superstructure performance requirements; therefore the design is considered satisfactory for the proposed loads and performance criteria.

G3.3.2 *Pile group effects*

To determine pile loads within the pile group a 3D model of the grillage has been created using final element software Autodesk Robot Structural Analysis Professional. The gantry loads received from the superstructure designers were used to create load combinations according to CD365 and Eurocode 0 and the grillage and load distribution has been determined accordingly using a FEM software. Individual pile loads, and the redistribution of the loads between the piles within the pile group, have been calculated considering the pile and the grillage beam arrangement and the stiffness of all the grillage elements.

Large diameter reinforced concrete piles are commonly analysed as a group since the collective capacity of the pile group is less than the sum of the individual pile capacities. By contrast, helical pile group capacity is simply the sum of the individual pile capacities provided pile spacing is adequate. Adequate pile spacing is checked for each structure type in the corresponding worst case pile ground conditions following Perko (2009), to determine whether any group reduction factor is required. These checks are provided in Appendix B.

G3.3.3 *Methodology for Category III checking of ScrewFast helical piles – compression and tension*

As per the Category III requirements, all pile designs are independently checked prior to approval by Richter Associates.

In accordance with the conventional soil mechanics approach, the helical piles are checked for their serviceability and ultimate limit states specified in BS 8004:2015 + A1 2020.

G3.3.4 *Durability design*

The foundation site has been classified as C5 (M) in accordance with BS EN ISO 12944-2:2007 which is an appropriate classification for steel structures located in the highway verge susceptible to de-icing salts.

The piles, including all connecting bolts, have been designed for a 30 years design life plus 10 years for fatigue, with reference to BS EN 1993-5: 2007. All structural steelwork above ground and steel piles to the minimum depth of 2 meters below ground level are protected by galvanizing and a coating in accordance with protection system SHW Series 1900 Table 19/4C – G2B ground section for piles and upper section for grillage. The above ground bolts are to be visually inspected every two years with a principal inspection every six years.

G3.4 *Design of ScrewFast Helical Piles Cap Analysis*

The piles, grillage and plinth are designed using finite element software Autodesk Robot Structural Analysis Professional. The superstructure loads are applied at the top of the plinth connection and the pile loads are determined from the analysis output. The output from the analysis includes load effects in the plinth and grillage members enabling these items to be designed.

The deflection and rotation outputs from the analysis at the plinth top are checked against the limits specified by the superstructure designer. Spring stiffness supports are used to model the pile settlements and deflections. The analysis also gives horizontal and vertical loads applied to each of the piles.

The plinth to gantry leg connection is analysed as a rigid connection. The pile to grillage connection is a single stud. It is neither fully fixed nor a pure pin connection. The pile to grillage connection is modelled as fixed and pinned in turn, the output giving the most onerous conditions is then used in the design.

G3.4.1 *Lateral capacity*

The software, Oasys Alp, was used to calculate the horizontal pile capacities. The model inputs include the loads derived from wind action on the signs, groundwater level and the soil strength based on the ground investigation data. The horizontal displacement (deflection) and bending are calculated under the combination of the shear force and bending moment. The laterally loaded piles are subject to cyclical actions resulting in the application and removal of the variable loads. In this instance the generated P-Y curve method based upon cyclical loads is used in Oasys Alp provided in Appendix B. The P-Y curves are generated from the same data set as those used in the vertical pile model. Lateral loads are supported by the passive resistance of the soil and fixed pile head with partial restraint to rotation.

From the design calculation sheet, the structural utilisation is 19% The calculated substructure deflection and rotation falls within the superstructure performance requirements and therefore the design is considered satisfactory for the proposed loads and performance criteria.

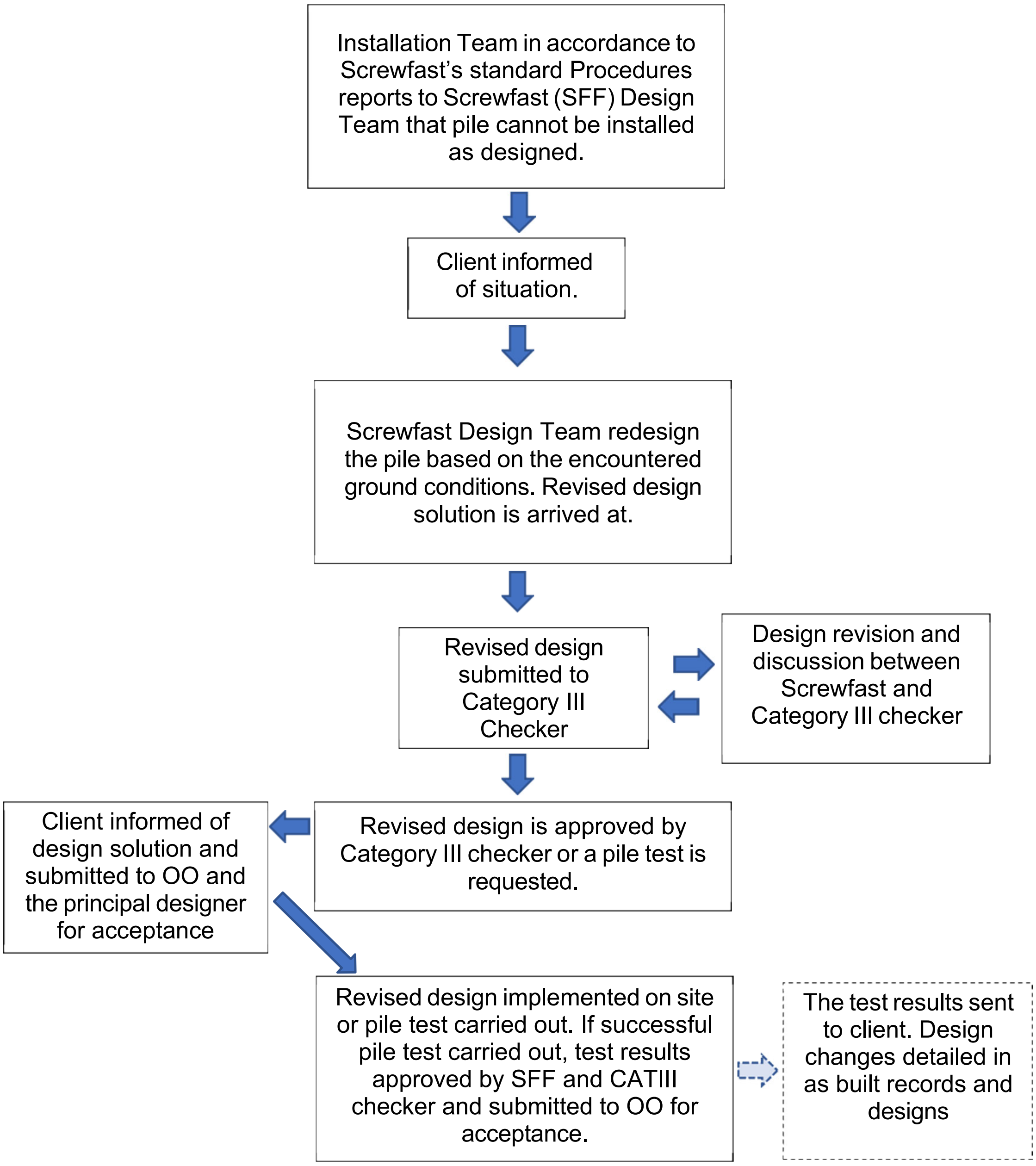
G3.4.2 *Methodology for Category III checking of ScrewFast helical piles – lateral capacity*

As per requirements, all pile designs are independently checked prior to approval by Richter Associates prior to approval by the Overseeing Organisation (OO)

G3.5 *Monitoring during pile installation*

The process described in Figure 2-2 is carried out as soon as and only if an issue is detected with the design. The installation team reports to Screwfast's design engineers that the pile cannot be installed as designed by the end of the shift at the latest. Screwfast's design engineers inform the Category III checkers and OO as soon as possible and the redesign process begins, with a view to reaching an agreed solution as soon as practicable. Installation of the revised design and any pile testing is then undertaken as soon as the installation programme permits. The testing equipment will be stored at a nearby compound so that instances as described above can be tested quickly.

Figure 2-2: Process for dealing with a pile that does not achieve design depth:



G4 SGM

Not used.

G5 Drainage

Not used

G6 Pavement design, subgrade design (including the need for in-situ treatment, etc.) and capping

Not used

G7 Contamination and ground gas risk

Refer to main report.

G8 Ground treatment (including void stabilisation)

Refer to main report.

G9 Geotechnical risk register

A review of the geotechnical and environmental risks associated with the proposed works has been undertaken using risk rating criteria outlined in Table 11 - 1.

Table 11 - 1: Risk Rating Criteria

Likelihood (L)		**Severity (S)**		**=**	**Risk (R)**					
						Likelihood				
						1	2	3	4	5
Negligible	1	Catastrophic	5	Severity	5	5	10	15	20	25
Unlikely	2	Major	4		4	4	8	12	16	20
Possible	3	Moderate	3		3	3	6	9	12	15
Probable	4	Minor	2		2	2	4	6	8	10
Almost Certain	5	Insignificant	1		1	1	2	3	4	5

Risk Ratings

1 to 5	Risk is negligible or of otherwise low severity and shall be set aside for further consideration.
6 to 10	Risk is unacceptable, avoid or manage with mitigation measures and controls.
11 to 25	Risk is intolerable, avoid or manage with mitigation measures and controls.

The geotechnical risk register provided as part of the GDR and is presented in Table 11 - 2, incorporating residual risks, anticipated geotechnical 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			Owner
			L	S	R		L	S	R	
A – Slopes and Earthworks										
A1	Unknown slope gradients on or adjacent to scheme leading to unfavourable slope conditions	Instability	3	4	12	Assess slope data to confirm slope angles. Where necessary undertake earthworks inspection to incorporate data in the design phase.	1	4	4	Pile Contractor
A2	Unknown ground conditions and potential geo-hazards	Instability resulting from compressible soils, voids due to presence of soluble rocks, coal, glacial features where pre-existing shear surfaces may exist, e.g. in Coal	2	4	8	Geotechnical design appropriate to project ground models and parameters based on site-specific review of stratigraphy and parameters and ground investigations. Select a low impact piling technique for the work such as helical.	2	3	6	Pile Contractor
B – Foundations and Substructures										
B1	Unknown levels of hard ground. Risk to buildability	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 requirement for re-design during construction	4	3	12	Appropriate foundation solutions designed for ground conditions present. Prepared plan for pile design changes.	2	3	6	Pile Contractor
B2	Adjacent Structures – works affecting services. Unplanned against other structures	Damage to services and endangering road users. Damage to adjacent structures. Increased costs in repair to damage incurred.	3	5	15	Locate all structures prior to design and leave sufficient distance from location. Locate services prior to commencement of works.	1	5	5	Pile Contractor
B3	Unknown ground chemistry – attack on buried steel leading to reduced strength of foundations	Risk to road users from failed post/piles. Increased cost to scheme to repair/replace gantries or piles	4	3	12	Used appropriate steel design in for piles and posts.	1	3	3	Pile Contractor
B4	Variability in ground conditions unknown, i.e. presence of buried channels.	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 pile materials and costs.	4	4	16	Designed to practicable worst-case scenario. Prepared with alternative piling methods.	2	4	8	Pile Contractor
B5	Softening / weakening of ground on exposure	Failure or deformation in excess of structure serviceability limits resulting in structure / infrastructure damage.	4	4	16	Piling techniques chosen that do not result in exposure of ground conditions.	1	4	4	Pile Contractor
B6	Presence of voids	Loss of end bearing for piles. Collapse of bore in location of voids.	2	4	8	Identify and report potential voids during installation to enable design checks to be undertaken.	1	4	4	Pile Contractor
B7	Boulders / hard ground	False identification of rock head. Early refusal of piles on insufficient ground condition.	3	4	12	Best available BH data is used at each location following all stages of site wide GI.	1	4	4	Pile Contractor
C – Drainage and Flooding										
C1	Shallow groundwater levels unknown	Dewatering required during construction. Risks to foundations due to uplift	3	3	9	Conservative ground water levels are assumed in the design.	1	3	3	Pile Contractor
C2	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	Locations checked for areas of high flooding risk during design phase. Pile technique chosen to limit temporary works and open holes. Design also results in reduced Gantry footprint area. Contractor to be aware of weather conditions and adverse weather warnings. Contractor to plan temporary works to avoid working in adverse weather conditions. Contractor to plan emergency procedures for flooding events.	2	3	6	Pile Contractor
D – Mining/Underground Voids										
D1	Unknown presence of Coal/solution features/natural cavities/man-made cavities leading to unstable ground	Surface deformation, damage to structures. Pile instability leading to risk to road users. Repairs required leading to increased cost to development. Reviewed as part of GISR.	3	4	12	No evidence of any mine workings from GI carried out to date. Piling to be closely monitored throughout the installation for the presence of any voids. Feeding back to design where necessary or when Coal presence seems larger than predicted.	1	4	4	Principal Contractor
E – Temporary Works/Construction Issues										

Ref	Hazard	Consequence	Risk			Design Control Measures	Residual Risk			Owner
			L	S	R		L	S	R	
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 piling.	2	5	10	Pile Contractor
E2	Contaminated ground presence unknown.	Health and safety risk to site workers/road users. Increased cost to dispose of material off site. Delay programme and increase in cost to development. Reviewed as part of GIR and considered to be low risk.	2	4	8	Monitor for signs of contaminated land throughout the works.	1	4	4	Pile Contractor
F – Insufficient Geotechnical Data										
F1	Insufficient GI and/or laboratory testing for design	Stratigraphy and materials not as expected. Unforeseen ground conditions. Inappropriate design solutions. Re-design may be required with cost and programme implications	5	3	15	The pile design has taken projections of the best available information. The designs have been made to achieve the most flexible design possible, i.e. longer piles as pile shortening is simpler than lengthening once at site.	2	2	4	Pile Contractor
F2	Lack of groundwater monitoring	Not able to define groundwater level, leading to inappropriate design solutions.	3	3	9	Under normal conditions conservative assumptions made for ground water level based on topography and geology and adopted a groundwater at ground level as a conservative assumption.	1	3	3	Pile Contractor

G10 Specification appendices

Appendix 1/5 Rev 00: Testing to be carried out by the contractor
Appendix 16/6 Rev 00: Steel Helical Piles
Appendix 16/9 Rev 00: Static load testing of piles
Appendix 19/5 Rev 00: General requirements for protection of steelwork against corrosion

G11 Instrumentation and monitoring

Piles will be monitored for depth during installation.

G12 Pile testing requirements

Static load pile testing will be undertaken as part of ScrewFast's work. Testing will be undertaken to the requirements of the ICE SPERW 3rd Edition, EN 1997-1 section 7.5 and in accordance with SHW 1600 Series Appendix 16/9 (included at Annex 1). The details of this testing are outlined in Appendix 16/9 of Annex 1.

It is common UK pile testing practice that at least one percent of locations will be tested. There are a total of 13 piles. Therefore, we propose 1 tension test as this is the governing load case between tension and compression. A test report will be prepared summarising the results and performance of the piles.

Due to buildability and safety restrictions, it is not proposed that any lateral tests are undertaken at the site as this would require extensive and time consuming temporary works.

G13 Annex 1

APPENDIX 1/5: TESTING TO BE CARRIED OUT BY THE CONTRACTOR

1.5.1 the Contractor shall be responsible for carrying out the following tests detailed in the following Table in accordance with Clause 105.

Clause	Work, Goods or Material	Test	Frequency of Testing	Test Certificate	Comments
Series 1600					
1606	Helical piles		See comments	Required	Refer to Appendix 16/6 for details
1609	Static load testing of piles		See comments	Required	Refer to Appendix 16/9 for guidance
Series 1800					
1801 1803	Structural steels to BS EN 10025-1 and BS EN 10210			Required	
	Welding procedures	Test specified in BS EN ISO 15614-1	As required in BS EN ISO 15614-1 and Appendix 18		Reported in accordance with Annex B of BS EN 287: Part 1
Series 1900					
1909	Galvanised coating	Tests specified in BS EN ISO 1461 and Series 1900 of Volume 2 – Notes for Guidance on the SHW.	As required in BS EN ISO 1461 and Series 1900.		Method for sampling to be in accordance with Clause 1910.
1911	Paints				
	A and B samples	Specific Gravity Colour Match Composition Application Characteristic	As required in Clause 1911 and 1912		Samples will be selected in accordance with Clause 1911 and 1912

Notes:

1. Tests comparable to those specified in this Appendix will be necessary for any equivalent work, goods or materials
2. Unless otherwise shown in this Appendix tests and test certificates for work, goods or materials as scheduled under any one Clause are required for all such work, goods or materials in the Works.

APPENDIX 16/6: STEEL HELICAL PILES

The clause numbers in the schedule below refer to ICE SPERW 3rd Edition, 2017. The general piling works shall be undertaken in accordance with ICE SPERW 3rd Edition, 2017, section B7. Where the is a conflict of requirements the specification appendices shall take precedence.

B7 Clause number	Title	Requirements
7.1	General	Applies
7.2		
A	Penetration or depth	As per site specific design
B	Pre-drilling	To BS 8004:2015+A1:2020 where required.
C	Installation records	Applies, see installation sheets
D	Grades of steel	Shaft and helix • BS EN 10210 for shafts and BS EN 10025 for helices • Grade S355 J2H for shafts and S355 J2 for helices Bolts and studs • BS EN 15048 Class 8.8 bolts with class 10.9 nuts for galvanised bolts and class 8.8 nuts for other class 8.8 bolts • BS EN 14399-3 – class 10.9/10 – HR - tZn with washers to BS EN 14399-5
E	Types of corrosion protection	As per HA 1900 series table 19/4C-G2b ground section.
F	Thickness of primer and coats	As per HA 1900 series table 19/4C-G2b ground section.
G	Adhesion tests	As per 1900 series and project specific RAM
H	Welding procedures	Not required
I	Non-destructive testing of welds	Not required
J	Marking of piles	Not required
K	Constraints on pile testing	As per appendix 16/9
L	Other technical requirements	Not required
7.3.1	Compliance with standards	Applies
7.3.2	Inspection and test certs	Applies
7.3.3	Manufacturing tolerances	Applies
7.4.1	Ordering of piles	Not required
7.4.2	Marking of piles	Applies
7.4.3	Handling of piles	Applies
7.4.4	Installation of piles	Applies
7.4.4.1	Installation torque	Applies
7.4.4.2	Minimum torque	Applies
7.4.4.3	Maximum torque	Applies
7.4.4.4	Penetration rate	Applies
7.4.5	Extraction	Applies if required
7.5	Corrosion protection	Applies in aerobic zone
7.6	Welding Procedures	In accordance with Appendix 18/1. Non destructive MPI testing to BS EN ISO 9934-1
7.7	Static Load Testing	Applies; additional details in Appendix 16/9. Test pile removal only where specifically required
7.8	Records	Applies and included in the installation records

APPENDIX 16/9: STATIC LOAD TESTING OF PILES

1. Particular requirements for static load testing of piles

(a) Type of pile

This document refers to the Screwfast designed and installed helical piles. The site is designed for site specific ground conditions and loads. Tests are to be conducted on the site detailed in this report for which this appendix forms a part thereof. The pile testing is to be undertaken on helical piles.

(b) Type of test

All testing of piles shall be maintained load testing. Vertical tests will be two stage testing.

As there is one gantry with a total of 13 piles, one tension working pile test is proposed to be undertaken

(c) Details of working pile tests

Axial testing of working piles is proposed. The general procedure of this pile test type is included in this document.

All pile testing procedures will adhere to the National Highways' Specification for Highway Works (HA SHW) Clause 1609.33 and Table 16/6 and Institution of Civil Engineer's Specification for Piling and Embedded Retaining Walls, 3rd Edition (ICE SPERW) specifically section B17. No pile will be tested more than once to ensure the pile performance data is accurate and test conditions are repeatable.

Pile Testing Details

Working pile tests will be conducted on the project. The piles to be tested are intentionally left unspecified. In this way the test locations can be matched to the locations where construction constraints have been encountered or design changes have been necessary, or if any other issues arise. The vertical pile tests will be tested in two stages only as detailed in Table 1. Indicative pile testing layout is shown in Appendix C.

Table 1 – Vertical Maintained Load Test

	Load	Minimum Time to Maintain Load	Elapsed Time (minutes)
Stage 1	25% DVL	30 minutes	30
	50% DVL	30 minutes	60
	75% DVL	30 minutes	90
	100% DVL	6 hours	450
	75% DVL	10 minutes	460
	50% DVL	10 minutes	470
	25% DVL	10 minutes	480
Stage 2	Nominal 5kN	1 hour	540
	100% DVL	1 hour	600
	100% DVL + 25% SWL	1 hour	660
	100% DVL + 50% SWL	6 hours	1020
	100% DVL + 25% SWL	10 minutes	1030
	100% DVL	10 minutes	1040
	75% DVL	10 minutes	1050
	50% DVL	10 minutes	1060
	25% DVL	10 minutes	1070
	Nominal 5kN	1 hour	1130

Table adapted from ICE SPERW 3rd B17.1

Pile Testing Method

Vertical piles will be tested individually with a test beam, reaction piles or kentledge blocks and a test pile. The Specified Working Load (SWL, similar to F_{rep} discussed below), Design Verification Load (DVL) and maximum test load shall be specified in the individual test documentation.

The ICE SPERW defines DVL as the load which will be substituted for the SWL for the purpose of a test. In this case the unfactored load will be used as the DVL, so that the 100% DVL load increment will demonstrate pile displacement under the unfactored working load.

The ICE SPERW indicates that SWL is the unfactored load and that it is similar to the Representative Action (F_{rep}) defined in BS EN 1990 as $F_{rep} = \psi.F_k$ If the unfactored load was used as both SWL and DVL for the testing then the maximum test load would be 150% of the unfactored load. However, since the piles have been designed in accordance with Eurocode 0 and CD365, the characteristic loads (F_k) when multiplied by the appropriate partial factors (ψ) are less than 150% of the unfactored load. It is therefore considered inappropriate to use the unfactored load as the SWL. Accordingly, for the purposes of the testing, the value of SWL has been selected to ensure that the maximum test load of 100% DVL + 50% SWL is equal to the F_{rep} used for the designs, to ensure that the piles are tested to the precise design loads. Accidental loads, for which all piles have been designed, do not form part of the test loads combinations.

All testing shall be carried out in accordance with a Method Statement. The Method Statement will include details of the pile testing equipment, arrangement, form of test records and any temporary works required.

In all cases the loads applied shall be appropriate to the site specific working pile, any temporary reaction piles or kentledge blocks required shall be designed by Screwfast Foundations and are subject to the same design conditions as all the other piles on the project. Any working piles used as reaction piles shall be monitored during static load testing. Working reaction piles shall not uplift/settle by more than half the specified permissible settlement of the test pile at working load. If a test pile is deemed to have failed the test load, then the Designer shall be notified, and the pile shall be re-designed based on the results of the pile tests.

Unless otherwise agreed, the performance criteria for working piles tested for axial loads shall be as shown in table 2.

Table 2 – Pile Test Performance Criteria

Load	*Measurable Criterion*
Variable load only	5mm
100% DVL (under load)	10mm
Residual (load released)	-
100% DVL + 50% SWL (under load)	No excessive creep
Residual (load released)	-

Note: "-" represents that a deflection limit was not specified. This is applied to 'Residual Load' cases as these do not require a measurable deflection criterion.

The allowable pile vertical deflection (settlement) is 10mm under DVL. As the grillage design assumes a spring stiffness value predicated on 5mm settlement under variable action then this is an additional settlement limit. This 5mm limit however is determined under the variable actions only. This is based on the Highways Standard CD365 which states pre-camber in the gantry design accounts for the permanent action effects. This has been confirmed with the superstructure designer. Therefore, it is only the variable loads that account for the 5mm limit stated.

In order that testing stages do not have to be deviated from the testing standards the following method is proposed to make this determination with an illustrative example. If the test pile has a DVL of 100kN permanent and 70kN variable making it 170kN in total and the permanent and variable action split is 59/41. If, during the 170kN load stage, the pile settled by 8mm., then pile settlement under 70kN variable action is 8mm x 41% = 3.3mm. This test has passed because 8mm < 10mm, and 3.3mm < 5mm.

Ambient temperature will be monitored during testing. Should large temperature variations occur during testing, the deflections will be adjusted during reporting if temperature is deemed to have influenced the results.

The testing is to be completed by competent and experienced pile testing contractor. The applied load is to be monitored during load stages and pressure reapplied to that required for the stage should the hydraulic pressure fall. All such reapplications of pressure will be recorded.

The load test report shall include the following items in accordance with BS EN 1997-1:2004+A1:2013:

- A description of the site
- The ground conditions with reference to the ground investigation
- The pile type including details of the reaction piles
- Description of the loading and measuring apparatus and the reaction system
- Calibration documents for the load cells, the jacks and gauges.
- The installation records of the test piles
- Photographic records of the pile and the test site
- Test results in numerical form
- Time-displacement plots for each applied load when a step loading procedure is used
- Reasons for any departures from the above requirements

(d) Special materials to be used in construction of test piles where appropriate

(e) Special construction detail requirements for test piles
All construction details shall be as per the requirements for a working pile.

(f) Special requirements for pile-testing equipment and arrangement
None.

(g) Pile installation criteria
As per the site specific pile design installation.

(h) Time interval between pile installation and testing.

No time interval is necessary for helical pile testing as there is no concrete in the pile design.

(i) Removal of temporary works
Not applicable.

(j) Details of work to be carried out to the test pile cap or head at the completion of a test.

APPENDIX 19/5: GENERAL REQUIREMENTS FOR PROTECTION OF STEELWORK AGAINST CORROSION

19.5.1 Steelwork shall be designed to transfer the required working loads safely for the design life duration in the appropriate environmental conditions as per BS EN 1993-5 Section 4.

19.5.2 The sections of steelwork to be protected against corrosion and the details of the protection method shall be shown on the design fabrication drawings and detailed below.

19.5.3 The protective system shall include all required steelwork preparation, primers and all other coats.

19.5.4 The preparation of surfaces for the application of barrier or electrolytic systems shall be carried out safely by competent and appropriately trained personnel.

19.5.5 All work associated with surface preparation shall be undertaken inside a waterproof structure.

19.5.6 All surfaces to be coated shall be clean and dry and prepared as per the specific product requirements.

19.5.7 The method of application of protective systems shall comply with the manufacturer's instructions, including controls on limits of humidity.

19.5.8 All primary steelwork above ground and to a depth of 2m below ground level, unless specifically indicated on drawing to be own colour, will be galvanised and coated in a protective system to 1900 Series specification.

19.5.9 The protective system will be in accordance with National Highways Series 1900 Table 19/4C – G2b ground section for piles and upper section of the grillage.

19.5.10 The nominal mean thickness of the finished protective coating and, if necessary, of each protective system shall be as specified in the relevant standard BS EN ISO 1461, BS EN ISO 12944 or other.

19.5.11 In no case shall any protective system be less than 75% of the nominal thickness. Each coat shall be applied after an interval that ensures proper hardening or curing of the previous coat in accordance with the manufacturer's instructions. The completed protective system shall be checked for thickness and electrical connectivity. Areas where the thickness is less than that specified shall receive additional treatment and areas where the connection is not sound shall receive remedial attention.

19.5.12 The finished protective system shall be smooth, of dense and uniform texture and free from sharp protuberances or pin holes. Areas of excessive sags, dimpling or curtaining shall be re-treated.

19.5.13 Galvanising where specified on fabrication drawing to be in accordance with BS EN ISO 1461 with minimum mean cover of 85 microns unless otherwise stated.

19.5.14 Sacrificial anode(s) where specified to be of suitable material, appropriately sized for the application, and adequately fixed to the steelwork.

19.5.15 All bolts above ground and to a depth of 2m below ground level, to be galvanised, unless specified otherwise.

19.5.16 Surface soil which has been particularly contaminated by road salts should be removed and replaced by suitable compacted granular fill.

19.5.17 Any system damaged by subsequent processes or deterioration shall be removed and an approved manufacturers repair system used.

19.5.18 Where attachments are to be welded to the steelwork after installation, it is necessary to ensure that the coating system is removed and made good, or replaced where appropriate.

G14 Annex 2

Not applicable

References

- National Emergency Area Retrofit M1 J32-35a Approval in Principle, doc. ref No., HE614830-WSP-SGY-P015_S2_ALLGENR-AV-CB-0001
- BS EN 1997-1: 2004+A1:2013 Eurocode 7: Geotechnical design (EC7)
- NA to BS EN 1997-1: 2004+A1:2013 UK National Annex
- BS EN 1990:2002 Eurocode 0: Basis of Structural Design (EC0)
- NA to BS EN 1990:2002 UK National Annex
- BS EN 1993-5: 2007
- BS 8004:2015+A1:2020 Code of practice for foundations
- Japanese Road Association, 1990, Specification for Highway Bridges, IV.
- Tomlinson, M. & Woodward, J., 2008. Pile Design and Construction Practice. 5th Edition. Taylor & Francis
- PERKO, H.A., 2009, Helical piles – a practical guide to design and installation., Hoboken, New Jersey: John-Wiley, 2009, ISBN 978-0-470-40479-9.
- Barnes, G.E., 2010, Soil Mechanics Principles and Practice. 3rd Edition. Palgrave Macmillan.
- CD365 Portal and Cantilever Sign/Signal Gantries
- Factual Report on Ground Investigation – Strata Geotechnics – G230600 Issue 001 and dated 08/08/23
- Cerato, A.B. and R. Victor. 2008. “Effects of Helical Anchor Geometry on Long-Term Performance for Small Wind Tower Foundations Subject to Dynamic Loads.” Journal of Deep Foundations Institute, Vol 2, pp 30–41.
  ———. (in press). “Effects of Long-Term Dynamic Loading and Fluctuating Water Table on Helical Anchor Performance for SmallWind Tower Foundations.” Journal of Performance of Constructed Facilities.
- Ghaly, A.M. and S.P. Clemence. 1998. “Pullout Performance of Inclined Helical Screw Anchors in Sand.” Journal of Geotechnical and Geoenvironmental Engineering, Vol. 124, No. 7, pp. 617–627.

G14 Annex 2

Not applicable

References

- National Emergency Area Retrofit M1 J32-35a Approval in Principle, doc. ref No., HE614830-WSP-SGY-P015_S2_ALLGENR-AV-CB-0001
- BS EN 1997-1: 2004+A1:2013 Eurocode 7: Geotechnical design (EC7)
- NA to BS EN 1997-1: 2004+A1:2013 UK National Annex
- BS EN 1990:2002 Eurocode 0: Basis of Structural Design (EC0)
- NA to BS EN 1990:2002 UK National Annex
- BS EN 1993-5: 2007
- BS 8004:2015+A1:2020 Code of practice for foundations
- Japanese Road Association, 1990, Specification for Highway Bridges, IV.
- Tomlinson, M. & Woodward, J., 2008. Pile Design and Construction Practice. 5th Edition. Taylor & Francis
- PERKO, H.A., 2009, Helical piles – a practical guide to design and installation., Hoboken, New Jersey: John-Wiley, 2009, ISBN 978-0-470-40479-9.
- Barnes, G.E., 2010, Soil Mechanics Principles and Practice. 3rd Edition. Palgrave Macmillan.
- CD365 Portal and Cantilever Sign/Signal Gantries
- Factual Report on Ground Investigation – Strata Geotechnics – G230600 Issue 001 and dated 08/08/23
- Cerato, A.B. and R. Victor. 2008. “Effects of Helical Anchor Geometry on Long-Term Performance for Small Wind Tower Foundations Subject to Dynamic Loads.” Journal of Deep Foundations Institute, Vol 2, pp 30–41.
  ———. (in press). “Effects of Long-Term Dynamic Loading and Fluctuating Water Table on Helical Anchor Performance for SmallWind Tower Foundations.” Journal of Performance of Constructed Facilities.
- Ghaly, A.M. and S.P. Clemence. 1998. “Pullout Performance of Inclined Helical Screw Anchors in Sand.” Journal of Geotechnical and Geoenvironmental Engineering, Vol. 124, No. 7, pp. 617–627.

APPENDIX A1: Site Specific Datasheets
Primary Piles

Geotechnical Design Statement Appendix to GDR			
Structure:	**Document reference number**	**Version No:**	C00
MS4 190+485 PRIMARY PILES	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0001	**Last update:**	19/12/23

General Details	**Feature:** Gantry		**Ground Level:**	38.7m AOD
	Type: MS4 Cantilever		**Earthwork:**	Embankment
	Chainage: 190+485	**Section:**	**Carriageway:**	Northbound (NB)

Relevant Exploratory Holes	**Borehole Reference**	**Distance**	**Reference**
	G230600 – BH1904N	48m	233630

Mapped Geology

The British Geological Survey GeoIndex Onshore geology viewer indicates the site to be underlain by the Hemington Member, comprising gravels, sands and loam of Late Pleistocene to Holocene Epoch age overlying the Edwalton Member, part of the Mercia Mudstone Group, mainly comprising Mudstone and Siltstone, with beds of variably dolomitic siltstone and very fine grained sandstone, common in the lower half and finely disseminated gypsum, common in the upper half and deposited in the Carnian Age (227.3-237Ma)

Hydrogeology and Hydrology

From BGS database, hydrogeology maps record the Mercia Mudstone under its previous name of the Keuper Marl. It is described as concealed aquifers; aquifers with limited potential, regions without significant groundwater. They are described as Red-brown marls and siltstones, with important salt and gypsum horizons, reach great thickness in Cheshire. Minor sandstone intercalations can provide up to 0.3 l/s.

Recorded Ground Conditions

The vertical ground profile at this location consists of:

- 39.2 – 38.3mAD: Made Ground.
- 38.3 – 38.0mAD: Reddish Brown clayey sandy gravel.
- 38.0 – 31.7mAD: Very stiff gravelly silty sandy clay.
- 31.7 – 31.2mAD: Very stiff clayey sandy gravel
- 31.2 – 30.0mAD: Very soft slightly gravelly sandy clay.
- 30.0 – 29.7mAD: Very stiff slightly sandy slightly gravelly clay.
- 29.7 – 27.5mAD: Very stiff sandy gravelly clay.
- 27.5 – 27.3mAD: Fine to coarse sand.
- 27.3 – 27.2mAD: Firm gravelly sandy clay.
- 27.2 – 24.35mAD: Very dense medium to coarse GRAVEL
- 24.35 – 23.2mAD: Very stiff reddish brown sandy clay.
- 23.2 – 19.2mAD: Bedrock identified as mudstone and sandstone.

No groundwater was encountered in borehole BH1904N.

Geotechnical Ground Model for Design

Material	Level (mAD) Top of Strata	Notes
Sandy GRAVEL	38.21	Considered in lateral analysis only.
Very Stiff Sandy CLAY(1)	38.0	
Very Stiff Sandy CLAY(2)	36.2	
Very Stiff Sandy CLAY(3)	35.2	
Very Stiff Sandy CLAY(4)	33.2	
Very Stiff Sandy CLAY(5)	32.2	
Very Stiff Sandy GRAVEL	31.7	
Very Soft Gravelly CLAY	30.0	

Groundwater level coincident with ground level for vertical capacity.

Characteristic Values of Geotechnical Parameters

Stratum	γ (kN/m^3)	C_u (kN/m^2)	Φ' (°)	UCS (MN/m^2)
Sandy GRAVEL	20	-	36	-
V Stiff CLAY(1)	21	75	-	-
V Stiff CLAY(2)	21	85	-	-
V Stiff CLAY(3)	21	125	-	-
V Stiff CLAY(4)	21	140	-	-
V Stiff CLAY(5)	21	150	-	-
V Stiff GRAVEL	21	-	37	-

	V Soft Grav. CLAY	21	100	-	-
Characteristic and Factored Actions	**Characteristic**	Permanent Action (self-weight)	Permanent Action (removable)	Wind Action	Accidental Action
	Compression	40kN	20kN	120kN	-
	Tension	10kN	-	120kN	-
	Shear	-	-	40kN	-
	Factored		A1		R1
	DA1-C1	Compression	258kN		849.6kN
		Tension	198kN		622.4kN
			A2	R4 for M1	R4 for M2
	DA1-C2	Compression	216kN	499.8kN	326.8kN
		Tension	166kN	366.1kN	237.2kN
Design utilisation for ULS GEO/STR axial compression/tension (governing case)	DA1-C1 32%			DA1-C2 70%	
Governing load case	Vertical Case:	Permanent (self-weight) + Permanent (removable) + Wind along carriageway + Vertical Wind + Snow + Access Live Load			
	Horizontal Case:	Wind Load			
Foundation Design Recommendations	Piling Technique	Pile Raking Angle	Pile dimensions (length; shear tube; helical configuration)		
	Helical	0	9.0m pile comprising 406.4mm CHS A2m Galv, 355.6mm CHS B2M Galv, C2M 600/600, C1M 600, E2M 550/550		
	Pile Spacing	No. of Piles			
	1.2m	8			
Anticipated settlement and elastic deflections	Post-construction settlement and elastic vertical deflection (z-axis) under characteristic wind loading.			<5mm	
	Post-construction settlement and elastic vertical deflection (z-axis) under full characteristic loading.			<10mm	
	Deflection perpendicular to carriageway (x axis) for wind loads			<7mm	
	Deflection parallel to carriageway (y axis) for wind loads			<7mm	
	Rotation at top of plinth level perpendicular to carriageway (x axis) under wind load			<1.6 mrad	
	Rotation at top of plinth level parallel to carriageway (y axis) under wind load			<10.2mRad	
	Rotation at top of plinth level about vertical axis (z-axis) under wind load			<5.7 mRad	
Contaminated Land Assessment	Refer to main report				
BS EN 1993-5 Corrosion Assessment	The ground conditions are anticipated to be natural undisturbed soil, but have conservatively been taken as non-compacted and non-aggressive fills.			Design Life:	30 Years
Supervision, Instrumentation Monitoring and Testing Requirements	Monitor of pile depth and torque readings. For static pile testing requirements refer to Appendix 16/9 of Screwfast/Van-elle GDR				

APPENDIX A2: Site Specific Datasheets
Stair Piles

Geotechnical Design Statement Appendix to GDR			
Structure:	**Document reference number**	**Version No:**	C00
MS4 190+485 STAIR PILES	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0006	**Last update:**	19/12/23

General Details	**Feature:** Gantry		**Ground Level:**	38.7m AOD
	Type: MS4 Cantilever		**Earthwork:**	Embankment
	Chainage: 190+485	**Section:**	**Carriageway:**	Northbound (NB)
Relevant Exploratory Holes	**Borehole Reference**	**Distance**	**Reference**	
	G230600 – BH1904N	48m	233630	

Mapped Geology

The British Geological Survey GeoIndex Onshore geology viewer indicates the site to be underlain by the Hemington Member, comprising gravels, sands and loam of Late Pleistocene to Holocene Epoch age overlying the Edwalton Member, part of the Mercia Mudstone Group, mainly comprising Mudstone and Siltstone, with beds of variably dolomitic siltstone and very fine grained sandstone, common in the lower half and finely disseminated gypsum, common in the upper half and deposited in the Carnian Age (227.3-237Ma)

Hydrogeology and Hydrology

From BGS database, hydrogeology maps record the Mercia Mudstone under its previous name of the Keuper Marl. It is described as concealed aquifers; aquifers with limited potential, regions without significant groundwater. They are described as Red-brown marls and siltstones, with important salt and gypsum horizons, reach great thickness in Cheshire. Minor sandstone intercalations can provide up to 0.3 l/s.

Recorded Ground Conditions

The vertical ground profile at this location consists of:

- 39.2 – 38.3mAD: Made Ground.
- 38.3 – 38.0mAD: Reddish Brown clayey sandy gravel.
- 38.0 – 31.7mAD: Very stiff gravelly silty sandy clay.
- 31.7 – 31.2mAD: Very stiff clayey sandy gravel
- 31.2 – 30.0mAD: Very soft slightly gravelly sandy clay.
- 30.0 – 29.7mAD: Very stiff slightly sandy slightly gravelly clay.
- 29.7 – 27.5mAD: Very stiff sandy gravelly clay.
- 27.5 – 27.3mAD: Fine to coarse sand.
- 27.3 – 27.2mAD: Firm gravelly sandy clay.
- 27.2 – 24.35mAD: Very dense medium to coarse GRAVEL
- 24.35 – 23.2mAD: Very stiff reddish brown sandy clay.
- 23.2 – 19.2mAD: Bedrock identified as mudstone and sandstone.

No groundwater was encountered in borehole BH1904N.

Geotechnical Ground Model for Design

Material	Level (mAD) Top of Strata	Notes
Very Stiff Sandy CLAY(1)	38.4	
Very Stiff Sandy CLAY(2)	36.2	
Very Stiff Sandy CLAY(3)	35.2	
Very Stiff Sandy CLAY(4)	33.2	
Very Stiff Sandy CLAY(5)	32.2	
Very Stiff Sandy GRAVEL	31.7	
Very Soft Gravelly CLAY	30.0	

Groundwater level coincident with ground level for vertical capacity.

Characteristic Values of Geotechnical Parameters

Stratum	γ (kN/m^3)	C_u (kN/m^2)	Φ' (°)	UCS (MN/m^2)
V Stiff CLAY(1)	21	75	-	-
V Stiff CLAY(2)	21	85	-	-
V Stiff CLAY(3)	21	125	-	-
V Stiff CLAY(4)	21	140	-	-
V Stiff CLAY(5)	21	150	-	-
V Stiff GRAVEL	21	-	37	-
V Soft Grav. CLAY	21	100	-	-

<table>
<tr><td rowspan="12">Characteristic and Factored Actions</td><td>Characteristic</td><td>Permanent Action (self-weight)</td><td>Permanent Action (removable)</td><td>Variable Action</td><td>Accidental Action</td></tr>
<tr><td>Compression</td><td>5kN</td><td>-</td><td>5kN</td><td>-</td></tr>
<tr><td>Tension</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Shear</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="2">Factored</td><td>A1</td><td colspan="2">R1</td></tr>
<tr><td rowspan="2">DA1-C1</td><td>Compression</td><td>12.8kN</td><td colspan="2">89.0kN</td></tr>
<tr><td>Tension</td><td>-</td><td colspan="2">61.1kN</td></tr>
<tr><td colspan="2"></td><td>A2</td><td>R4 for M1</td><td>R4 for M2</td></tr>
<tr><td rowspan="2">DA1-C2</td><td>Compression</td><td>10.8kN</td><td>52.3kN</td><td>37.4kN</td></tr>
<tr><td>Tension</td><td>-kN</td><td>35.9kN</td><td>25.7kN</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>Design utilisation for ULS GEO/STR axial compression</td><td colspan="2">DA1-C1 14%</td><td colspan="3">DA1-C2 26%</td></tr>
<tr><td rowspan="2">Governing load case</td><td>Vertical Case:</td><td colspan="4">Permanent (self-weight) + Pedestrian</td></tr>
<tr><td>Horizontal Case:</td><td colspan="4">n/a</td></tr>
<tr><td rowspan="5">Foundation Design Recommendations</td><td>Piling Technique</td><td>Pile Raking Angle</td><td colspan="3">Pile dimensions (length; shear tube; helical configuration)</td></tr>
<tr><td>Helical</td><td>0</td><td colspan="3">3.0m pile comprising 139.7mm CHS A1.0m Galv, 114.3mm CHS, E2M 450.</td></tr>
<tr><td>Pile Spacing</td><td>No. of Piles</td><td colspan="3"></td></tr>
<tr><td>1.2m</td><td>1</td><td colspan="3"></td></tr>
<tr><td colspan="3">Post-construction settlement and elastic vertical deflection (z-axis) under full characteristic loading.</td><td colspan="2"><10mm</td></tr>
<tr><td>Contaminated Land Assessment</td><td colspan="5">Refer to main report</td></tr>
<tr><td>BS EN 1993-5 Corrosion Assessment</td><td colspan="3">The ground conditions are anticipated to be natural undisturbed soil, but have conservatively been taken as non-compacted and non-aggressive fills.</td><td>Design Life:</td><td>30 Years</td></tr>
<tr><td>Supervision, Instrumentation Monitoring and Testing Requirements</td><td colspan="5">Monitor of pile depth and torque readings.
For static pile testing requirements refer to Appendix 16/9 of Screwfast/Van-elle GDR</td></tr>
</table>

APPENDIX A3: Site Specific Datasheets
Secondary Piles

Geotechnical Design Statement Appendix to GDR			
Structure:	**Document reference number**	**Version No:**	C00
MS4 190+485 SECONDARY PILES	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0007	**Last update:**	21/12/23

General Details	**Feature:** Gantry		**Ground Level:**	38.7m AOD
	Type: MS4 Cantilever		**Earthwork:**	Embankment
	Chainage: 190+485	**Section:**	**Carriageway:**	Northbound (NB)
Relevant Exploratory Holes	**Borehole Reference**	**Distance**	**Reference**	
	G230600 – BH1904N	48m	233630	
Mapped Geology	The British Geological Survey GeoIndex Onshore geology viewer indicates the site to be underlain by the Hemington Member, comprising gravels, sands and loam of Late Pleistocene to Holocene Epoch age overlying the Edwalton Member, part of the Mercia Mudstone Group, mainly comprising Mudstone and Siltstone, with beds of variably dolomitic siltstone and very fine grained sandstone, common in the lower half and finely disseminated gypsum, common in the upper half and deposited in the Carnian Age (227.3-237Ma)			
Hydrogeology and Hydrology	From BGS database, hydrogeology maps record the Mercia Mudstone under its previous name of the Keuper Marl. It is described as concealed aquifers; aquifers with limited potential, regions without significant groundwater. They are described as Red-brown marls and siltstones, with important salt and gypsum horizons, reach great thickness in Cheshire. Minor sandstone intercalations can provide up to 0.3 l/s.			
Recorded Ground Conditions	The vertical ground profile at this location consists of: • 39.2 – 38.3mAD: Made Ground. • 38.3 – 38.0mAD: Reddish Brown clayey sandy gravel. • 38.0 – 31.7mAD: Very stiff gravelly silty sandy clay. • 31.7 – 31.2mAD: Very stiff clayey sandy gravel • 31.2 – 30.0mAD: Very soft slightly gravelly sandy clay. • 30.0 – 29.7mAD: Very stiff slightly sandy slightly gravelly clay. • 29.7 – 27.5mAD: Very stiff sandy gravelly clay. • 27.5 – 27.3mAD: Fine to coarse sand. • 27.3 – 27.2mAD: Firm gravelly sandy clay. • 27.2 – 24.35mAD: Very dense medium to coarse GRAVEL • 24.35 – 23.2mAD: Very stiff reddish brown sandy clay. • 23.2 – 19.2mAD: Bedrock identified as mudstone and sandstone. No groundwater was encountered in borehole BH1904N.			

Geotechnical Ground Model for Design	**Material**	**Level (mAD) Top of Strata**	**Notes**
	Sandy GRAVEL	38.21	Considered in lateral analysis only.
	Very Stiff Sandy CLAY(1)	38.0	
	Very Stiff Sandy CLAY(2)	36.2	
	Very Stiff Sandy CLAY(3)	35.2	
	Very Stiff Sandy CLAY(4)	33.2	
	Very Stiff Sandy CLAY(5)	32.2	
	Very Stiff Sandy GRAVEL	31.7	
	Very Soft Gravelly CLAY	30.0	
	Groundwater level coincident with ground level for vertical capacity.		

Characteristic Values of Geotechnical Parameters	**Stratum**	**γ (kN/m^3)**	**C_u (kN/m^2)**	**Φ' (°)**	**UCS (MN/m^2)**
	Sandy GRAVEL	20	-	36	-
	V Stiff CLAY(1)	21	75	-	-
	V Stiff CLAY(2)	21	85	-	-
	V Stiff CLAY(3)	21	125	-	-
	V Stiff CLAY(4)	21	140	-	-
	V Stiff CLAY(5)	21	150	-	-

Characteristic and Factored Actions	V Stiff GRAVEL	21	-	37	-
	V Soft Grav. CLAY	21	100	-	-
	Characteristic	Permanent Action (self-weight)	Permanent Action (removable)	Pedestrian Action	Accidental Action
	Compression	20kN	-	20kN	-
	Tension	-	-	-	-
	Shear	-	-	-	5kN
	Factored		A1	R1	
	DA1-C1	Compression	51kN	180.3kN	
	DA1-C1	Tension	-	-	
			A2	R4 for M1	R4 for M2
	DA1-C2	Compression	43.0kN	106.1kN	75.8kN
	DA1-C2	Tension	-	-	-
Design utilisation for ULS GEO/STR axial compression	DA1-C1 28%			DA1-C2 57%	
Governing load case	Vertical Case:	Permanent (self-weight) + Pedestrian Action			
	Horizontal Case:	Wind			
Foundation Design Recommendations	Piling Technique	Pile Raking Angle	Pile dimensions (length; shear tube; helix configuration)		
	Helical	0	5.0m pile comprising 139.7mm CHS A3m Galv, 114.3mm CHS, E2M 350/500		
	Pile Spacing	No. of Piles			
	1.2m	4			
	Post-construction settlement and elastic vertical deflection (z-axis) under full characteristic loading.			<10mm	
	Deflection perpendicular to carriageway (x axis) for shear loads			<10mm	
	Deflection parallel to carriageway (y axis) for shear loads			<10mm	
Contaminated Land Assessment	Refer to main report				
BS EN 1993-5 Corrosion Assessment	The ground conditions are anticipated to be natural undisturbed soil, but have conservatively been taken as non-compacted and non-aggressive fills.			Design Life:	30 Years
Supervision, Instrumentation Monitoring and Testing Requirements	Monitor of pile depth and torque readings. For static pile testing requirements refer to Appendix 16/9 of Screwfast/Van-elle GDR				

APPENDIX B1: Design Calculation Sheets
Primary Piles

HELICAL PILE DESIGN

for GEO limit state to Eurocode 7: Geotechnical Design - Part 1: BS EN 1997-1:2004+A1:2013, BS EN 14199:2015 and BS8004:2015
26/07/18
SFFQR-021 TEMPLATE

ScrewFast FOUNDATIONS LTD

www.screwfast.com

ph. +44 (0) 1727 735 550

SFF JOB No:	233630
JOB NAME:	NEAR
CLIENT:	BMJV

SITE NAME:	M1 Junction 23-25a
STRUCTURE TYPE:	Gantry Foundation
CLIENT REF NUMBER:	

PILE DESIGN REF:	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0001
LOAD REF:	HEINNOVA-ATK-SGY-SG_MULTI-DR-S-5400
SFF DRAWING REF:	
CLIENT GA DRAWING REF:	

DESIGNER		COMMENTS
NAME:	Michael Christie	Primary Piles
DATE:	21/11/2023	

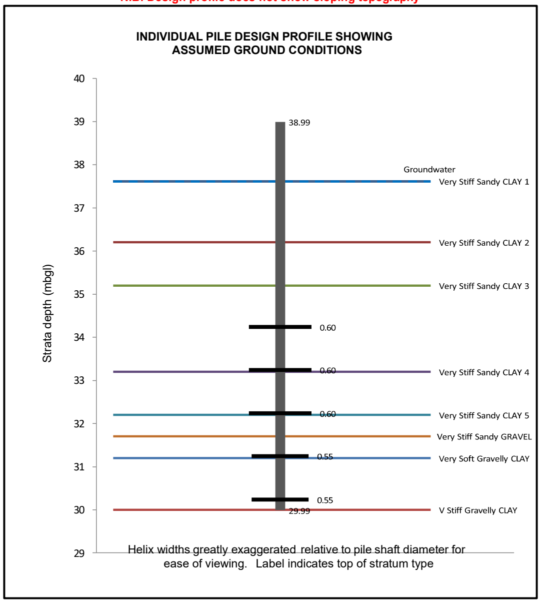
REVIEWED & CHECKED		
NAME:	Andrej Podpriatov	COMPANY (IF NOT SFF):
DATE:	28/11/2023	
COMMENTS:		

SFF REV No:	00
DATE:	21/11/23
REVISION DESCRIPTION:	

N.B. Design profile does not show sloping topography

LEVELS	
G.I. REF NUMBER:	G230600 Rev 001
G.I. DATUM (mAOD)	39.20
TOP OF PILE (mAOD)	38.99
GROUND LEVEL (G.L.) (mAOD)	37.61
GROUNDWATER DEPTH (mAOD) (See note)	37.61

NOTE: Groundwater depth: 2.4.6.1(6)P: When dealing with ground-water pressures for limit states with severe consequences (generally ultimate limit states), design values shall represent the most unfavourable values that could occur during the design lifetime of the structure. For limit states with less severe consequences (generally serviceability limit states), design values shall be the most unfavourable values which could occur in normal circumstances. 2.4.6.1(11): Unless the adequacy of the drainage system can be demonstrated and its maintenance ensured, the design ground-water table should be taken as the maximum possible level, which may be the ground surface.



PILE GROUP FOUNDATION DESIGN	
RAKE ANGLE FROM VERTICAL (°)	0
ALTER PILE DESIGN TO ACCOUNT FOR RAKING	NO
MINIMUM PILE SPACING C/C (m)	1.2
PILES PER STRUCTURE	8
TOPOGRAPHY AT SITE	Embankment
MAXIMUM PILE PROJECTION ABOVE GROUND LEVEL (m)	1.38
BRACING REQUIRED	YES
PILE POSITION SELECTED FROM GROUP FOR DESIGN:	Furthest down slope; greatest projection

PILE DETAILS

Pile diameter at helix depth(s) (mm)	Wall thickness (mm)	Length (m)	Top (mAOD)	Bottom (mAOD)
355.6	10.00	9.00	38.99	29.99
Surface Area A_s (m^2 per m)		1.12		
Helix plate thickness		12mm		

GROUND CONDITIONS USING CHARACTERISTIC VALUES ($_k$) FROM GROUND TEST RESULTS

Strata description	Top of layer (mAOD)	Bottom of layer (mAOD)	Cumulative depth (mbgl)	Strata type for purposes of analysis	Unit weight γ (kN/m³)	Average SPT 'N' value	$c_{u;k}$ (kPa)	$Φ'_k$ (°)	α (see note)	Shaft resistance $R_{s;k}$ (kN)
Very Stiff Sandy CLAY 1	37.61	36.20	1.41	Cohesive	21	15	75		0.80	94.51
Very Stiff Sandy CLAY 2	36.20	35.20	2.41	Cohesive	21	17	85		0.77	73.12
Very Stiff Sandy CLAY 3	35.20	33.20	4.41	Cohesive	21	25	125		0.68	189.92
Very Stiff Sandy CLAY 4	33.20	32.20	5.41	Cohesive	21	28	140		0.64	100.10
Very Stiff Sandy CLAY 5	32.20	31.70	5.91	Cohesive	21	30	150		0.62	51.95
Very Stiff Sandy GRAVEL	31.70	31.20	6.41	Non-cohesive	21	61		37		26.11
Very Soft Gravelly CLAY	31.20	30.00	7.61	Cohesive	21	61	100		0.74	99.20
V Stiff Gravelly CLAY	30.00	29.00	8.61	Cohesive	21	49	220.5		0.50	0.00
										0.00
NOTE: SPT 'N' value is used to calculate anticipated torque during installation; it is not used in pile capacity calculation					TOTAL SHAFT RESISTANCE $R_{s;k} = ΣA_s q_{s;k}$ (kN)					634.90
NOTE: Refer to A.3.3.2 and A.3.3.3 if characteristic values of ground strength are derived from static load tests					NOTE: Factored ground conditions for M1 Material Factors are same as $R_{s;k}$ value above since all factors = 1.0					

PARTIAL MATERIAL FACTORS FOR SOIL PARAMETERS ($γ_M$) (TABLE A.NA.4)

		M1 SET	M2 SET	Reciprocal of M2 Set	Most onerous factor for M2
Angle of shearing resistance	$γ_φ'$	1.00	1.25	0.80	0.80
Effective cohesion	$γ_c'$	1.00	1.25	0.80	0.80
Undrained shear strength	$γ_{cu}$	1.00	1.40	0.71	0.71
Unconfined strength	$γ_{qu}$	1.00	1.40	0.71	0.71

NOTE: The value of the partial factor should be taken as the reciprocal of the specified value if such a reciprocal value produces a more onerous effect than the specified value (Note to Table A.NA.4). The characteristic values may have to be adjusted to upper values for the M2 situation as per 7.3.2.1(2)

FACTORED GROUND CONDITIONS FOR M2 MATERIAL FACTORS SET

Strata description	Top of layer (mAOD)	Bottom of layer (mAOD)	Cumulative depth (mbgl)	Strata type for purposes of analysis	Unit weight γ (kN/m³)	Average 'N' value	$c_{u;d}$ (kPa)	$Φ'_d$ (°)	α (see note)	Shaft resistance $R_{s;d}$ (kN)
Very Stiff Sandy CLAY 1	37.61	36.20	1.41	Cohesive	21	15	53.6		0.8	67.5
Very Stiff Sandy CLAY 2	36.20	35.20	2.41	Cohesive	21	17	60.7		0.8	52.2
Very Stiff Sandy CLAY 3	35.20	33.20	4.41	Cohesive	21	25	89.3		0.7	135.7
Very Stiff Sandy CLAY 4	33.20	32.20	5.41	Cohesive	21	28	100.0		0.6	71.5
Very Stiff Sandy CLAY 5	32.20	31.70	5.91	Cohesive	21	30	107.1		0.6	37.1
Very Stiff Sandy GRAVEL	31.70	31.20	6.41	Non-cohesive	21	61		31.1		20.9
Very Soft Gravelly CLAY	31.20	30.00	7.61	Cohesive	21	61	71.4		0.7	70.9
V Stiff Gravelly CLAY	30.00	29.00	8.61	Cohesive	21	49	157.5		0.5	88.0
TOTAL SHAFT RESISTANCE $R_{s;d} = ΣA_s q_{s;d}$ (kN)										543.7

BASE RESISTANCE FOR M1 MATERIAL FACTORS SET											
Helix Plate Diameter (m)	Plate Area A_b (m^2)	Helix Depth (m below top of pile)	Helix Depth z_h (mAOD)	Resistance in compression (kN)			Resistance in tension (kN)			Plate base resistance in compression $r_{b;k}$ (kN)	Plate base resistance in tension $r_{b;k}$ (kN)
				at z_h	at z_h-0.25m	at z_h-0.75m	at z_h	at z_h+0.25m	at z_h+0.75m		
0.60	**0.18**	**4.75**	**34.24**	206.4	206.4	206.4	206.4	206.4	206.4	**206.4**	**206.4**
0.60	**0.18**	**5.75**	**33.24**	206.4	231.1	231.1	206.4	206.4	206.4	**218.7**	**206.4**
0.60	**0.18**	**6.75**	**32.24**	231.1	247.6	542.4	231.1	231.1	231.1	**298.3**	**231.1**
0.55	**0.14**	**7.75**	**31.24**	408.9	124.4	124.4	408.9	408.9	186.7	**266.7**	**364.4**
0.55	**0.14**	**8.75**	**30.24**	124.4	274.4	274.4	124.4	124.4	124.4	**199.4**	**124.4**
NOTE: $A_b = A_{helix} - A_{b;shaft}$. For compression rb;k = $(0.5.r_{b;k\ at\ zh})+(0.3.r_{b;k\ at\ zh-0.25m})+(0.2.r_{b;k\ at\ zh-0.75})$ For tension rb;k = $(0.5.r_{b;k\ at\ zh})+(0.3.r_{b;k\ at\ zh+0.25m})+(0.2.r_{b;k\ at\ zh+0.75})$							BASE RESISTANCE $\Sigma r_{b;k} = R_{b;k}$ (kN):			**1189.5**	**1132.7**

BASE RESISTANCE FOR M2 MATERIAL FACTORS SET											
Helix Plate Diameter (m)	Plate Area A_b (m^2)	Helix Depth (m below top of pile)	Helix Depth z_h (mAOD)	Resistance in compression (kN)			Resistance in tension (kN)			Plate base resistance in compression $r_{b;k}$ (kN)	Plate base resistance in tension $r_{b;k}$ (kN)
				at z_h	at z_h-0.25m	at z_h-0.75m	at z_h	at z_h+0.25m	at z_h+0.75m		
0.60	**0.18**	**4.75**	**34.24**	147.4	147.4	147.4	147.4	147.4	147.4	**147.4**	**147.4**
0.60	**0.18**	**5.75**	**33.24**	147.4	165.1	165.1	147.4	147.4	147.4	**156.2**	**147.4**
0.60	**0.18**	**6.75**	**32.24**	165.1	176.9	263.0	165.1	165.1	165.1	**188.2**	**165.1**
0.55	**0.14**	**7.75**	**31.24**	198.2	88.9	88.9	198.2	198.2	133.3	**143.6**	**185.3**
0.55	**0.14**	**8.75**	**30.24**	88.9	196.0	196.0	88.9	88.9	88.9	**142.4**	**88.9**
NOTE: Ab = Ahelix - Ab;shaft. For compression $r_{b;k} = (0.5.r_{b;k\ at\ zh})+(0.3.r_{b;k\ at\ zh-0.25m})+(0.2.r_{b;k\ at\ zh-0.75})$ For tension $r_{b;k} = (0.5.r_{b;k\ at\ zh})+(0.3.r_{b;k\ at\ zh+0.25m})+(0.2.r_{b;k\ at\ zh+0.75})$							BASE RESISTANCE $\Sigma r_{b;k} = R_{b;k}$ (kN):			**777.9**	**734.0**

NOTE: CALCULATION OF PILE RESISTANCE:

Pile capacity (resistance) is calculated as the sum of the helix resistances, assuming each acts like an end-bearing face. The helix plates are spaced far enough apart along the shaft to ensure that the effect of interference between the bulbs of loaded soil can be ignored in accordance with Boussinesq's theory. The skin friction over the embedded length of the pile shaft is considered negligible and is ignored for the purposes of pile capacity.

All input values are based on measured, site specific values where such information is available. Otherwise the input data is estimated using values taken from published literature.

Minimum helix spacing (m):	1
Distance between lowest helix and end of pile (m)	0.25

PARTIAL RESISTANCE FACTORS (γ_R) FOR DRIVEN PILES FOR THE GEO LIMIT STATE (TABLE A.NA.6)							
		R1	R4 without..	R4 with..	DO YOU HAVE "EXPLICIT VERIFICATION OF SLS" FOR R4?	NO	APPLICABLE R4 FACTORS
SHAFT IN COMPRESSION	γ_s	1.0	1.5	1.3	NOTE: The lower values in R4 may be adopted (a) if serviceability is verified by load tests (preliminary and/or working) carried out on more than 1% of the construction piles to loads not less than 1.5 times the representative load for which they are designed, or (b) if settlement is explicitly predicted by a means no less reliable than in (a), or (c) if settlement at the serviceability limit state is of no concern. (Note A to Table A.NA.6)		1.5
SHAFT IN TENSION	$\gamma_{s;t}$	1.0	2.0	1.7			2.0
BASE	γ_b	1.0	1.7	1.5			1.7
BASE IN TENSION	$\gamma_{b;t}$	1.3	2.2	2.0	NOTE: EC7 does not have a $\gamma_{b;t}$ factor since the base resistance does not contribute to tensile resistance in 'normal' pile design. The $\gamma_{b;t}$ factor is therefore a ScrewFast addition to account for the fact that the soil will provide less resistance to a tensile load on the helix plates than to the same load in compression.		2.2
MODEL FACTOR	γ_{Rd}	1.4	NOTE: The value of the model factor should be 1.4, except that it may be reduced to 1.2 if the resistance is verified by a maintained load test taken to the calculated, unfactored ultimate resistance. (A.3.3.2)				

PILE DESIGN ACTIONS (kN)									
CHARACTERISTIC DESIGN ACTIONS (kN) Permanent = G_k, Variable = Q_k			FAVOURABILITY i.e. promotes stability (favourable) or instability (unfavourable)	A1 SET			A2 SET		
				PARTIAL FACTOR γ_G or γ_Q	FACTORED ACTIONS $G_k \cdot \gamma_G$ & $Q_k \cdot \gamma_Q$	DESIGN ACTIONS $F_{c;d} = G_k \cdot \gamma_G + Q_k \cdot \gamma_Q$	PARTIAL FACTOR γ_G or γ_Q	FACTORED ACTIONS $G_k \cdot \gamma_G$ & $Q_k \cdot \gamma_Q$	DESIGN ACTIONS $F_{c;d} = G_k \cdot \gamma_G + Q_k \cdot \gamma_Q$
COMPRESSION:	PERMANENT	60	UNFAVOURABLE	1.20	72.0	258.0	1.00	60.0	216.0
	VARIABLE	120	UNFAVOURABLE	1.55	186.0		1.30	156.0	
TENSION:	PERMANENT	10.0	UNFAVOURABLE	1.20	12.0	198.0	1.00	10.0	166.0
	VARIABLE	120	UNFAVOURABLE	1.55	186.0		1.30	156.0	
NOTE: Refer to drawing referenced above for pile design load derivation and pile key plan. Partial factors from BS EN 1990:2002 as referenced in Table A.NA.3. Refer to A.NA.3 if actions relate to water level as factors may not be appropriate.									

DESIGN APPROACH 1, COMBINATION 1: A1 + M1 + R1				
	A1	M1	R1	DESIGN CHECK
	$F_d = G_k \cdot \gamma_G + Q_k \cdot \gamma_Q$	$R_{b;k}$	$R_{c;d} = R_{b;k}/\gamma_b/\gamma_{Rd}$	$F_d \leq R_d$
COMPRESSION	258.0	1189.5	849.6	Difference = 591.6 DESIGN OK
TENSION	198.0	1132.7	622.4	Difference = 424.4 DESIGN OK

The critical design case is
Design Approach 1, Combination 2
A2 + M2 + R4

DESIGN APPROACH 1, COMBINATION 2: A2 + (M1 or M2) + R4							
	$F_d = G_k \cdot \gamma_G + Q_k \cdot \gamma_Q$	$R_{b;k}$		$R_d = R_{b;k}/\gamma_b/\gamma_{Rd}$		DESIGN CHECK FOR M1	DESIGN CHECK FOR M2
	A2	M1	M2	R4 for M1	R4 for M2	$F_d \leq R_d$	$F_d \leq R_d$
COMPRESSION	216.0	1189.5	777.9	499.8	326.8	Difference = 283.8 DESIGN OK	Difference = 110.8 DESIGN OK
TENSION	166.0	1132.7	734.0	366.1	237.2	Difference = 200.1 DESIGN OK	Difference = 71.2 DESIGN OK
NOTE: The M2 situation covers unfavourable actions on piles e.g. negative skin friction. 7.3.2.1(2) states that: "for these situations, the design values of the strength and stiffness of the moving ground should usually be upper values".							

INSTALLATION TORQUE	
MINIMUM (kNm)	115
DESIGN (kNm)	234
MAXIMUM (kNm)	250

PILE HEAD SETTLEMENT PREDICTION AT THE SLS	
PREDICTED PILE HEAD SETTLEMENT (mm)	< 10
NOTE: Pile settlement predictions are based on simplified methods as outlined in Pile Design and Construction Practice (Tomlinson and Woodward, 2006, P195). This is a prediction only which satisfies the provision of EC7 SLS design. Actual pile head settlement at the SLS is dependent on external construction factors which are outside of ScrewFast's control.	

STEEL CORROSION PROTECTION					
ENVIRONMENT	Soils/Rock	LOCAL CONDITIONS	Non-compacted and non-aggressive fills (clay, schist, sand, silt,.......)	DESIGN LIFE	30 years
THICKNESS OF GALVANISING REQUIRED TO 2mbgl	85 µm	ADDITIONAL PROTECTION REQUIRED	G2b ground section to SHW Series 1900		

NOTE: Refer to SFF pile drawings for full details of pile corrosion protection. Protection measures required are calculated in accordance with BS EN 1993-5:2007, BS EN ISO 14713 and advice from Kevin Davies of CorroCiv Ltd as appropriate.

STRUCTURAL RESISTANCE TO BS EN 1993-1-1:2005

SECTION RELEVANT TO CHECK:	2nd	OUTSIDE DIAMETER (mm)	354.8	WALL THICKNESS (mm)	9.6	Dimensions used reflect design life

BUCKLING RESISTANCE OF PILE SHAFT SECTION, $N_{b,Rd}$

$$N_{b,Rd} = \frac{\chi A F_y}{\gamma_{M1}}$$

A = CROSS SECTIONAL AREA (mm²) =	10388
I = SECOND MOMENT OF AREA (mm⁴) =	154827279
i = RADIUS OF GYRATION (mm) =	122
F_y = STEEL GRADE (N/mm²) =	355
γ_{M1} = PARTIAL SAFETY FACTOR =	1
ESTIMATED PILE FIXITY POINT =	3.00
L_{eff} = EFFECTIVE LENGTH OF THE SECTION =	6.00
λ = NON-DIMENSIONAL SLENDERNESS	0.643
$\Phi = 0.5[1+\alpha(\lambda-0.2)+\lambda^2]$ =	0.816
χ = REDUCTION FACTOR FOR THE BUCKLING MODE =	0.759
$N_{b,Rd}$ =	2800.52
N_{Ed} = ULS COMPRESSION FORCE (kN) =	261

COMBINED ACTION OF BENDING MOMENT AND AXIAL FORCE

$$M_{Ed} \leq M_{N,Rd}$$

$W_{pl,y}$ = PLASTIC SECTION MODULUS (cm³) =	1141.62
F_y = STEEL GRADE (N/mm²) =	355
γ_{MO} = PARTIAL SAFETY FACTOR =	1.00
$M_{pl,Rd}$ = BENDING MOMENT RESISTANCE =	405.27
$N_{pl,Rd}$ = AXIAL RESISTANCE =	3687.59
M_{Ed}* = ULS BENDING MOMENT (kNm) =	75.90
N_{Ed}** = ULS AXIAL FORCE (kN) =	261.00
$n = N_{ed} / N_{pl,Rd}$	0.07
$M_{N,Rd} = M_{pl,Rd}(1 - n^{1.7})$	400.78

BUCKLING RESISTANCE CHECK	$N_{Ed}/N_{b,Rd} \leq 1$	0.093	OK	MOMENT AND AXIAL FORCE CHECK	$M_{Ed} \leq M_{N,Rd}$	OK

NOTE: The above buckling check applies to cold rolled tube section. Hot formed tube section of the same size will have greater buckling resistance. Design compression force is sum of positive permanent and variable actions.
* ULS pile bending moment force as advised by Structural Engineer. ** ULS pile compression or tension force - whichever is greater - as advised by Structural Engineer.

GRILLAGE REQUIRED?	Yes
PILE CONNECTION TYPE REQUIRED:	A-Section

INFORMATION FROM PILE DESIGN SELECTIONS ABOVE

Helix configuration	
Helix Plate Diameter (m)	Helix Depth (m below top of pile)
0.60	4.75
0.60	5.75
0.60	6.75
0.55	7.75
0.55	8.75

CHS dimensions over helix depth(s) (mm)	355.6 x 10
Distance between lowest helix and end of pile (m)	0.25

PILE SECTION SELECTION

CHS dimensions (mm)		SFF PILE SECTION	HELIX DEPTHS (m below top of pile)	BASE OF SECTION (m below top of pile)
Diameter	Wall			
406.4	20.0	A2M GALV.	(Plain section)	2
355.6	10.0	B2M GALV.	(Plain section)	4
355.6	10.0	C2M 600/600	4.75 & 5.75	6
355.6	10.0	C1M 600	6.75	7
355.6	10.0	E2M 550/550	7.75 & 8.75	9

Checks	
Sum of section lengths = total pile length	OKAY
Lowest helix to toe distance matches toe section selected	OKAY

INSTALLATION NOTES

1) Stop immediately if a void is encountered and contact project manager.
2) Ensure all buried services are detected and isolated prior to piling
3) BH1904N used to formulate the ground model

Titles

Job No.:	233630
Job Title:	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0001
Sub-title:	M1 Junction 23-25a
Calculation Heading:	Lateral load analysis (40kN)
Initials:	MC
Checker:	
Date Saved:	06-Oct-2023
Date Checked:	
Notes:	SLS Primary Piles
File Name:	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0002.alw
File Path:	J:\2023\233630\6. Design\InternallyChecked\Primary Piles\ProjectNumbered

General Data

Number of increments = 1
Increment applied loads only
Standard analysis type
Apply layered soil adjustments to P-Y curves: No

Convergence Control

Maximum number of iterations = 300
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Partial Factors

Partial Factor Set	Variable Load (Rest./Dist.)	Permanent Load (Rest./Dist.)	Unit Weight	Drained Cohesion	Undrained Cohesion	Shear Angle
SLS	**1.000000/ 1.000000**	**1.000000/ 1.000000**	**1.000000**	**1.000000**	**1.000000**	**1.000000**

Soil Data

Soil model : Generated P-Y curves for static loads

No.	Level [m]	Type	Unit wt [kN/m³]	E50	C_u top [kN/m²]	dC_u/dz [kN/m²/m]	K_0	K_1 [kN/m²/m]	Phi [°]	q_{ur} [kPa]	α_r	k_{rm}	E_{ir} [kPa]
1	38.210000	Sand (Reese et al.)	20.000	-	-	-	0.41000	33930.	36.000	-	-	-	-
2	38.000000	Soft Clay	21.000	0.010000	75.000	0.0	-	-	-	-	-	-	-
3	36.100000	Soft Clay	21.000	0.010000	85.000	0.0	-	-	-	-	-	-	-
4	35.200000	Stiff Clay	21.000	0.010000	125.00	0.0	-	-	-	-	-	-	-
5	33.200000	Stiff Clay	21.000	0.010000	140.00	0.0	-	-	-	-	-	-	-
6	32.200000	Stiff Clay	21.000	0.010000	150.00	0.0	-	-	-	-	-	-	-
7	31.700000	Sand (Reese et al.)	21.000	-	-	-	0.40000	33930.	37.000	-	-	-	-
8	31.200000	Stiff Clay	21.000	0.010000	100.00	0.0	-	-	-	-	-	-	-
9	30.500000	Stiff Clay	21.000	0.010000	220.50	0.0	-	-	-	-	-	-	-

Sections

No.	Level	Type	Unit wt	E50	C_u top	dC_u/dz	K_0	K_1	Phi	q_{ur}	α_r	k_{rm}	E_{ir}
	[m]		[kN/m³]		[kN/m²]	[kN/m²/m]		[kN/m²/m]	[°]	[kPa]			[kPa]

Name	Input Type	Description	Material	Class	Effective Width [m]	EI [kNm²]
406.4 x 20mm	Wizard Generated	STD%CHS%405.6%19.6	Steel		0.40691	88763.
355.6 x 10mm	Wizard Generated	STD%CHS%354.8%9.6	Steel		0.35594	31039.

Pile Properties

Level [m]	Section
38.990	406.4 x 20mm
36.990	355.6 x 10mm

Pile base at 29.990000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	38.990	40.000	0.0	0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	10000.

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
1	38.990	0	88763.	0.40691	0.0	0.0
2	38.766	0	88763.	0.40691	0.0	0.0
3	38.542	0	88763.	0.40691	0.0	0.0
4	38.318	0	88763.	0.40691	0.0	0.0
5	38.102	1	88763.	0.40691	1.0800	0.0
6	37.898	2	88763.	0.40691	3.1200	0.0
7	37.595	2	88763.	0.40691	6.1467	0.0
8	37.293	2	88763.	0.40691	9.1733	0.0
9	36.990	2	31039.	0.35594	12.200	0.0
10	36.736	2	31039.	0.35594	14.743	0.0
11	36.481	2	31039.	0.35594	17.286	0.0
12	36.227	2	31039.	0.35594	19.829	0.0
13	35.973	3	31039.	0.35594	22.371	0.0
14	35.749	3	31039.	0.35594	24.608	0.0
15	35.526	3	31039.	0.35594	26.844	0.0
16	35.302	3	31039.	0.35594	29.080	0.0
17	35.098	4	31039.	0.35594	31.120	0.0
18	34.806	4	31039.	0.35594	34.040	0.0
19	34.514	4	31039.	0.35594	36.960	0.0
20	34.222	4	31039.	0.35594	39.880	0.0
21	33.930	4	31039.	0.35594	42.800	0.0
22	33.638	4	31039.	0.35594	45.720	0.0
23	33.346	4	31039.	0.35594	48.640	0.0
24	33.054	5	31039.	0.35594	51.560	0.0
25	32.803	5	31039.	0.35594	54.067	0.0
26	32.553	5	31039.	0.35594	56.573	0.0
27	32.302	5	31039.	0.35594	59.080	0.0
28	32.098	6	31039.	0.35594	61.120	0.0
29	31.833	6	31039.	0.35594	63.773	0.0
30	31.567	7	31039.	0.35594	66.427	0.0
31	31.302	7	31039.	0.35594	69.080	0.0
32	31.098	8	31039.	0.35594	71.120	0.0
33	30.850	8	31039.	0.35594	73.600	0.0

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
34	30.602	8	31039.	0.35594	76.080	0.0
35	30.398	9	31039.	0.35594	78.120	0.0
36	30.194	9	31039.	0.35594	80.160	0.0
37	29.990	9	31039.	0.35594	82.200	0.0

CALCULATED Soil P-y curves

Node	P1 [kN/m]	Y1 [mm]	P2 [kN/m]	Y2 [mm]	P3 [kN/m]	Y3 [mm]
5	0.0	0.0	1.6496	0.45017	2.6241	2.0331
6	0.0	0.0	30.575	2.0345	52.283	10.173
7	0.0	0.0	34.290	2.0345	58.635	10.173
8	0.0	0.0	38.005	2.0345	64.987	10.173
9	0.0	0.0	38.170	1.7797	65.270	8.8986
10	0.0	0.0	41.249	1.7797	70.535	8.8986
11	0.0	0.0	44.329	1.7797	75.801	8.8986
12	0.0	0.0	47.408	1.7797	81.067	8.8986
13	0.0	0.0	56.881	1.7797	97.264	8.8986
14	0.0	0.0	59.915	1.7797	102.45	8.8986
15	0.0	0.0	62.950	1.7797	107.64	8.8986
16	0.0	0.0	65.985	1.7797	112.83	8.8986
17	0.0	0.0	71.006	1.7797	121.42	8.8986
18	0.0	0.0	74.009	1.7797	126.55	8.8986
19	0.0	0.0	77.011	1.7797	131.69	8.8986
20	0.0	0.0	80.014	1.7797	136.82	8.8986
21	0.0	0.0	83.016	1.7797	141.96	8.8986
22	0.0	0.0	86.019	1.7797	147.09	8.8986
23	0.0	0.0	89.021	1.7797	152.22	8.8986
24	0.0	0.0	102.36	1.7797	175.03	8.8986
25	0.0	0.0	105.21	1.7797	179.91	8.8986
26	0.0	0.0	108.07	1.7797	184.79	8.8986
27	0.0	0.0	110.92	1.7797	189.67	8.8986
28	0.0	0.0	120.83	1.7797	206.62	8.8986
29	0.0	0.0	124.04	1.7797	212.11	8.8986
30	0.0	0.0	492.87	2.1868	612.13	3.1232
31	0.0	0.0	512.70	2.1874	636.71	3.1236
32	0.0	0.0	91.333	1.7797	156.18	8.8986
33	0.0	0.0	93.430	1.7797	159.76	8.8986
34	0.0	0.0	93.671	1.7797	160.17	8.8986
35	0.0	0.0	203.69	1.7797	348.30	8.8986
36	0.0	0.0	206.54	1.7797	353.18	8.8986
37	0.0	0.0	206.54	1.7797	353.18	8.8986

Node	P4 [kN/m]	Y4 [mm]	P5 [kN/m]	Y5 [mm]	P6 [kN/m]	Y6 [mm]
5	3.1331	3.6160	3.8025	6.7818	5.2659	15.259
6	75.287	30.518	104.57	81.381	104.57	1017.3
7	84.434	30.518	117.27	81.381	117.27	1017.3
8	93.582	30.518	129.97	81.381	129.97	1017.3
9	93.988	26.696	130.54	71.189	130.54	889.86
10	101.57	26.696	141.07	71.189	141.07	889.86
11	109.15	26.696	151.60	71.189	151.60	889.86
12	116.74	26.696	162.13	71.189	162.13	889.86
13	140.06	26.696	194.53	71.189	194.53	889.86
14	147.53	26.696	204.91	71.189	204.91	889.86
15	155.01	26.696	215.29	71.189	215.29	889.86
16	162.48	26.696	225.67	71.189	225.67	889.86
17	174.84	26.696	242.84	71.189	242.84	889.86
18	182.24	26.696	253.11	71.189	253.11	889.86
19	189.63	26.696	263.38	71.189	263.38	889.86
20	197.02	26.696	273.64	71.189	273.64	889.86
21	204.42	26.696	283.91	71.189	283.91	889.86
22	211.81	26.696	294.18	71.189	294.18	889.86
23	219.20	26.696	304.45	71.189	304.45	889.86
24	252.05	26.696	350.07	71.189	350.07	889.86
25	259.07	26.696	359.82	71.189	359.82	889.86
26	266.10	26.696	369.58	71.189	369.58	889.86
27	273.12	26.696	379.33	71.189	379.33	889.86
28	297.53	26.696	413.23	71.189	413.23	889.86
29	305.44	26.696	424.22	71.189	424.22	889.86
30	717.94	4.0596	904.17	5.9324	1591.3	13.348
31	746.73	4.0599	940.40	5.9324	1655.1	13.348
32	224.90	26.696	312.35	71.189	312.35	889.86
33	230.06	26.696	319.53	71.189	319.53	889.86

Node	P4 [kN/m]	Y4 [mm]	P5 [kN/m]	Y5 [mm]	P6 [kN/m]	Y6 [mm]
34	230.65	26.696	320.35	71.189	320.35	889.86
35	501.56	26.696	696.61	71.189	696.61	889.86
36	508.59	26.696	706.37	71.189	706.37	889.86
37	508.59	26.696	706.37	71.189	706.37	889.86

Output for load increment 1

Iteration	Max Inc Disp [mm]	at node	Disp error [mm]	Pressure error [kN/m²]
10	5.98	1	0.0006	0.01

- The file is not completely converged till the specified tolerance limit.

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil	Pressure [kN/m²]	Bending [kNm]	Shear [kN]	
1	38.990	-5.9811	-0.0022497	0	0.0	0.0	0.0	
1	38.990					-22.497	-40.000	
2	38.766	-5.4716	-0.0022952	0	0.0	-13.537	-40.000	
3	38.542	-4.9545	-0.0023181	0	0.0	-4.5775	-40.000	
4	38.318	-4.4348	-0.0023183	0	0.0	4.3825	-40.000	
5	38.102	-3.9360	-0.0022971	1	-7.8661	13.023	-39.664	P
6	37.898	-3.4710	-0.0022580	2	-84.557	21.045	-34.970	P
7	37.595	-2.8001	-0.0021704	2	-89.898	30.310	-25.076	P
8	37.293	-2.1598	-0.0020570	2	-94.420	36.225	-13.726	P
9	36.990	-1.5563	-0.0019294	2	-93.775	38.619	-3.2639	
10	36.736	-1.1058	-0.0016145	2	-72.004	38.267	4.6423	
11	36.481	-0.73441	-0.0013093	2	-51.391	36.258	10.227	
12	36.227	-0.43813	-0.0010253	2	-32.789	33.066	14.036	
13	35.973	-0.21047	-770.68E-6	3	-18.898	29.120	16.324	
14	35.749	-0.060551	-574.74E-6	3	-5.7270	25.290	17.355	
15	35.526	0.048664	-406.77E-6	3	4.8359	21.358	17.391	
16	35.302	0.12346	-266.83E-6	3	12.860	17.512	16.709	
17	35.098	0.16690	-162.68E-6	4	18.708	14.203	15.394	
18	34.806	0.19686	-49.188E-6	4	22.999	9.9490	13.373	
19	34.514	0.19920	27.557E-6	4	24.217	6.3930	10.919	
20	34.222	0.18369	74.294E-6	4	23.201	3.5721	8.4551	
21	33.930	0.15808	97.794E-6	4	20.716	1.4552	6.1728	
22	33.638	0.12823	104.32E-6	4	17.412	-0.032883	4.1914	
23	33.346	0.098275	99.329E-6	4	13.810	-0.99256	2.5689	
24	33.054	0.070908	87.265E-6	5	11.458	-1.5331	1.2979	
25	32.803	0.050670	73.962E-6	5	8.4156	-1.7198	0.36916	
26	32.553	0.033892	59.904E-6	5	5.7816	-1.7182	-0.26420	
27	32.302	0.020594	46.371E-6	5	3.6059	-1.5873	-0.66801	
28	32.098	0.012177	36.327E-6	6	2.3227	-1.4213	-0.91091	
29	31.833	0.0040774	25.106E-6	6	0.79841	-1.1538	-1.0456	
30	31.567	-0.0013548	16.248E-6	7	-0.85787	-0.86639	-1.0428	
31	31.302	-0.0047531	9.7444E-6	7	-3.1299	-0.60045	-0.87158	
32	31.098	-0.0063532	6.1080E-6	8	-0.91599	-0.44931	-0.70402	
33	30.850	-0.0074485	2.9441E-6	8	-1.0986	-0.28385	-0.61869	
34	30.602	-0.0079141	997.33E-9	8	-1.1702	-0.14244	-0.52314	
35	30.398	-0.0080227	173.26E-9	9	-2.5796	-0.045323	-0.38241	
36	30.194	-0.0080192	-144.03E-9	9	-2.6146	0.013583	-0.19383	
37	29.990	-0.0079812	-207.36E-9	9	-2.6023	0.033759	-0.0044210	

- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections Min [mm]	Deflections Max [mm]	Rotations Min [rad]	Rotations Max [rad]	Moments Min [kNm]	Moments Max [kNm]	Shears Min [kN]	Shears Max [kN]
-5.9811	0.19920	-0.0023183	104.32E-6	-22.497	38.619	-40.000	17.391

RESTRAINT FORCES

No.	Node	Lateral force [kN]	Moment [kNm]
1	1	0.0	22.497

Titles

Job No.:	233630
Job Title:	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0003
Sub-title:	M1 Junction 23-25a
Calculation Heading:	Lateral load analysis (40kN)
Initials:	MC
Checker:	
Date Saved:	06-Oct-2023
Date Checked:	
Notes:	DA1-1 Primary Piles
File Name:	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0003.alw
File Path:	J:\2023\233630\6. Design\InternallyChecked\Primary Piles\ProjectNumbered

General Data

Number of increments = 1
Increment applied loads only
Standard analysis type
Apply layered soil adjustments to P-Y curves: No

Convergence Control

Maximum number of iterations = 300
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Partial Factors

Partial Factor Set	Variable Load (Rest./Dist.)	Permanent Load (Rest./Dist.)	Unit Weight	Drained Cohesion	Undrained Cohesion	Shear Angle
BS EN 1997-1:2004 (EC7 - UK) DA1-1(4)	0.000000/ 1.550000	1.000000/ 1.200000	1.000000	1.000000	1.000000	1.000000

Soil Data

Soil model : Generated P-Y curves for static loads

No.	Level [m]	Type	Unit wt [kN/m³]	E50	C_u top [kN/m²]	dC_u/dz [kN/m²/m]	K_0	K_1 [kN/m²/m]	Phi [°]	q_{ur} [kPa]	α_r	k_{rm}	E_{ir} [kPa]
1	38.210000	Sand (Reese et al.)	20.000	-	-	-	0.41000	33930.	36.000	-	-	-	-
2	38.000000	Soft Clay	21.000	0.010000	75.000	0.0	-	-	-	-	-	-	-
3	36.100000	Soft Clay	21.000	0.010000	85.000	0.0	-	-	-	-	-	-	-
4	35.200000	Stiff Clay	21.000	0.010000	125.00	0.0	-	-	-	-	-	-	-
5	33.200000	Stiff Clay	21.000	0.010000	140.00	0.0	-	-	-	-	-	-	-
6	32.200000	Stiff Clay	21.000	0.010000	150.00	0.0	-	-	-	-	-	-	-
7	31.700000	Sand (Reese et al.)	21.000	-	-	-	0.40000	33930.	37.000	-	-	-	-
8	31.200000	Stiff Clay	21.000	0.010000	100.00	0.0	-	-	-	-	-	-	-
9	29.500000	Stiff Clay	21.000	0.010000	220.50	0.0	-	-	-	-	-	-	-

Sections

No.	Level	Type	Unit wt	E50	C_u top	dC_u/dz	K_0	K_1	Phi	q_{ur}	α_r	k_{rm}	E_{ir}
	[m]		[kN/m³]		[kN/m²]	[kN/m²/m]		[kN/m²/m]	[°]	[kPa]			[kPa]

Name	Input Type	Description	Material	Class	Effective Width [m]	EI [kNm²]
406.4 x 20mm	Wizard Generated	STD%CHS%405.6%19.6	Steel		0.40691	88763.
355.6 x 10mm	Wizard Generated	STD%CHS%354.8%9.6	Steel		0.35594	31039.

Pile Properties

Level [m]	Section
38.990	406.4 x 20mm
36.990	355.6 x 10mm

Pile base at 29.990000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	38.990	40.000	0.0	0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	10000.

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
1	38.990	0	88763.	0.40691	0.0	0.0
2	38.886	0	88763.	0.40691	0.0	0.0
3	38.782	0	88763.	0.40691	0.0	0.0
4	38.678	0	88763.	0.40691	0.0	0.0
5	38.574	0	88763.	0.40691	0.0	0.0
6	38.470	0	88763.	0.40691	0.0	0.0
7	38.366	0	88763.	0.40691	0.0	0.0
8	38.262	0	88763.	0.40691	0.0	0.0
9	38.158	1	88763.	0.40691	0.52000	0.0
10	38.052	1	88763.	0.40691	1.5800	0.0
11	37.948	2	88763.	0.40691	2.6200	0.0
12	37.828	2	88763.	0.40691	3.8175	0.0
13	37.709	2	88763.	0.40691	5.0150	0.0
14	37.589	2	88763.	0.40691	6.2125	0.0
15	37.469	2	88763.	0.40691	7.4100	0.0
16	37.349	2	88763.	0.40691	8.6075	0.0
17	37.230	2	88763.	0.40691	9.8050	0.0
18	37.110	2	88763.	0.40691	11.003	0.0
19	36.990	2	31039.	0.35594	12.200	0.0
20	36.853	2	31039.	0.35594	13.569	0.0
21	36.716	2	31039.	0.35594	14.938	0.0
22	36.579	2	31039.	0.35594	16.308	0.0
23	36.442	2	31039.	0.35594	17.677	0.0
24	36.305	2	31039.	0.35594	19.046	0.0
25	36.168	2	31039.	0.35594	20.415	0.0
26	36.032	3	31039.	0.35594	21.785	0.0
27	35.876	3	31039.	0.35594	23.338	0.0
28	35.721	3	31039.	0.35594	24.890	0.0
29	35.566	3	31039.	0.35594	26.443	0.0
30	35.410	3	31039.	0.35594	27.996	0.0
31	35.255	3	31039.	0.35594	29.549	0.0
32	35.145	4	31039.	0.35594	30.651	0.0
33	34.989	4	31039.	0.35594	32.211	0.0

Node	Level	Soil	EI	Effective Width	Water Pressure	Soil Disp
	[m]		[kNm2]	[m]	[kN/m²]	[mm]
34	34.833	4	31039.	0.35594	33.771	0.0
35	34.677	4	31039.	0.35594	35.331	0.0
36	34.521	4	31039.	0.35594	36.891	0.0
37	34.365	4	31039.	0.35594	38.451	0.0
38	34.209	4	31039.	0.35594	40.011	0.0
39	34.053	4	31039.	0.35594	41.571	0.0
40	33.897	4	31039.	0.35594	43.131	0.0
41	33.741	4	31039.	0.35594	44.691	0.0
42	33.585	4	31039.	0.35594	46.251	0.0
43	33.429	4	31039.	0.35594	47.811	0.0
44	33.273	4	31039.	0.35594	49.371	0.0
45	33.127	5	31039.	0.35594	50.829	0.0
46	32.981	5	31039.	0.35594	52.288	0.0
47	32.835	5	31039.	0.35594	53.746	0.0
48	32.690	5	31039.	0.35594	55.205	0.0
49	32.544	5	31039.	0.35594	56.663	0.0
50	32.398	5	31039.	0.35594	58.122	0.0
51	32.252	5	31039.	0.35594	59.580	0.0
52	32.148	6	31039.	0.35594	60.620	0.0
53	32.020	6	31039.	0.35594	61.900	0.0
54	31.892	6	31039.	0.35594	63.180	0.0
55	31.764	6	31039.	0.35594	64.460	0.0
56	31.636	7	31039.	0.35594	65.740	0.0
57	31.508	7	31039.	0.35594	67.020	0.0
58	31.380	7	31039.	0.35594	68.300	0.0
59	31.252	7	31039.	0.35594	69.580	0.0
60	31.148	8	31039.	0.35594	70.620	0.0
61	31.003	8	31039.	0.35594	72.068	0.0
62	30.858	8	31039.	0.35594	73.515	0.0
63	30.714	8	31039.	0.35594	74.963	0.0
64	30.569	8	31039.	0.35594	76.410	0.0
65	30.424	8	31039.	0.35594	77.858	0.0
66	30.279	8	31039.	0.35594	79.305	0.0
67	30.135	8	31039.	0.35594	80.753	0.0
68	29.990	8	31039.	0.35594	82.200	0.0

CALCULATED Soil P-y curves

Node	P1	Y1	P2	Y2	P3	Y3
	[kN/m]	[mm]	[kN/m]	[mm]	[kN/m]	[mm]
9	0.0	0.0	0.72852	0.41291	1.1819	2.0051
10	0.0	0.0	2.5683	0.47909	4.0307	2.0548
11	0.0	0.0	29.961	2.0345	51.233	10.173
12	0.0	0.0	31.431	2.0345	53.746	10.173
13	0.0	0.0	32.901	2.0345	56.260	10.173
14	0.0	0.0	34.371	2.0345	58.773	10.173
15	0.0	0.0	35.841	2.0345	61.286	10.173
16	0.0	0.0	37.310	2.0345	63.800	10.173
17	0.0	0.0	38.780	2.0345	66.313	10.173
18	0.0	0.0	40.250	2.0345	68.826	10.173
19	0.0	0.0	38.170	1.7797	65.270	8.8986
20	0.0	0.0	39.828	1.7797	68.105	8.8986
21	0.0	0.0	41.486	1.7797	70.940	8.8986
22	0.0	0.0	43.144	1.7797	73.776	8.8986
23	0.0	0.0	44.802	1.7797	76.611	8.8986
24	0.0	0.0	46.461	1.7797	79.446	8.8986
25	0.0	0.0	48.119	1.7797	82.282	8.8986
26	0.0	0.0	56.084	1.7797	95.902	8.8986
27	0.0	0.0	58.192	1.7797	99.506	8.8986
28	0.0	0.0	60.299	1.7797	103.11	8.8986
29	0.0	0.0	62.407	1.7797	106.71	8.8986
30	0.0	0.0	64.515	1.7797	110.32	8.8986
31	0.0	0.0	66.622	1.7797	113.92	8.8986
32	0.0	0.0	70.524	1.7797	120.59	8.8986
33	0.0	0.0	72.128	1.7797	123.34	8.8986
34	0.0	0.0	73.732	1.7797	126.08	8.8986
35	0.0	0.0	75.336	1.7797	128.82	8.8986
36	0.0	0.0	76.940	1.7797	131.57	8.8986
37	0.0	0.0	78.544	1.7797	134.31	8.8986
38	0.0	0.0	80.148	1.7797	137.05	8.8986
39	0.0	0.0	81.752	1.7797	139.79	8.8986
40	0.0	0.0	83.356	1.7797	142.54	8.8986
41	0.0	0.0	84.960	1.7797	145.28	8.8986

Oasys

HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0003
M1 Junction 23-25a
Lateral load analysis (40kN)

Job No.	Sheet No.	Rev.
233630		

Drg. Ref.

Made by	Date	Checked	Date
MC	06-Oct-2023		

Node	P1 [kN/m]	Y1 [mm]	P2 [kN/m]	Y2 [mm]	P3 [kN/m]	Y3 [mm]
42	0.0	0.0	86.565	1.7797	148.02	8.8986
43	0.0	0.0	88.169	1.7797	150.77	8.8986
44	0.0	0.0	89.773	1.7797	153.51	8.8986
45	0.0	0.0	101.53	1.7797	173.61	8.8986
46	0.0	0.0	103.19	1.7797	176.45	8.8986
47	0.0	0.0	104.85	1.7797	179.29	8.8986
48	0.0	0.0	106.51	1.7797	182.13	8.8986
49	0.0	0.0	108.17	1.7797	184.96	8.8986
50	0.0	0.0	109.83	1.7797	187.80	8.8986
51	0.0	0.0	111.49	1.7797	190.64	8.8986
52	0.0	0.0	120.22	1.7797	205.58	8.8986
53	0.0	0.0	121.77	1.7797	208.23	8.8986
54	0.0	0.0	123.32	1.7797	210.88	8.8986
55	0.0	0.0	124.87	1.7797	213.53	8.8986
56	0.0	0.0	478.46	2.1450	597.57	3.0919
57	0.0	0.0	497.30	2.1869	617.63	3.1233
58	0.0	0.0	506.87	2.1872	629.48	3.1235
59	0.0	0.0	516.43	2.1875	641.34	3.1237
60	0.0	0.0	90.910	1.7797	155.45	8.8986
61	0.0	0.0	92.134	1.7797	157.55	8.8986
62	0.0	0.0	93.358	1.7797	159.64	8.8986
63	0.0	0.0	93.671	1.7797	160.17	8.8986
64	0.0	0.0	93.671	1.7797	160.17	8.8986
65	0.0	0.0	93.671	1.7797	160.17	8.8986
66	0.0	0.0	93.671	1.7797	160.17	8.8986
67	0.0	0.0	93.671	1.7797	160.17	8.8986
68	0.0	0.0	93.671	1.7797	160.17	8.8986

Node	P4 [kN/m]	Y4 [mm]	P5 [kN/m]	Y5 [mm]	P6 [kN/m]	Y6 [mm]
9	1.4136	3.5973	1.7164	6.7818	2.3734	15.259
10	4.8071	3.6304	5.8329	6.7818	8.0896	15.259
11	73.776	30.518	102.47	81.381	102.47	1017.3
12	77.395	30.518	107.49	81.381	107.49	1017.3
13	81.014	30.518	112.52	81.381	112.52	1017.3
14	84.633	30.518	117.55	81.381	117.55	1017.3
15	88.252	30.518	122.57	81.381	122.57	1017.3
16	91.872	30.518	127.60	81.381	127.60	1017.3
17	95.491	30.518	132.63	81.381	132.63	1017.3
18	99.110	30.518	137.65	81.381	137.65	1017.3
19	93.988	26.696	130.54	71.189	130.54	889.86
20	98.071	26.696	136.21	71.189	136.21	889.86
21	102.15	26.696	141.88	71.189	141.88	889.86
22	106.24	26.696	147.55	71.189	147.55	889.86
23	110.32	26.696	153.22	71.189	153.22	889.86
24	114.40	26.696	158.89	71.189	158.89	889.86
25	118.49	26.696	164.56	71.189	164.56	889.86
26	138.10	26.696	191.80	71.189	191.80	889.86
27	143.29	26.696	199.01	71.189	199.01	889.86
28	148.48	26.696	206.22	71.189	206.22	889.86
29	153.67	26.696	213.43	71.189	213.43	889.86
30	158.86	26.696	220.64	71.189	220.64	889.86
31	164.05	26.696	227.84	71.189	227.84	889.86
32	173.66	26.696	241.19	71.189	241.19	889.86
33	177.61	26.696	246.67	71.189	246.67	889.86
34	181.56	26.696	252.16	71.189	252.16	889.86
35	185.51	26.696	257.65	71.189	257.65	889.86
36	189.45	26.696	263.13	71.189	263.13	889.86
37	193.40	26.696	268.62	71.189	268.62	889.86
38	197.35	26.696	274.10	71.189	274.10	889.86
39	201.30	26.696	279.59	71.189	279.59	889.86
40	205.25	26.696	285.07	71.189	285.07	889.86
41	209.20	26.696	290.56	71.189	290.56	889.86
42	213.15	26.696	296.05	71.189	296.05	889.86
43	217.10	26.696	301.53	71.189	301.53	889.86
44	221.05	26.696	307.02	71.189	307.02	889.86
45	250.00	26.696	347.23	71.189	347.23	889.86
46	254.09	26.696	352.90	71.189	352.90	889.86
47	258.18	26.696	358.58	71.189	358.58	889.86
48	262.26	26.696	364.25	71.189	364.25	889.86
49	266.35	26.696	369.93	71.189	369.93	889.86
50	270.43	26.696	375.60	71.189	375.60	889.86

Node	P4 [kN/m]	Y4 [mm]	P5 [kN/m]	Y5 [mm]	P6 [kN/m]	Y6 [mm]
51	274.52	26.696	381.28	71.189	381.28	889.86
52	296.03	26.696	411.16	71.189	411.16	889.86
53	299.85	26.696	416.46	71.189	416.46	889.86
54	303.67	26.696	421.76	71.189	421.76	889.86
55	307.49	26.696	427.06	71.189	427.06	889.86
56	702.96	4.0387	888.10	5.9324	1563.0	13.348
57	724.37	4.0596	912.27	5.9324	1605.6	13.348
58	738.26	4.0598	929.75	5.9324	1636.4	13.348
59	752.16	4.0599	947.22	5.9324	1667.1	13.348
60	223.85	26.696	310.91	71.189	310.91	889.86
61	226.87	26.696	315.09	71.189	315.09	889.86
62	229.88	26.696	319.28	71.189	319.28	889.86
63	230.65	26.696	320.35	71.189	320.35	889.86
64	230.65	26.696	320.35	71.189	320.35	889.86
65	230.65	26.696	320.35	71.189	320.35	889.86
66	230.65	26.696	320.35	71.189	320.35	889.86
67	230.65	26.696	320.35	71.189	320.35	889.86
68	230.65	26.696	320.35	71.189	320.35	889.86

Output for load increment 1

Iteration	Max Inc Disp [mm]	at node	Disp error [mm]	Pressure error [kN/m²]
17	11.43	1	0.0007	0.02

- The file is not completely converged till the specified tolerance limit.

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil	Pressure [kN/m²]	Bending [kNm]	Shear [kN]	
1	38.990	-11.430	-0.0040321	0	0.0	0.0	0.0	
1	38.990					-40.321	-62.000	
2	38.886	-11.008	-0.0040756	0	0.0	-33.873	-62.000	
3	38.782	-10.583	-0.0041115	0	0.0	-27.425	-62.000	
4	38.678	-10.154	-0.0041398	0	0.0	-20.977	-62.000	
5	38.574	-9.7218	-0.0041606	0	0.0	-14.529	-62.000	
6	38.470	-9.2884	-0.0041739	0	0.0	-8.0810	-62.000	
7	38.366	-8.8539	-0.0041796	0	0.0	-1.6330	-62.000	
8	38.262	-8.4193	-0.0041777	0	0.0	4.8150	-62.000	
9	38.158	-7.9852	-0.0041683	1	-4.4475	11.263	-61.905	P
10	38.052	-7.5443	-0.0041509	1	-14.834	17.815	-61.493	P
11	37.948	-7.1138	-0.0041263	2	-106.26	24.177	-58.758	P
12	37.828	-6.6218	-0.0040892	2	-108.16	30.924	-53.704	P
13	37.709	-6.1348	-0.0040433	2	-109.78	37.039	-48.394	P
14	37.589	-5.6537	-0.0039896	2	-111.14	42.514	-43.012	P
15	37.469	-5.1795	-0.0039290	2	-112.25	47.341	-37.569	P
16	37.349	-4.7130	-0.0038624	2	-113.12	51.512	-32.079	P
17	37.230	-4.2547	-0.0037905	2	-113.76	55.023	-26.551	P
18	37.110	-3.8053	-0.0037143	2	-114.20	57.871	-20.997	P
19	36.990	-3.3652	-0.0036348	2	-124.19	60.052	-15.378	P
20	36.853	-2.8859	-0.0033661	2	-124.24	61.770	-9.5142	P
21	36.716	-2.4437	-0.0030917	2	-124.27	62.658	-3.4584	P
22	36.579	-2.0393	-0.0028152	2	-124.35	62.717	2.6000	P
23	36.442	-1.6727	-0.0025403	2	-118.30	61.946	8.5130	
24	36.305	-1.3434	-0.0022705	2	-98.529	60.385	13.797	
25	36.168	-1.0506	-0.0020091	2	-79.799	58.168	18.142	
26	36.032	-0.79275	-0.0017586	3	-70.185	55.417	21.912	
27	35.876	-0.54070	-0.0014906	3	-49.669	51.731	25.110	
28	35.721	-0.32878	-0.0012421	3	-31.296	47.618	27.347	
29	35.566	-0.15381	-0.0010149	3	-15.153	43.237	28.631	
30	35.410	-0.012403	-809.99E-6	3	-1.2632	38.726	29.085	
31	35.255	0.098930	-627.64E-6	3	10.404	34.204	28.874	
32	35.145	0.16159	-511.92E-6	4	17.990	31.050	28.202	
33	34.989	0.22985	-366.86E-6	4	26.171	26.717	27.050	
34	34.833	0.27715	-243.01E-6	4	32.259	22.611	25.427	
35	34.677	0.30671	-139.10E-6	4	36.475	18.784	23.519	
36	34.521	0.32151	-53.639E-6	4	39.050	15.273	21.422	
37	34.365	0.32432	15.019E-6	4	40.212	12.100	19.222	
38	34.209	0.31761	68.599E-6	4	40.184	9.2758	16.990	
39	34.053	0.30361	108.85E-6	4	39.181	6.7995	14.786	
40	33.897	0.28425	137.51E-6	4	37.403	4.6626	12.660	

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil	Pressure [kN/m²]	Bending [kNm]	Shear [kN]
41	33.741	0.26122	156.23E-6	4	35.034	2.8497	10.649
42	33.585	0.23594	166.59E-6	4	32.242	1.3402	8.7808
43	33.429	0.20960	170.06E-6	4	29.173	0.11005	7.0757
44	33.273	0.18317	167.98E-6	4	25.958	-0.86741	5.5686
45	33.127	0.15906	162.06E-6	5	25.494	-1.5779	4.2096
46	32.981	0.13604	153.25E-6	5	22.160	-2.0953	2.9727
47	32.835	0.11446	142.40E-6	5	18.945	-2.4450	1.9057
48	32.690	0.094567	130.24E-6	5	15.900	-2.6512	1.0013
49	32.544	0.076505	117.38E-6	5	13.063	-2.7370	0.24951
50	32.398	0.060337	104.35E-6	5	10.461	-2.7240	-0.36110
51	32.252	0.046057	91.553E-6	5	8.1056	-2.6317	-0.81283
52	32.148	0.036996	82.755E-6	6	7.0212	-2.5284	-1.1380
53	32.020	0.027069	72.473E-6	6	5.2034	-2.3642	-1.4015
54	31.892	0.018411	62.927E-6	6	3.5843	-2.1697	-1.6017
55	31.764	0.010923	54.221E-6	6	2.1533	-1.9542	-1.7324
56	31.636	0.0044921	46.425E-6	7	2.8150	-1.7262	-1.8456
57	31.508	-0.0010027	39.598E-6	7	-0.64056	-1.4817	-1.8951
58	31.380	-0.0056875	33.767E-6	7	-3.7029	-1.2410	-1.7961
59	31.252	-0.0096873	28.879E-6	7	-6.4252	-1.0219	-1.5791
60	31.148	-0.012512	25.524E-6	8	-1.7956	-0.87149	-1.4067
61	31.003	-0.015916	21.660E-6	8	-2.3148	-0.67362	-1.3074
62	30.858	-0.018825	18.673E-6	8	-2.7743	-0.49301	-1.1763
63	30.714	-0.021360	16.474E-6	8	-3.1584	-0.33309	-1.0234
64	30.569	-0.023627	14.960E-6	8	-3.4937	-0.19672	-0.85206
65	30.424	-0.025718	14.015E-6	8	-3.8029	-0.086415	-0.66409
66	30.279	-0.027706	13.512E-6	8	-4.0968	-0.0044677	-0.46059
67	30.135	-0.029645	13.314E-6	8	-4.3835	0.046926	-0.24213
68	29.990	-0.031568	13.273E-6	8	-4.6679	0.065628	-0.0089511

- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min [mm]	Max [mm]	Min [rad]	Max [rad]	Min [kNm]	Max [kNm]	Min [kN]	Max [kN]
-11.430	0.32432	-0.0041796	170.06E-6	-40.321	62.717	-62.000	29.085

RESTRAINT FORCES

No.	Node	Lateral force [kN]	Moment [kNm]
1	1	0.0	40.321

Oasys	Job No.	Sheet No.	Rev.
HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0004 M1 Junction 23-25a Lateral load analysis (40kN)	**233630**		
	Drg. Ref.		
	Made by MC	Date 06-Oct-2023	Checked / Date

Titles

Job No.:	233630
Job Title:	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0004
Sub-title:	M1 Junction 23-25a
Calculation Heading:	Lateral load analysis (40kN)
Initials:	MC
Checker:	
Date Saved:	06-Oct-2023
Date Checked:	
Notes:	DA1-2 Primary Piles
File Name:	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0004.alw
File Path:	J:\2023\233630\6. Design\InternallyChecked\Primary Piles\ProjectNumbered

General Data

Number of increments = 1
Increment applied loads only
Standard analysis type
Apply layered soil adjustments to P-Y curves: No

Convergence Control

Maximum number of iterations = 300
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Partial Factors

Partial Factor Set	Variable Load (Rest./Dist.)	Permanent Load (Rest./Dist.)	Unit Weight	Drained Cohesion	Undrained Cohesion	Shear Angle
BS EN 1997-1:2004 (EC7 - UK) DA1-2	0.000000/ 1.300000	1.000000/ 1.000000	1.000000	1.250000	1.400000	1.250000

Soil Data

Soil model : Generated P-Y curves for static loads

No.	Level [m]	Type	Unit wt [kN/m³]	E50	C_u top [kN/m²]	dC_u/dz [kN/m²/m]	K_0	K_1 [kN/m²/m]	Phi [°]	q_{ur} [kPa]	α_r	k_{rm}	E_{ir} [kPa]
1	38.210000	Sand (Reese et al.)	20.000	-	-	-	0.41000	33930.	36.000	-	-	-	-
2	38.000000	Soft Clay	21.000	0.010000	75.000	0.0	-	-	-	-	-	-	-
3	36.100000	Soft Clay	21.000	0.010000	85.000	0.0	-	-	-	-	-	-	-
4	35.200000	Stiff Clay	21.000	0.010000	125.00	0.0	-	-	-	-	-	-	-
5	33.200000	Stiff Clay	21.000	0.010000	140.00	0.0	-	-	-	-	-	-	-
6	32.200000	Stiff Clay	21.000	0.010000	150.00	0.0	-	-	-	-	-	-	-
7	31.700000	Sand (Reese et al.)	21.000	-	-	-	0.40000	33930.	37.000	-	-	-	-
8	31.200000	Stiff Clay	21.000	0.010000	100.00	0.0	-	-	-	-	-	-	-
9	29.500000	Stiff Clay	21.000	0.010000	220.50	0.0	-	-	-	-	-	-	-

Sections

No.	Level [m]	Type	Unit wt [kN/m³]	E50	C_u top [kN/m²]	dC_u/dz [kN/m²/m]	K_0	K_1 [kN/m²/m]	Phi [°]	q_{ur} [kPa]	α_r	k_{rm}	E_{ir} [kPa]

Name	Input Type	Description	Material	Class	Effective Width [m]	EI [kNm²]
406.4 x 20mm	Wizard Generated	STD%CHS%405.6%19.6	Steel		0.40691	88763.
355.6 x 10mm	Wizard Generated	STD%CHS%354.8%9.6	Steel		0.35594	31039.

Pile Properties

Level [m]	Section
38.990	406.4 x 20mm
36.990	355.6 x 10mm

Pile base at 29.990000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	38.990	40.000	0.0	0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	10000.

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
1	38.990	0	88763.	0.40691	0.0	0.0
2	38.886	0	88763.	0.40691	0.0	0.0
3	38.782	0	88763.	0.40691	0.0	0.0
4	38.678	0	88763.	0.40691	0.0	0.0
5	38.574	0	88763.	0.40691	0.0	0.0
6	38.470	0	88763.	0.40691	0.0	0.0
7	38.366	0	88763.	0.40691	0.0	0.0
8	38.262	0	88763.	0.40691	0.0	0.0
9	38.158	1	88763.	0.40691	0.52000	0.0
10	38.052	1	88763.	0.40691	1.5800	0.0
11	37.948	2	88763.	0.40691	2.6200	0.0
12	37.828	2	88763.	0.40691	3.8175	0.0
13	37.709	2	88763.	0.40691	5.0150	0.0
14	37.589	2	88763.	0.40691	6.2125	0.0
15	37.469	2	88763.	0.40691	7.4100	0.0
16	37.349	2	88763.	0.40691	8.6075	0.0
17	37.230	2	88763.	0.40691	9.8050	0.0
18	37.110	2	88763.	0.40691	11.003	0.0
19	36.990	2	31039.	0.35594	12.200	0.0
20	36.853	2	31039.	0.35594	13.569	0.0
21	36.716	2	31039.	0.35594	14.938	0.0
22	36.579	2	31039.	0.35594	16.308	0.0
23	36.442	2	31039.	0.35594	17.677	0.0
24	36.305	2	31039.	0.35594	19.046	0.0
25	36.168	2	31039.	0.35594	20.415	0.0
26	36.032	3	31039.	0.35594	21.785	0.0
27	35.876	3	31039.	0.35594	23.338	0.0
28	35.721	3	31039.	0.35594	24.890	0.0
29	35.566	3	31039.	0.35594	26.443	0.0
30	35.410	3	31039.	0.35594	27.996	0.0
31	35.255	3	31039.	0.35594	29.549	0.0
32	35.145	4	31039.	0.35594	30.651	0.0
33	34.989	4	31039.	0.35594	32.211	0.0

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
34	34.833	4	31039.	0.35594	33.771	0.0
35	34.677	4	31039.	0.35594	35.331	0.0
36	34.521	4	31039.	0.35594	36.891	0.0
37	34.365	4	31039.	0.35594	38.451	0.0
38	34.209	4	31039.	0.35594	40.011	0.0
39	34.053	4	31039.	0.35594	41.571	0.0
40	33.897	4	31039.	0.35594	43.131	0.0
41	33.741	4	31039.	0.35594	44.691	0.0
42	33.585	4	31039.	0.35594	46.251	0.0
43	33.429	4	31039.	0.35594	47.811	0.0
44	33.273	4	31039.	0.35594	49.371	0.0
45	33.127	5	31039.	0.35594	50.829	0.0
46	32.981	5	31039.	0.35594	52.288	0.0
47	32.835	5	31039.	0.35594	53.746	0.0
48	32.690	5	31039.	0.35594	55.205	0.0
49	32.544	5	31039.	0.35594	56.663	0.0
50	32.398	5	31039.	0.35594	58.122	0.0
51	32.252	5	31039.	0.35594	59.580	0.0
52	32.148	6	31039.	0.35594	60.620	0.0
53	32.020	6	31039.	0.35594	61.900	0.0
54	31.892	6	31039.	0.35594	63.180	0.0
55	31.764	6	31039.	0.35594	64.460	0.0
56	31.636	7	31039.	0.35594	65.740	0.0
57	31.508	7	31039.	0.35594	67.020	0.0
58	31.380	7	31039.	0.35594	68.300	0.0
59	31.252	7	31039.	0.35594	69.580	0.0
60	31.148	8	31039.	0.35594	70.620	0.0
61	31.003	8	31039.	0.35594	72.068	0.0
62	30.858	8	31039.	0.35594	73.515	0.0
63	30.714	8	31039.	0.35594	74.963	0.0
64	30.569	8	31039.	0.35594	76.410	0.0
65	30.424	8	31039.	0.35594	77.858	0.0
66	30.279	8	31039.	0.35594	79.305	0.0
67	30.135	8	31039.	0.35594	80.753	0.0
68	29.990	8	31039.	0.35594	82.200	0.0

CALCULATED Soil P-y curves

Node	P1 [kN/m]	Y1 [mm]	P2 [kN/m]	Y2 [mm]	P3 [kN/m]	Y3 [mm]
9	0.0	0.0	0.46558	0.26388	0.85124	1.8934
10	0.0	0.0	1.5623	0.29142	2.7975	1.9140
11	0.0	0.0	21.492	2.0345	36.750	10.173
12	0.0	0.0	22.586	2.0345	38.622	10.173
13	0.0	0.0	23.681	2.0345	40.494	10.173
14	0.0	0.0	24.776	2.0345	42.366	10.173
15	0.0	0.0	25.870	2.0345	44.238	10.173
16	0.0	0.0	26.965	2.0345	46.109	10.173
17	0.0	0.0	28.060	2.0345	47.981	10.173
18	0.0	0.0	29.154	2.0345	49.853	10.173
19	0.0	0.0	27.657	1.7797	47.293	8.8986
20	0.0	0.0	28.886	1.7797	49.395	8.8986
21	0.0	0.0	30.115	1.7797	51.497	8.8986
22	0.0	0.0	31.345	1.7797	53.598	8.8986
23	0.0	0.0	32.574	1.7797	55.700	8.8986
24	0.0	0.0	33.803	1.7797	57.802	8.8986
25	0.0	0.0	35.032	1.7797	59.904	8.8986
26	0.0	0.0	40.766	1.7797	69.710	8.8986
27	0.0	0.0	42.323	1.7797	72.371	8.8986
28	0.0	0.0	43.879	1.7797	75.032	8.8986
29	0.0	0.0	45.435	1.7797	77.693	8.8986
30	0.0	0.0	46.991	1.7797	80.354	8.8986
31	0.0	0.0	48.548	1.7797	83.015	8.8986
32	0.0	0.0	51.371	1.7797	87.843	8.8986
33	0.0	0.0	52.567	1.7797	89.889	8.8986
34	0.0	0.0	53.764	1.7797	91.935	8.8986
35	0.0	0.0	54.961	1.7797	93.982	8.8986
36	0.0	0.0	56.158	1.7797	96.028	8.8986
37	0.0	0.0	57.355	1.7797	98.075	8.8986
38	0.0	0.0	58.551	1.7797	100.12	8.8986
39	0.0	0.0	59.748	1.7797	102.17	8.8986
40	0.0	0.0	60.945	1.7797	104.21	8.8986
41	0.0	0.0	62.142	1.7797	106.26	8.8986

Oasys	Job No.	Sheet No.	Rev.
HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0004	233630		
M1 Junction 23-25a	Drg. Ref.		
Lateral load analysis (40kN)	Made by MC	Date 06-Oct-2023	Checked / Date

Node	**P1** [kN/m]	**Y1** [mm]	**P2** [kN/m]	**Y2** [mm]	**P3** [kN/m]	**Y3** [mm]
42	0.0	0.0	63.338	1.7797	108.31	8.8986
43	0.0	0.0	64.535	1.7797	110.35	8.8986
44	0.0	0.0	65.732	1.7797	112.40	8.8986
45	0.0	0.0	74.177	1.7797	126.84	8.8986
46	0.0	0.0	75.410	1.7797	128.95	8.8986
47	0.0	0.0	76.644	1.7797	131.06	8.8986
48	0.0	0.0	77.877	1.7797	133.17	8.8986
49	0.0	0.0	79.110	1.7797	135.28	8.8986
50	0.0	0.0	80.343	1.7797	137.38	8.8986
51	0.0	0.0	81.576	1.7797	139.49	8.8986
52	0.0	0.0	87.851	1.7797	150.22	8.8986
53	0.0	0.0	89.000	1.7797	152.19	8.8986
54	0.0	0.0	90.149	1.7797	154.15	8.8986
55	0.0	0.0	91.298	1.7797	156.12	8.8986
56	0.0	0.0	71.511	0.32060	198.84	1.7235
57	0.0	0.0	72.914	0.32064	202.72	1.7236
58	0.0	0.0	74.316	0.32069	206.61	1.7236
59	0.0	0.0	75.719	0.32073	210.49	1.7236
60	0.0	0.0	66.908	1.7797	114.41	8.8986
61	0.0	0.0	66.908	1.7797	114.41	8.8986
62	0.0	0.0	66.908	1.7797	114.41	8.8986
63	0.0	0.0	66.908	1.7797	114.41	8.8986
64	0.0	0.0	66.908	1.7797	114.41	8.8986
65	0.0	0.0	66.908	1.7797	114.41	8.8986
66	0.0	0.0	66.908	1.7797	114.41	8.8986
67	0.0	0.0	66.908	1.7797	114.41	8.8986
68	0.0	0.0	66.908	1.7797	114.41	8.8986

Node	**P4** [kN/m]	**Y4** [mm]	**P5** [kN/m]	**Y5** [mm]	**P6** [kN/m]	**Y6** [mm]
9	1.0295	3.5228	1.2581	6.7818	1.7397	15.259
10	3.3830	3.5366	4.1383	6.7818	5.7393	15.259
11	52.921	30.518	73.501	81.381	73.501	1017.3
12	55.616	30.518	77.244	81.381	77.244	1017.3
13	58.311	30.518	80.988	81.381	80.988	1017.3
14	61.007	30.518	84.732	81.381	84.732	1017.3
15	63.702	30.518	88.475	81.381	88.475	1017.3
16	66.398	30.518	92.219	81.381	92.219	1017.3
17	69.093	30.518	95.962	81.381	95.962	1017.3
18	71.788	30.518	99.706	81.381	99.706	1017.3
19	68.102	26.696	94.586	71.189	94.586	889.86
20	71.128	26.696	98.789	71.189	98.789	889.86
21	74.155	26.696	102.99	71.189	102.99	889.86
22	77.182	26.696	107.20	71.189	107.20	889.86
23	80.208	26.696	111.40	71.189	111.40	889.86
24	83.235	26.696	115.60	71.189	115.60	889.86
25	86.262	26.696	119.81	71.189	119.81	889.86
26	100.38	26.696	139.42	71.189	139.42	889.86
27	104.21	26.696	144.74	71.189	144.74	889.86
28	108.05	26.696	150.06	71.189	150.06	889.86
29	111.88	26.696	155.39	71.189	155.39	889.86
30	115.71	26.696	160.71	71.189	160.71	889.86
31	119.54	26.696	166.03	71.189	166.03	889.86
32	126.49	26.696	175.69	71.189	175.69	889.86
33	129.44	26.696	179.78	71.189	179.78	889.86
34	132.39	26.696	183.87	71.189	183.87	889.86
35	135.33	26.696	187.96	71.189	187.96	889.86
36	138.28	26.696	192.06	71.189	192.06	889.86
37	141.23	26.696	196.15	71.189	196.15	889.86
38	144.17	26.696	200.24	71.189	200.24	889.86
39	147.12	26.696	204.34	71.189	204.34	889.86
40	150.07	26.696	208.43	71.189	208.43	889.86
41	153.02	26.696	212.52	71.189	212.52	889.86
42	155.96	26.696	216.61	71.189	216.61	889.86
43	158.91	26.696	220.71	71.189	220.71	889.86
44	161.86	26.696	224.80	71.189	224.80	889.86
45	182.65	26.696	253.68	71.189	253.68	889.86
46	185.69	26.696	257.90	71.189	257.90	889.86
47	188.72	26.696	262.12	71.189	262.12	889.86
48	191.76	26.696	266.33	71.189	266.33	889.86
49	194.80	26.696	270.55	71.189	270.55	889.86
50	197.83	26.696	274.77	71.189	274.77	889.86

Node	P4 [kN/m]	Y4 [mm]	P5 [kN/m]	Y5 [mm]	P6 [kN/m]	Y6 [mm]
51	200.87	26.696	278.99	71.189	278.99	889.86
52	216.32	26.696	300.45	71.189	300.45	889.86
53	219.15	26.696	304.38	71.189	304.38	889.86
54	221.98	26.696	308.31	71.189	308.31	889.86
55	224.81	26.696	312.23	71.189	312.23	889.86
56	285.59	3.1265	421.57	5.9324	741.97	13.348
57	291.17	3.1265	429.81	5.9324	756.46	13.348
58	296.75	3.1265	438.04	5.9324	770.95	13.348
59	302.33	3.1266	446.27	5.9324	785.44	13.348
60	164.75	26.696	228.82	71.189	228.82	889.86
61	164.75	26.696	228.82	71.189	228.82	889.86
62	164.75	26.696	228.82	71.189	228.82	889.86
63	164.75	26.696	228.82	71.189	228.82	889.86
64	164.75	26.696	228.82	71.189	228.82	889.86
65	164.75	26.696	228.82	71.189	228.82	889.86
66	164.75	26.696	228.82	71.189	228.82	889.86
67	164.75	26.696	228.82	71.189	228.82	889.86
68	164.75	26.696	228.82	71.189	228.82	889.86

Output for load increment 1

Iteration	Max Inc Disp [mm]	at node	Disp error [mm]	Pressure error [kN/m²]
17	11.43	1	0.0007	0.01

- The file is not completely converged till the specified tolerance limit.

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil	Pressure [kN/m²]	Bending [kNm]	Shear [kN]	
1	38.990	-11.435	-0.0037912	0	0.0	0.0	0.0	
1	38.990					-37.912	-52.000	
2	38.886	-11.039	-0.0038325	0	0.0	-32.504	-52.000	
3	38.782	-10.638	-0.0038674	0	0.0	-27.096	-52.000	
4	38.678	-10.234	-0.0038960	0	0.0	-21.688	-52.000	
5	38.574	-9.8280	-0.0039182	0	0.0	-16.280	-52.000	
6	38.470	-9.4196	-0.0039341	0	0.0	-10.872	-52.000	
7	38.366	-9.0099	-0.0039437	0	0.0	-5.4641	-52.000	
8	38.262	-8.5995	-0.0039469	0	0.0	-0.056064	-52.000	
9	38.158	-8.1892	-0.0039438	1	-3.2884	5.3519	-51.930	P
10	38.052	-7.7716	-0.0039341	1	-10.629	10.849	-51.632	P
11	37.948	-7.3632	-0.0039183	2	-77.371	16.195	-49.644	P
12	37.828	-6.8954	-0.0038926	2	-79.047	21.929	-45.957	P
13	37.709	-6.4312	-0.0038594	2	-80.521	27.202	-42.070	P
14	37.589	-5.9714	-0.0038195	2	-81.800	32.005	-38.115	P
15	37.469	-5.5167	-0.0037734	2	-82.892	36.331	-34.103	P
16	37.349	-5.0679	-0.0037218	2	-83.805	40.172	-30.041	P
17	37.230	-4.6255	-0.0036653	2	-84.546	43.525	-25.940	P
18	37.110	-4.1902	-0.0036047	2	-85.123	46.385	-21.806	P
19	36.990	-3.7623	-0.0035405	2	-93.065	48.748	-17.606	P
20	36.853	-3.2925	-0.0033208	2	-93.398	50.868	-13.205	P
21	36.716	-2.8533	-0.0030931	2	-93.666	52.364	-8.6464	P
22	36.579	-2.4457	-0.0028603	2	-93.909	53.235	-4.0754	P
23	36.442	-2.0702	-0.0026249	2	-94.165	53.480	0.50762	P
24	36.305	-1.7269	-0.0023899	2	-92.146	53.096	5.0477	
25	36.168	-1.4156	-0.0021579	2	-78.282	52.098	9.2008	
26	36.032	-1.1357	-0.0019315	3	-73.084	50.577	13.009	
27	35.876	-0.85507	-0.0016843	3	-57.127	48.261	16.488	
28	35.721	-0.61190	-0.0014499	3	-42.384	45.456	19.238	
29	35.566	-0.40399	-0.0012305	3	-28.975	42.286	21.211	
30	35.410	-0.22888	-0.0010275	3	-16.979	38.868	22.481	
31	35.255	-0.083950	-842.05E-6	3	-6.4336	35.304	23.102	
32	35.145	0.0020755	-721.37E-6	4	0.16831	32.743	23.250	
33	34.989	0.10225	-566.01E-6	4	8.4853	29.116	23.010	
34	34.833	0.17961	-428.70E-6	4	15.244	25.564	22.351	
35	34.677	0.23692	-308.91E-6	4	20.555	22.143	21.358	
36	34.521	0.27686	-205.88E-6	4	24.544	18.900	20.105	
37	34.365	0.30197	-118.62E-6	4	27.340	15.870	18.665	
38	34.209	0.31463	-45.998E-6	4	29.081	13.077	17.098	
39	34.053	0.31702	13.211E-6	4	29.901	10.535	15.461	
40	33.897	0.31114	60.292E-6	4	29.934	8.2527	13.800	

Job No.	Sheet No.	Rev.
233630		

Drg. Ref.

Made by	Date	Checked	Date
MC	06-Oct-2023		

Oasys

HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0004
M1 Junction 23-25a
Lateral load analysis (40kN)

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil	Pressure [kN/m²]	Bending [kNm]	Shear [kN]
41	33.741	0.29877	96.547E-6	4	29.309	6.2296	12.155
42	33.585	0.28151	123.27E-6	4	28.147	4.4603	10.560
43	33.429	0.26075	141.70E-6	4	26.563	2.9349	9.0408
44	33.273	0.23767	153.04E-6	4	24.662	1.6396	7.6409
45	33.127	0.21492	158.20E-6	5	25.166	0.62182	6.3253
46	32.981	0.19174	159.02E-6	5	22.825	-0.20543	5.0796
47	32.835	0.16870	156.36E-6	5	20.411	-0.85987	3.9574
48	32.690	0.14626	150.97E-6	5	17.981	-1.3598	2.9609
49	32.544	0.12476	143.56E-6	5	15.580	-1.7235	2.0897
50	32.398	0.10446	134.70E-6	5	13.248	-1.9693	1.3415
51	32.252	0.085516	124.92E-6	5	11.012	-2.1148	0.75276
52	32.148	0.072902	117.61E-6	6	10.110	-2.1677	0.29920
53	32.020	0.058432	108.48E-6	6	8.2093	-2.1792	-0.096527
54	31.892	0.045130	99.393E-6	6	6.4223	-2.1429	-0.42984
55	31.764	0.032978	90.530E-6	6	4.7528	-2.0692	-0.68441
56	31.636	0.021939	82.024E-6	7	13.748	-1.9677	-1.1059
57	31.508	0.011955	74.097E-6	7	7.6375	-1.7861	-1.5930
58	31.380	0.0029340	67.008E-6	7	1.9102	-1.5599	-1.8105
59	31.252	-0.0052397	60.869E-6	7	-3.4753	-1.3226	-1.7823
60	31.148	-0.011342	56.574E-6	8	-1.1979	-1.1447	-1.6841
61	31.003	-0.019155	51.566E-6	8	-2.0231	-0.90477	-1.6054
62	30.858	-0.026322	47.636E-6	8	-2.7801	-0.67993	-1.4817
63	30.714	-0.032993	44.701E-6	8	-3.4847	-0.47582	-1.3203
64	30.569	-0.039306	42.652E-6	8	-4.1514	-0.29770	-1.1236
65	30.424	-0.045377	41.356E-6	8	-4.7927	-0.15055	-0.89316
66	30.279	-0.051307	40.657E-6	8	-5.4190	-0.039133	-0.63009
67	30.135	-0.057168	40.379E-6	8	-6.0381	0.031865	-0.33494
68	29.990	-0.063007	40.321E-6	8	-6.6548	0.057832	-0.0079522

- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min [mm]	Max [mm]	Min [rad]	Max [rad]	Min [kNm]	Max [kNm]	Min [kN]	Max [kN]
-11.435	0.31702	-0.0039469	159.02E-6	-37.912	53.480	-52.000	23.250

RESTRAINT FORCES

No.	Node	Lateral force [kN]	Moment [kNm]
1	1	0.0	37.912

TITLE;	**HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0005**	**Notes**	
Pile Group Efficiency in accordance with Perko, Section 5.4		**PRIMARY PILES**	
Symbol			*Units*
P_{ug}	Ultimate capacity of the group = $q_{ult}(m_1)(m_2)+2Ts(n-1)(m_1+m_2)$	11374.00	kN
q_{ult}	ultimate bearing pressure of soil or rock	675.00	kN/m^2
	soil type	cohesive	
	q_{ult} for non cohesive soil = $q'(N_q-1)$	529.07	kN/m^2
	q_{ult} for cohesive soil = $9s_u$	675.00	kN/m^2
m_1	width of pile group in plan view	4.2	m
m_2	breadth of pile group in plan view	2	
T	installation torque	115	kN/m^3
s	spacing of helical bearing plates along the length of the shaft	1	
n	number of helical bearing plates per pile	5	
η	group efficiency of a helical pile system = $P_{ug}/\Sigma_i P_u$	1.32	
q'	effective overburden stress at bearing depth	27.85	kN/m^2
d	Embedment depth of group, i.e. bearing level for group (worst case s	3.4	m
γ	unit weight of soil	18	kN/m^3
N_q	Bearing capacity factor	20	
ϕ	Angle of internal friction	30	°
s_u	undrained shear strength	75	
i	number of piles in group	8	
P_u	Ultimate axial capacity of a helical pile	1076	kN
Result:	Group capacity exceeds sum of individual capacities so no issues related to group effects		

APPENDIX B2: Design Calculation Sheets
Stair Piles

HELICAL PILE DESIGN

for GEO limit state to Eurocode 7: Geotechnical Design - Part 1: BS EN 1997-1:2004+A1:2013, BS EN 14199:2015 and BS8004:2015
26/07/18

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SFF JOB No:	233630
JOB NAME:	NEAR
CLIENT:	BMJV

SITE NAME:	M1 Junction 23-25a
STRUCTURE TYPE:	Stair Pile
CLIENT REF NUMBER:	

PILE DESIGN REF:	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0006
LOAD REF:	See email from AP dated 14/11/23
SFF DRAWING REF:	
CLIENT GA DRAWING REF:	

DESIGNER		COMMENTS
NAME:	Michael Christie	Stair Piles
DATE:	20/11/2023	

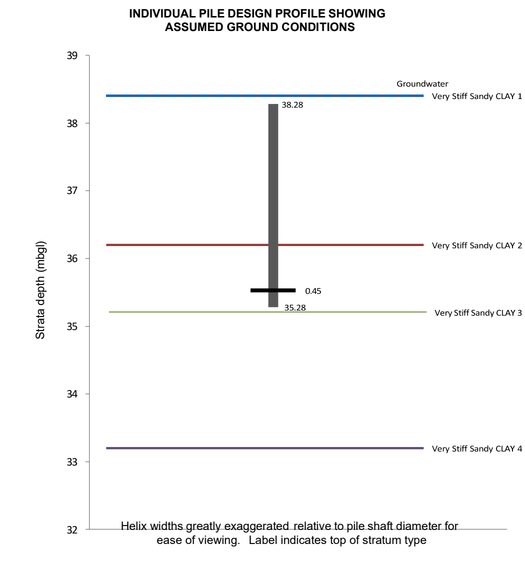
SFF REV No:	00
DATE:	20/11/23
REVISION DESCRIPTION:	

REVIEWED & CHECKED		
NAME:	Andrej Podpriatov	COMPANY (IF NOT SFF):
DATE:	28/11/2023	
COMMENTS:		

N.B. Design profile does not show sloping topography

LEVELS	
G.I. REF NUMBER:	G230600 Rev 001
G.I. DATUM (mAOD)	39.20
TOP OF PILE (mAOD)	38.28
GROUND LEVEL (G.L.) (mAOD)	38.40
GROUNDWATER DEPTH (mAOD) (See note)	38.40

NOTE: Groundwater depth: 2.4.6.1(6)P: When dealing with ground-water pressures for limit states with severe consequences (generally ultimate limit states), design values shall represent the most unfavourable values that could occur during the design lifetime of the structure. For limit states with less severe consequences (generally serviceability limit states), design values shall be the most unfavourable values which could occur in normal circumstances. 2.4.6.1(11): Unless the adequacy of the drainage system can be demonstrated and its maintenance ensured, the design ground-water table should be taken as the maximum possible level, which may be the ground surface.



PILE GROUP FOUNDATION DESIGN	
RAKE ANGLE FROM VERTICAL (°)	0
ALTER PILE DESIGN TO ACCOUNT FOR RAKING	NO
MINIMUM PILE SPACING C/C (m)	0.9
PILES PER STRUCTURE	1
TOPOGRAPHY AT SITE	Embankment
MAXIMUM PILE PROJECTION ABOVE GROUND LEVEL (m)	-0.12
BRACING REQUIRED	NO
PILE POSITION SELECTED FROM GROUP FOR DESIGN:	Middle pile; average projection

PILE DETAILS

Pile diameter at helix depth(s) (mm)	Wall thickness (mm)	Length (m)	Top (mAOD)	Bottom (mAOD)
114.3	10.00	3.00	38.28	35.28
Surface Area A_s (m^2 per m)		0.36		
Helix plate thickness		12mm		

GROUND CONDITIONS USING CHARACTERISTIC VALUES ($_k$) FROM GROUND TEST RESULTS

Strata description	Top of layer (mAOD)	Bottom of layer (mAOD)	Cumulative depth (mbgl)	Strata type for purposes of analysis	Unit weight γ (kN/m³)	Average SPT 'N' value	$c_{u;k}$ (kPa)	Φ'$_k$ (°)	α (see note)	Shaft resistance $R_{s;k}$ (kN)
Very Stiff Sandy CLAY 1	38.40	36.20	2.20	Cohesive	21	15	75		0.80	47.40
Very Stiff Sandy CLAY 2	36.20	35.20	3.20	Cohesive	21	17	85		0.77	0.00
Very Stiff Sandy CLAY 3	35.20	33.20	5.20	Cohesive	21	25	125		0.68	0.00
Very Stiff Sandy CLAY 4	33.20	32.20	6.20	Cohesive	21	28	140		0.64	0.00
										0.00
										0.00
										0.00
										0.00
										0.00
NOTE: SPT 'N' value is used to calculate anticipated torque during installation; it is not used in pile capacity calculation					TOTAL SHAFT RESISTANCE $R_{s;k} = \Sigma A_s q_{s;k}$ (kN)					47.40
NOTE: Refer to A.3.3.2 and A.3.3.3 if characteristic values of ground strength are derived from static load tests					NOTE: Factored ground conditions for M1 Material Factors are same as $R_{s;k}$ value above since all factors = 1.0					

PARTIAL MATERIAL FACTORS FOR SOIL PARAMETERS (γ_M) (TABLE A.NA.4)

		M1 SET	M2 SET	Reciprocal of M2 Set	Most onerous factor for M2
Angle of shearing resistance	γ_{φ}'	1.00	1.25	0.80	0.80
Effective cohesion	γ_c'	1.00	1.25	0.80	0.80
Undrained shear strength	γ_{cu}	1.00	1.40	0.71	0.71
Unconfined strength	γ_{qu}	1.00	1.40	0.71	0.71

NOTE: The value of the partial factor should be taken as the reciprocal of the specified value if such a reciprocal value produces a more onerous effect than the specified value (Note to Table A.NA.4). The characteristic values may have to be adjusted to upper values for the M2 situation as per 7.3.2.1(2)

FACTORED GROUND CONDITIONS FOR M2 MATERIAL FACTORS SET

Strata description	Top of layer (mAOD)	Bottom of layer (mAOD)	Cumulative depth (mbgl)	Strata type for purposes of analysis	Unit weight γ (kN/m³)	Average 'N' value	$c_{u;d}$ (kPa)	Φ'$_d$ (°)	α (see note)	Shaft resistance $R_{s;d}$ (kN)
Very Stiff Sandy CLAY 1	38.40	36.20	2.20	Cohesive	21	15	53.6		0.8	33.9
Very Stiff Sandy CLAY 2	36.20	35.20	3.20	Cohesive	21	17	60.7		0.8	16.8
Very Stiff Sandy CLAY 3	35.20	33.20	5.20	Cohesive	21	25	89.3		0.7	43.6
Very Stiff Sandy CLAY 4	33.20	32.20	6.20	Cohesive	21	28	100.0		0.6	23.0
TOTAL SHAFT RESISTANCE $R_{s;d} = \Sigma A_s q_{s;d}$ (kN)										117.2

BASE RESISTANCE FOR M1 MATERIAL FACTORS SET											
Helix Plate Diameter (m)	Plate Area A_b (m^2)	Helix Depth (m below top of pile)	Helix Depth z_h (mAOD)	Resistance in compression (kN)			Resistance in tension (kN)			Plate base resistance in compression $r_{b;k}$ (kN)	Plate base resistance in tension $r_{b;k}$ (kN)
				at z_h	at z_h-0.25m	at z_h-0.75m	at z_h	at z_h+0.25m	at z_h+0.75m		
0.45	0.15	2.75	35.53	113.8	113.8	167.4	113.8	113.8	100.4	124.5	111.1
NOTE: $A_b = A_{helix} - A_{b;shaft}$. For compression rb;k = $(0.5.r_{b;k\ at\ zh})+(0.3.r_{b;k\ at\ zh-0.25m})+(0.2.r_{b;k\ at\ zh-0.75})$ For tension rb;k = $(0.5.r_{b;k\ at\ zh})+(0.3.r_{b;k\ at\ zh+0.25m})+(0.2.r_{b;k\ at\ zh+0.75})$							BASE RESISTANCE $\Sigma r_{b;k} = R_{b;k}$ (kN):			124.5	111.1

BASE RESISTANCE FOR M2 MATERIAL FACTORS SET											
Helix Plate Diameter (m)	Plate Area A_b (m^2)	Helix Depth (m below top of pile)	Helix Depth z_h (mAOD)	Resistance in compression (kN)			Resistance in tension (kN)			Plate base resistance in compression $r_{b;k}$ (kN)	Plate base resistance in tension $r_{b;k}$ (kN)
				at z_h	at z_h-0.25m	at z_h-0.75m	at z_h	at z_h+0.25m	at z_h+0.75m		
0.45	0.15	2.75	35.53	81.3	81.3	119.6	81.3	81.3	71.7	89.0	79.4
NOTE: Ab = Ahelix - Ab;shaft. For compression $r_{b;k} = (0.5.r_{b;k\ at\ zh})+(0.3.r_{b;k\ at\ zh-0.25m})+(0.2.r_{b;k\ at\ zh-0.75})$ For tension $r_{b;k} = (0.5.r_{b;k\ at\ zh})+(0.3.r_{b;k\ at\ zh+0.25m})+(0.2.r_{b;k\ at\ zh+0.75})$							BASE RESISTANCE $\Sigma r_{b;k} = R_{b;k}$ (kN):			89.0	79.4

NOTE: CALCULATION OF PILE RESISTANCE:

Pile capacity (resistance) is calculated as the sum of the helix resistances, assuming each acts like an end-bearing face. The helix plates are spaced far enough apart along the shaft to ensure that the effect of interference between the bulbs of loaded soil can be ignored in accordance with Boussinesq's theory. The skin friction over the embedded length of the pile shaft is considered negligible and is ignored for the purposes of pile capacity.

All input values are based on measured, site specific values where such information is available. Otherwise the input data is estimated using values taken from published literature.

Minimum helix spacing (m):	Single helix only
Distance between lowest helix and end of pile (m)	0.25

PARTIAL RESISTANCE FACTORS (γ_R) FOR DRIVEN PILES FOR THE GEO LIMIT STATE (TABLE A.NA.6)							
		R1	R4 without..	R4 with..	DO YOU HAVE "EXPLICIT VERIFICATION OF SLS" FOR R4?	NO	APPLICABLE R4 FACTORS
SHAFT IN COMPRESSION	γ_s	1.0	1.5	1.3	NOTE: The lower values in R4 may be adopted (a) if serviceability is verified by load tests (preliminary and/or working) carried out on more than 1% of the construction piles to loads not less than 1.5 times the representative load for which they are designed, or (b) if settlement is explicitly predicted by a means no less reliable than in (a), or (c) if settlement at the serviceability limit state is of no concern. (Note A to Table A.NA.6)		1.5
SHAFT IN TENSION	$\gamma_{s;t}$	1.0	2.0	1.7			2.0
BASE	γ_b	1.0	1.7	1.5			1.7
BASE IN TENSION	$\gamma_{b;t}$	1.3	2.2	2.0	NOTE: EC7 does not have a $\gamma_{b;t}$ factor since the base resistance does not contribute to tensile resistance in 'normal' pile design. The $\gamma_{b;t}$ factor is therefore a ScrewFast addition to account for the fact that the soil will provide less resistance to a tensile load on the helix plates than to the same load in compression.		2.2
MODEL FACTOR	γ_{Rd}	1.4	NOTE: The value of the model factor should be 1.4, except that it may be reduced to 1.2 if the resistance is verified by a maintained load test taken to the calculated, unfactored ultimate resistance. (A.3.3.2)				

PILE DESIGN ACTIONS (kN)									
CHARACTERISTIC DESIGN ACTIONS (kN) Permanent = G_k, Variable = Q_k			FAVOURABILITY i.e. promotes stability (favourable) or instability (unfavourable)	A1 SET			A2 SET		
				PARTIAL FACTOR γ_G or γ_Q	FACTORED ACTIONS $G_k.\gamma_G$ & $Q_k.\gamma_Q$	DESIGN ACTIONS $F_{c;d} = G_k.\gamma_G + Q_k.\gamma_Q$	PARTIAL FACTOR γ_G or γ_Q	FACTORED ACTIONS $G_k.\gamma_G$ & $Q_k.\gamma_Q$	DESIGN ACTIONS $F_{c;d} = G_k.\gamma_G + Q_k.\gamma_Q$
COMPRESSION:	PERMANENT	5	UNFAVOURABLE	1.20	6.0	12.8	1.00	5.0	10.8
	VARIABLE	5	UNFAVOURABLE	1.35	6.8		1.15	5.8	
TENSION:	PERMANENT			1.20	0.0	0.0	1.00	0.0	0.0
	VARIABLE			1.55	0.0		0.00	0.0	
NOTE: Refer to drawing referenced above for pile design load derivation and pile key plan. Partial factors from BS EN 1990:2002 as referenced in Table A.NA.3. Refer to A.NA.3 if actions relate to water level as factors may not be appropriate.									

DESIGN APPROACH 1, COMBINATION 1: A1 + M1 + R1				
	A1	M1	R1	DESIGN CHECK $F_d \le R_d$
	$F_d = G_k.\gamma_G + Q_k.\gamma_Q$	$R_{b;k}$	$R_{c;d} = R_{b;k}/\gamma_b/\gamma_{Rd}$	
COMPRESSION	12.8	124.5	89.0	Difference = 76.2 DESIGN OK
TENSION	0.0	111.1	61.1	DESIGN OK

The critical design case is
Design Approach 1, Combination 2
A2 + M2 + R4

DESIGN APPROACH 1, COMBINATION 2: A2 + (M1 or M2) + R4							
	$F_d = G_k.\gamma_G + Q_k.\gamma_Q$	$R_{b;k}$		$R_d = R_{b;k}/\gamma_b/\gamma_{Rd}$		DESIGN CHECK FOR M1 $F_d \le R_d$	DESIGN CHECK FOR M2 $F_d \le R_d$
	A2	M1	M2	R4 for M1	R4 for M2		
COMPRESSION	10.8	124.5	89.0	52.3	37.4	Difference = 41.5 DESIGN OK	Difference = 26.6 DESIGN OK
TENSION	0.0	111.1	79.4	35.9	25.7	NO TENSILE ACTION	DESIGN OK
NOTE: The M2 situation covers unfavourable actions on piles e.g. negative skin friction. 7.3.2.1(2) states that: "for these situations, the design values of the strength and stiffness of the moving ground should usually be upper values".							

INSTALLATION TORQUE	
MINIMUM (kNm)	5
DESIGN (kNm)	11
MAXIMUM (kNm)	32

PILE HEAD SETTLEMENT PREDICTION AT THE SLS	
PREDICTED PILE HEAD SETTLEMENT (mm)	< 10
NOTE: Pile settlement predictions are based on simplified methods as outlined in Pile Design and Construction Practice (Tomlinson and Woodward, 2006, P195). This is a prediction only which satisfies the provision of EC7 SLS design. Actual pile head settlement at the SLS is dependent on external construction factors which are outside of ScrewFast's control.	

STEEL CORROSION PROTECTION					
ENVIRONMENT	Soils/Rock	LOCAL CONDITIONS	Non-compacted and non-aggressive fills (clay, schist, sand, silt,.......)	DESIGN LIFE	30 years
THICKNESS OF GALVANISING REQUIRED TO 2mbgl		85 μm	ADDITIONAL PROTECTION REQUIRED	G2b ground section to SHW Series 1900	
NOTE: Refer to SFF pile drawings for full details of pile corrosion protection. Protection measures required are calculated in accordance with BS EN 1993-5:2007, BS EN ISO 14713 and advice from Kevin Davies of CorroCiv Ltd as appropriate.					

STRUCTURAL RESISTANCE TO BS EN 1993-1-1:2005

SECTION RELEVANT TO CHECK:	2nd	OUTSIDE DIAMETER (mm)	113.5	WALL THICKNESS (mm)	9.6	Dimensions used reflect design life

BUCKLING RESISTANCE OF PILE SHAFT SECTION, $N_{b,Rd}$

$$N_{b,Rd} = \frac{\chi A F_y}{\gamma_{M1}}$$

A = CROSS SECTIONAL AREA (mm²) =	3126
I = SECOND MOMENT OF AREA (mm⁴) =	4252464
i = RADIUS OF GYRATION (mm) =	37
F_y = STEEL GRADE (N/mm²) =	355
γ_{M1} = PARTIAL SAFETY FACTOR =	1
ESTIMATED PILE FIXITY POINT =	3.00
L_{eff} = EFFECTIVE LENGTH OF THE SECTION =	6.00
λ = NON-DIMENSIONAL SLENDERNESS	2.129
$\Phi = 0.5[1+\alpha(\lambda-0.2)+\lambda^2]$ =	3.240
χ = REDUCTION FACTOR FOR THE BUCKLING MODE =	0.176
$N_{b,Rd}$ =	195.33
N_{Ed} = ULS COMPRESSION FORCE (kN) =	14

BUCKLING RESISTANCE CHECK	$N_{Ed}/N_{b,Rd} \leq 1$	0.073	OK

COMBINED ACTION OF BENDING MOMENT AND AXIAL FORCE

$$M_{Ed} \leq M_{N,Rd}$$

$W_{pl,y}$ = PLASTIC SECTION MODULUS (cm³) =	103.66
F_y = STEEL GRADE (N/mm²) =	355
γ_{MO} = PARTIAL SAFETY FACTOR =	1.00
$M_{pl,Rd}$ = BENDING MOMENT RESISTANCE =	36.80
$N_{pl,Rd}$ = AXIAL RESISTANCE =	1109.75
M_{Ed}* = ULS BENDING MOMENT (kNm) =	0.64
N_{Ed}** = ULS AXIAL FORCE (kN) =	14.25
$n = N_{ed} / N_{pl,Rd}$	0.01
$M_{N,Rd} = M_{pl,Rd}(1 - n^{1.7})$	36.78

MOMENT AND AXIAL FORCE CHECK	$M_{Ed} \leq M_{N,Rd}$	OK

NOTE: The above buckling check applies to cold rolled tube section. Hot formed tube section of the same size will have greater buckling resistance. Design compression force is sum of positive permanent and variable actions.
* ULS pile bending moment force as advised by Structural Engineer. ** ULS pile compression or tension force - whichever is greater - as advised by Structural Engineer.

GRILLAGE REQUIRED?		No	
PILE CONNECTION TYPE REQUIRED:		A-Section	
INFORMATION FROM PILE DESIGN SELECTIONS ABOVE			
Helix configuration		CHS dimensions over helix depth(s) (mm)	114.3 x 10
Helix Plate Diameter (m)	Helix Depth (m below top of pile)		
0.45	2.75	Distance between lowest helix and end of pile (m)	0.25

PILE SECTION SELECTION				
CHS dimensions (mm)		SFF PILE SECTION	HELIX DEPTHS (m below top of pile)	BASE OF SECTION (m below top of pile)
Diameter	Wall			
139.7	10.0	A1M (GALV)	(Plain section)	1
114.3	10.0	E2M 450 (GALV)	2.75	3
Checks	Sum of section lengths = total pile length			OKAY
	Lowest helix to toe distance matches toe section selected			OKAY

INSTALLATION NOTES

1) Stop immediately if a void is encountered and contact project manager.
2) Ensure all buried services are detected and isolated prior to piling
3) BH1904N used to formulate the ground model

APPENDIX B3: Design Calculation Sheets
Secondary Piles

HELICAL PILE DESIGN

ScrewFast FOUNDATIONS LTD

for GEO limit state to Eurocode 7: Geotechnical Design - Part 1: BS EN 1997-1:2004+A1:2013, BS EN 14199:2015 and BS8004:2015

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SFF JOB No:	233630
JOB NAME:	NEAR
CLIENT:	BMJV

SITE NAME:	M1 Junction 23-25a
STRUCTURE TYPE:	Secondary Piles
CLIENT REF NUMBER:	

PILE DESIGN REF:	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0007
LOAD REF:	See AP email dated 14/11/23
SFF DRAWING REF:	
CLIENT GA DRAWING REF:	

DESIGNER		COMMENTS
NAME:	Michael Christie	Secondary Piles
DATE:	21/11/2023	

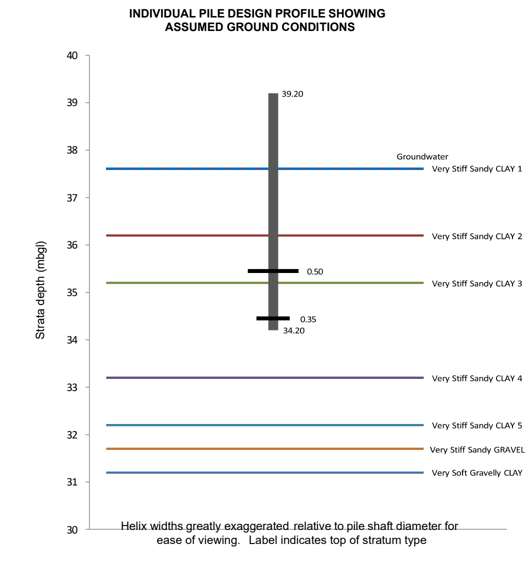
SFF REV No:	00
DATE:	21/11/23
REVISION DESCRIPTION:	

REVIEWED & CHECKED		
NAME:	Andrej Podpriatov	COMPANY (IF NOT SFF):
DATE:	28/11/2023	
COMMENTS:		

LEVELS	
G.I. REF NUMBER:	G230600 Rev 001
G.I. DATUM (mAOD)	39.20
TOP OF PILE (mAOD)	39.20
GROUND LEVEL (G.L.) (mAOD)	37.61
GROUNDWATER DEPTH (mAOD) (See note)	37.61

NOTE: Groundwater depth: 2.4.6.1(6)P: When dealing with ground-water pressures for limit states with severe consequences (generally ultimate limit states), design values shall represent the most unfavourable values that could occur during the design lifetime of the structure. For limit states with less severe consequences (generally serviceability limit states), design values shall be the most unfavourable values which could occur in normal circumstances. 2.4.6.1(11): Unless the adequacy of the drainage system can be demonstrated and its maintenance ensured, the design ground-water table should be taken as the maximum possible level, which may be the ground surface.

N.B. Design profile does not show sloping topography



PILE GROUP FOUNDATION DESIGN	
RAKE ANGLE FROM VERTICAL (º)	0
ALTER PILE DESIGN TO ACCOUNT FOR RAKING	NO
MINIMUM PILE SPACING C/C (m)	1.2
PILES PER STRUCTURE	4
TOPOGRAPHY AT SITE	Embankment
MAXIMUM PILE PROJECTION ABOVE GROUND LEVEL (m)	1.59
BRACING REQUIRED	YES
PILE POSITION SELECTED FROM GROUP FOR DESIGN:	Furthest down slope; greatest projection

PILE DETAILS

Pile diameter at helix depth(s) (mm)	Wall thickness (mm)	Length (m)	Top (mAOD)	Bottom (mAOD)
114.3	10.00	5.00	39.20	34.20
Surface Area A_s (m^2 per m)		0.36		
Helix plate thickness		12mm		

GROUND CONDITIONS USING CHARACTERISTIC VALUES ($_k$) FROM GROUND TEST RESULTS

Strata description	Top of layer (mAOD)	Bottom of layer (mAOD)	Cumulative depth (mbgl)	Strata type for purposes of analysis	Unit weight γ (kN/m³)	Average SPT 'N' value	$c_{u;k}$ (kPa)	Φ'_k (º)	α (see note)	Shaft resistance $R_{s;k}$ (kN)
Very Stiff Sandy CLAY 1	37.61	36.20	1.41	Cohesive	21	15	75		0.80	30.38
Very Stiff Sandy CLAY 2	36.20	35.20	2.41	Cohesive	21	17	85		0.77	23.50
Very Stiff Sandy CLAY 3	35.20	33.20	4.41	Cohesive	21	25	125		0.68	0.00
Very Stiff Sandy CLAY 4	33.20	32.20	5.41	Cohesive	21	28	140		0.64	0.00
Very Stiff Sandy CLAY 5	32.20	31.70	5.91	Cohesive	21	30	150		0.62	0.00
Very Stiff Sandy GRAVEL	31.70	31.20	6.41	Non-cohesive	21	61		37		0.00
Very Soft Gravelly CLAY	31.20	30.20	7.41	Cohesive	21	61	100		0.74	0.00
										0.00
										0.00
NOTE: SPT 'N' value is used to calculate anticipated torque during installation; it is not used in pile capacity calculation					TOTAL SHAFT RESISTANCE $R_{s;k} = \Sigma A_s q_{s;k}$ (kN)					53.88
NOTE: Refer to A.3.3.2 and A.3.3.3 if characteristic values of ground strength are derived from static load tests					NOTE: Factored ground conditions for M1 Material Factors are same as $R_{s;k}$ value above since all factors = 1.0					

PARTIAL MATERIAL FACTORS FOR SOIL PARAMETERS (γ_M) (TABLE A.NA.4)

		M1 SET	M2 SET	Reciprocal of M2 Set	Most onerous factor for M2
Angle of shearing resistance	γ_{φ}'	1.00	1.25	0.80	0.80
Effective cohesion	γ_c'	1.00	1.25	0.80	0.80
Undrained shear strength	γ_{cu}	1.00	1.40	0.71	0.71
Unconfined strength	γ_{qu}	1.00	1.40	0.71	0.71

NOTE: The value of the partial factor should be taken as the reciprocal of the specified value if such a reciprocal value produces a more onerous effect than the specified value (Note to Table A.NA.4). The characteristic values may have to be adjusted to upper values for the M2 situation as per 7.3.2.1(2)

FACTORED GROUND CONDITIONS FOR M2 MATERIAL FACTORS SET

Strata description	Top of layer (mAOD)	Bottom of layer (mAOD)	Cumulative depth (mbgl)	Strata type for purposes of analysis	Unit weight γ (kN/m³)	Average 'N' value	$c_{u;d}$ (kPa)	Φ'_d (º)	α (see note)	Shaft resistance $R_{s;d}$ (kN)
Very Stiff Sandy CLAY 1	37.61	36.20	1.41	Cohesive	21	15	53.6		0.8	21.7
Very Stiff Sandy CLAY 2	36.20	35.20	2.41	Cohesive	21	17	60.7		0.8	16.8
Very Stiff Sandy CLAY 3	35.20	33.20	4.41	Cohesive	21	25	89.3		0.7	43.6
Very Stiff Sandy CLAY 4	33.20	32.20	5.41	Cohesive	21	28	100.0		0.6	23.0
Very Stiff Sandy CLAY 5	32.20	31.70	5.91	Cohesive	21	30	107.1		0.6	11.9
Very Stiff Sandy GRAVEL	31.70	31.20	6.41	Non-cohesive	21	61		31.1		6.7
Very Soft Gravelly CLAY	31.20	30.20	7.41	Cohesive	21	61	71.4		0.7	19.0
									TOTAL SHAFT RESISTANCE $R_{s;d} = \Sigma A_s q_{s;d}$ (kN)	142.7

BASE RESISTANCE FOR M1 MATERIAL FACTORS SET											
Helix Plate Diameter (m)	Plate Area A_b (m^2)	Helix Depth (m below top of pile)	Helix Depth z_h (mAOD)	Resistance in compression (kN)			Resistance in tension (kN)			Plate base resistance in compression $r_{b;k}$ (kN)	Plate base resistance in tension $r_{b;k}$ (kN)
				at z_h	at z_h-0.25m	at z_h-0.75m	at z_h	at z_h+0.25m	at z_h+0.75m		
0.50	0.19	3.75	35.45	142.4	142.4	209.3	142.4	142.4	125.6	155.8	139.0
0.35	0.09	4.75	34.45	96.7	96.7	96.7	96.7	96.7	65.8	96.7	90.5
NOTE: $A_b = A_{helix} - A_{b;shaft}$. For compression rb;k = $(0.5.r_{b;k\ at\ zh})+(0.3.r_{b;k\ at\ zh-0.25m})+(0.2.r_{b;k\ at\ zh-0.75})$ For tension rb;k = $(0.5.r_{b;k\ at\ zh})+(0.3.r_{b;k\ at\ zh+0.25m})+(0.2.r_{b;k\ at\ zh+0.75})$							BASE RESISTANCE $\Sigma r_{b;k} = R_{b;k}$ (kN):			252.5	229.5

BASE RESISTANCE FOR M2 MATERIAL FACTORS SET											
Helix Plate Diameter (m)	Plate Area A_b (m^2)	Helix Depth (m below top of pile)	Helix Depth z_h (mAOD)	Resistance in compression (kN)			Resistance in tension (kN)			Plate base resistance in compression $r_{b;k}$ (kN)	Plate base resistance in tension $r_{b;k}$ (kN)
				at z_h	at z_h-0.25m	at z_h-0.75m	at z_h	at z_h+0.25m	at z_h+0.75m		
0.50	0.19	3.75	35.45	101.7	101.7	149.5	101.7	101.7	89.7	111.3	99.3
0.35	0.09	4.75	34.45	69.1	69.1	69.1	69.1	69.1	47.0	69.1	64.6
NOTE: Ab = Ahelix - Ab;shaft. For compression $r_{b;k} = (0.5.r_{b;k\ at\ zh})+(0.3.r_{b;k\ at\ zh-0.25m})+(0.2.r_{b;k\ at\ zh-0.75})$ For tension $r_{b;k} = (0.5.r_{b;k\ at\ zh})+(0.3.r_{b;k\ at\ zh+0.25m})+(0.2.r_{b;k\ at\ zh+0.75})$							BASE RESISTANCE $\Sigma r_{b;k} = R_{b;k}$ (kN):			180.3	163.9

NOTE: CALCULATION OF PILE RESISTANCE:

Pile capacity (resistance) is calculated as the sum of the helix resistances, assuming each acts like an end-bearing face. The helix plates are spaced far enough apart along the shaft to ensure that the effect of interference between the bulbs of loaded soil can be ignored in accordance with Boussinesq's theory. The skin friction over the embedded length of the pile shaft is considered negligible and is ignored for the purposes of pile capacity.

All input values are based on measured, site specific values where such information is available. Otherwise the input data is estimated using values taken from published literature.

Minimum helix spacing (m):	1
Distance between lowest helix and end of pile (m)	0.25

PARTIAL RESISTANCE FACTORS (γ_R) FOR DRIVEN PILES FOR THE GEO LIMIT STATE (TABLE A.NA.6)							
		R1	R4 without..	R4 with..	DO YOU HAVE "EXPLICIT VERIFICATION OF SLS" FOR R4?	NO	APPLICABLE R4 FACTORS
SHAFT IN COMPRESSION	γ_s	1.0	1.5	1.3	NOTE: The lower values in R4 may be adopted (a) if serviceability is verified by load tests (preliminary and/or working) carried out on more than 1% of the construction piles to loads not less than 1.5 times the representative load for which they are designed, or (b) if settlement is explicitly predicted by a means no less reliable than in (a), or (c) if settlement at the serviceability limit state is of no concern. (Note A to Table A.NA.6)		1.5
SHAFT IN TENSION	$\gamma_{s;t}$	1.0	2.0	1.7			2.0
BASE	γ_b	1.0	1.7	1.5			1.7
BASE IN TENSION	$\gamma_{b;t}$	1.3	2.2	2.0	NOTE: EC7 does not have a $\gamma_{b;t}$ factor since the base resistance does not contribute to tensile resistance in 'normal' pile design. The $\gamma_{b;t}$ factor is therefore a ScrewFast addition to account for the fact that the soil will provide less resistance to a tensile load on the helix plates than to the same load in compression.		2.2
MODEL FACTOR	γ_{Rd}	1.4	NOTE: The value of the model factor should be 1.4, except that it may be reduced to 1.2 if the resistance is verified by a maintained load test taken to the calculated, unfactored ultimate resistance. (A.3.3.2)				

PILE DESIGN ACTIONS (kN)									
CHARACTERISTIC DESIGN ACTIONS (kN) Permanent = G_k, Variable = Q_k			FAVOURABILITY i.e. promotes stability (favourable) or instability (unfavourable)	A1 SET			A2 SET		
				PARTIAL FACTOR γ_G or γ_Q	FACTORED ACTIONS $G_k.\gamma_G$ & $Q_k.\gamma_Q$	DESIGN ACTIONS $F_{c;d} = G_k.\gamma_G + Q_k.\gamma_Q$	PARTIAL FACTOR γ_G or γ_Q	FACTORED ACTIONS $G_k.\gamma_G$ & $Q_k.\gamma_Q$	DESIGN ACTIONS $F_{c;d} = G_k.\gamma_G + Q_k.\gamma_Q$
COMPRESSION:	PERMANENT	20	UNFAVOURABLE	1.20	24.0	51.0	1.00	20.0	43.0
	VARIABLE	20	UNFAVOURABLE	1.35	27.0		1.15	23.0	
TENSION:	PERMANENT			1.20	0.0	0.0	1.00	0.0	0.0
	VARIABLE			1.35	0.0		1.15	0.0	
NOTE: Refer to drawing referenced above for pile design load derivation and pile key plan. Partial factors from BS EN 1990:2002 as referenced in Table A.NA.3. Refer to A.NA.3 if actions relate to water level as factors may not be appropriate.									

DESIGN APPROACH 1, COMBINATION 1: A1 + M1 + R1				
	A1	M1	R1	DESIGN CHECK $F_d \leq R_d$
	$F_d = G_k.\gamma_G + Q_k.\gamma_Q$	$R_{b;k}$	$R_{c;d} = R_{b;k}/\gamma_b/\gamma_{Rd}$	
COMPRESSION	51.0	252.5	180.3	Difference = 129.3 DESIGN OK
TENSION	0.0	229.5	126.1	DESIGN OK

The critical design case is
Design Approach 1, Combination 2
A2 + M2 + R4

DESIGN APPROACH 1, COMBINATION 2: A2 + (M1 or M2) + R4							
	$F_d = G_k.\gamma_G + Q_k.\gamma_Q$	$R_{b;k}$		$R_d = R_{b;k}/\gamma_b/\gamma_{Rd}$		DESIGN CHECK FOR M1 $F_d \leq R_d$	DESIGN CHECK FOR M2 $F_d \leq R_d$
	A2	M1	M2	R4 for M1	R4 for M2		
COMPRESSION	43.0	252.5	180.3	106.1	75.8	Difference = 63.1 DESIGN OK	Difference = 32.8 DESIGN OK
TENSION	0.0	229.5	163.9	74.2	53.0	NO TENSILE ACTION	DESIGN OK
NOTE: The M2 situation covers unfavourable actions on piles e.g. negative skin friction. 7.3.2.1(2) states that: "for these situations, the design values of the strength and stiffness of the moving ground should usually be upper values".							

INSTALLATION TORQUE	
MINIMUM (kNm)	12
DESIGN (kNm)	18
MAXIMUM (kNm)	32

PILE HEAD SETTLEMENT PREDICTION AT THE SLS	
PREDICTED PILE HEAD SETTLEMENT (mm)	< 10
NOTE: Pile settlement predictions are based on simplified methods as outlined in Pile Design and Construction Practice (Tomlinson and Woodward, 2006, P195). This is a prediction only which satisfies the provision of EC7 SLS design. Actual pile head settlement at the SLS is dependent on external construction factors which are outside of ScrewFast's control.	

STEEL CORROSION PROTECTION					
ENVIRONMENT	Soils/Rock	LOCAL CONDITIONS	Non-compacted and non-aggressive fills (clay, schist, sand, silt,.......)	DESIGN LIFE	30 years
THICKNESS OF GALVANISING REQUIRED TO 2mbgl	85 μm	ADDITIONAL PROTECTION REQUIRED	G2b ground section to SHW Series 1900		
NOTE: Refer to SFF pile drawings for full details of pile corrosion protection. Protection measures required are calculated in accordance with BS EN 1993-5:2007, BS EN ISO 14713 and advice from Kevin Davies of CorroCiv Ltd as appropriate.					

STRUCTURAL RESISTANCE TO BS EN 1993-1-1:2005

SECTION RELEVANT TO CHECK:	2nd	OUTSIDE DIAMETER (mm)	113.5	WALL THICKNESS (mm)	9.6	Dimensions used reflect design life

BUCKLING RESISTANCE OF PILE SHAFT SECTION, $N_{b,Rd}$

$$N_{b,Rd} = \frac{\chi A F_y}{\gamma_{M1}}$$

A = CROSS SECTIONAL AREA (mm^2) =	3126
I = SECOND MOMENT OF AREA (mm^4) =	4252464
i = RADIUS OF GYRATION (mm) =	37
F_y = STEEL GRADE (N/mm^2) =	355
γ_{M1} = PARTIAL SAFETY FACTOR =	1
ESTIMATED PILE FIXITY POINT =	3.00
L_{eff} = EFFECTIVE LENGTH OF THE SECTION =	6.00
λ = NON-DIMENSIONAL SLENDERNESS	2.129
$\Phi = 0.5[1+\alpha(\lambda-0.2)+\lambda^2]$ =	3.240
χ = REDUCTION FACTOR FOR THE BUCKLING MODE =	0.176
$N_{b,Rd}$ =	195.33
N_{Ed} = ULS COMPRESSION FORCE (kN) =	57
BUCKLING RESISTANCE CHECK: $N_{Ed}/N_{b,Rd} \leq 1$ = 0.292	OK

COMBINED ACTION OF BENDING MOMENT AND AXIAL FORCE

$$M_{Ed} \leq M_{N,Rd}$$

$W_{pl,y}$ = PLASTIC SECTION MODULUS (cm^3) =	103.66
F_y = STEEL GRADE (N/mm^2) =	355
γ_{MO} = PARTIAL SAFETY FACTOR =	1.00
$M_{pl,Rd}$ = BENDING MOMENT RESISTANCE =	36.80
$N_{pl,Rd}$ = AXIAL RESISTANCE =	1109.75
M_{Ed}* = ULS BENDING MOMENT (kNm) =	10.05
N_{Ed}** = ULS AXIAL FORCE (kN) =	57.00
$n = N_{ed} / N_{pl,Rd}$	0.05
$M_{N,Rd} = M_{pl,Rd} (1 - n^{1.7})$	36.56
MOMENT AND AXIAL FORCE CHECK: $M_{Ed} \leq M_{N,Rd}$	OK

NOTE: The above buckling check applies to cold rolled tube section. Hot formed tube section of the same size will have greater buckling resistance. Design compression force is sum of positive permanent and variable actions.
* ULS pile bending moment force as advised by Structural Engineer. ** ULS pile compression or tension force - whichever is greater - as advised by Structural Engineer.

GRILLAGE REQUIRED?	Yes
PILE CONNECTION TYPE REQUIRED:	A-Section

INFORMATION FROM PILE DESIGN SELECTIONS ABOVE

Helix Plate Diameter (m)	Helix Depth (m below top of pile)
0.50	3.75
0.35	4.75

CHS dimensions over helix depth(s) (mm)	114.3 x 10
Distance between lowest helix and end of pile (m)	0.25

PILE SECTION SELECTION

CHS dimensions (mm) Diameter	Wall	SFF PILE SECTION	HELIX DEPTHS (m below top of pile)	BASE OF SECTION (m below top of pile)
139.7	10.0	A3M (GALV)	(Plain section)	3
114.3	10.0	E2M 350/500 GALV	3.75 & 4.75	5

Checks		
	Sum of section lengths = total pile length	OKAY
	Lowest helix to toe distance matches toe section selected	OKAY

INSTALLATION NOTES

1) Stop immediately if a void is encountered and contact project manager.
2) Ensure all buried services are detected and isolated prior to piling
3) BH1904N used to formulate the ground model

Titles

Job No.:	233630
Job Title:	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0008
Sub-title:	M1 Junction 23-25a
Calculation Heading:	Lateral load analysis (5kN)
Initials:	MC
Checker:	
Date Saved:	06-Oct-2023
Date Checked:	
Notes:	SLS Secondary Piles
File Name:	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0008.alw
File Path:	J:\2023\233630\6. Design\InternallyChecked\Secondary Piles\ProjectNumbered

General Data

Number of increments = 1
Increment applied loads only
Standard analysis type
Apply layered soil adjustments to P-Y curves: No

Convergence Control

Maximum number of iterations = 300
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Partial Factors

Partial Factor Set	Variable Load (Rest./Dist.)	Permanent Load (Rest./Dist.)	Unit Weight	Drained Cohesion	Undrained Cohesion	Shear Angle
SLS	**1.000000/ 1.000000**	**1.000000/ 1.000000**	**1.000000**	**1.000000**	**1.000000**	**1.000000**

Soil Data

Soil model : Generated P-Y curves for static loads

No.	Level [m]	Type	Unit wt [kN/m³]	E50	C_u top [kN/m²]	dC_u/dz [kN/m²/m]	K_0	K_1 [kN/m²/m]	Phi [°]	q_{ur} [kPa]	α_r	k_{rm}	E_{ir} [kPa]
1	38.430000	Sand (Reese et al.)	18.000	-	-	-	0.50000	33930.	30.000	-	-	-	-
2	38.300000	Sand (Reese et al.)	20.000	-	-	-	0.41000	33930.	36.000	-	-	-	-
3	38.000000	Soft Clay	21.000	0.010000	75.000	0.0	-	-	-	-	-	-	-
4	36.100000	Soft Clay	21.000	0.010000	85.000	0.0	-	-	-	-	-	-	-
5	35.200000	Stiff Clay	21.000	0.010000	125.00	0.0	-	-	-	-	-	-	-
6	33.200000	Stiff Clay	21.000	0.010000	140.00	0.0	-	-	-	-	-	-	-
7	32.200000	Stiff Clay	21.000	0.010000	150.00	0.0	-	-	-	-	-	-	-
8	31.700000	Sand (Reese et al.)	21.000	-	-	-	0.40000	33930.	37.000	-	-	-	-

Sections

Oasys

HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0008
M1 Junction 23-25a
Lateral load analysis (5kN)

Job No.	Sheet No.	Rev.
233630		

Drg. Ref.

Made by	Date	Checked	Date
MC	06-Oct-2023		

No.	Level [m]	Type	Unit wt [kN/m³]	E50	C_u top [kN/m²]	dC_u/dz [kN/m²/m]	K_0	K_1 [kN/m²/m]	Phi [°]	q_{ur} [kPa]	α_r	k_{rm}	E_{ir} [kPa]

Name	Input Type	Description	Material	Class	Effective Width [m]	EI [kNm²]
139.7 x 10mm	Wizard Generated	STD%CHS%138.9%9.6	Steel		0.13935	1638.9
114.3 x 10mm	Wizard Generated	STD%CHS%113.5%9.6	Steel		0.11387	852.91

Pile Properties

Level [m]	Section
39.200	**139.7 x 10mm**
36.200	**114.3 x 10mm**

Pile base at 34.200000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	39.200	5.0000	0.0	0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	10000.

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
1	39.200	0	1638.9	0.13935	0.0	0.0
2	39.138	0	1638.9	0.13935	0.0	0.0
3	39.077	0	1638.9	0.13935	0.0	0.0
4	39.015	0	1638.9	0.13935	0.0	0.0
5	38.954	0	1638.9	0.13935	0.0	0.0
6	38.892	0	1638.9	0.13935	0.0	0.0
7	38.830	0	1638.9	0.13935	0.0	0.0
8	38.769	0	1638.9	0.13935	0.0	0.0
9	38.707	0	1638.9	0.13935	0.0	0.0
10	38.646	0	1638.9	0.13935	0.0	0.0
11	38.584	0	1638.9	0.13935	0.0	0.0
12	38.522	0	1638.9	0.13935	0.0	0.0
13	38.461	0	1638.9	0.13935	0.0	0.0
14	38.399	1	1638.9	0.13935	0.0	0.0
15	38.331	1	1638.9	0.13935	0.0	0.0
16	38.269	2	1638.9	0.13935	0.0	0.0
17	38.190	2	1638.9	0.13935	0.19624	0.0
18	38.112	2	1638.9	0.13935	0.98448	0.0
19	38.033	2	1638.9	0.13935	1.7727	0.0
20	37.967	3	1638.9	0.13935	2.4273	0.0
21	37.902	3	1638.9	0.13935	3.0818	0.0
22	37.836	3	1638.9	0.13935	3.7364	0.0
23	37.771	3	1638.9	0.13935	4.3909	0.0
24	37.705	3	1638.9	0.13935	5.0455	0.0
25	37.640	3	1638.9	0.13935	5.7000	0.0
26	37.575	3	1638.9	0.13935	6.3545	0.0
27	37.509	3	1638.9	0.13935	7.0091	0.0
28	37.444	3	1638.9	0.13935	7.6636	0.0
29	37.378	3	1638.9	0.13935	8.3182	0.0
30	37.313	3	1638.9	0.13935	8.9727	0.0
31	37.247	3	1638.9	0.13935	9.6273	0.0
32	37.182	3	1638.9	0.13935	10.282	0.0
33	37.116	3	1638.9	0.13935	10.936	0.0

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
34	37.051	3	1638.9	0.13935	11.591	0.0
35	36.985	3	1638.9	0.13935	12.245	0.0
36	36.920	3	1638.9	0.13935	12.900	0.0
37	36.855	3	1638.9	0.13935	13.555	0.0
38	36.789	3	1638.9	0.13935	14.209	0.0
39	36.724	3	1638.9	0.13935	14.864	0.0
40	36.658	3	1638.9	0.13935	15.518	0.0
41	36.593	3	1638.9	0.13935	16.173	0.0
42	36.527	3	1638.9	0.13935	16.827	0.0
43	36.462	3	1638.9	0.13935	17.482	0.0
44	36.396	3	1638.9	0.13935	18.136	0.0
45	36.331	3	1638.9	0.13935	18.791	0.0
46	36.265	3	1638.9	0.13935	19.445	0.0
47	36.200	3	852.91	0.11387	20.100	0.0
48	36.133	3	852.91	0.11387	20.767	0.0
49	36.067	4	852.91	0.11387	21.433	0.0
50	35.974	4	852.91	0.11387	22.357	0.0
51	35.882	4	852.91	0.11387	23.281	0.0
52	35.789	4	852.91	0.11387	24.205	0.0
53	35.697	4	852.91	0.11387	25.129	0.0
54	35.605	4	852.91	0.11387	26.053	0.0
55	35.512	4	852.91	0.11387	26.977	0.0
56	35.420	4	852.91	0.11387	27.901	0.0
57	35.327	4	852.91	0.11387	28.825	0.0
58	35.235	4	852.91	0.11387	29.749	0.0
59	35.165	5	852.91	0.11387	30.451	0.0
60	35.077	5	852.91	0.11387	31.328	0.0
61	34.989	5	852.91	0.11387	32.205	0.0
62	34.902	5	852.91	0.11387	33.082	0.0
63	34.814	5	852.91	0.11387	33.960	0.0
64	34.726	5	852.91	0.11387	34.837	0.0
65	34.639	5	852.91	0.11387	35.714	0.0
66	34.551	5	852.91	0.11387	36.591	0.0
67	34.463	5	852.91	0.11387	37.468	0.0
68	34.375	5	852.91	0.11387	38.346	0.0
69	34.288	5	852.91	0.11387	39.223	0.0
70	34.200	5	852.91	0.11387	40.100	0.0

CALCULATED Soil P-y curves

Node	P1 [kN/m]	Y1 [mm]	P2 [kN/m]	Y2 [mm]	P3 [kN/m]	Y3 [mm]
14	0.0	0.0	0.22957	0.21968	0.33418	0.74537
15	0.0	0.0	0.85509	0.25405	1.2125	0.77115
16	0.0	0.0	2.6596	0.48747	3.2810	0.94622
17	0.0	0.0	4.3264	0.53213	5.1990	0.97971
18	0.0	0.0	4.4871	0.41528	5.7368	0.89208
19	0.0	0.0	3.2348	0.23998	5.1775	0.76060
20	0.0	0.0	14.510	0.69674	24.813	3.4837
21	0.0	0.0	15.258	0.69674	26.090	3.4837
22	0.0	0.0	16.005	0.69674	27.367	3.4837
23	0.0	0.0	16.752	0.69674	28.645	3.4837
24	0.0	0.0	17.499	0.69674	29.922	3.4837
25	0.0	0.0	18.246	0.69674	31.200	3.4837
26	0.0	0.0	18.993	0.69674	32.477	3.4837
27	0.0	0.0	19.740	0.69674	33.755	3.4837
28	0.0	0.0	20.487	0.69674	35.032	3.4837
29	0.0	0.0	21.234	0.69674	36.310	3.4837
30	0.0	0.0	21.981	0.69674	37.587	3.4837
31	0.0	0.0	22.728	0.69674	38.864	3.4837
32	0.0	0.0	23.475	0.69674	40.142	3.4837
33	0.0	0.0	24.222	0.69674	41.419	3.4837
34	0.0	0.0	24.969	0.69674	42.697	3.4837
35	0.0	0.0	25.716	0.69674	43.974	3.4837
36	0.0	0.0	26.463	0.69674	45.252	3.4837
37	0.0	0.0	27.210	0.69674	46.529	3.4837
38	0.0	0.0	27.503	0.69674	47.030	3.4837
39	0.0	0.0	27.503	0.69674	47.030	3.4837
40	0.0	0.0	27.503	0.69674	47.030	3.4837
41	0.0	0.0	27.503	0.69674	47.030	3.4837
42	0.0	0.0	27.503	0.69674	47.030	3.4837
43	0.0	0.0	27.503	0.69674	47.030	3.4837
44	0.0	0.0	27.503	0.69674	47.030	3.4837

Node	P1 [kN/m]	Y1 [mm]	P2 [kN/m]	Y2 [mm]	P3 [kN/m]	Y3 [mm]
45	0.0	0.0	27.503	0.69674	47.030	3.4837
46	0.0	0.0	27.503	0.69674	47.030	3.4837
47	0.0	0.0	22.474	0.56933	38.430	2.8466
48	0.0	0.0	22.474	0.56933	38.430	2.8466
49	0.0	0.0	25.470	0.56933	43.554	2.8466
50	0.0	0.0	25.470	0.56933	43.554	2.8466
51	0.0	0.0	25.470	0.56933	43.554	2.8466
52	0.0	0.0	25.470	0.56933	43.554	2.8466
53	0.0	0.0	25.470	0.56933	43.554	2.8466
54	0.0	0.0	25.470	0.56933	43.554	2.8466
55	0.0	0.0	25.470	0.56933	43.554	2.8466
56	0.0	0.0	25.470	0.56933	43.554	2.8466
57	0.0	0.0	25.470	0.56933	43.554	2.8466
58	0.0	0.0	25.470	0.56933	43.554	2.8466
59	0.0	0.0	37.456	0.56933	64.049	2.8466
60	0.0	0.0	37.456	0.56933	64.049	2.8466
61	0.0	0.0	37.456	0.56933	64.049	2.8466
62	0.0	0.0	37.456	0.56933	64.049	2.8466
63	0.0	0.0	37.456	0.56933	64.049	2.8466
64	0.0	0.0	37.456	0.56933	64.049	2.8466
65	0.0	0.0	37.456	0.56933	64.049	2.8466
66	0.0	0.0	37.456	0.56933	64.049	2.8466
67	0.0	0.0	37.456	0.56933	64.049	2.8466
68	0.0	0.0	37.456	0.56933	64.049	2.8466
69	0.0	0.0	37.456	0.56933	64.049	2.8466
70	0.0	0.0	37.456	0.56933	64.049	2.8466

Node	P4 [kN/m]	Y4 [mm]	P5 [kN/m]	Y5 [mm]	P6 [kN/m]	Y6 [mm]
14	0.39375	1.2711	0.47389	2.3225	0.65594	5.2255
15	1.4248	1.2883	1.7149	2.3225	2.3891	5.2255
16	3.7184	1.4050	4.3597	2.3225	6.0849	5.2255
17	5.8225	1.4273	6.7414	2.3225	9.2779	5.2255
18	6.5830	1.3689	7.8019	2.3225	10.936	5.2255
19	6.4040	1.2812	8.1617	2.3225	12.321	5.2255
20	35.730	10.451	49.625	27.870	49.625	348.37
21	37.570	10.451	52.180	27.870	52.180	348.37
22	39.409	10.451	54.735	27.870	54.735	348.37
23	41.249	10.451	57.290	27.870	57.290	348.37
24	43.088	10.451	59.845	27.870	59.845	348.37
25	44.928	10.451	62.400	27.870	62.400	348.37
26	46.767	10.451	64.954	27.870	64.954	348.37
27	48.607	10.451	67.509	27.870	67.509	348.37
28	50.446	10.451	70.064	27.870	70.064	348.37
29	52.286	10.451	72.619	27.870	72.619	348.37
30	54.125	10.451	75.174	27.870	75.174	348.37
31	55.965	10.451	77.729	27.870	77.729	348.37
32	57.804	10.451	80.284	27.870	80.284	348.37
33	59.644	10.451	82.839	27.870	82.839	348.37
34	61.483	10.451	85.393	27.870	85.393	348.37
35	63.323	10.451	87.948	27.870	87.948	348.37
36	65.162	10.451	90.503	27.870	90.503	348.37
37	67.002	10.451	93.058	27.870	93.058	348.37
38	67.723	10.451	94.060	27.870	94.060	348.37
39	67.723	10.451	94.060	27.870	94.060	348.37
40	67.723	10.451	94.060	27.870	94.060	348.37
41	67.723	10.451	94.060	27.870	94.060	348.37
42	67.723	10.451	94.060	27.870	94.060	348.37
43	67.723	10.451	94.060	27.870	94.060	348.37
44	67.723	10.451	94.060	27.870	94.060	348.37
45	67.723	10.451	94.060	27.870	94.060	348.37
46	67.723	10.451	94.060	27.870	94.060	348.37
47	55.339	8.5399	76.859	22.773	76.859	284.66
48	55.339	8.5399	76.859	22.773	76.859	284.66
49	62.717	8.5399	87.107	22.773	87.107	284.66
50	62.717	8.5399	87.107	22.773	87.107	284.66
51	62.717	8.5399	87.107	22.773	87.107	284.66
52	62.717	8.5399	87.107	22.773	87.107	284.66
53	62.717	8.5399	87.107	22.773	87.107	284.66
54	62.717	8.5399	87.107	22.773	87.107	284.66
55	62.717	8.5399	87.107	22.773	87.107	284.66
56	62.717	8.5399	87.107	22.773	87.107	284.66

Node	P4	Y4	P5	Y5	P6	Y6
	[kN/m]	[mm]	[kN/m]	[mm]	[kN/m]	[mm]
57	62.717	8.5399	87.107	22.773	87.107	284.66
58	62.717	8.5399	87.107	22.773	87.107	284.66
59	92.231	8.5399	128.10	22.773	128.10	284.66
60	92.231	8.5399	128.10	22.773	128.10	284.66
61	92.231	8.5399	128.10	22.773	128.10	284.66
62	92.231	8.5399	128.10	22.773	128.10	284.66
63	92.231	8.5399	128.10	22.773	128.10	284.66
64	92.231	8.5399	128.10	22.773	128.10	284.66
65	92.231	8.5399	128.10	22.773	128.10	284.66
66	92.231	8.5399	128.10	22.773	128.10	284.66
67	92.231	8.5399	128.10	22.773	128.10	284.66
68	92.231	8.5399	128.10	22.773	128.10	284.66
69	92.231	8.5399	128.10	22.773	128.10	284.66
70	92.231	8.5399	128.10	22.773	128.10	284.66

Output for load increment 1

Iteration	Max Inc Disp	at node	Disp error	Pressure error
	[mm]		[mm]	[kN/m²]
6	2.11	1	0.0004	0.01

- The file is not completely converged till the specified tolerance limit.

Node	Level	Defl	Rotation	Soil	Pressure	Bending	Shear	
	[m]	[mm]	[rad]		[kN/m²]	[kNm]	[kN]	
1	39.200	-2.1062	-414.99E-6	0	0.0	0.0	0.0	
1	39.200					-4.1499	-5.0000	
2	39.138	-2.0760	-565.18E-6	0	0.0	-3.8419	-5.0000	
3	39.077	-2.0368	-703.79E-6	0	0.0	-3.5339	-5.0000	
4	39.015	-1.9895	-830.83E-6	0	0.0	-3.2259	-5.0000	
5	38.954	-1.9347	-946.29E-6	0	0.0	-2.9179	-5.0000	
6	38.892	-1.8731	-0.0010502	0	0.0	-2.6099	-5.0000	
7	38.830	-1.8056	-0.0011425	0	0.0	-2.3019	-5.0000	
8	38.769	-1.7326	-0.0012232	0	0.0	-1.9939	-5.0000	
9	38.707	-1.6551	-0.0012924	0	0.0	-1.6859	-5.0000	
10	38.646	-1.5737	-0.0013499	0	0.0	-1.3779	-5.0000	
11	38.584	-1.4890	-0.0013959	0	0.0	-1.0699	-5.0000	
12	38.522	-1.4019	-0.0014304	0	0.0	-0.76186	-5.0000	
13	38.461	-1.3130	-0.0014532	0	0.0	-0.45386	-5.0000	
14	38.399	-1.2231	-0.0014645	1	-2.7867	-0.14586	-4.9874	P
15	38.331	-1.1229	-0.0014635	1	-9.7375	0.19442	-4.9307	P
16	38.269	-1.0331	-0.0014505	2	-24.140	0.49543	-4.7685	P
17	38.190	-0.91992	-0.0014179	2	-36.473	0.86199	-4.4501	P
18	38.112	-0.81000	-0.0013684	2	-39.625	1.1970	-4.0321	P
19	38.033	-0.70460	-0.0013036	2	-35.655	1.4977	-3.6353	P
20	37.967	-0.62134	-0.0012392	3	-92.862	1.7239	-3.0326	
21	37.902	-0.54255	-0.0011670	3	-85.262	1.8946	-2.2203	
22	37.836	-0.46870	-0.0010889	3	-77.262	2.0145	-1.4791	
23	37.771	-0.40009	-0.0010070	3	-69.031	2.0883	-0.81192	
24	37.705	-0.33692	-922.95E-6	3	-60.724	2.1208	-0.22018	
25	37.640	-0.27928	-838.33E-6	3	-52.484	2.1171	0.29610	
26	37.575	-0.22716	-754.49E-6	3	-44.437	2.0820	0.73810	
27	37.509	-0.18047	-672.57E-6	3	-36.692	2.0205	1.1081	
28	37.444	-0.13905	-593.56E-6	3	-29.340	1.9370	1.4092	
29	37.378	-0.10268	-518.23E-6	3	-22.457	1.8360	1.6454	
30	37.313	-0.071111	-447.21E-6	3	-16.100	1.7216	1.8213	
31	37.247	-0.044035	-380.94E-6	3	-10.308	1.5976	1.9417	
32	37.182	-0.021131	-319.76E-6	3	-5.1094	1.4674	2.0120	
33	37.116	-0.0020610	-263.83E-6	3	-0.51420	1.3342	2.0377	
34	37.051	0.013523	-213.24E-6	3	3.4779	1.2006	2.0242	
35	36.985	0.025969	-167.93E-6	3	6.8785	1.0692	1.9769	
36	36.920	0.035620	-127.80E-6	3	9.7088	0.94185	1.9013	
37	36.855	0.042808	-92.636E-6	3	11.997	0.82030	1.8023	
38	36.789	0.047850	-62.186E-6	3	13.555	0.70591	1.6858	
39	36.724	0.051045	-36.145E-6	3	14.460	0.59962	1.5580	
40	36.658	0.052670	-14.177E-6	3	14.920	0.50195	1.4240	
41	36.593	0.052982	4.0664E-6	3	15.009	0.41320	1.2875	
42	36.527	0.052211	18.943E-6	3	14.790	0.33340	1.1516	
43	36.462	0.050568	30.807E-6	3	14.325	0.26244	1.0189	
44	36.396	0.048236	40.007E-6	3	13.664	0.20003	0.89121	

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil	Pressure [kN/m²]	Bending [kNm]	Shear [kN]
45	36.331	0.045381	46.876E-6	3	12.856	0.14577	0.77027
46	36.265	0.042144	51.729E-6	3	11.938	0.099193	0.65719
47	36.200	0.038647	54.864E-6	3	13.398	0.059740	0.55236
48	36.133	0.034865	58.146E-6	3	12.087	0.026275	0.45609
49	36.067	0.030947	59.048E-6	4	12.159	-0.0010727	0.35516
50	35.974	0.025548	57.311E-6	4	10.038	-0.028802	0.24730
51	35.882	0.020432	53.093E-6	4	8.0278	-0.046774	0.15227
52	35.789	0.015783	47.346E-6	4	6.2013	-0.056941	0.077412
53	35.697	0.011707	40.819E-6	4	4.5995	-0.061080	0.020593
54	35.605	0.0082465	34.081E-6	4	3.2400	-0.060747	-0.020648
55	35.512	0.0054023	27.545E-6	4	2.1225	-0.057264	-0.048858
56	35.420	0.0031414	21.492E-6	4	1.2342	-0.051718	-0.066517
57	35.327	0.0014102	16.100E-6	4	0.55408	-0.044972	-0.075924
58	35.235	142.88E-6	11.463E-6	4	0.056138	-0.037687	-0.079099
59	35.165	-553.36E-6	8.4680E-6	5	-0.31973	-0.032121	-0.077922
60	35.077	-0.0011544	5.3493E-6	5	-0.66699	-0.025412	-0.073154
61	34.989	-0.0015110	2.8860E-6	5	-0.87306	-0.019287	-0.065463
62	34.902	-0.0016779	1.0087E-6	5	-0.96945	-0.013927	-0.056261
63	34.814	-0.0017027	-365.59E-9	5	-0.98381	-0.0094163	-0.046506
64	34.726	-0.0016259	-1.3250E-6	5	-0.93940	-0.0057678	-0.036901
65	34.639	-0.0014799	-1.9560E-6	5	-0.85505	-0.0029424	-0.027939
66	34.551	-0.0012899	-2.3396E-6	5	-0.74530	-866.12E-6	-0.019946
67	34.463	-0.0010745	-2.5479E-6	5	-0.62084	557.09E-6	-0.013124
68	34.375	-846.24E-6	-2.6424E-6	5	-0.48895	0.0014363	-0.0075811
69	34.288	-612.79E-6	-2.6731E-6	5	-0.35406	0.0018871	-0.0033709
70	34.200	-378.01E-6	-2.6780E-6	5	-0.21841	0.0020277	-511.89E-6

- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min [mm]	Max [mm]	Min [rad]	Max [rad]	Min [kNm]	Max [kNm]	Min [kN]	Max [kN]
-2.1062	0.052982	-0.0014645	59.048E-6	-4.1499	2.1208	-5.0000	2.0377

RESTRAINT FORCES

No.	Node	Lateral force [kN]	Moment [kNm]
1	1	0.0	4.1499

Titles

Job No.:	233630
Job Title:	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0009
Sub-title:	M1 Junction 23-25a
Calculation Heading:	Lateral load analysis (5kN)
Initials:	MC
Checker:	
Date Saved:	06-Oct-2023
Date Checked:	
Notes:	DA1-1 Secondary Piles
File Name:	HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0009.alw
File Path:	J:\2023\233630\6. Design\InternallyChecked\Secondary Piles\ProjectNumbered

General Data

Number of increments = 1
Increment applied loads only
Standard analysis type
Apply layered soil adjustments to P-Y curves: No

Convergence Control

Maximum number of iterations = 300
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Partial Factors

Partial Factor Set	Variable Load (Rest./Dist.)	Permanent Load (Rest./Dist.)	Unit Weight	Drained Cohesion	Undrained Cohesion	Shear Angle
BS EN 1997-1:2004 (EC7 - UK) DA1-1(4)	0.000000/ 1.550000	1.000000/ 1.200000	1.000000	1.000000	1.000000	1.000000

Soil Data

Soil model : Generated P-Y curves for static loads

No.	Level [m]	Type	Unit wt [kN/m³]	E50	C_u top [kN/m²]	dC_u/dz [kN/m²/m]	K_0	K_1 [kN/m²/m]	Phi [°]	q_{ur} [kPa]	α_r	k_{rm}	E_{ir} [kPa]
1	38.430000	Sand (Reese et al.)	18.000	-	-	-	0.50000	33930.	30.000	-	-	-	-
2	38.300000	Sand (Reese et al.)	20.000	-	-	-	0.41000	33930.	36.000	-	-	-	-
3	38.000000	Soft Clay	21.000	0.010000	75.000	0.0	-	-	-	-	-	-	-
4	36.100000	Soft Clay	21.000	0.010000	85.000	0.0	-	-	-	-	-	-	-
5	35.200000	Stiff Clay	21.000	0.010000	125.00	0.0	-	-	-	-	-	-	-
6	33.200000	Stiff Clay	21.000	0.010000	140.00	0.0	-	-	-	-	-	-	-
7	32.200000	Stiff Clay	21.000	0.010000	150.00	0.0	-	-	-	-	-	-	-
8	31.700000	Sand (Reese et al.)	21.000	-	-	-	0.40000	33930.	37.000	-	-	-	-

Sections

No.	Level [m]	Type	Unit wt [kN/m³]	E50	C_u top [kN/m²]	dC_u/dz [kN/m²/m]	K_0	K_1 [kN/m²/m]	Phi [°]	q_{ur} [kPa]	α_r	k_{rm}	E_{ir} [kPa]

Name	Input Type	Description	Material	Class	Effective Width [m]	EI [kNm²]
139.7 x 10mm	Wizard Generated	STD%CHS%138.9%9.6	Steel		0.13935	1638.9
114.3 x 10mm	Wizard Generated	STD%CHS%113.5%9.6	Steel		0.11387	852.91

Pile Properties

Level [m]	Section
39.200	**139.7 x 10mm**
36.200	**114.3 x 10mm**

Pile base at 34.200000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	39.200	5.0000	0.0	0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	10000.

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
1	39.200	0	1638.9	0.13935	0.0	0.0
2	39.138	0	1638.9	0.13935	0.0	0.0
3	39.077	0	1638.9	0.13935	0.0	0.0
4	39.015	0	1638.9	0.13935	0.0	0.0
5	38.954	0	1638.9	0.13935	0.0	0.0
6	38.892	0	1638.9	0.13935	0.0	0.0
7	38.830	0	1638.9	0.13935	0.0	0.0
8	38.769	0	1638.9	0.13935	0.0	0.0
9	38.707	0	1638.9	0.13935	0.0	0.0
10	38.646	0	1638.9	0.13935	0.0	0.0
11	38.584	0	1638.9	0.13935	0.0	0.0
12	38.522	0	1638.9	0.13935	0.0	0.0
13	38.461	0	1638.9	0.13935	0.0	0.0
14	38.399	1	1638.9	0.13935	0.0	0.0
15	38.331	1	1638.9	0.13935	0.0	0.0
16	38.269	2	1638.9	0.13935	0.0	0.0
17	38.190	2	1638.9	0.13935	0.19624	0.0
18	38.112	2	1638.9	0.13935	0.98448	0.0
19	38.033	2	1638.9	0.13935	1.7727	0.0
20	37.967	3	1638.9	0.13935	2.4273	0.0
21	37.902	3	1638.9	0.13935	3.0818	0.0
22	37.836	3	1638.9	0.13935	3.7364	0.0
23	37.771	3	1638.9	0.13935	4.3909	0.0
24	37.705	3	1638.9	0.13935	5.0455	0.0
25	37.640	3	1638.9	0.13935	5.7000	0.0
26	37.575	3	1638.9	0.13935	6.3545	0.0
27	37.509	3	1638.9	0.13935	7.0091	0.0
28	37.444	3	1638.9	0.13935	7.6636	0.0
29	37.378	3	1638.9	0.13935	8.3182	0.0
30	37.313	3	1638.9	0.13935	8.9727	0.0
31	37.247	3	1638.9	0.13935	9.6273	0.0
32	37.182	3	1638.9	0.13935	10.282	0.0
33	37.116	3	1638.9	0.13935	10.936	0.0

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
34	37.051	3	1638.9	0.13935	11.591	0.0
35	36.985	3	1638.9	0.13935	12.245	0.0
36	36.920	3	1638.9	0.13935	12.900	0.0
37	36.855	3	1638.9	0.13935	13.555	0.0
38	36.789	3	1638.9	0.13935	14.209	0.0
39	36.724	3	1638.9	0.13935	14.864	0.0
40	36.658	3	1638.9	0.13935	15.518	0.0
41	36.593	3	1638.9	0.13935	16.173	0.0
42	36.527	3	1638.9	0.13935	16.827	0.0
43	36.462	3	1638.9	0.13935	17.482	0.0
44	36.396	3	1638.9	0.13935	18.136	0.0
45	36.331	3	1638.9	0.13935	18.791	0.0
46	36.265	3	1638.9	0.13935	19.445	0.0
47	36.200	3	852.91	0.11387	20.100	0.0
48	36.133	3	852.91	0.11387	20.767	0.0
49	36.067	4	852.91	0.11387	21.433	0.0
50	35.974	4	852.91	0.11387	22.357	0.0
51	35.882	4	852.91	0.11387	23.281	0.0
52	35.789	4	852.91	0.11387	24.205	0.0
53	35.697	4	852.91	0.11387	25.129	0.0
54	35.605	4	852.91	0.11387	26.053	0.0
55	35.512	4	852.91	0.11387	26.977	0.0
56	35.420	4	852.91	0.11387	27.901	0.0
57	35.327	4	852.91	0.11387	28.825	0.0
58	35.235	4	852.91	0.11387	29.749	0.0
59	35.165	5	852.91	0.11387	30.451	0.0
60	35.077	5	852.91	0.11387	31.328	0.0
61	34.989	5	852.91	0.11387	32.205	0.0
62	34.902	5	852.91	0.11387	33.082	0.0
63	34.814	5	852.91	0.11387	33.960	0.0
64	34.726	5	852.91	0.11387	34.837	0.0
65	34.639	5	852.91	0.11387	35.714	0.0
66	34.551	5	852.91	0.11387	36.591	0.0
67	34.463	5	852.91	0.11387	37.468	0.0
68	34.375	5	852.91	0.11387	38.346	0.0
69	34.288	5	852.91	0.11387	39.223	0.0
70	34.200	5	852.91	0.11387	40.100	0.0

CALCULATED Soil P-y curves

Node	P1 [kN/m]	Y1 [mm]	P2 [kN/m]	Y2 [mm]	P3 [kN/m]	Y3 [mm]
14	0.0	0.0	0.22957	0.21968	0.33418	0.74537
15	0.0	0.0	0.85509	0.25405	1.2125	0.77115
16	0.0	0.0	2.6596	0.48747	3.2810	0.94622
17	0.0	0.0	4.3264	0.53213	5.1990	0.97971
18	0.0	0.0	4.4871	0.41528	5.7368	0.89208
19	0.0	0.0	3.2348	0.23998	5.1775	0.76060
20	0.0	0.0	14.510	0.69674	24.813	3.4837
21	0.0	0.0	15.258	0.69674	26.090	3.4837
22	0.0	0.0	16.005	0.69674	27.367	3.4837
23	0.0	0.0	16.752	0.69674	28.645	3.4837
24	0.0	0.0	17.499	0.69674	29.922	3.4837
25	0.0	0.0	18.246	0.69674	31.200	3.4837
26	0.0	0.0	18.993	0.69674	32.477	3.4837
27	0.0	0.0	19.740	0.69674	33.755	3.4837
28	0.0	0.0	20.487	0.69674	35.032	3.4837
29	0.0	0.0	21.234	0.69674	36.310	3.4837
30	0.0	0.0	21.981	0.69674	37.587	3.4837
31	0.0	0.0	22.728	0.69674	38.864	3.4837
32	0.0	0.0	23.475	0.69674	40.142	3.4837
33	0.0	0.0	24.222	0.69674	41.419	3.4837
34	0.0	0.0	24.969	0.69674	42.697	3.4837
35	0.0	0.0	25.716	0.69674	43.974	3.4837
36	0.0	0.0	26.463	0.69674	45.252	3.4837
37	0.0	0.0	27.210	0.69674	46.529	3.4837
38	0.0	0.0	27.503	0.69674	47.030	3.4837
39	0.0	0.0	27.503	0.69674	47.030	3.4837
40	0.0	0.0	27.503	0.69674	47.030	3.4837
41	0.0	0.0	27.503	0.69674	47.030	3.4837
42	0.0	0.0	27.503	0.69674	47.030	3.4837
43	0.0	0.0	27.503	0.69674	47.030	3.4837
44	0.0	0.0	27.503	0.69674	47.030	3.4837

Node	P1 [kN/m]	Y1 [mm]	P2 [kN/m]	Y2 [mm]	P3 [kN/m]	Y3 [mm]
45	0.0	0.0	27.503	0.69674	47.030	3.4837
46	0.0	0.0	27.503	0.69674	47.030	3.4837
47	0.0	0.0	22.474	0.56933	38.430	2.8466
48	0.0	0.0	22.474	0.56933	38.430	2.8466
49	0.0	0.0	25.470	0.56933	43.554	2.8466
50	0.0	0.0	25.470	0.56933	43.554	2.8466
51	0.0	0.0	25.470	0.56933	43.554	2.8466
52	0.0	0.0	25.470	0.56933	43.554	2.8466
53	0.0	0.0	25.470	0.56933	43.554	2.8466
54	0.0	0.0	25.470	0.56933	43.554	2.8466
55	0.0	0.0	25.470	0.56933	43.554	2.8466
56	0.0	0.0	25.470	0.56933	43.554	2.8466
57	0.0	0.0	25.470	0.56933	43.554	2.8466
58	0.0	0.0	25.470	0.56933	43.554	2.8466
59	0.0	0.0	37.456	0.56933	64.049	2.8466
60	0.0	0.0	37.456	0.56933	64.049	2.8466
61	0.0	0.0	37.456	0.56933	64.049	2.8466
62	0.0	0.0	37.456	0.56933	64.049	2.8466
63	0.0	0.0	37.456	0.56933	64.049	2.8466
64	0.0	0.0	37.456	0.56933	64.049	2.8466
65	0.0	0.0	37.456	0.56933	64.049	2.8466
66	0.0	0.0	37.456	0.56933	64.049	2.8466
67	0.0	0.0	37.456	0.56933	64.049	2.8466
68	0.0	0.0	37.456	0.56933	64.049	2.8466
69	0.0	0.0	37.456	0.56933	64.049	2.8466
70	0.0	0.0	37.456	0.56933	64.049	2.8466

Node	P4 [kN/m]	Y4 [mm]	P5 [kN/m]	Y5 [mm]	P6 [kN/m]	Y6 [mm]
14	0.39375	1.2711	0.47389	2.3225	0.65594	5.2255
15	1.4248	1.2883	1.7149	2.3225	2.3891	5.2255
16	3.7184	1.4050	4.3597	2.3225	6.0849	5.2255
17	5.8225	1.4273	6.7414	2.3225	9.2779	5.2255
18	6.5830	1.3689	7.8019	2.3225	10.936	5.2255
19	6.4040	1.2812	8.1617	2.3225	12.321	5.2255
20	35.730	10.451	49.625	27.870	49.625	348.37
21	37.570	10.451	52.180	27.870	52.180	348.37
22	39.409	10.451	54.735	27.870	54.735	348.37
23	41.249	10.451	57.290	27.870	57.290	348.37
24	43.088	10.451	59.845	27.870	59.845	348.37
25	44.928	10.451	62.400	27.870	62.400	348.37
26	46.767	10.451	64.954	27.870	64.954	348.37
27	48.607	10.451	67.509	27.870	67.509	348.37
28	50.446	10.451	70.064	27.870	70.064	348.37
29	52.286	10.451	72.619	27.870	72.619	348.37
30	54.125	10.451	75.174	27.870	75.174	348.37
31	55.965	10.451	77.729	27.870	77.729	348.37
32	57.804	10.451	80.284	27.870	80.284	348.37
33	59.644	10.451	82.839	27.870	82.839	348.37
34	61.483	10.451	85.393	27.870	85.393	348.37
35	63.323	10.451	87.948	27.870	87.948	348.37
36	65.162	10.451	90.503	27.870	90.503	348.37
37	67.002	10.451	93.058	27.870	93.058	348.37
38	67.723	10.451	94.060	27.870	94.060	348.37
39	67.723	10.451	94.060	27.870	94.060	348.37
40	67.723	10.451	94.060	27.870	94.060	348.37
41	67.723	10.451	94.060	27.870	94.060	348.37
42	67.723	10.451	94.060	27.870	94.060	348.37
43	67.723	10.451	94.060	27.870	94.060	348.37
44	67.723	10.451	94.060	27.870	94.060	348.37
45	67.723	10.451	94.060	27.870	94.060	348.37
46	67.723	10.451	94.060	27.870	94.060	348.37
47	55.339	8.5399	76.859	22.773	76.859	284.66
48	55.339	8.5399	76.859	22.773	76.859	284.66
49	62.717	8.5399	87.107	22.773	87.107	284.66
50	62.717	8.5399	87.107	22.773	87.107	284.66
51	62.717	8.5399	87.107	22.773	87.107	284.66
52	62.717	8.5399	87.107	22.773	87.107	284.66
53	62.717	8.5399	87.107	22.773	87.107	284.66
54	62.717	8.5399	87.107	22.773	87.107	284.66
55	62.717	8.5399	87.107	22.773	87.107	284.66
56	62.717	8.5399	87.107	22.773	87.107	284.66

Node	P4 [kN/m]	Y4 [mm]	P5 [kN/m]	Y5 [mm]	P6 [kN/m]	Y6 [mm]
57	62.717	8.5399	87.107	22.773	87.107	284.66
58	62.717	8.5399	87.107	22.773	87.107	284.66
59	92.231	8.5399	128.10	22.773	128.10	284.66
60	92.231	8.5399	128.10	22.773	128.10	284.66
61	92.231	8.5399	128.10	22.773	128.10	284.66
62	92.231	8.5399	128.10	22.773	128.10	284.66
63	92.231	8.5399	128.10	22.773	128.10	284.66
64	92.231	8.5399	128.10	22.773	128.10	284.66
65	92.231	8.5399	128.10	22.773	128.10	284.66
66	92.231	8.5399	128.10	22.773	128.10	284.66
67	92.231	8.5399	128.10	22.773	128.10	284.66
68	92.231	8.5399	128.10	22.773	128.10	284.66
69	92.231	8.5399	128.10	22.773	128.10	284.66
70	92.231	8.5399	128.10	22.773	128.10	284.66

Output for load increment 1

Iteration	Max Inc Disp [mm]	at node	Disp error [mm]	Pressure error [kN/m²]
10	3.52	1	0.0006	0.04

- The file is not completely converged till the specified tolerance limit.

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil	Pressure [kN/m²]	Bending [kNm]	Shear [kN]	
1	39.200	-3.5192	-663.45E-6	0	0.0	0.0	0.0	
1	39.200					-6.6345	-7.7500	
2	39.138	-3.4708	-903.85E-6	0	0.0	-6.1571	-7.7500	
3	39.077	-3.4082	-0.0011263	0	0.0	-5.6797	-7.7500	
4	39.015	-3.3324	-0.0013308	0	0.0	-5.2023	-7.7500	
5	38.954	-3.2446	-0.0015174	0	0.0	-4.7249	-7.7500	
6	38.892	-3.1459	-0.0016860	0	0.0	-4.2475	-7.7500	
7	38.830	-3.0373	-0.0018367	0	0.0	-3.7701	-7.7500	
8	38.769	-2.9200	-0.0019694	0	0.0	-3.2927	-7.7500	
9	38.707	-2.7950	-0.0020842	0	0.0	-2.8153	-7.7500	
10	38.646	-2.6636	-0.0021810	0	0.0	-2.3379	-7.7500	
11	38.584	-2.5267	-0.0022599	0	0.0	-1.8605	-7.7500	
12	38.522	-2.3855	-0.0023209	0	0.0	-1.3831	-7.7500	
13	38.461	-2.2411	-0.0023639	0	0.0	-0.90570	-7.7500	
14	38.399	-2.0946	-0.0023890	1	-3.2761	-0.42830	-7.7352	P
15	38.331	-1.9309	-0.0023958	1	-11.518	0.099767	-7.6682	P
16	38.269	-1.7836	-0.0023833	2	-28.583	0.56891	-7.4762	P
17	38.190	-1.5972	-0.0023420	2	-43.035	1.1472	-7.1000	P
18	38.112	-1.4151	-0.0022738	2	-47.666	1.6882	-6.6019	P
19	38.033	-1.2394	-0.0021806	2	-45.250	2.1880	-6.1126	P
20	37.967	-1.0997	-0.0020855	3	-114.82	2.5732	-5.3616	P
21	37.902	-0.96665	-0.0019765	3	-117.02	2.8898	-4.3043	P
22	37.836	-0.84117	-0.0018561	3	-119.08	3.1366	-3.2275	P
23	37.771	-0.72385	-0.0017274	3	-121.05	3.3124	-2.1325	P
24	37.705	-0.61516	-0.0015930	3	-110.87	3.4158	-1.0748	
25	37.640	-0.51537	-0.0014559	3	-96.853	3.4531	-0.12748	
26	37.575	-0.42458	-0.0013184	3	-83.057	3.4325	0.69299	
27	37.509	-0.34274	-0.0011828	3	-69.684	3.3623	1.3896	
28	37.444	-0.26966	-0.0010508	3	-56.902	3.2506	1.9669	
29	37.378	-0.20507	-923.93E-6	3	-44.849	3.1049	2.4309	
30	37.313	-0.14857	-803.43E-6	3	-33.637	2.9324	2.7888	
31	37.247	-0.099731	-690.23E-6	3	-23.347	2.7398	3.0487	
32	37.182	-0.058041	-585.01E-6	3	-14.034	2.5333	3.2192	
33	37.116	-0.022965	-488.20E-6	3	-5.7294	2.3184	3.3093	
34	37.051	0.0060576	-400.06E-6	3	1.5579	2.1000	3.3283	
35	36.985	0.029596	-320.62E-6	3	7.8392	1.8827	3.2855	
36	36.920	0.048217	-249.78E-6	3	13.142	1.6699	3.1898	
37	36.855	0.062476	-187.28E-6	3	17.510	1.4651	3.0500	
38	36.789	0.072908	-132.76E-6	3	20.653	1.2707	2.8760	
39	36.724	0.080020	-85.766E-6	3	22.668	1.0886	2.6784	
40	36.658	0.084288	-45.780E-6	3	23.877	0.92005	2.4661	
41	36.593	0.086154	-12.247E-6	3	24.406	0.76576	2.2459	
42	36.527	0.086020	15.408E-6	3	24.368	0.62604	2.0235	
43	36.462	0.084252	37.767E-6	3	23.867	0.50086	1.8035	
44	36.396	0.081179	55.406E-6	3	22.996	0.38994	1.5898	

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil	Pressure [kN/m²]	Bending [kNm]	Shear [kN]
45	36.331	0.077090	68.882E-6	3	21.838	0.29274	1.3853
46	36.265	0.072241	78.730E-6	3	20.464	0.20858	1.1924
47	36.200	0.066852	85.455E-6	3	23.176	0.13664	1.0119
48	36.133	0.060864	93.383E-6	3	21.100	0.074990	0.84469
49	36.067	0.054499	96.896E-6	4	21.412	0.024016	0.66765
50	35.974	0.045537	96.128E-6	4	17.891	-0.028716	0.47657
51	35.882	0.036882	90.564E-6	4	14.491	-0.064055	0.30622
52	35.789	0.028896	81.912E-6	4	11.353	-0.085306	0.17027
53	35.697	0.021798	71.531E-6	4	8.5643	-0.095521	0.065494
54	35.605	0.015698	60.470E-6	4	6.1676	-0.097409	-0.012005
55	35.512	0.010620	49.505E-6	4	4.1726	-0.093302	-0.066400
56	35.420	0.0065294	39.181E-6	4	2.5654	-0.085139	-0.10185
57	35.327	0.0033487	29.853E-6	4	1.3157	-0.074481	-0.12226
58	35.235	975.60E-6	21.724E-6	4	0.38331	-0.062544	-0.13096
59	35.165	-357.30E-6	16.412E-6	5	-0.20644	-0.053236	-0.13180
60	35.077	-0.0015431	10.817E-6	5	-0.89157	-0.041755	-0.12642
61	34.989	-0.0022877	6.3403E-6	5	-1.3218	-0.031056	-0.11537
62	34.902	-0.0026852	2.8832E-6	5	-1.5515	-0.021514	-0.10102
63	34.814	-0.0028195	315.90E-9	5	-1.6291	-0.013333	-0.085134
64	34.726	-0.0027625	-1.5050E-6	5	-1.5961	-0.0065783	-0.069027
65	34.639	-0.0025731	-2.7249E-6	5	-1.4867	-0.0012224	-0.053631
66	34.551	-0.0022979	-3.4826E-6	5	-1.3277	0.0028308	-0.039575
67	34.463	-0.0019719	-3.9049E-6	5	-1.1393	0.0057207	-0.027254
68	34.375	-0.0016194	-4.1030E-6	5	-0.93567	0.0076123	-0.016891
69	34.288	-0.0012559	-4.1705E-6	5	-0.72562	0.0086841	-0.0085941
70	34.200	-889.34E-6	-4.1820E-6	5	-0.51385	0.0091201	-0.0024038

- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min [mm]	Max [mm]	Min [rad]	Max [rad]	Min [kNm]	Max [kNm]	Min [kN]	Max [kN]
-3.5192	0.086154	-0.0023958	96.896E-6	-6.6345	3.4531	-7.7500	3.3283

RESTRAINT FORCES

No.	Node	Lateral force [kN]	Moment [kNm]
1	1	0.0	6.6345

Titles

Job No.: 233630
Job Title: HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0010
Sub-title: M1 Junction 23-25a
Calculation Heading: Lateral load analysis (5kN)
Initials: MC
Checker:
Date Saved: 06-Oct-2023
Date Checked:
Notes: DA1-2 Secondary Piles
File Name: HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0010.alw
File Path: J:\2023\233630\6. Design\InternallyChecked\Secondary Piles\ProjectNumbered

General Data

Number of increments = 1
Increment applied loads only
Standard analysis type
Apply layered soil adjustments to P-Y curves: No

Convergence Control

Maximum number of iterations = 300
Maximum displacement error [mm] = 0.0010000
Maximum pressure error [kN/m²] = 0.10000
Damping coefficient = 1.0000
Maximum incremental deflection [m] = 2.0000

Partial Factors

Partial Factor Set	Variable Load (Rest./Dist.)	Permanent Load (Rest./Dist.)	Unit Weight	Drained Cohesion	Undrained Cohesion	Shear Angle
BS EN 1997-1:2004 (EC7 - UK) DA1-2	0.000000/ 1.300000	1.000000/ 1.000000	1.000000	1.250000	1.400000	1.250000

Soil Data

Soil model : Generated P-Y curves for static loads

No.	Level [m]	Type	Unit wt [kN/m³]	E50	C_u top [kN/m²]	dC_u/dz [kN/m²/m]	K_0	K_1 [kN/m²/m]	Phi [°]	q_{ur} [kPa]	α_r	k_{rm}	E_{ir} [kPa]
1	38.430000	Sand (Reese et al.)	18.000	-	-	-	0.50000	33930.	30.000	-	-	-	-
2	38.300000	Sand (Reese et al.)	20.000	-	-	-	0.41000	33930.	36.000	-	-	-	-
3	38.000000	Soft Clay	21.000	0.010000	75.000	0.0	-	-	-	-	-	-	-
4	36.100000	Soft Clay	21.000	0.010000	85.000	0.0	-	-	-	-	-	-	-
5	35.200000	Stiff Clay	21.000	0.010000	125.00	0.0	-	-	-	-	-	-	-
6	33.200000	Stiff Clay	21.000	0.010000	140.00	0.0	-	-	-	-	-	-	-
7	32.200000	Stiff Clay	21.000	0.010000	150.00	0.0	-	-	-	-	-	-	-
8	31.700000	Sand (Reese et al.)	21.000	-	-	-	0.40000	33930.	37.000	-	-	-	-

Sections

No.	Level	Type	Unit wt	E50	C_u top	dC_u/dz	K_0	K_1	Phi	q_{ur}	α_r	k_{rm}	E_{ir}
	[m]		[kN/m³]		[kN/m²]	[kN/m²/m]		[kN/m²/m]	[°]	[kPa]			[kPa]

Name	Input Type	Description	Material	Class	Effective Width [m]	EI [kNm²]
139.7 x 10mm	Wizard Generated	STD%CHS%138.9%9.6	Steel		0.13935	1638.9
114.3 x 10mm	Wizard Generated	STD%CHS%113.5%9.6	Steel		0.11387	852.91

Pile Properties

Level [m]	Section
39.200	**139.7 x 10mm**
36.200	**114.3 x 10mm**

Pile base at 34.200000 m

Applied Loads and Displacements

No.	Level [m]	Force [kN]	Moment [kNm]	Displacement [mm]
1	39.200	5.0000	0.0	0.0

Restraints

No.	Node	Lateral Stiffness [kN/m]	Rotational Stiffness [kNm/rad]
1	1	0.0	10000.

Geometry and Initial state

Node	Level [m]	Soil	EI [kNm2]	Effective Width [m]	Water Pressure [kN/m²]	Soil Disp [mm]
1	39.200	0	1638.9	0.13935	0.0	0.0
2	39.138	0	1638.9	0.13935	0.0	0.0
3	39.077	0	1638.9	0.13935	0.0	0.0
4	39.015	0	1638.9	0.13935	0.0	0.0
5	38.954	0	1638.9	0.13935	0.0	0.0
6	38.892	0	1638.9	0.13935	0.0	0.0
7	38.830	0	1638.9	0.13935	0.0	0.0
8	38.769	0	1638.9	0.13935	0.0	0.0
9	38.707	0	1638.9	0.13935	0.0	0.0
10	38.646	0	1638.9	0.13935	0.0	0.0
11	38.584	0	1638.9	0.13935	0.0	0.0
12	38.522	0	1638.9	0.13935	0.0	0.0
13	38.461	0	1638.9	0.13935	0.0	0.0
14	38.399	1	1638.9	0.13935	0.0	0.0
15	38.331	1	1638.9	0.13935	0.0	0.0
16	38.269	2	1638.9	0.13935	0.0	0.0
17	38.190	2	1638.9	0.13935	0.19624	0.0
18	38.112	2	1638.9	0.13935	0.98448	0.0
19	38.033	2	1638.9	0.13935	1.7727	0.0
20	37.967	3	1638.9	0.13935	2.4273	0.0
21	37.902	3	1638.9	0.13935	3.0818	0.0
22	37.836	3	1638.9	0.13935	3.7364	0.0
23	37.771	3	1638.9	0.13935	4.3909	0.0
24	37.705	3	1638.9	0.13935	5.0455	0.0
25	37.640	3	1638.9	0.13935	5.7000	0.0
26	37.575	3	1638.9	0.13935	6.3545	0.0
27	37.509	3	1638.9	0.13935	7.0091	0.0
28	37.444	3	1638.9	0.13935	7.6636	0.0
29	37.378	3	1638.9	0.13935	8.3182	0.0
30	37.313	3	1638.9	0.13935	8.9727	0.0
31	37.247	3	1638.9	0.13935	9.6273	0.0
32	37.182	3	1638.9	0.13935	10.282	0.0
33	37.116	3	1638.9	0.13935	10.936	0.0

Job No.	Sheet No.	Rev.
233630		

Oasys

HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0010
M1 Junction 23-25a
Lateral load analysis (5kN)

Drg. Ref.

Made by	Date	Checked	Date
MC	06-Oct-2023		

Node	Level	Soil	EI	Effective Width	Water Pressure	Soil Disp
	[m]		[kNm2]	[m]	[kN/m²]	[mm]
34	37.051	3	1638.9	0.13935	11.591	0.0
35	36.985	3	1638.9	0.13935	12.245	0.0
36	36.920	3	1638.9	0.13935	12.900	0.0
37	36.855	3	1638.9	0.13935	13.555	0.0
38	36.789	3	1638.9	0.13935	14.209	0.0
39	36.724	3	1638.9	0.13935	14.864	0.0
40	36.658	3	1638.9	0.13935	15.518	0.0
41	36.593	3	1638.9	0.13935	16.173	0.0
42	36.527	3	1638.9	0.13935	16.827	0.0
43	36.462	3	1638.9	0.13935	17.482	0.0
44	36.396	3	1638.9	0.13935	18.136	0.0
45	36.331	3	1638.9	0.13935	18.791	0.0
46	36.265	3	1638.9	0.13935	19.445	0.0
47	36.200	3	852.91	0.11387	20.100	0.0
48	36.133	3	852.91	0.11387	20.767	0.0
49	36.067	4	852.91	0.11387	21.433	0.0
50	35.974	4	852.91	0.11387	22.357	0.0
51	35.882	4	852.91	0.11387	23.281	0.0
52	35.789	4	852.91	0.11387	24.205	0.0
53	35.697	4	852.91	0.11387	25.129	0.0
54	35.605	4	852.91	0.11387	26.053	0.0
55	35.512	4	852.91	0.11387	26.977	0.0
56	35.420	4	852.91	0.11387	27.901	0.0
57	35.327	4	852.91	0.11387	28.825	0.0
58	35.235	4	852.91	0.11387	29.749	0.0
59	35.165	5	852.91	0.11387	30.451	0.0
60	35.077	5	852.91	0.11387	31.328	0.0
61	34.989	5	852.91	0.11387	32.205	0.0
62	34.902	5	852.91	0.11387	33.082	0.0
63	34.814	5	852.91	0.11387	33.960	0.0
64	34.726	5	852.91	0.11387	34.837	0.0
65	34.639	5	852.91	0.11387	35.714	0.0
66	34.551	5	852.91	0.11387	36.591	0.0
67	34.463	5	852.91	0.11387	37.468	0.0
68	34.375	5	852.91	0.11387	38.346	0.0
69	34.288	5	852.91	0.11387	39.223	0.0
70	34.200	5	852.91	0.11387	40.100	0.0

CALCULATED Soil P-y curves

Node	P1	Y1	P2	Y2	P3	Y3
	[kN/m]	[mm]	[kN/m]	[mm]	[kN/m]	[mm]
14	0.0	0.0	0.14971	0.14326	0.24250	0.68806
15	0.0	0.0	0.52497	0.15597	0.84087	0.69759
16	0.0	0.0	1.4860	0.27237	2.0775	0.78489
17	0.0	0.0	2.3727	0.29182	3.2135	0.79948
18	0.0	0.0	2.3640	0.21879	3.5042	0.74471
19	0.0	0.0	1.5240	0.11306	3.1394	0.66541
20	0.0	0.0	11.662	0.69674	19.942	3.4837
21	0.0	0.0	12.266	0.69674	20.974	3.4837
22	0.0	0.0	12.869	0.69674	22.006	3.4837
23	0.0	0.0	13.473	0.69674	23.038	3.4837
24	0.0	0.0	14.076	0.69674	24.070	3.4837
25	0.0	0.0	14.680	0.69674	25.102	3.4837
26	0.0	0.0	15.283	0.69674	26.134	3.4837
27	0.0	0.0	15.887	0.69674	27.166	3.4837
28	0.0	0.0	16.490	0.69674	28.198	3.4837
29	0.0	0.0	17.094	0.69674	29.230	3.4837
30	0.0	0.0	17.697	0.69674	30.262	3.4837
31	0.0	0.0	18.301	0.69674	31.294	3.4837
32	0.0	0.0	18.904	0.69674	32.326	3.4837
33	0.0	0.0	19.508	0.69674	33.358	3.4837
34	0.0	0.0	20.111	0.69674	34.390	3.4837
35	0.0	0.0	20.715	0.69674	35.422	3.4837
36	0.0	0.0	21.318	0.69674	36.454	3.4837
37	0.0	0.0	21.922	0.69674	37.486	3.4837
38	0.0	0.0	22.003	0.69674	37.624	3.4837
39	0.0	0.0	22.003	0.69674	37.624	3.4837
40	0.0	0.0	22.003	0.69674	37.624	3.4837
41	0.0	0.0	22.003	0.69674	37.624	3.4837
42	0.0	0.0	22.003	0.69674	37.624	3.4837
43	0.0	0.0	22.003	0.69674	37.624	3.4837
44	0.0	0.0	22.003	0.69674	37.624	3.4837

Oasys

HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0010
M1 Junction 23-25a
Lateral load analysis (5kN)

Job No.	Sheet No.	Rev.
233630		

Drg. Ref.

Made by	Date	Checked	Date
MC	06-Oct-2023		

Node	P1 [kN/m]	Y1 [mm]	P2 [kN/m]	Y2 [mm]	P3 [kN/m]	Y3 [mm]
45	0.0	0.0	22.003	0.69674	37.624	3.4837
46	0.0	0.0	22.003	0.69674	37.624	3.4837
47	0.0	0.0	17.979	0.56933	30.744	2.8466
48	0.0	0.0	17.979	0.56933	30.744	2.8466
49	0.0	0.0	20.376	0.56933	34.843	2.8466
50	0.0	0.0	20.376	0.56933	34.843	2.8466
51	0.0	0.0	20.376	0.56933	34.843	2.8466
52	0.0	0.0	20.376	0.56933	34.843	2.8466
53	0.0	0.0	20.376	0.56933	34.843	2.8466
54	0.0	0.0	20.376	0.56933	34.843	2.8466
55	0.0	0.0	20.376	0.56933	34.843	2.8466
56	0.0	0.0	20.376	0.56933	34.843	2.8466
57	0.0	0.0	20.376	0.56933	34.843	2.8466
58	0.0	0.0	20.376	0.56933	34.843	2.8466
59	0.0	0.0	29.965	0.56933	51.240	2.8466
60	0.0	0.0	29.965	0.56933	51.240	2.8466
61	0.0	0.0	29.965	0.56933	51.240	2.8466
62	0.0	0.0	29.965	0.56933	51.240	2.8466
63	0.0	0.0	29.965	0.56933	51.240	2.8466
64	0.0	0.0	29.965	0.56933	51.240	2.8466
65	0.0	0.0	29.965	0.56933	51.240	2.8466
66	0.0	0.0	29.965	0.56933	51.240	2.8466
67	0.0	0.0	29.965	0.56933	51.240	2.8466
68	0.0	0.0	29.965	0.56933	51.240	2.8466
69	0.0	0.0	29.965	0.56933	51.240	2.8466
70	0.0	0.0	29.965	0.56933	51.240	2.8466

Node	P4 [kN/m]	Y4 [mm]	P5 [kN/m]	Y5 [mm]	P6 [kN/m]	Y6 [mm]
14	0.29010	1.2329	0.35243	2.3225	0.48782	5.2255
15	1.0074	1.2392	1.2274	2.3225	1.7100	5.2255
16	2.4358	1.2974	2.9288	2.3225	4.0878	5.2255
17	3.7260	1.3071	4.4298	2.3225	6.0966	5.2255
18	4.1605	1.2706	5.0503	2.3225	7.0789	5.2255
19	4.0167	1.2178	5.2263	2.3225	7.8899	5.2255
20	28.717	10.451	39.884	27.870	39.884	348.37
21	30.203	10.451	41.948	27.870	41.948	348.37
22	31.689	10.451	44.012	27.870	44.012	348.37
23	33.175	10.451	46.076	27.870	46.076	348.37
24	34.661	10.451	48.140	27.870	48.140	348.37
25	36.147	10.451	50.204	27.870	50.204	348.37
26	37.633	10.451	52.268	27.870	52.268	348.37
27	39.119	10.451	54.332	27.870	54.332	348.37
28	40.605	10.451	56.396	27.870	56.396	348.37
29	42.091	10.451	58.460	27.870	58.460	348.37
30	43.577	10.451	60.524	27.870	60.524	348.37
31	45.063	10.451	62.588	27.870	62.588	348.37
32	46.549	10.451	64.652	27.870	64.652	348.37
33	48.035	10.451	66.716	27.870	66.716	348.37
34	49.521	10.451	68.780	27.870	68.780	348.37
35	51.007	10.451	70.844	27.870	70.844	348.37
36	52.493	10.451	72.908	27.870	72.908	348.37
37	53.979	10.451	74.972	27.870	74.972	348.37
38	54.178	10.451	75.248	27.870	75.248	348.37
39	54.178	10.451	75.248	27.870	75.248	348.37
40	54.178	10.451	75.248	27.870	75.248	348.37
41	54.178	10.451	75.248	27.870	75.248	348.37
42	54.178	10.451	75.248	27.870	75.248	348.37
43	54.178	10.451	75.248	27.870	75.248	348.37
44	54.178	10.451	75.248	27.870	75.248	348.37
45	54.178	10.451	75.248	27.870	75.248	348.37
46	54.178	10.451	75.248	27.870	75.248	348.37
47	44.271	8.5399	61.487	22.773	61.487	284.66
48	44.271	8.5399	61.487	22.773	61.487	284.66
49	50.174	8.5399	69.686	22.773	69.686	284.66
50	50.174	8.5399	69.686	22.773	69.686	284.66
51	50.174	8.5399	69.686	22.773	69.686	284.66
52	50.174	8.5399	69.686	22.773	69.686	284.66
53	50.174	8.5399	69.686	22.773	69.686	284.66
54	50.174	8.5399	69.686	22.773	69.686	284.66
55	50.174	8.5399	69.686	22.773	69.686	284.66
56	50.174	8.5399	69.686	22.773	69.686	284.66

Node	P4 [kN/m]	Y4 [mm]	P5 [kN/m]	Y5 [mm]	P6 [kN/m]	Y6 [mm]
57	50.174	8.5399	69.686	22.773	69.686	284.66
58	50.174	8.5399	69.686	22.773	69.686	284.66
59	73.785	8.5399	102.48	22.773	102.48	284.66
60	73.785	8.5399	102.48	22.773	102.48	284.66
61	73.785	8.5399	102.48	22.773	102.48	284.66
62	73.785	8.5399	102.48	22.773	102.48	284.66
63	73.785	8.5399	102.48	22.773	102.48	284.66
64	73.785	8.5399	102.48	22.773	102.48	284.66
65	73.785	8.5399	102.48	22.773	102.48	284.66
66	73.785	8.5399	102.48	22.773	102.48	284.66
67	73.785	8.5399	102.48	22.773	102.48	284.66
68	73.785	8.5399	102.48	22.773	102.48	284.66
69	73.785	8.5399	102.48	22.773	102.48	284.66
70	73.785	8.5399	102.48	22.773	102.48	284.66

Output for load increment 1

Iteration	Max Inc Disp [mm]	at node	Disp error [mm]	Pressure error [kN/m²]
11	3.22	1	0.0005	0.03

- The file is not completely converged till the specified tolerance limit.

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil	Pressure [kN/m²]	Bending [kNm]	Shear [kN]	
1	39.200	-3.2237	-574.84E-6	0	0.0	0.0	0.0	
1	39.200					-5.7484	-6.5000	
2	39.138	-3.1818	-783.38E-6	0	0.0	-5.3480	-6.5000	
3	39.077	-3.1275	-976.87E-6	0	0.0	-4.9476	-6.5000	
4	39.015	-3.0618	-0.0011553	0	0.0	-4.5472	-6.5000	
5	38.954	-2.9855	-0.0013187	0	0.0	-4.1468	-6.5000	
6	38.892	-2.8996	-0.0014670	0	0.0	-3.7464	-6.5000	
7	38.830	-2.8051	-0.0016003	0	0.0	-3.3460	-6.5000	
8	38.769	-2.7028	-0.0017186	0	0.0	-2.9456	-6.5000	
9	38.707	-2.5937	-0.0018218	0	0.0	-2.5452	-6.5000	
10	38.646	-2.4787	-0.0019099	0	0.0	-2.1448	-6.5000	
11	38.584	-2.3587	-0.0019830	0	0.0	-1.7444	-6.5000	
12	38.522	-2.2347	-0.0020410	0	0.0	-1.3440	-6.5000	
13	38.461	-2.1075	-0.0020840	0	0.0	-0.94361	-6.5000	
14	38.399	-1.9782	-0.0021120	1	-2.3878	-0.54321	-6.4892	P
15	38.331	-1.8332	-0.0021254	1	-8.0953	-0.10009	-6.4417	P
16	38.269	-1.7023	-0.0021217	2	-18.878	0.29446	-6.3127	P
17	38.190	-1.5359	-0.0020958	2	-27.877	0.78478	-6.0673	P
18	38.112	-1.3725	-0.0020468	2	-30.476	1.2510	-5.7468	P
19	38.033	-1.2138	-0.0019761	2	-28.780	1.6908	-5.4348	P
20	37.967	-1.0868	-0.0019017	3	-92.008	2.0370	-4.8705	P
21	37.902	-0.96515	-0.0018145	3	-94.041	2.3283	-4.0220	P
22	37.836	-0.84953	-0.0017168	3	-95.948	2.5635	-3.1556	P
23	37.771	-0.74059	-0.0016109	3	-97.764	2.7414	-2.2722	P
24	37.705	-0.63878	-0.0014990	3	-92.613	2.8610	-1.4040	
25	37.640	-0.54443	-0.0013835	3	-82.317	2.9252	-0.60620	
26	37.575	-0.45770	-0.0012664	3	-72.049	2.9403	0.097785	
27	37.509	-0.37864	-0.0011496	3	-61.957	2.9124	0.70892	
28	37.444	-0.30717	-0.0010346	3	-52.173	2.8475	1.2294	
29	37.378	-0.24313	-922.81E-6	3	-42.807	2.7515	1.6626	
30	37.313	-0.18627	-815.40E-6	3	-33.954	2.6299	2.0126	
31	37.247	-0.13628	-713.25E-6	3	-25.687	2.4880	2.2846	
32	37.182	-0.092773	-617.08E-6	3	-18.064	2.3308	2.4841	
33	37.116	-0.055354	-527.40E-6	3	-11.122	2.1628	2.6172	
34	37.051	-0.023582	-444.57E-6	3	-4.8848	1.9882	2.6902	
35	36.985	0.0029985	-368.78E-6	3	0.63975	1.8106	2.7096	
36	36.920	0.024850	-300.08E-6	3	5.4564	1.6335	2.6818	
37	36.855	0.042435	-238.39E-6	3	9.5814	1.4596	2.6132	
38	36.789	0.056207	-183.54E-6	3	12.738	1.2914	2.5114	
39	36.724	0.066605	-135.26E-6	3	15.094	1.1308	2.3845	
40	36.658	0.074050	-93.216E-6	3	16.781	0.97923	2.2391	
41	36.593	0.078936	-57.030E-6	3	17.889	0.83768	2.0810	
42	36.527	0.081634	-26.289E-6	3	18.500	0.70681	1.9151	
43	36.462	0.082487	-558.77E-9	3	18.693	0.58698	1.7455	
44	36.396	0.081807	20.604E-6	3	18.539	0.47831	1.5757	

Node	Level [m]	Defl [mm]	Rotation [rad]	Soil	Pressure [kN/m²]	Bending [kNm]	Shear [kN]
45	36.331	0.079879	37.643E-6	3	18.103	0.38071	1.4086
46	36.265	0.076960	50.995E-6	3	17.441	0.29392	1.2465
47	36.200	0.073275	61.085E-6	3	20.322	0.21754	1.0905
48	36.133	0.068703	75.194E-6	3	19.054	0.14994	0.94174
49	36.067	0.063358	84.388E-6	4	19.915	0.091974	0.77924
50	35.974	0.055224	90.526E-6	4	17.358	0.028304	0.59776
51	35.882	0.046814	90.663E-6	4	14.714	-0.018491	0.42904
52	35.789	0.038602	86.488E-6	4	12.133	-0.050982	0.28780
53	35.697	0.030920	79.414E-6	4	9.7187	-0.071677	0.17285
54	35.605	0.023980	70.593E-6	4	7.5374	-0.082924	0.082069
55	35.512	0.017900	60.933E-6	4	5.6264	-0.086843	0.012820
56	35.420	0.012724	51.127E-6	4	3.9995	-0.085293	-0.037818
57	35.327	0.0084409	41.682E-6	4	2.6531	-0.079855	-0.072815
58	35.235	0.0049995	32.949E-6	4	1.5714	-0.071837	-0.094042
59	35.165	0.0029032	26.930E-6	5	1.3419	-0.064732	-0.10734
60	35.077	840.58E-6	20.264E-6	5	0.38854	-0.054786	-0.11531
61	34.989	-681.97E-6	14.623E-6	5	-0.31523	-0.044501	-0.11568
62	34.902	-0.0017550	10.010E-6	5	-0.81121	-0.034491	-0.11005
63	34.814	-0.0024667	6.3741E-6	5	-1.1402	-0.025193	-0.10031
64	34.726	-0.0028993	3.6274E-6	5	-1.3401	-0.016893	-0.087921
65	34.639	-0.0031259	1.6581E-6	5	-1.4449	-0.0097675	-0.074012
66	34.551	-0.0032092	340.82E-9	5	-1.4834	-0.0039080	-0.059388
67	34.463	-0.0032009	-456.43E-9	5	-1.4795	651.64E-6	-0.044590
68	34.375	-0.0031405	-867.15E-9	5	-1.4516	0.0039149	-0.029951
69	34.288	-0.0030562	-1.0234E-6	5	-1.4127	0.0059063	-0.015646
70	34.200	-0.0029646	-1.0543E-6	5	-1.3703	0.0066600	-0.0017476

- The letter "P" next to a result indicates that the effective earth pressure is greater than 0.99 times the passive limit, but within the convergence pressure limit.

EXTREME values so far:-

Deflections		Rotations		Moments		Shears	
Min [mm]	Max [mm]	Min [rad]	Max [rad]	Min [kNm]	Max [kNm]	Min [kN]	Max [kN]
-3.2237	0.082487	-0.0021254	90.663E-6	-5.7484	2.9403	-6.5000	2.7096

RESTRAINT FORCES

No.	Node	Lateral force [kN]	Moment [kNm]
1	1	0.0	5.7484

TITLE;	**HE614830-VAE-SGY-P015_S2_ALLGENR-CA-CB-0011**	**Notes**	
Pile Group Efficiency in accordance with Perko, Section 5.4		**SECONDARY PILES**	
Symbol			*Units*
P_{ug}	Ultimate capacity of the group = $q_{ult}(m_1)(m_2)+2Ts(n-1)(m_1+m_2)$	2521.20	kN
q_{ult}	ultimate bearing pressure of soil or rock	675.00	kN/m^2
	soil type	cohesive	
	q_{ult} for non cohesive soil = $q'(N_q-1)$	-17.69	kN/m^2
	q_{ult} for cohesive soil = $9s_u$	675.00	kN/m^2
m_1	width of pile group in plan view	1.8	m
m_2	breadth of pile group in plan view	2	
T	installation torque	12	kN/m^3
s	spacing of helical bearing plates along the length of the shaft	1	
n	number of helical bearing plates per pile	2	
η	group efficiency of a helical pile system = $P_{ug}/\Sigma_i P_u$	2.50	
q'	effective overburden stress at bearing depth	17.69	kN/m^2
d	Embedment depth of group, i.e. bearing level for group (worst case soi	2.16	m
γ	unit weight of soil	18	kN/m^3
N_q	Bearing capacity factor		
ϕ	Angle of internal friction		°
s_u	undrained shear strength	75	
i	number of piles in group	4	
P_u	Ultimate axial capacity of a helical pile	252.5	kN

Result:	Group capacity exceeds sum of individual capacities so no issues related to group effects

APPENDIX C: Drawings

General Notes:

1. Conforms to BS 8888. All geometrical tolerances must not exceed steel execution tolerances specified in BS EN 1090 for the execution class specified in General Note 5.
2. All dimensions are in millimetres unless otherwise stated.
3. All levels are in metres related to site datum unless otherwise specified.
4. This drawing is to be read in conjunction with the relevant specification.
5. Design & fabrication to latest edition of BS EN 1090-2 (execution class 3), BS EN 1990, BS EN 1993-1, BS EN 1993-5 unless otherwise specified.
6. All constituent steel products to be CE marked and DoP's shall be provided for acceptance.
7. All RHS, SHS and CHS to be minimum S355 J2H complying with BS EN 10210 unless otherwise stated.
8. All open sections and plates to be S355 J2 complying with BS EN 10025 unless otherwise stated. Plates greater than 55mm thick are to be grade S355 NL unless otherwise stated
9. All welding to be by qualified artisans certified to BS EN ISO 9606-1 in accordance with client requirements and approved by Screwfast Foundations.
10. All welds to be BS EN 1011-1 and are specified as 'z - leg length' on drawing. Continuous fillet welds to all seams unless otherwise specified.
11. Trim or notch all mating ends of sections and prepare all edges of sections or plates for acceptable fit before welding.
12. Do not grind off welds unless otherwise specified.
13. All butt welds where specified to full penetration and capped over with additional cap weld where specified.
14. All structural bolts to be BS EN 15048 class 8.8 unless noted otherwise. Class 10.9 nuts for galvanised class 8.8 bolts.
Class 8.8 nuts for other class 8.8 bolts. Bolts connecting pile sections to be zinc coated below 2m below ground level and galvanised within 2m below ground level.
Bolts connecting plinth to grillage to be preloaded bolts to BS EN 14399-1. Protection system SHW Series 1900 Table 19/4C - G2b upper section.
15. All structural bolts to be torqued as per the installation requirements on the quality checklist. Fit & tighten lock nuts as required after primary nuts have been torqued.
16. All holding down bolts, washers, nuts & lock nuts as specified to be provided by others unless otherwise agreed.
17. Min. 40Mpa non-shrink grout to be used where specified unless otherwise indicated.
18. Grout to be placed as soon as reasonably possible after placement of structure.
19. All steelwork unless specifically indicated to be self colour, to be protected with a coating system.
20. All grillage sections and plates and the top 2 metres of the pile below ground level and all visible pile above ground level to be in accordance with protection system SHW Series 1900 19/4C - G2b ground section for piles and upper section for grillages.
21. All galvanising to be in accordance with BS EN ISO 1461 min. cover 85 microns unless otherwise stated. All galvanising drainage holes to be fitted with plastic plugs during assembly.
22. It is the fabricators responsibility to perform all quality checks in accordance with Screwfast quality procedures and observe all normal good practice.
23. All health and safety regulations during fabrication, handling, loading or offloading and while transporting components or complete assemblies should be adopted.
24. The fabricator must assemble the grillage prior to delivery to ensure full design compliance. Failure to comply could necessitate in on site remedial work which will be at the cost of the fabricator.
25. Grillages and other structures or substructures to be delivered in fully or partially assembled form as confirmed by the Screwfast project manager prior to delivery on site.
26. Where required, the supply and installation of earth bonding equipment is by others. Where foundation earthing or equipotential bond testing is required, this is to be by others.
27. This design is copyright to Screwfast Foundations and some patents may apply.

Design Residual Risk Assessment - Construction

Activity	Residual risk	Control
Piling near to existing structures	Causing minor damage to existing structure during piling operation	Undertake investigations to determine position and level of existing structure prior to piling
Piling installation including work on sloping ground	Personal injury	Use mechanical lift. Adequate lighting. Manual handling risk assessment. Create level access on sloping ground. Exclusion zone around work zone area.
Buried/overhead services	Damage to service and workers	Provide with information and drawings, contractor to ensure adequate steps are followed onsite to locate services
Unexpected ground conditions	Not being able to get piles into ground, or longer piles required	Pre-auger, to request redesign, or to request site move.
Piles installed out of position	Not being able to install grillage in correct position	Ensure piles are installed within allowable tolerance
Lifting materials	Dropping materials	Certification for all lifting equipment and provide suitable supervision

SAFETY,HEALTH AND ENVIRONMENTAL INFORMATION

The significant residual risks detailed on this drawing are linked to the referencing system within the Hazard Elimination and Risk Reduction Register (HE**************). Each risk is given a unique number followed by a letter that corresponds to one of the six stages affected.	STAGES S - Survey C - Construction M - Maintenance O - Operation U - Road User D - Demolition

SIGNIFICANT RESIDUAL RISKS

0 200
SCALE 1:2500 METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	20/12/2023	SUITABLE FOR ACCEPTANCE	APO	APO	APO	APO

Designer: VAN ELLE TOTAL FOUNDATION SOLUTIONS / ScrewFast FOUNDATIONS LTD

Client: national highways / smp alliance

Project
NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25

Drawing title
GENERAL NOTES.
DESIGNER'S RESIDUAL RISK
ASSESSMENT - CONSTRUCTION NOTES

Drawing status
S5 - SUITABLE FOR REVIEW AND ACCEPTANCE

State Code	PRELIMINARY	
Project Stage	STAGE 5	
Scale	N/A	DO NOT SCALE
Sheet Size	A3	Rev P01
Client no.	HE614830	

Drawing number
PIN | Originator | Volume
HE614830 - VAE - SGY -
Location | Type | Role | Number
P015_S2_ALLGENR - DR - CB - 0001

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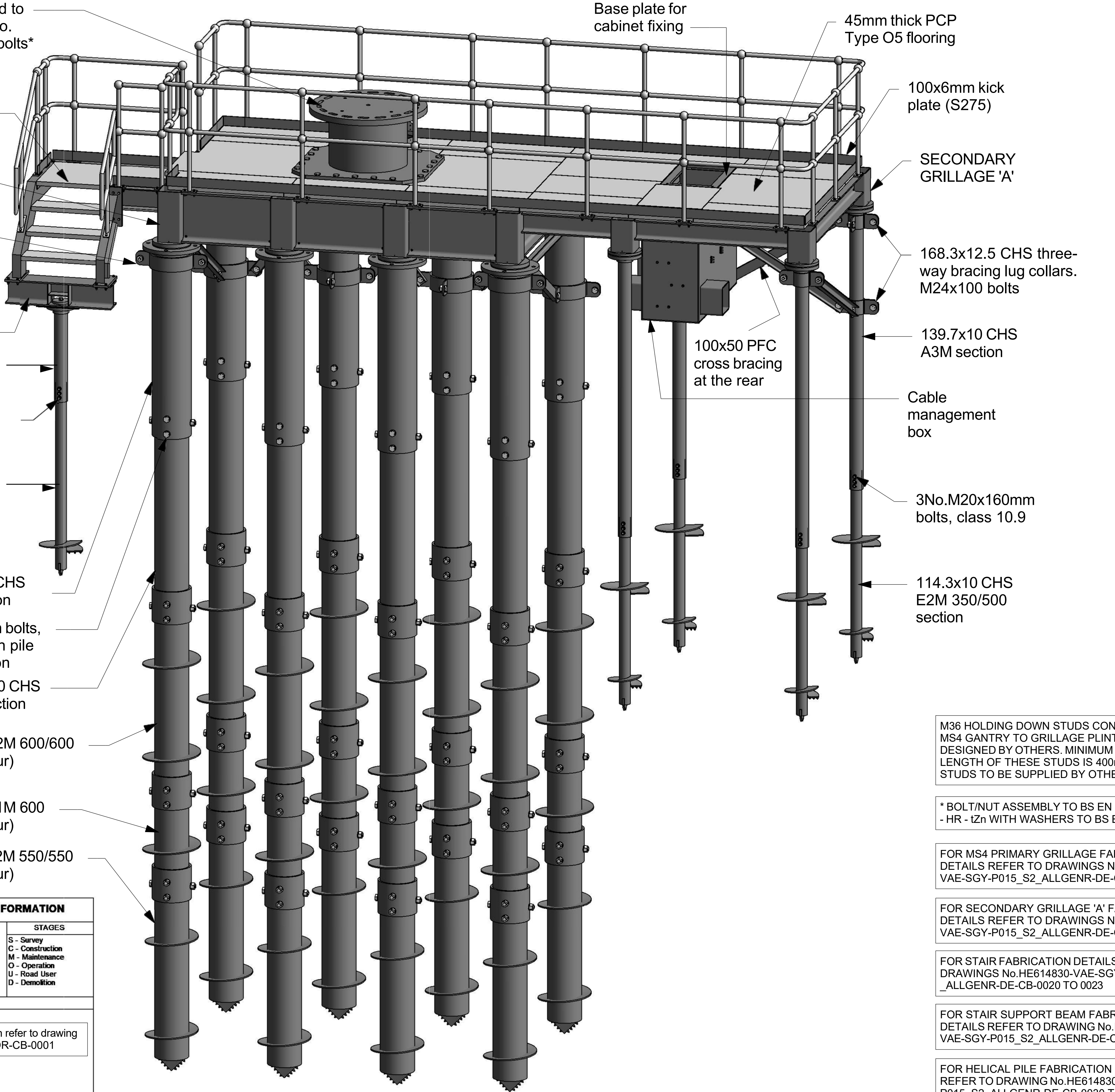
For general notes refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001



1

3D VIEW

M36 HOLDING DOWN STUDS CONNECTING MS4 GANTRY TO GRILLAGE PLINTH WERE DESIGNED BY OTHERS. MINIMUM REQUIRED LENGTH OF THESE STUDS IS 400mm. THE STUDS TO BE SUPPLIED BY OTHERS

* BOLT/NUT ASSEMBLY TO BS EN 14399-3 - 8.8/8 - HR - tZn WITH WASHERS TO BS EN 14399-5

FOR MS4 PRIMARY GRILLAGE FABRICATION DETAILS REFER TO DRAWINGS No.HE614830-VAE-SGY-P015_S2_ALLGENR-DE-CB-0001 TO 0004

FOR SECONDARY GRILLAGE 'A' FABRICATION DETAILS REFER TO DRAWINGS No.HE614830-VAE-SGY-P015_S2_ALLGENR-DE-CB-0010 TO 0012

FOR STAIR FABRICATION DETAILS REFER TO DRAWINGS No.HE614830-VAE-SGY-P015_S2 _ALLGENR-DE-CB-0020 TO 0023

FOR STAIR SUPPORT BEAM FABRICATION DETAILS REFER TO DRAWING No.HE614830-VAE-SGY-P015_S2_ALLGENR-DE-CB-0024

FOR HELICAL PILE FABRICATION DETAILS REFER TO DRAWING No.HE614830-VAE-SGY-P015_S2_ALLGENR-DE-CB-0030 TO 0033

0 200
SCALE 1:2500 METRES

SAFETY,HEALTH AND ENVIRONMENTAL INFORMATION

	STAGES
The significant residual risks detailed on this drawing are linked to the referencing system within the Hazard Elimination and Risk Reduction Register (HE**************). Each risk is given a unique number followed by a letter that corresponds to one of the six stages affected.	S - Survey C - Construction M - Maintenance O - Operation U - Road User D - Demolition

SIGNIFICANT RESIDUAL RISKS

For designer's residual risk assessment-construction refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001

Design life:
30 years

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	03/01/2024	SUITABLE FOR ACCEPTANCE	APO	APO	MCH	APO

Designer:
VAN ELLE TOTAL FOUNDATION SOLUTIONS
ScrewFast FOUNDATIONS LTD

Client
national highways
smp alliance

Project
NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25

Drawing title
MS4 GANTRY FOUNDATIONS
CH 190485/STR_43871.
3D VIEW

Drawing status
S5 - SUITABLE FOR REVIEW AND ACCEPTANCE

State Code	PRELIMINARY		
Project Stage	STAGE 5		
Scale	N/A	DO NOT SCALE	
Sheet Size	A3	Rev	P01
Client no.	HE614830		

Drawing number
PIN | Originator | Volume
HE614830 - VAE - SGY -
Location | Type | Role | Number
P015_S2_ALLGENR - DR - CB - 0002

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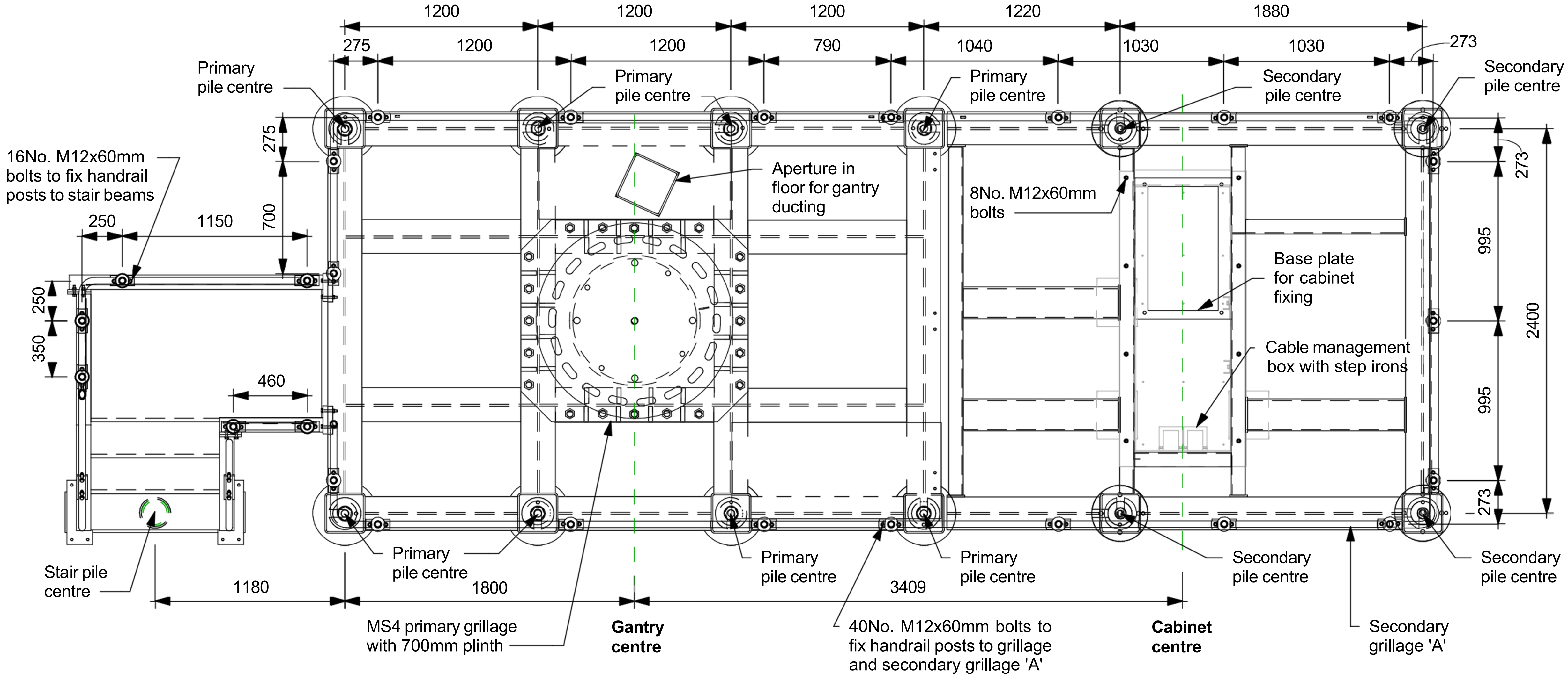
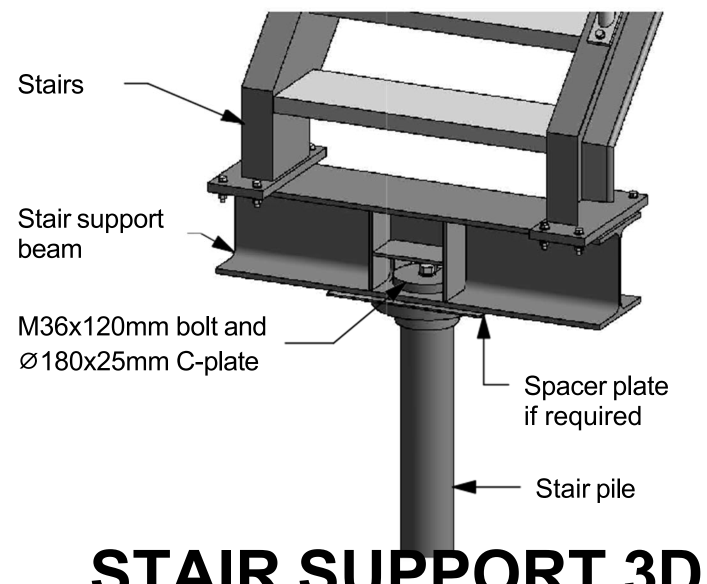
For general notes refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001



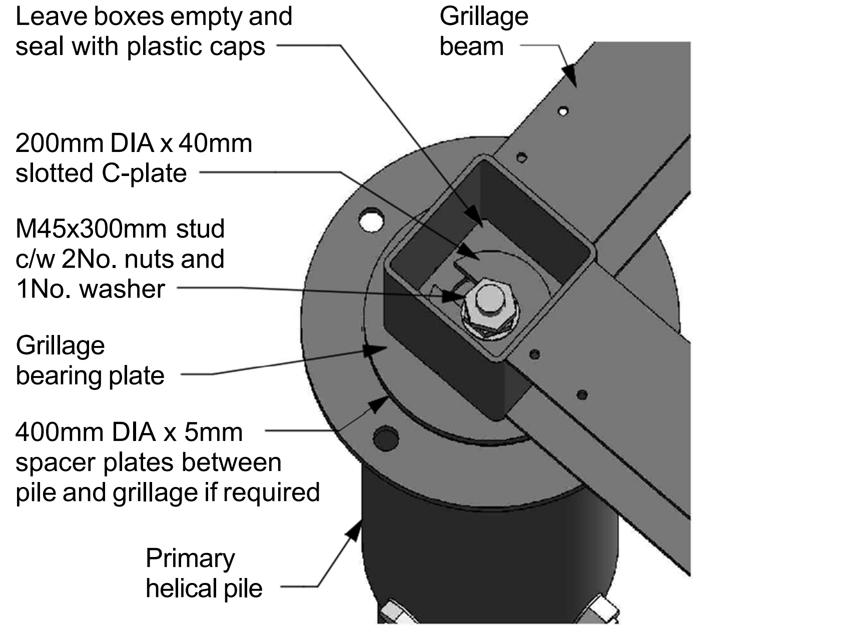
VRS BY OTHERS SHOWN INDICATIVELY

1 PLAN VIEW
1 : 30

FOR HANDRAIL POST DETAILS REFER TO DRAWING No. HE614830-VAE-SGY-P015_S2_ALLGENR -DE-CB-0040



2 STAIR SUPPORT 3D



3 CONNECTION DETAIL

SAFETY,HEALTH AND ENVIRONMENTAL INFORMATION

The significant residual risks detailed on this drawing are linked to the referencing system within the Hazard Elimination and Risk Reduction Register (HE**************).

Each risk is given a unique number followed by a letter that corresponds to one of the six stages affected.

STAGES
S - Survey
C - Construction
M - Maintenance
O - Operation
U - Road User
D - Demolition

SIGNIFICANT RESIDUAL RISKS

For designer's residual risk assessment-construction refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001

Design life: 30 years

0 200
SCALE 1:2500 METRES

Rev	Rev. Date	Purpose of revision	Drawn	Check'd	Rev'd	Apprv'd
P01	03/01/2024	SUITABLE FOR ACCEPTANCE	APO	APO	MCH	APO

Designer: VAN ELLE / ScrewFast FOUNDATIONS

Client: national highways / smp alliance

Project:
NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25

Drawing title:
MS4 GANTRY FOUNDATIONS
CH 190485/STR_43871.
PLAN VIEW

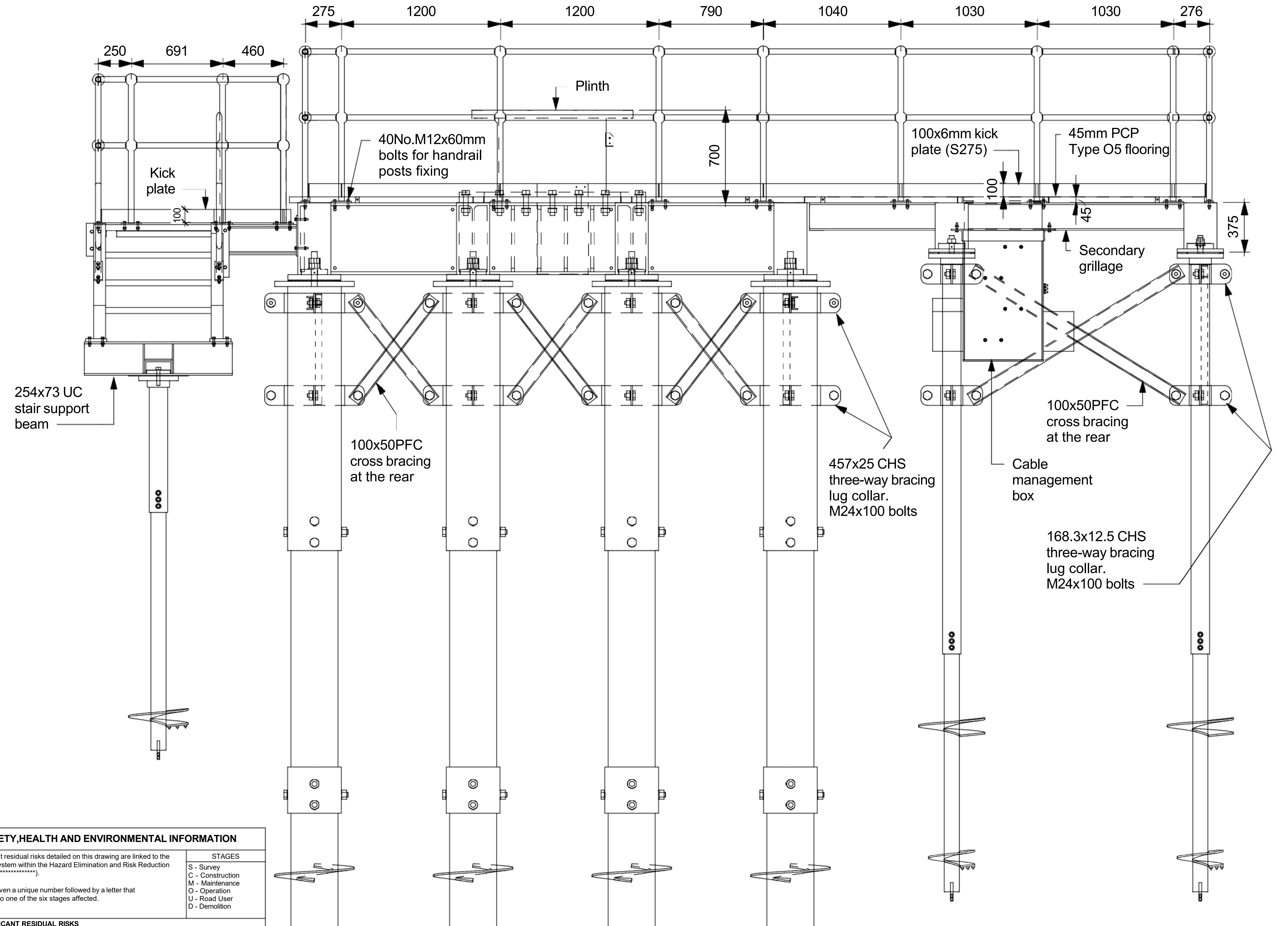
Drawing status:
S5 - SUITABLE FOR REVIEW AND ACCEPTANCE

Stats Code	PRELIMINARY
Project Stage	STAGE 5
Scale	AS SHOWN
Sheet Size	A3
Client no.	HE614830

DO NOT SCALE
Rev P01

Drawing number
HE614830 - VAE - SGY
P015_S2_ALLGENR - DR - CB - 0003

For general notes refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001



VIEW FROM CARRIAGEWAY

1

1 : 30

FOR PILE BRACING AND BRACING LUG COLLAR FABRICATION DETAILS REFER TO DRAWING HE614830-VAE-SGY-P015_S2_ALLGENR-DE-CB-0041

Minimum gap from FGL to underside of bracing is 300mm

0 200
SCALE 1:2500 METRES

SAFETY,HEALTH AND ENVIRONMENTAL INFORMATION

The significant residual risks detailed on this drawing are linked to the referencing system within the Hazard Elimination and Risk Reduction Register (HE**************).

Each risk is given a unique number followed by a letter that corresponds to one of the six stages affected.

STAGES
S - Survey
C - Construction
M - Maintenance
O - Operation
U - Road User
D - Demolition

SIGNIFICANT RESIDUAL RISKS

For designer's residual risk assessment-construction refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001

Design life: 30 years

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	03/01/2024	SUITABLE FOR ACCEPTANCE	APO	APO	MCH	APO

Designer: VAN ELLE TOTAL FOUNDATION SOLUTIONS; ScrewFast FOUNDATIONS LTD

Client: national highways; smp alliance

Project
NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25

Drawing title
MS4 GANTRY FOUNDATIONS
CH 190485/STR_43871.
VIEW FROM CARRIAGEWAY

Drawing status
S5 - SUITABLE FOR REVIEW AND ACCEPTANCE

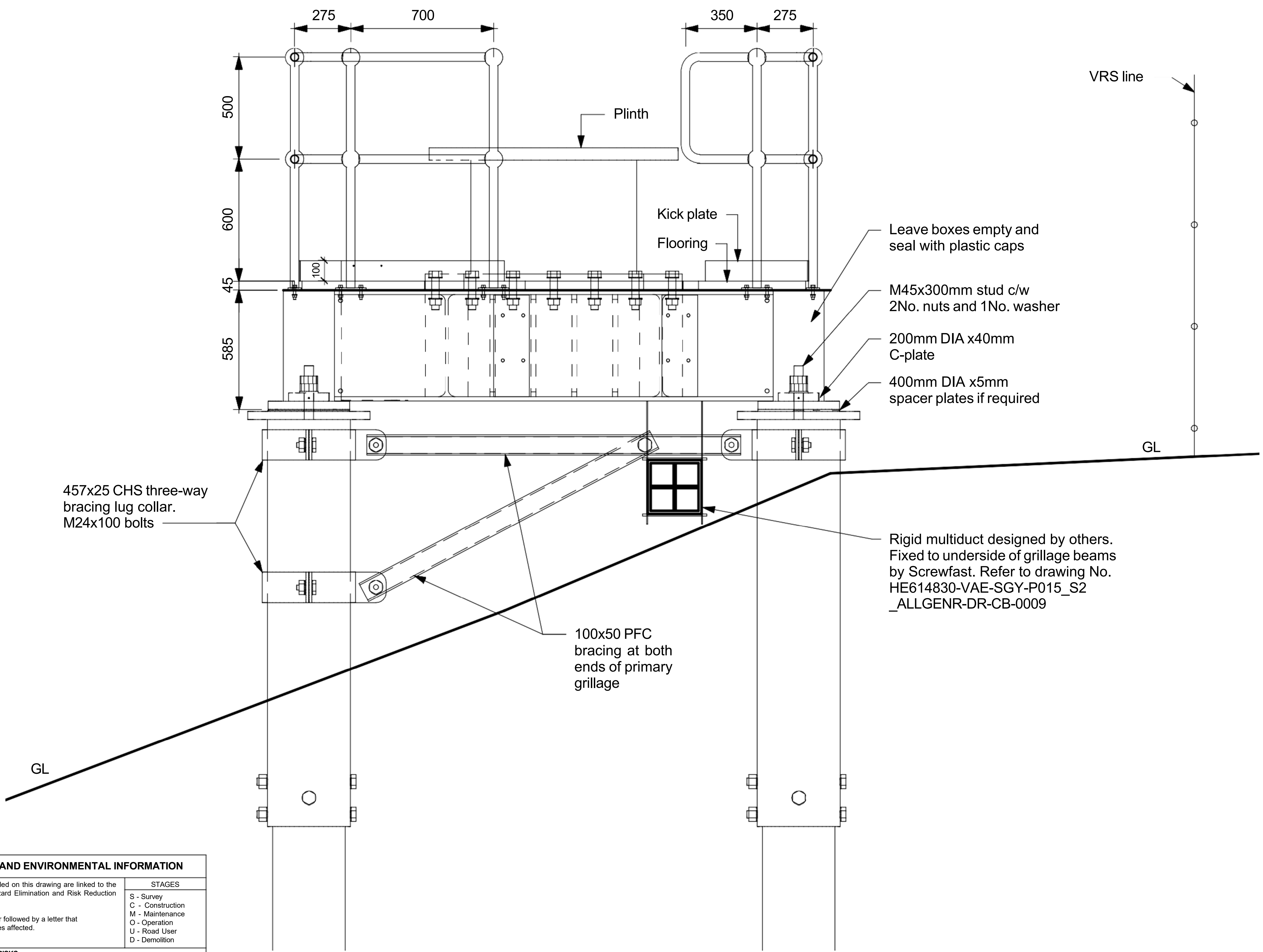
State Code	PRELIMINARY
Project Stage	STAGE 5
Scale	AS SHOWN
Sheet Size	A3
Client no.	HE614830

DO NOT SCALE

Rev P01

Drawing number
PIN | Originator | Volume | Location | Type | Role | Number
HE614830 - VAE - SGY - P015_S2_ALLGENR - DR - CB - 0004

For general notes refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001



UPSTREAM VIEW

1

1 : 20

Minimum gap from FGL to underside of bracing to be 300mm

Design life: 30 years

0 200
SCALE 1:2500 METRES

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

The significant residual risks detailed on this drawing are linked to the referencing system within the Hazard Elimination and Risk Reduction Register (HE**************).

Each risk is given a unique number followed by a letter that corresponds to one of the six stages affected.

STAGES
- S - Survey
- C - Construction
- M - Maintenance
- O - Operation
- U - Road User
- D - Demolition

SIGNIFICANT RESIDUAL RISKS

For designer's residual risk assessment-construction refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	03/01/2024	SUITABLE FOR ACCEPTANCE	APO	APO	MCH	APO

Designer: VAN ELLE TOTAL FOUNDATION SOLUTIONS; ScrewFast FOUNDATIONS LTD

Client: national highways; smp alliance

Project
NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25

Drawing title
MS4 GANTRY FOUNDATIONS
CH 190485/STR_43871.
UPSTREAM VIEW

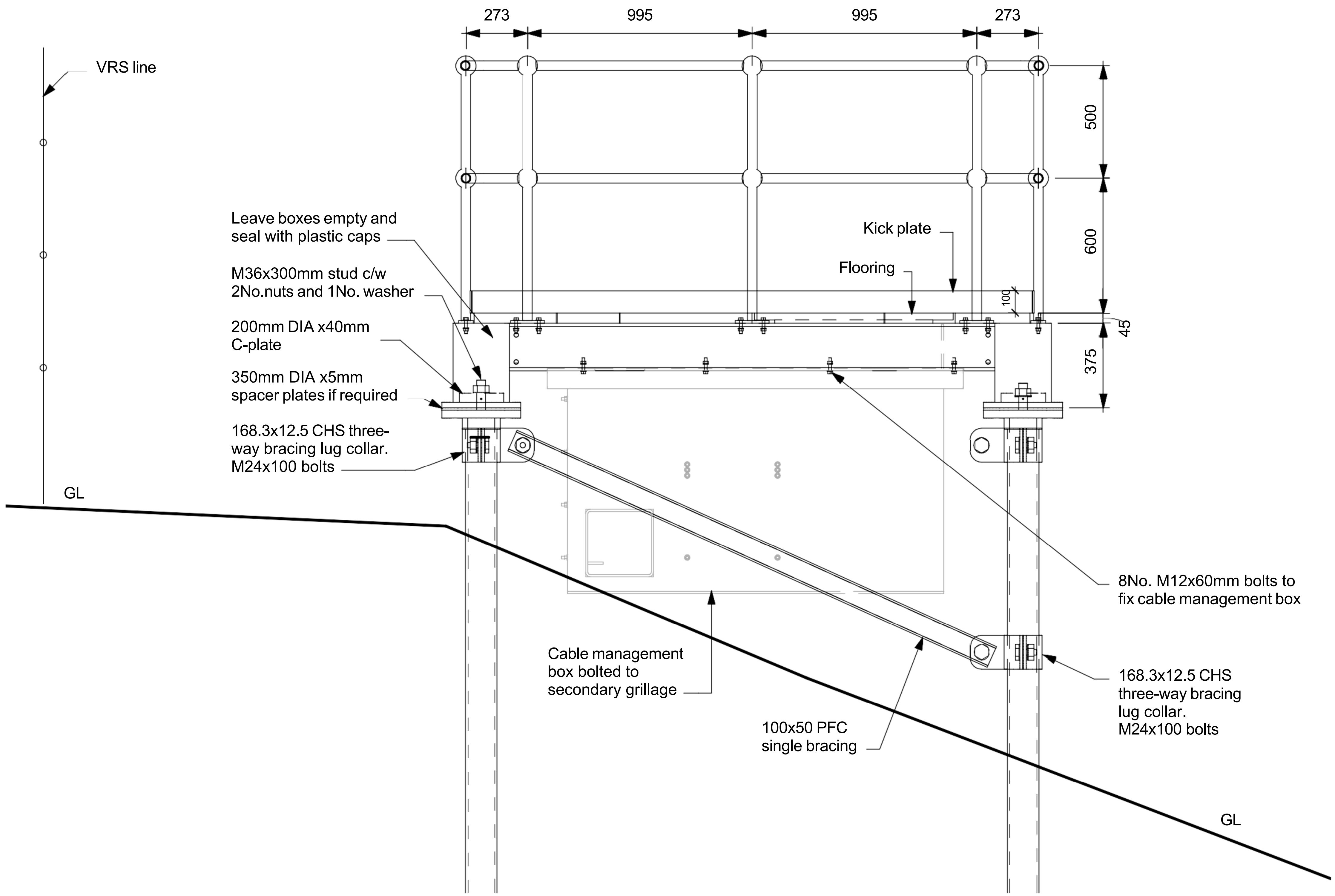
Drawing status
S5 - SUITABLE FOR REVIEW AND ACCEPTANCE

State Code	PRELIMINARY
Project Stage	PCF 5
Scale	AS SHOWN
Sheet Size	A3
Client no.	HE614830

DO NOT SCALE
Rev P01

Drawing number
PIN HE614830 - Originator VAE - Volume SGY - Location P015_S2_ALLGENR - Type DR - Role CB - Number 0005

For general notes refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001



1 DOWNSTREAM VIEW

1 : 20

Minimum gap from FGL to underside of bracing to be 300mm

0 200
SCALE 1:2500 METRES

SAFETY,HEALTH AND ENVIRONMENTAL INFORMATION

	STAGES
The significant residual risks detailed on this drawing are linked to the referencing system within the Hazard Elimination and Risk Reduction Register (HE***************). Each risk is given a unique number followed by a letter that corresponds to one of the six stages affected.	S - Survey C - Construction M - Maintenance O - Operation U - Road User D - Demolition

SIGNIFICANT RESIDUAL RISKS

For designer's residual risk assessment-construction refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001

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Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	03/01/2024	SUITABLE FOR ACCEPTANCE	APO	APO	MCH	APO

Designer: VAN ELLE TOTAL FOUNDATION SOLUTIONS; ScrewFast FOUNDATIONS LTD

Client: national highways; smp alliance

Project: NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25

Drawing title: MS4 GANTRY FOUNDATIONS
CH 190485/STR_43871.
DOWNSTREAM VIEW

Drawing status: S5 - SUITABLE FOR REVIEW AND ACCEPTANCE

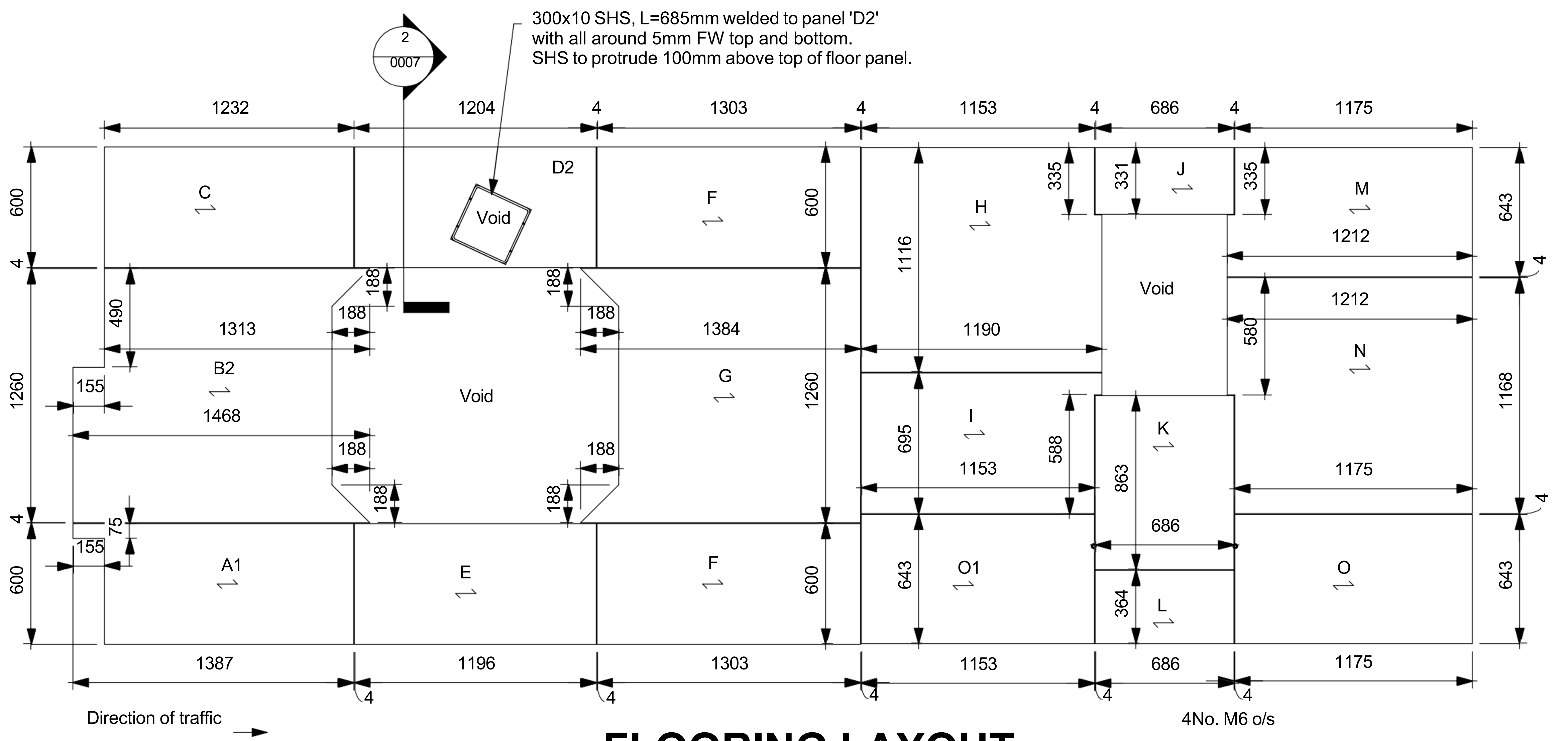
State Code	PRELIMINARY
Project Stage	STAGE 5
Scale	AS SHOWN
Sheet Size	A3
Client no.	HE614830

DO NOT SCALE
Rev P01

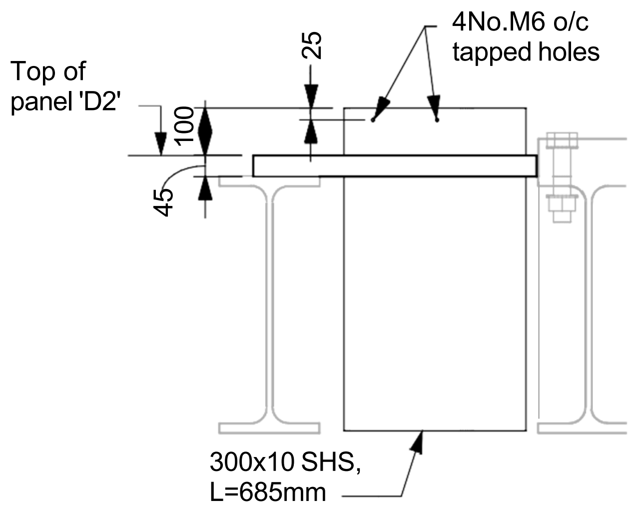
Drawing number

PIN	Originator	Volume	Location	Type	Role	Number
HE614830	VAE	SGY	P015_S2_ALLGENR	DR	CB	0006

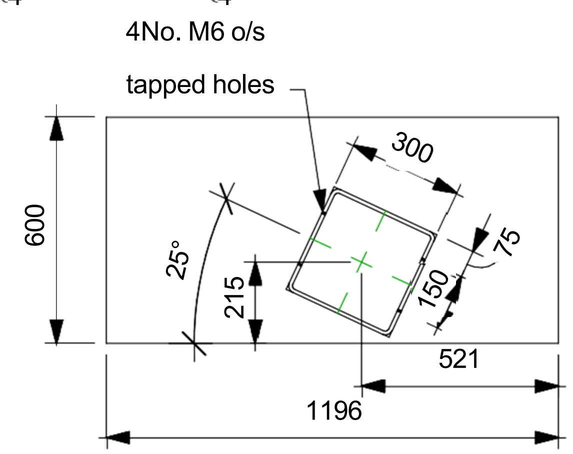
For general notes refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001



1 FLOORING LAYOUT
1 : 25



2 Section 1
1 : 16



3 PANEL 'D2'
1 : 20

ALL FLOORING TO BE 45mm THICK TYPE O5 PCP GALVANISED FLOORING PANELS.
DEFLECTION FROM LIVE LOADING OF 5kN/m² NOT TO EXCEED SPAN/360.
FABRICATOR TO PROVIDE ADDITIONAL STIFFENERS AS REQUIRED.
FLOORING AS SHOWN HERE IS FOR CONCEPT PURPOSE ONLY.
FINAL DETAILING TO BE PROVIDED BY FLOORING SPECIALISTS PCP OR OTHER APPROVED TO EQUAL PCP O5 IN ALL ASPECTS.
ALL FLOORING PANELS FIXED TO GRILLAGE BEAMS BY SPECIALIST WITH TEK SCREWS TO BEAM TOP FLANGES

TO ACCESS CABLE MANAGEMENT BOX REMOVE FLOOR PANEL 'K'

0 200
SCALE 1:2500 METRES

SAFETY,HEALTH AND ENVIRONMENTAL INFORMATION

The significant residual risks detailed on this drawing are linked to the referencing system within the Hazard Elimination and Risk Reduction Register (HE***************).

Each risk is given a unique number followed by a letter that corresponds to one of the six stages affected.

STAGES
S - Survey
C - Construction
M - Maintenance
O - Operation
U - Road User
D - Demolition

SIGNIFICANT RESIDUAL RISKS

For designer's residual risk assessment-construction refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001

Rev	Rev. Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
P01	03/01/2024	SUITABLE FOR ACCEPTANCE	APO	APO	MCH	APO

Designer: VAN ELLE TOTAL FOUNDATION SOLUTIONS / ScrewFast FOUNDATIONS

Client: national highways / smp alliance

Project
NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25

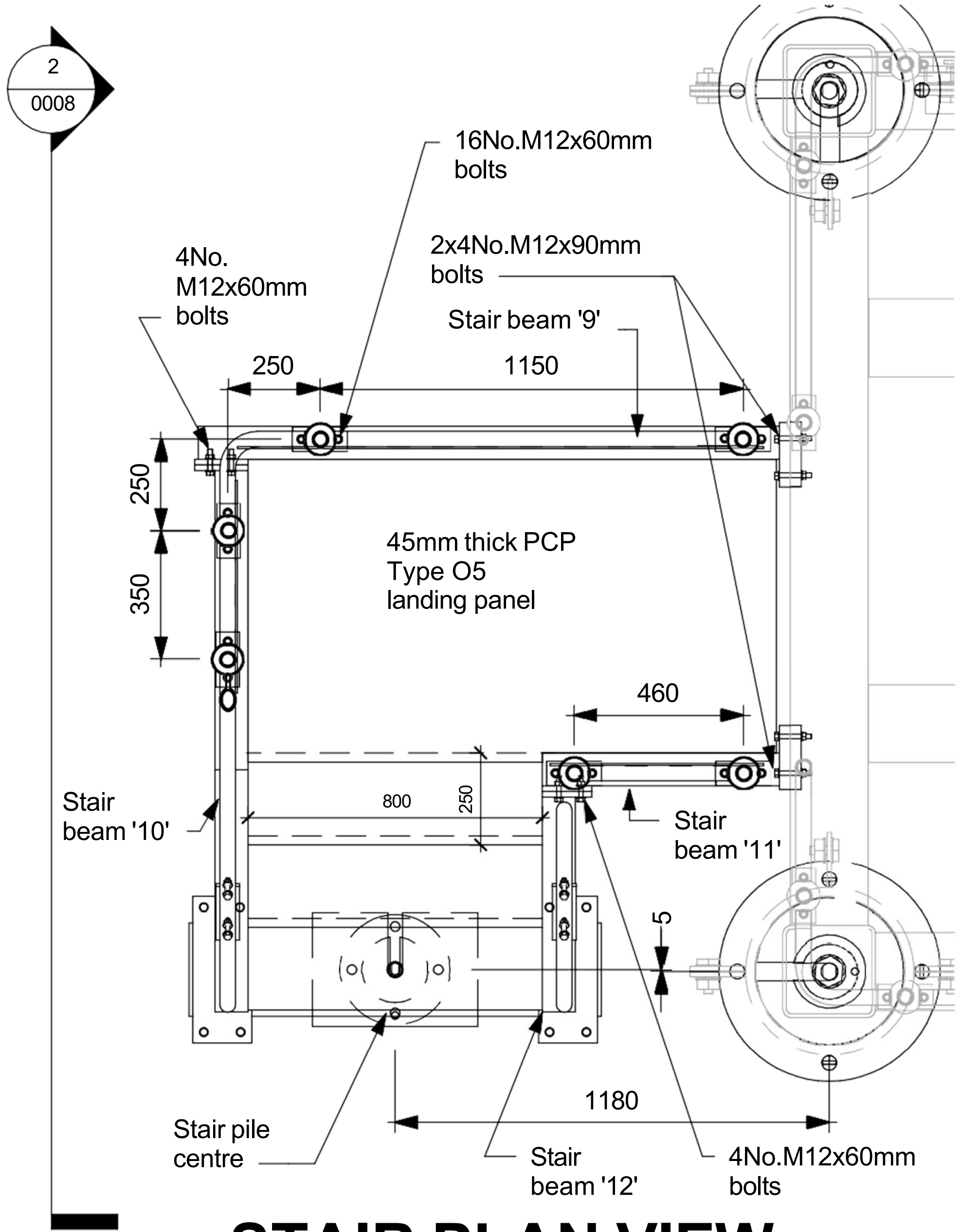
Drawing title
MS4 GANTRY FOUNDATIONS
CH 190485/STR_43871.
FLOORING LAYOUT

Drawing status
S5 - SUITABLE FOR REVIEW AND ACCEPTANCE

State Code: PRELIMINARY
Project Stage: STAGE 5
Scale: AS SHOWN — DO NOT SCALE
Sheet Size: A3 — Rev P01
Client no.: HE614830

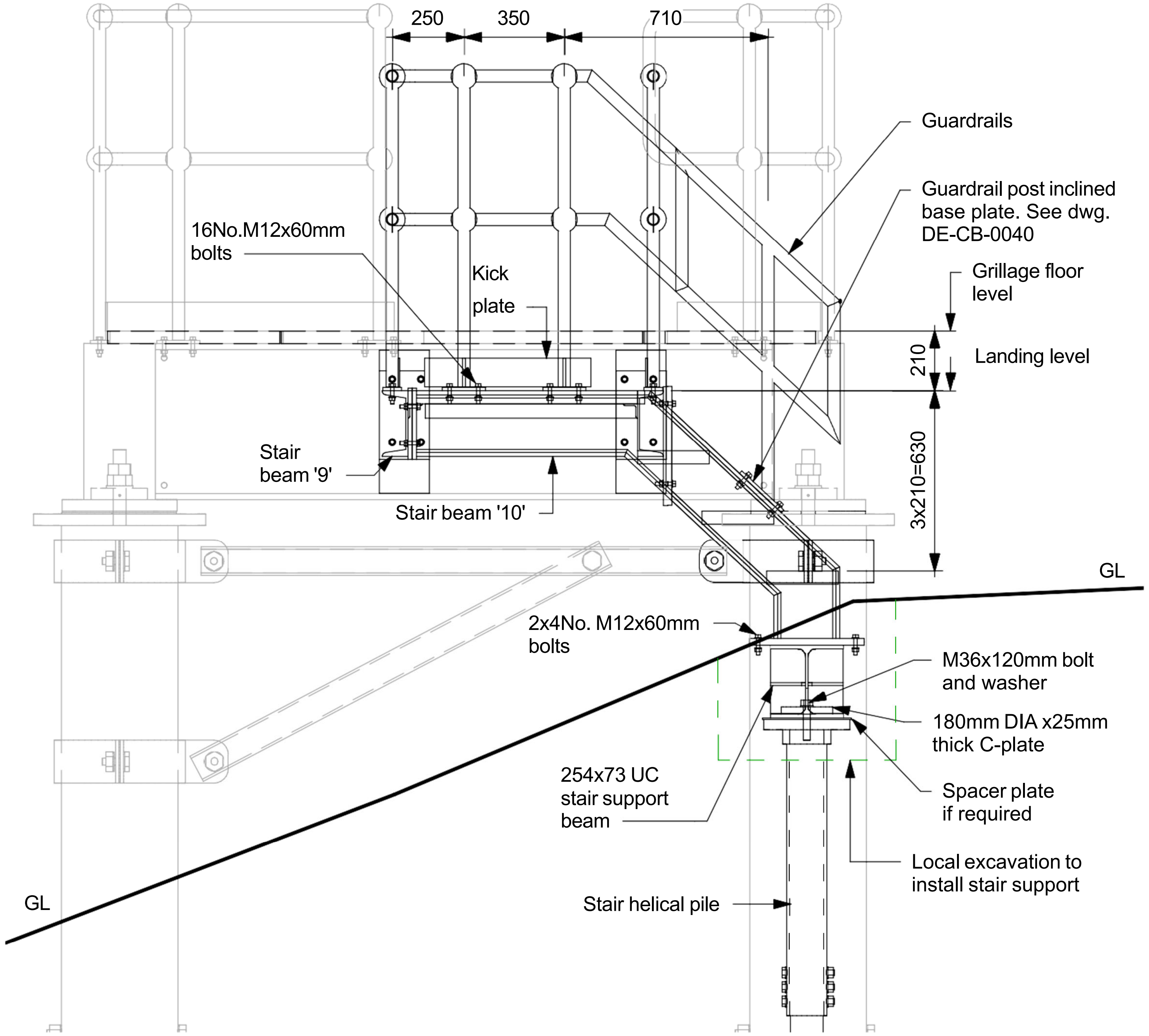
Drawing number
PIN HE614830 - Originator VAE - Volume SGY -
Location P015_S2_ALLGENR - Type DR - Role CB - Number 0007

For general notes refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001



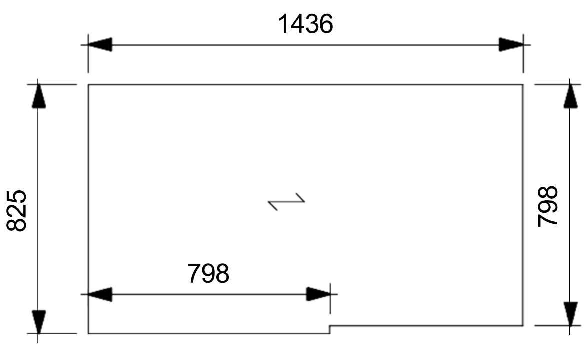
STAIR PLAN VIEW

1 1 : 20



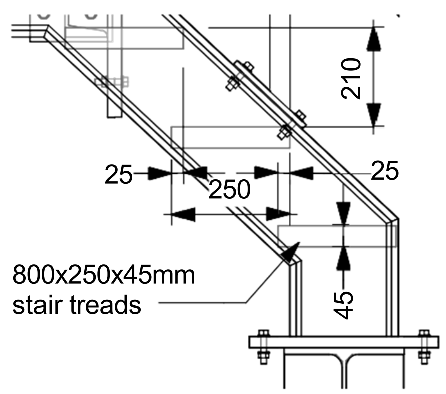
STAIR SIDE VIEW

2 1 : 20



LANDING PANEL

3 1 : 25



Enlarged view

4 1 : 16

SAFETY,HEALTH AND ENVIRONMENTAL INFORMATION

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STAGES
S - Survey
C - Construction
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U - Road User
D - Demolition

SIGNIFICANT RESIDUAL RISKS

For designer's residual risk assessment-construction refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001

FOR STAIR, STAIR SUPPORT BEAM, STAIR C-PLATE AND STAIR SPACER PLATE REFER TO DRAWINGS No .... DE-CB-0020 TO 0024

STAIR GUARDRAILS TO COMPLY WITH MCX 0138 DRAWINGS. REFER TO STANDARDS FOR HIGHWAYS

800x250x45mm PCP TYPE O2 ACHIL OR SIMILAR APPROVED STAIR TREADS TO BE BOLTED TO STAIR BEAM WEBS

LOCAL REGRADE IN FRONT OF THE STAIRS TO BE DONE BY OTHERS AS AND IF REQUIRED

Design life: 30 years

0 200
SCALE 1:2500 METRES

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	03/01/2024	SUITABLE FOR ACCEPTANCE	APO	APO	MCH	APO

Designer: VAN ELLE TOTAL FOUNDATION SOLUTIONS / ScrewFast FOUNDATIONS

Client: national highways / smp alliance

Project
NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25

Drawing title
MS4 GANTRY FOUNDATIONS
CH 190485/STR_43871.
STAIR GENERAL ARRANGEMENT

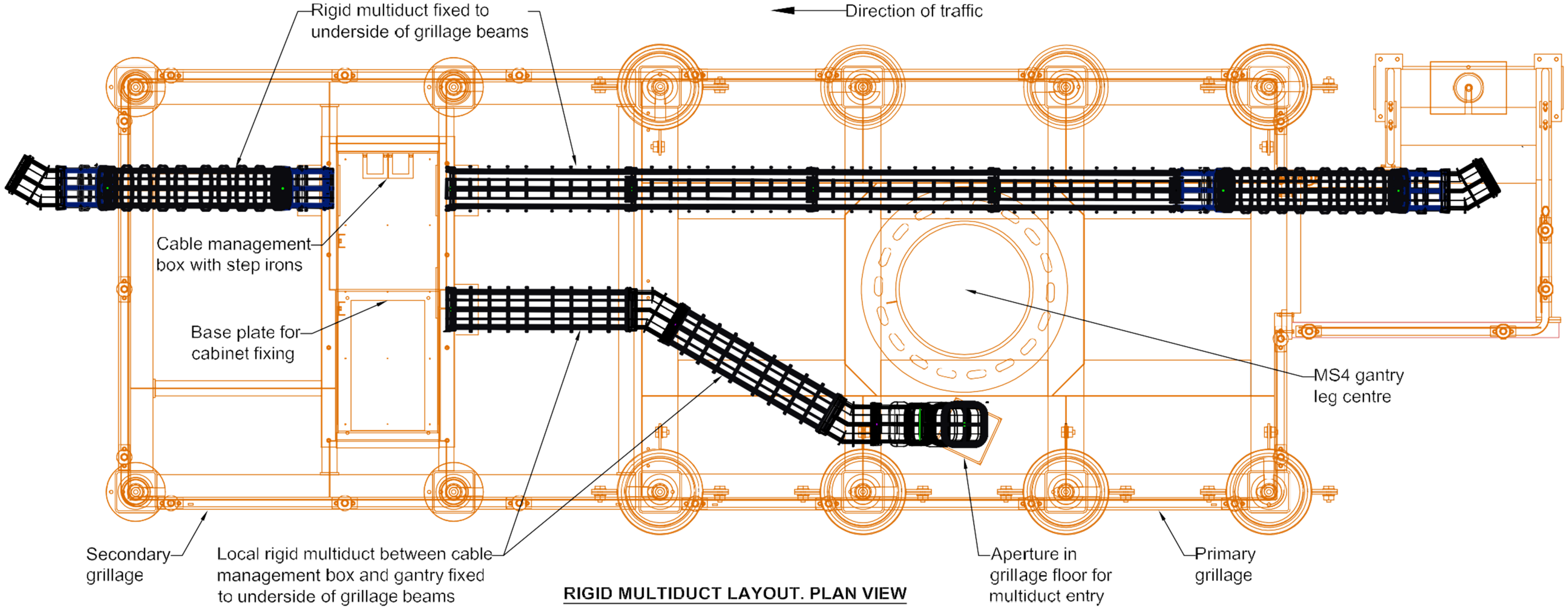
Drawing status
S5 - SUITABLE FOR REVIEW AND ACCEPTANCE

State Code	PRELIMINARY
Project Stage	STAGE 5
Scale	AS SHOWN
Sheet Size	A3
Client no.	HE614830

DO NOT SCALE
Rev P01

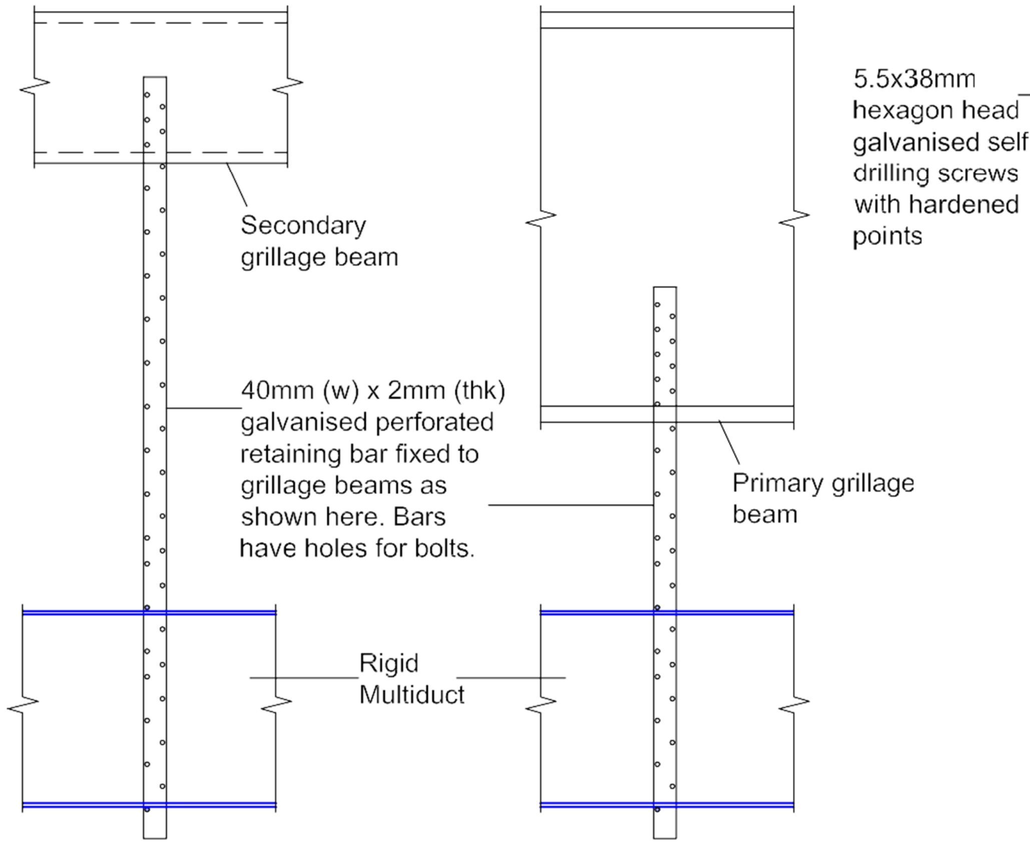
Drawing number
HE614830 - VAE - SGY - P015_S2_ALLGENR - DR - CB - 0008

For General Notes refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001

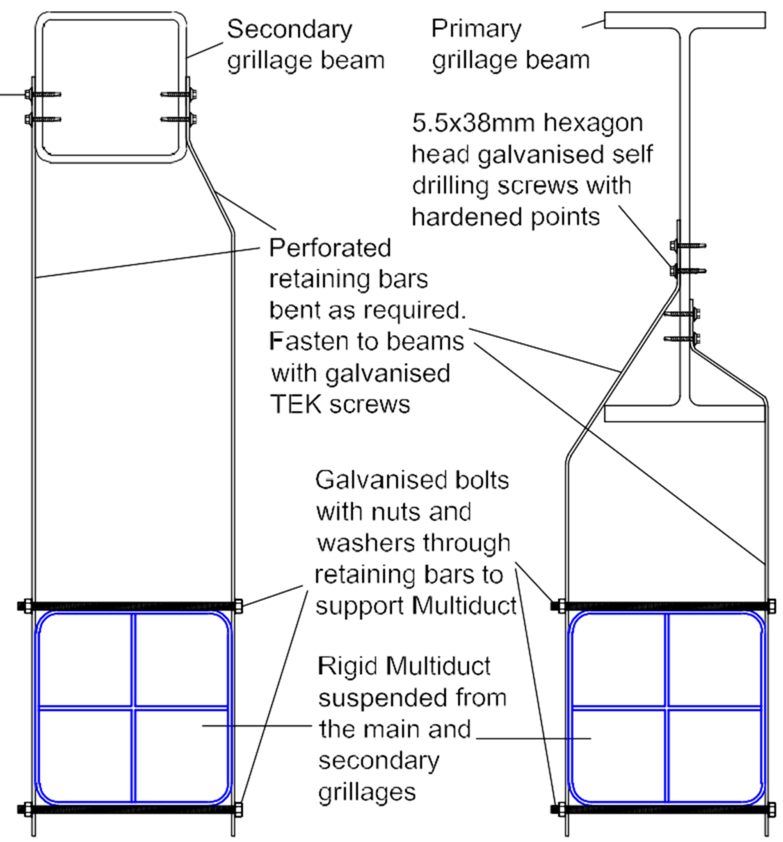


RIGID MULTIDUCT LAYOUT. PLAN VIEW

RIGID MULTIDUCT DESIGNED BY OTHERS. MULTIDUCT TO BE FIXED TO UNDERSIDE OF GRILLAGE BEAMS BY SCREWFAST PRIOR TO GRILLAGE LANDING ON SITE



Multiduct fixing. Typical side view



Multiduct fixing. Typical end view

Design life: 30 Years

0 200
SCALE 1:2500 METRES

SAFETY,HEALTH AND ENVIRONMENTAL INFORMATION

The significant residual risks detailed on this drawing are linked to the referencing system within the Hazard Elimination and Risk Reduction Register (HE**************).

Each risk is given a unique number followed by a letter that corresponds to one of the six stages affected.

STAGES
- S - Survey
- C - Construction
- M - Maintenance
- O - Operation
- U - Road User
- D - Demolition

SIGNIFICANT RESIDUAL RISKS

For designer's residual risk assessment-construction refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001

J:\2023\233630\15. Drawings\DWG\HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0009.dwg - 04/01/2024 10:24:27 - DR-CB-0009 - andrej.podpriatov

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	03/01/24	SUITABLE FOR ACCEPTANCE	APO	APO	APO	APO

Designer: VAN ELLE TOTAL FOUNDATION SOLUTIONS; ScrewFast FOUNDATIONS LTD

Client: national highways; smp alliance

Project: NATIONAL EMERGENCY AREA RETROFIT M1 J23a-25

Drawing title: MS4 GANTRY FOUNDATIONS CH 190485/STR_43871 RIGID MULTIDUCT LAYOUT AND FIXING TO GRILLAGE

Drawing status: S5 - SUITABLE FOR REVIEW AND ACCEPTANCE

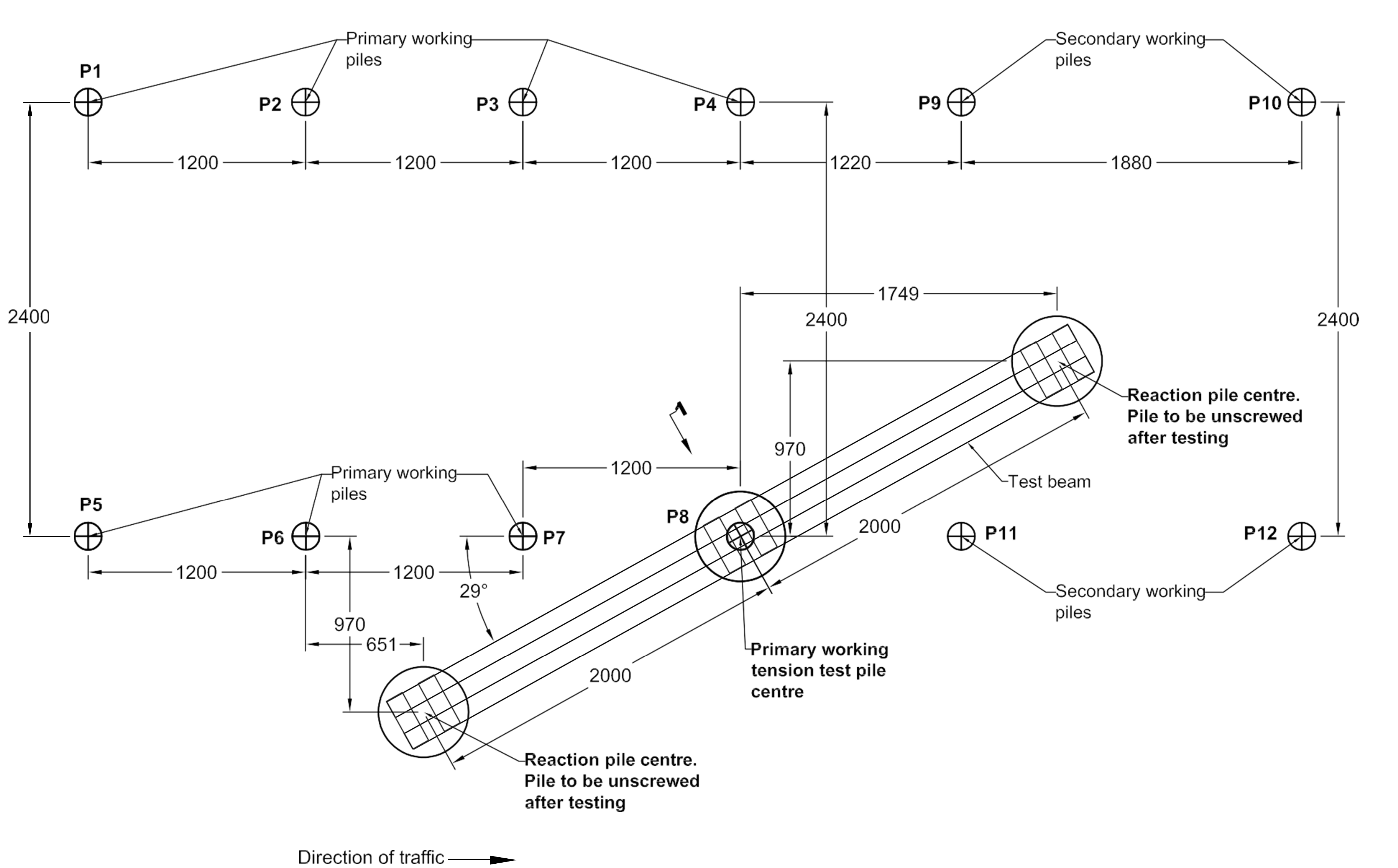
State Code	PRELIMINARY
Project Stage	STAGE 5
Scale	AS SHOWN
Sheet Size	A3
Client no.	HE614830

DO NOT SCALE

Rev P01

Drawing number (PIN - Originator - Volume - Location - Type - Role - Number): HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0009

For general notes refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001



MS4 GANTRY FOUNDATIONS AT CHAINAGE 190+485
PILE TEST ARRANGEMENT. PLAN VIEW

Rev	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
P01	23/02/2023	SUITABLE FOR ACCEPTANCE	APO	APO	MCH	APO

Designer: VAN ELLE TOTAL FOUNDATION SOLUTIONS / ScrewFast FOUNDATIONS

Client: national highways / smp alliance

Project: NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25

Drawing title: MS4 GANTRY FOUNDATIONS
CH 190485/STR_43871
PILE TESTING ARRANGEMENT.
PLAN VIEW

Drawing status: S5 - SUITABLE FOR REVIEW AND ACCEPTANCE

State Code	PRELIMINARY
Project Stage	STAGE 5
Scale	AS SHOWN
Sheet Size	A3
Client no.	HE614830

DO NOT SCALE

Rev P01

Drawing number: HE614830 - VAE - SGY - P015_S2_ALLGENR - DR - CB - 0010

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

The significant residual risks detailed on this drawing are linked to the referencing system within the Hazard Elimination and Risk Reduction Register (HE**************).

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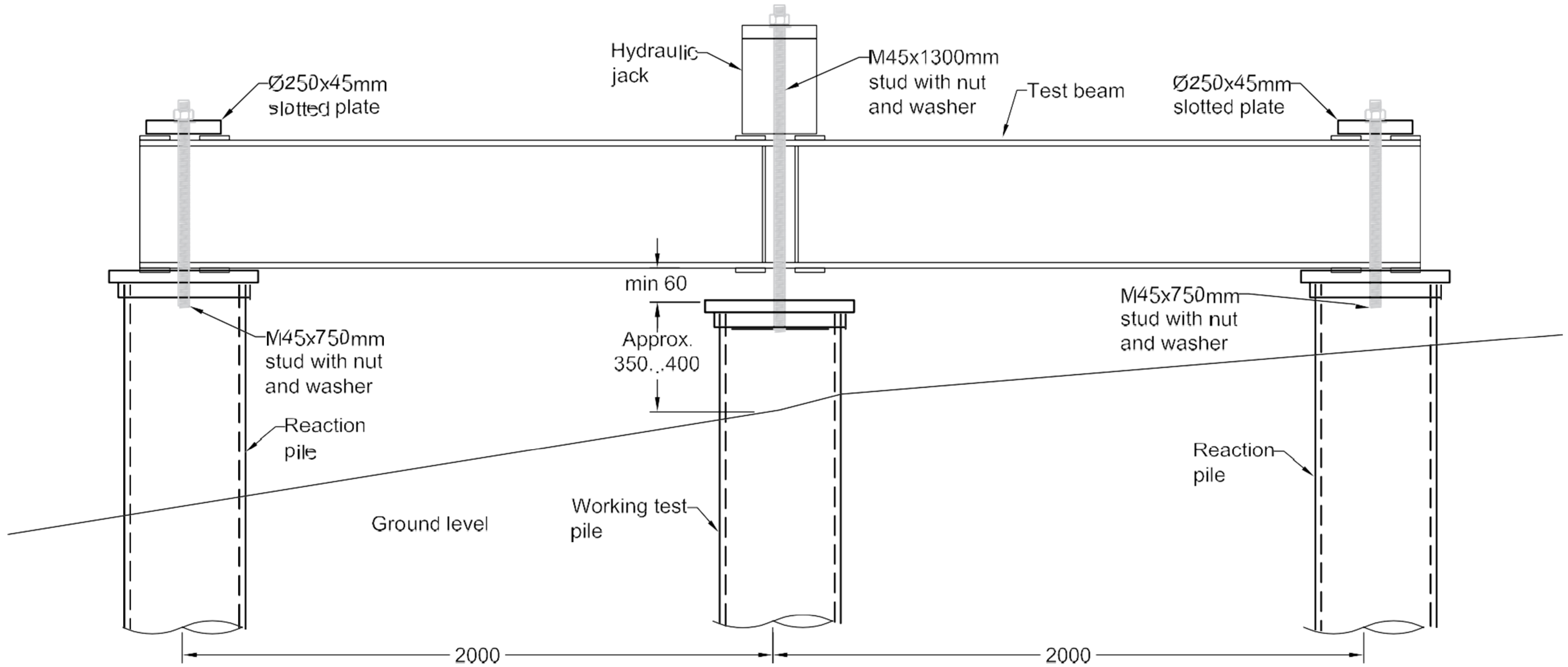
STAGES
S - Survey
C - Construction
M - Maintenance
O - Operation
U - Road User
D - Demolition

SIGNIFICANT RESIDUAL RISKS

For design residual risk assessment-construction refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001

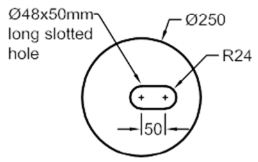
0 200
SCALE 1:2500 METRES

For general notes refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001

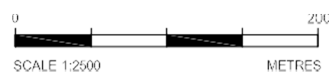


MS4 GANTRY FOUNDATIONS AT CHAINAGE 190+485
PILE TEST ARRANGEMENT. VIEW '1'

Tension test loads:
100% DVL = 130kN
100% DVL + 50% SWL = 198kN



Ø250x45mm SLOTTED PLATE
(steel min. S355 J0)



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

The significant residual risks detailed on this drawing are linked to the referencing system within the Hazard Elimination and Risk Reduction Register (HE**************).

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- C - Construction
- M - Maintenance
- O - Operation
- U - Road User
- D - Demolition

SIGNIFICANT RESIDUAL RISKS

For design residual risk assessment-construction refer to drawing No. HE614830-VAE-SGY-P015_S2_ALLGENR-DR-CB-0001

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	23/02/2023	SUITABLE FOR ACCEPTANCE	APO	APO	MCH	APO

Designer: VAN ELLE TOTAL FOUNDATION SOLUTIONS / ScrewFast FOUNDATIONS LTD

Client: national highways / smp alliance

Project: NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25

Drawing title: MS4 GANTRY FOUNDATIONS
CH 190485/STR_43871
PILE TESTING ARRANGEMENT.
VIEW '1'

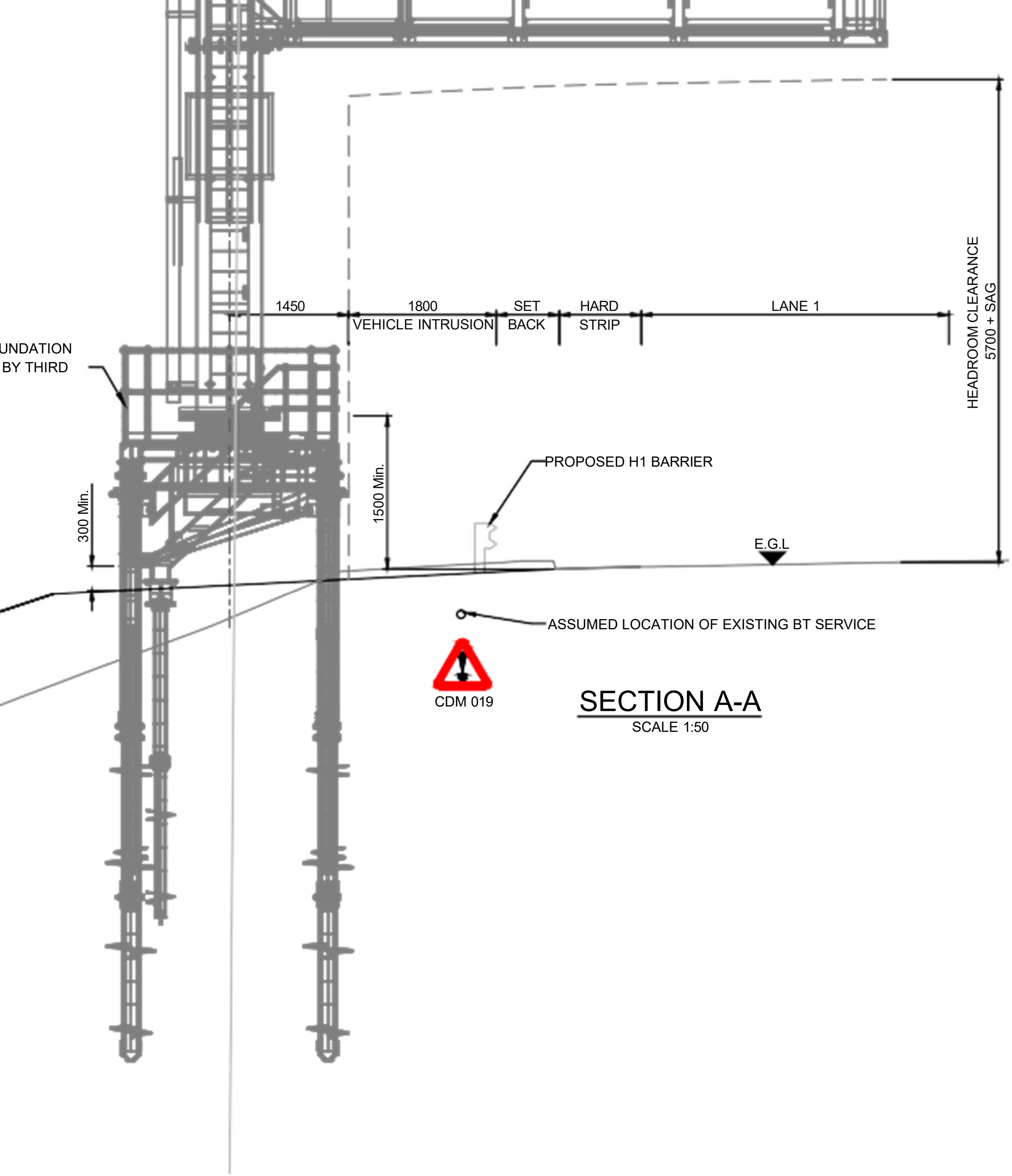
Drawing status: S5 - SUITABLE FOR REVIEW AND ACCEPTANCE

State Code	PRELIMINARY
Project Stage	STAGE 5
Scale	AS SHOWN
Sheet Size	A3
Client no.	HE614830

DO NOT SCALE

Rev P01

Drawing number
PIN | Originator | Volume
HE614830 - VAE - SGY -
Location | Type | Role | Number
P015_S2_ALLGENR -DR-CB-0011



SECTION A-A

SCALE 1:50

P01	16/02/24	SUITABLE FOR INFORMATION	OWO	FQA	FQA	PCO
Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

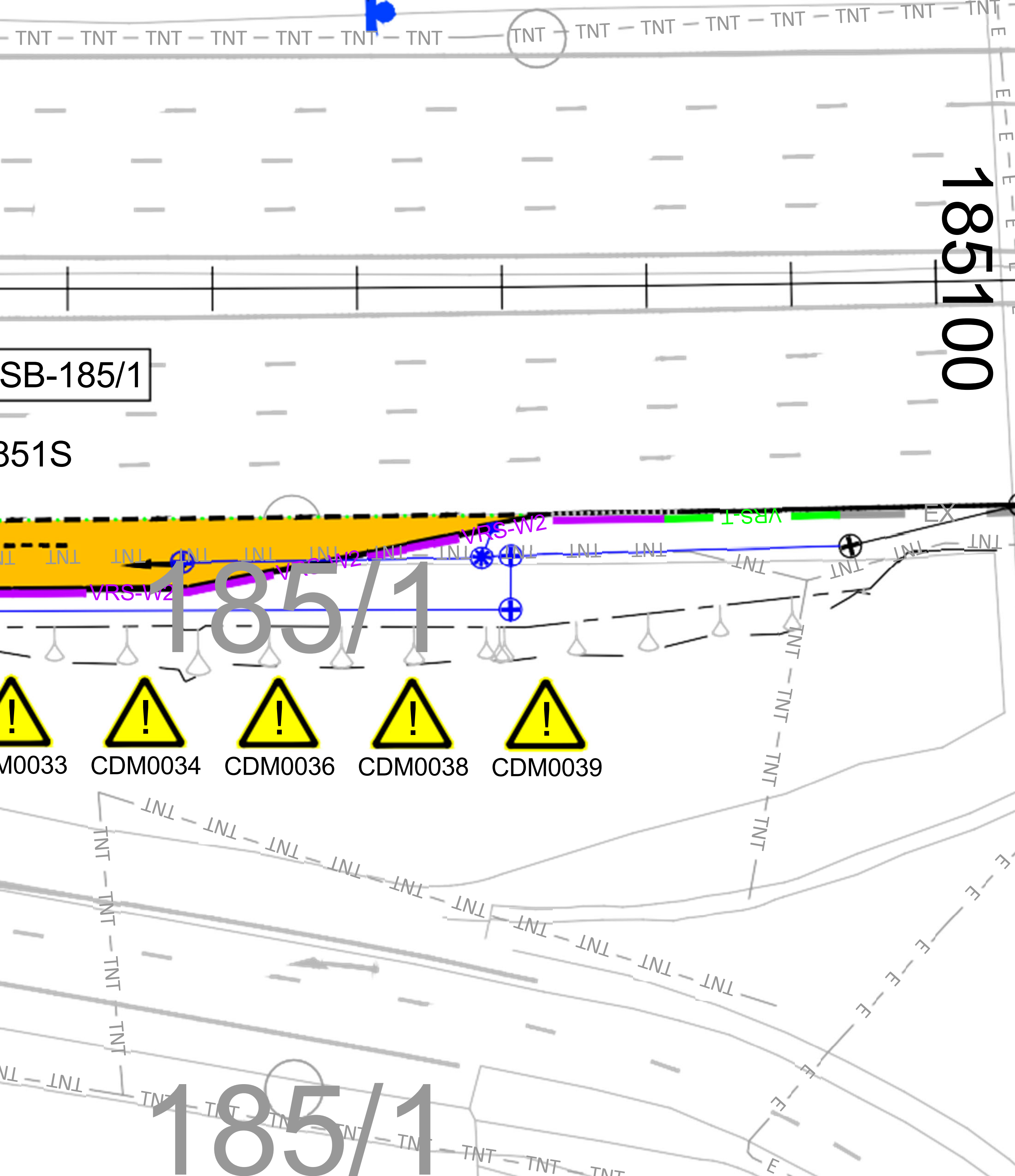
Designer:

Client

Project NATIONAL EMERGENCY AREA RETROFIT

M1 J23a-25

Annex E General Arrangement Drawings of the Proposed Locations



DERIVED FROM LAND REGISTRY CADASTRAL PARCELS, ORDNANCE SURVEY AND HAPMS.

3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE FOLLOWING SCHEDULES AND SPECIFICATION APPENDICES:
Series 0200: HE614830-WSP-HSC-P015_AL_ALLGENR-SP-ZZ-0001
Series 0400: HE614830-WSP-HRR-P015_AL_ALLGENR-SH-CH-0001 & HE614830 WSP-HRR-P015_AL_ALLGENR-SP-CH-0001
Series 0700: HE614830-JAC-HPV-P015_AL_ALLGENR-SP-CH-0002
Series 1100: HE614830-WSP-HKF-P015_AL_ALLGENR-SH-CD-0001 & HE614830-WSP-HKF-P015_AL_ALLGENR-SP-CH-0001
Series 1200: HE614830-WSP-HSN-P015_AL_ALLGENR-SH-CH-0003, HE614830-WSP-HMK-P015_AL_ALLGENR-SH-CH-0001 & HE614830-WSP-HSN-P015_AL_ALLGENR-SP-CH-0001
Series 1300: HE614830-WSP-HLG-P015_AL_ALLGENR-SH-EO-0002 & HE614830-WSP-HLG-P015_AL_ALLGENR-SP-EO-0001
Series 1500: HE614830-WSP-HMC-P015_AL_ALLGENR-SH-EC-0001
Geotechnical Intervention Schedule: HE614830-WSP-HGT-P015_AL_ALLGENR-SH-GE-0001

KEY GENERAL
- Highway Boundary
- Verge at PRS location
- Proposed Earthworks
- RW Proposed Retaining Wall
- Proposed kerb line
- Proposed Maintenance Footway
- Existing Footway
- Existing Gabion Wall to be Retained
- Proposed Sign Face and Post (size indicative)
- Retained or Relocated Sign

PRS
- Existing EA
- Proposed EA
- Proposed EA with Maintenance Hardstanding

VRS
- Existing VRS
- Proposed VRS - W2
- Proposed VRS - H1
- Proposed VRS - W1
- End Terminal P1
- End Terminal P4
- Transition
- End Terminal FHA
- Handrail

UTILITIES
- Gas
- BT
- BT Overhead
- BT Planned
- Electricity
- Electricity Overhead
- Vodafone
- Virgin
- National Grid Electric
- Sky
- Surface Sewer
- Foul Sewer
- UKPD Electric
- Network Rail
- Water
- Telent
- Water Abandoned
- Aqueduct
- OCU

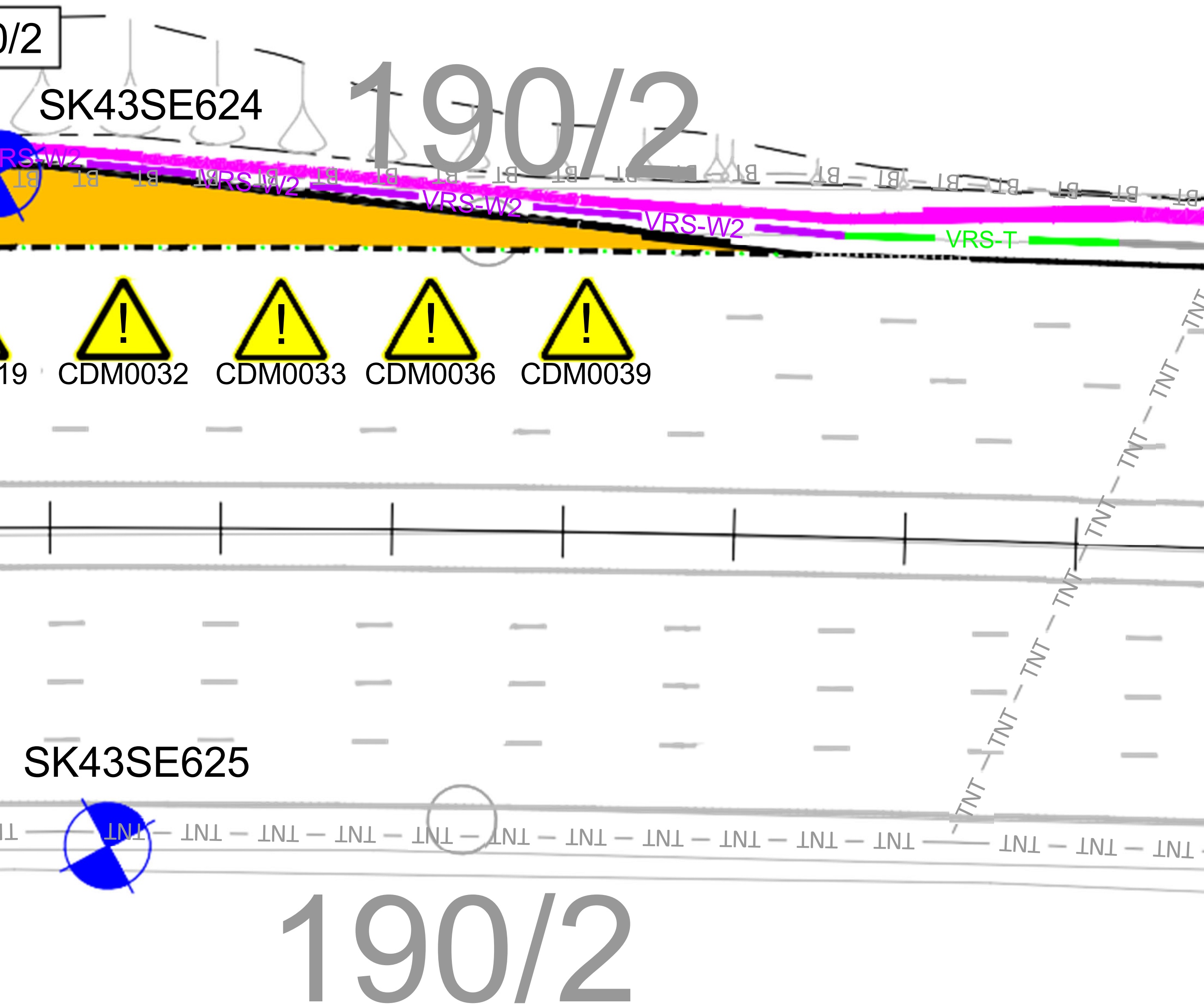
Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	27/02/24	SUITABLE FOR ACCEPTANCE	HSO	AKO	GBE	PCO

Designer: wsp

Client: national highways | amp alliance

Project: NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25

Series 0200: HE614830-WSP-HSC-P015_AL_ALLGENR-SP-ZZ-0001
Series 0400: HE614830-WSP-HRR-P015_AL_ALLGENR-SH-CH-0001 & HE614830 WSP-HRR-P015_AL_ALLGENR-SP-CH-0001
Series 0700: HE614830-JAC-HPV-P015_AL_ALLGENR-SP-CH-0002
Series 1100: HE614830-WSP-HKF-P015_AL_ALLGENR-SH-CD-0001 & HE614830-WSP-HKF-P015_AL_ALLGENR-SP-CH-0001
Series 1200: HE614830-WSP-HSN-P015_AL_ALLGENR-SH-CH-0003, HE614830-WSP-HMK-P015_AL_ALLGENR-SH-CH-0001 & HE614830-WSP-HSN-P015_AL_ALLGENR-SP-CH-0001
Series 1300: HE614830-WSP-HLG-P015_AL_ALLGENR-SH-EO-0002 & HE614830-WSP-HLG-P015_AL_ALLGENR-SP-EO-0001
Series 1500: HE614830-WSP-HMC-P015_AL_ALLGENR-SH-EC-0001
Geotechnical Intervention Schedule: HE614830-WSP-HGT-P015_AL_ALLGENR-SH-GE-0001



KEY GENERAL
- Highway Boundary
- Verge at PRS location
- Proposed Earthworks
- RW Proposed Retaining Wall
- Proposed kerb line
- Proposed Maintenance Footway
- Existing Footway
- Existing Gabion Wall to be Retained
- Proposed Sign Face and Post (size indicative)
- Retained or Relocated Sign

PRS
- Existing EA
- Proposed EA
- Proposed EA with Maintenance Hardstanding

VRS
- Existing VRS
- Proposed VRS - W2
- Proposed VRS - H1
- Proposed VRS - W1
- End Terminal P1
- End Terminal P4
- Transition
- End Terminal FHA
- Handrail

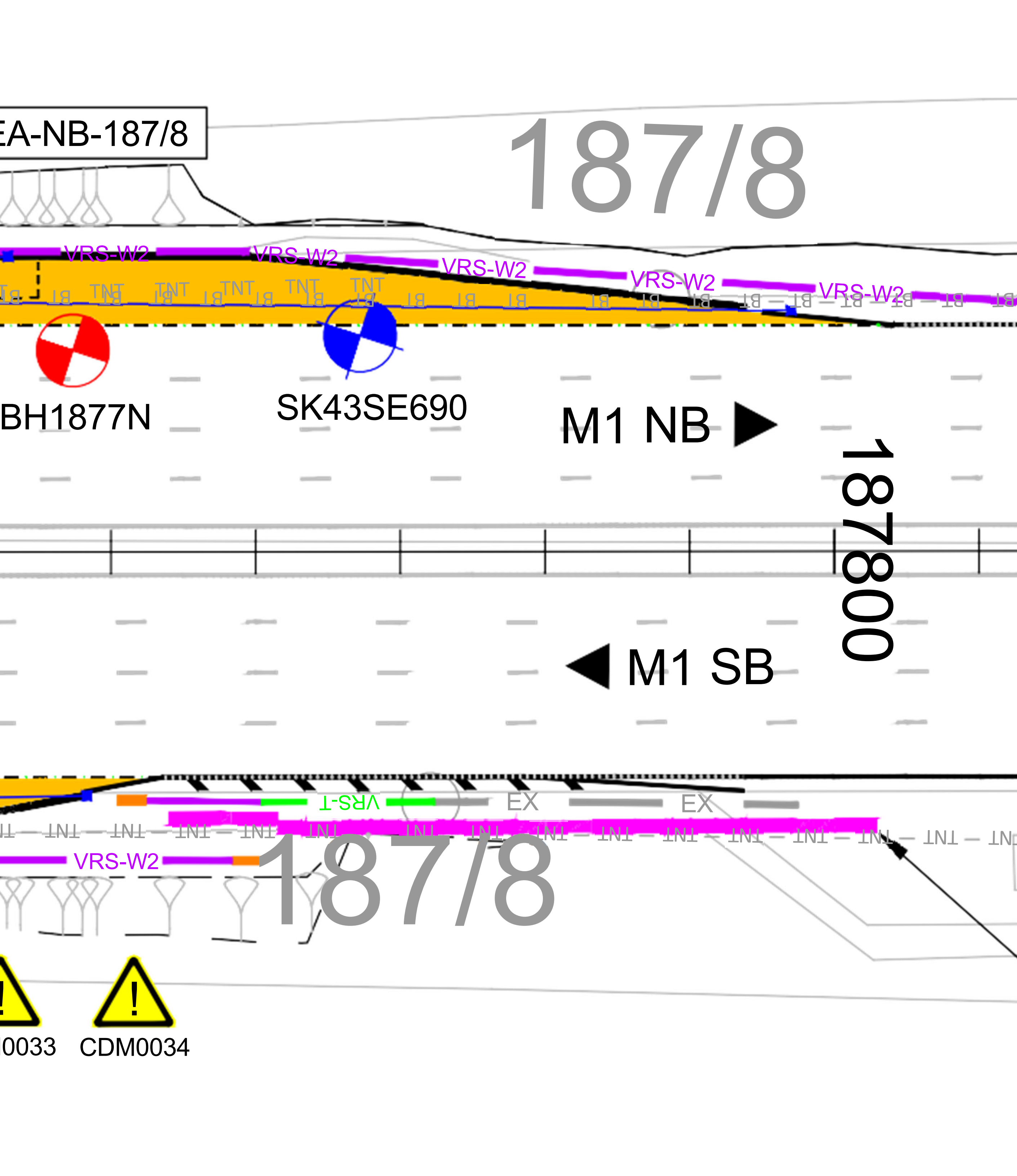
UTILITIES
- Gas
- BT
- BT Overhead
- BT Planned
- Electricity
- Electricity Overhead
- Vodafone
- Virgin
- National Grid Electric
- Sky
- Surface Sewer
- Foul Sewer
- UKPD Electric
- Network Rail
- Water
- Telent
- Water Abandoned
- Aqueduct
- OCU

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	27/02/24	SUITABLE FOR ACCEPTANCE	HSO	AKO	GBE	PCO

Designer: wsp

Client: national highways | smp alliance

Project: NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25



2. HIGHWAYS BOUNDARY IS CREATED FROM THE DATASET DERIVED FROM LAND REGISTRY CADASTRAL PARCELS, ORDNANCE SURVEY AND HAPMS.
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE FOLLOWING SCHEDULES AND SPECIFICATION APPENDICES:
Series 0200: HE614830-WSP-HSC-P015_AL_ALLGENR-SP-ZZ-0001
Series 0400: HE614830-WSP-HRR-P015_AL_ALLGENR-SH-CH-0001 & HE614830 WSP-HRR-P015_AL_ALLGENR-SP-CH-0001
Series 0700: HE614830-JAC-HPV-P015_AL_ALLGENR-SP-CH-0002
Series 1100: HE614830-WSP-HKF-P015_AL_ALLGENR-SH-CD-0001 & HE614830-WSP-HKF-P015_AL_ALLGENR-SP-CH-0001
Series 1200: HE614830-WSP-HSN-P015_AL_ALLGENR-SH-CH-0003, HE614830-WSP-HMK-P015_AL_ALLGENR-SH-CH-0001 & HE614830-WSP-HSN-P015_AL_ALLGENR-SP-CH-0001
Series 1300: HE614830-WSP-HLG-P015_AL_ALLGENR-SH-EO-0002 & HE614830-WSP-HLG-P015_AL_ALLGENR-SP-EO-0001
Series 1500: HE614830-WSP-HMC-P015_AL_ALLGENR-SH-EC-0001
Geotechnical Intervention Schedule: HE614830-WSP-HGT-P015_AL_ALLGENR-SH-GE-0001

KEY GENERAL

Highway Boundary
Verge at PRS location
Proposed Earthworks
RW Proposed Retaining Wall
Proposed kerb line
Proposed Maintenance Footway
Existing Footway
Existing Gabion Wall to be Retained
Proposed Sign Face and Post (size indicative)
Retained or Relocated Sign

PRS

Existing EA
Proposed EA
Proposed EA with Maintenance Hardstanding

VRS

Existing VRS
Proposed VRS - W2
Proposed VRS - H1
Proposed VRS - W1
End Terminal P1
End Terminal P4
Transition
End Terminal FHA
Handrail

UTILITIES

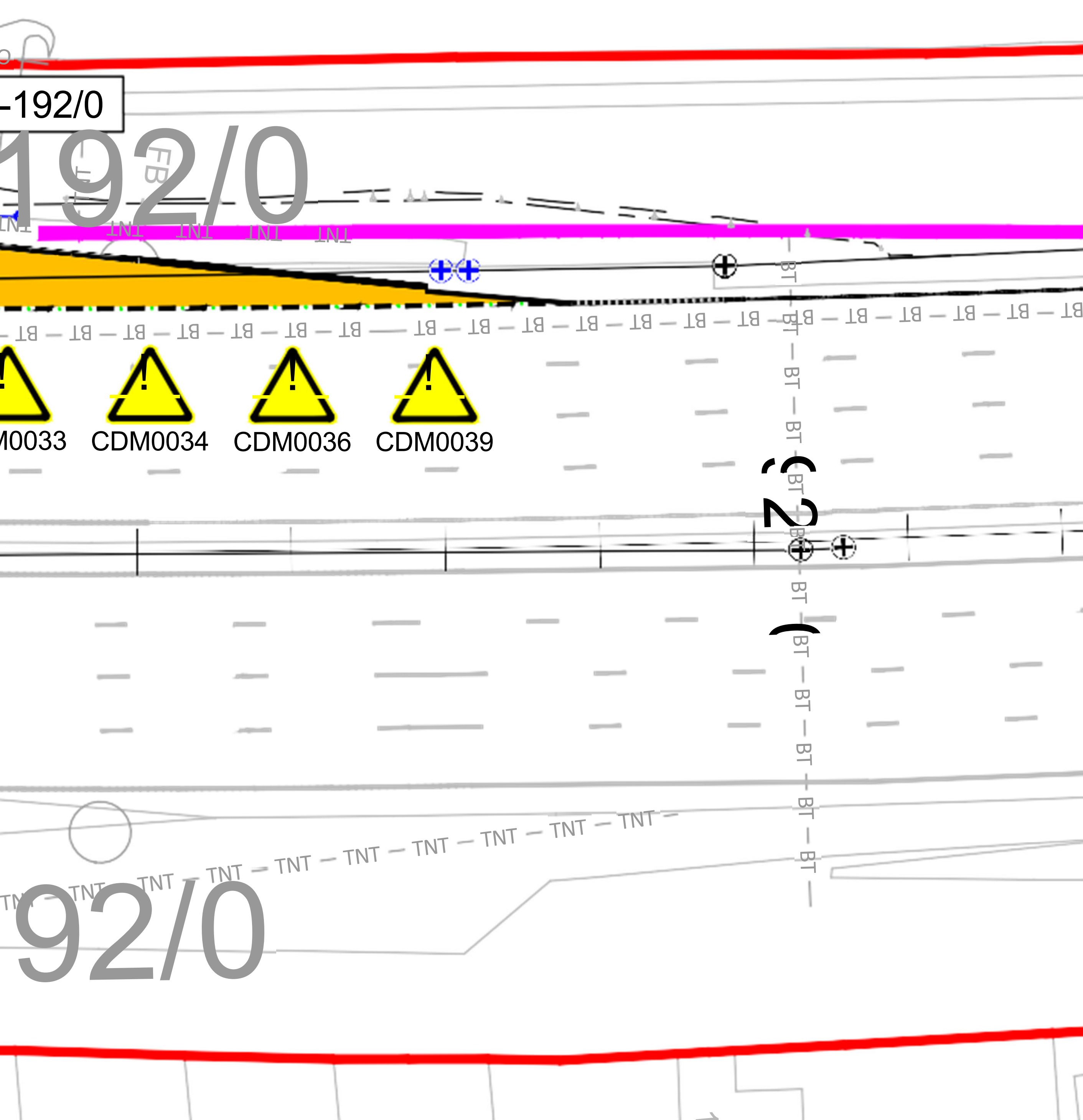
Gas
BT
BT Overhead
BT Planned
Electricity
Electricity Overhead
Vodafone
Virgin
National Grid Electric
Sky
Surface Sewer
Foul Sewer
UKPD Electric
Network Rail
Water
Telent
Water Abandoned
Aqueduct
OCU

P01	27/02/24	SUITABLE FOR ACCEPTANCE	HSO	AKO	GBE	PCO
Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer:

Client

Project
NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25



ORDNANCE SURVEY AND HAPMS.

3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE FOLLOWING SCHEDULES AND SPECIFICATION APPENDICES:
Series 0200: HE614830-WSP-HSC-P015_AL_ALLGENR-SP-ZZ-0001
Series 0400: HE614830-WSP-HRR-P015_AL_ALLGENR-SH-CH-0001 & HE614830 WSP-HRR-P015_AL_ALLGENR-SP-CH-0001
Series 0700: HE614830-JAC-HPV-P015_AL_ALLGENR-SP-CH-0002
Series 1100: HE614830-WSP-HKF-P015_AL_ALLGENR-SH-CD-0001 & HE614830-WSP-HKF-P015_AL_ALLGENR-SP-CH-0001
Series 1200: HE614830-WSP-HSN-P015_AL_ALLGENR-SH-CH-0003, HE614830-WSP-HMK-P015_AL_ALLGENR-SH-CH-0001 & HE614830-WSP-HSN-P015_AL_ALLGENR-SP-CH-0001
Series 1300: HE614830-WSP-HLG-P015_AL_ALLGENR-SH-EO-0002 & HE614830-WSP-HLG-P015_AL_ALLGENR-SP-EO-0001
Series 1500: HE614830-WSP-HMC-P015_AL_ALLGENR-SH-EC-0001
Geotechnical Intervention Schedule: HE614830-WSP-HGT-P015_AL_ALLGENR-SH-GE-0001

KEY GENERAL
- Highway Boundary
- Verge at PRS location
- Proposed Earthworks
- RW Proposed Retaining Wall
- Proposed kerb line
- Proposed Maintenance Footway
- Existing Footway
- Existing Gabion Wall to be Retained
- Proposed Sign Face and Post (size indicative)
- Retained or Relocated Sign

PRS
- Existing EA
- Proposed EA
- Proposed EA with Maintenance Hardstanding

VRS
- Existing VRS
- Proposed VRS - W2
- Proposed VRS - H1
- Proposed VRS - W1
- End Terminal P1
- End Terminal P4
- Transition
- End Terminal FHA
- Handrail

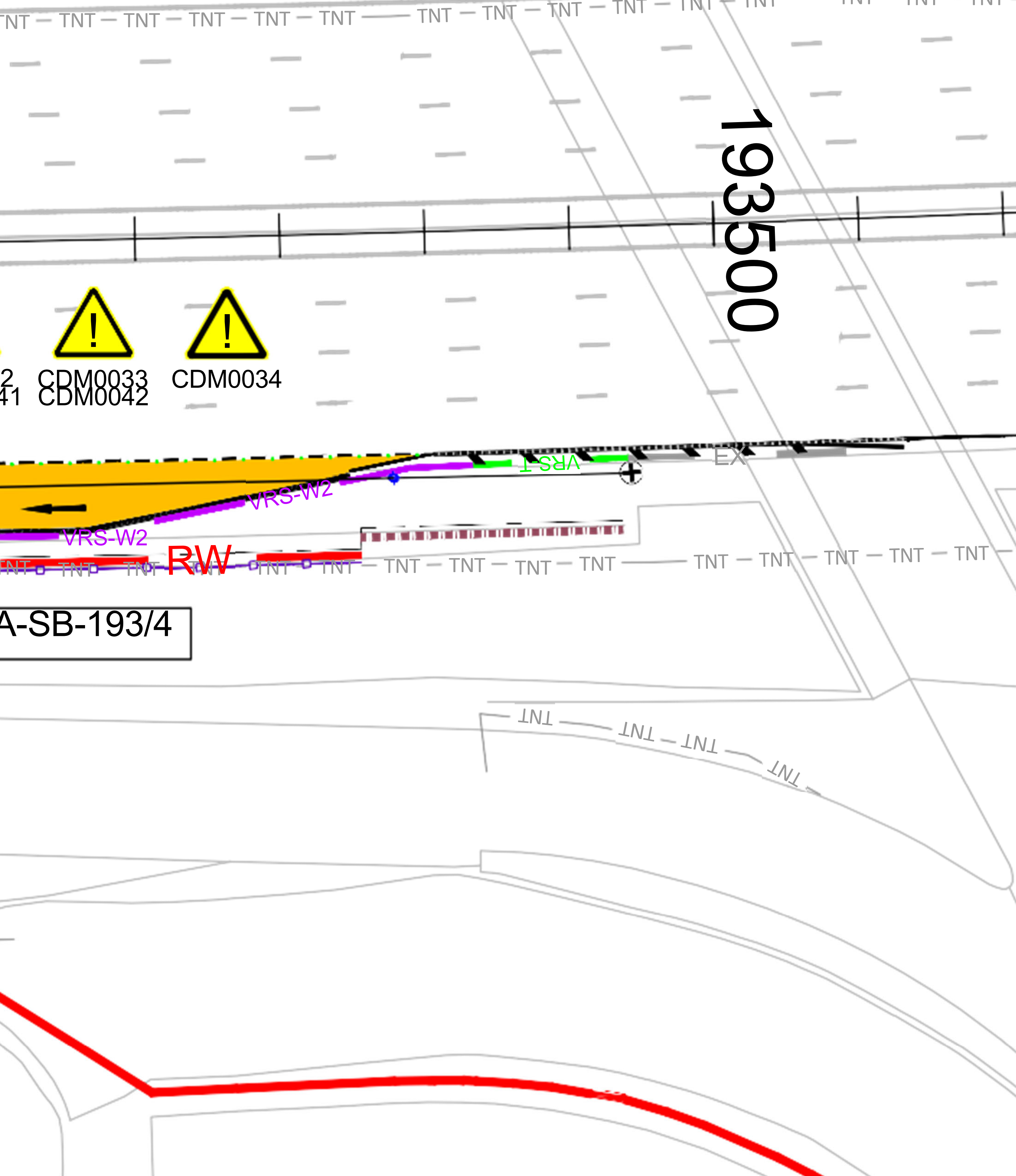
UTILITIES
- Gas
- BT
- BT Overhead
- BT Planned
- Electricity
- Electricity Overhead
- Vodafone
- Virgin
- National Grid Electric
- Sky
- Surface Sewer
- Foul Sewer
- UKPD Electric
- Network Rail
- Water
- Telent
- Water Abandoned
- Aqueduct
- OCU

P01.1	26/02/24	FIRST ISSUE	VMA	VMA	VMA	VMA
Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer:

Client

Project
NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25



NOTES:

1. ALL DIMENSIONS ARE IN METRES, UNLESS STATED OTHERWISE.
2. HIGHWAYS BOUNDARY IS CREATED FROM THE DATASET DERIVED FROM LAND REGISTRY CADASTRAL PARCELS, ORDNANCE SURVEY AND HAPMS.
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE FOLLOWING SCHEDULES AND SPECIFICATION APPENDICES:
   Series 0200: HE614830-WSP-HSC-P015_AL_ALLGENR-SP-ZZ-0001
   Series 0400: HE614830-WSP-HRR-P015_AL_ALLGENR-SH-CH-0001 & HE614830 WSP-HRR-P015_AL_ALLGENR-SP-CH-0001
   Series 0700: HE614830-JAC-HPV-P015_AL_ALLGENR-SP-CH-0002
   Series 1100: HE614830-WSP-HKF-P015_AL_ALLGENR-SH-CD-0001 & HE614830-WSP-HKF-P015_AL_ALLGENR-SP-CH-0001
   Series 1200: HE614830-WSP-HSN-P015_AL_ALLGENR-SH-CH-0003, HE614830-WSP-HMK-P015_AL_ALLGENR-SH-CH-0001 & HE614830-WSP-HSN-P015_AL_ALLGENR-SP-CH-0001
   Series 1300: HE614830-WSP-HLG-P015_AL_ALLGENR-SH-EO-0002 & HE614830-WSP-HLG-P015_AL_ALLGENR-SP-EO-0001
   Series 1500: HE614830-WSP-HMC-P015_AL_ALLGENR-SH-EC-0001
   Geotechnical Intervention Schedule: HE614830-WSP-HGT-P015_AL_ALLGENR-SH-GE-0001

KEY GENERAL

- Highway Boundary
- Verge at PRS location
- Proposed Earthworks
- RW Proposed Retaining Wall
- Proposed kerb line
- Proposed Maintenance Footway
- Existing Footway
- Existing Gabion Wall to be Retained
- Proposed Sign Face and Post (size indicative)
- Retained or Relocated Sign

PRS

- Existing EA
- Proposed EA
- Proposed EA with Maintenance Hardstanding

VRS

- Existing VRS
- Proposed VRS - W2
- Proposed VRS - H1
- Proposed VRS - W1
- End Terminal P1
- End Terminal P4
- Transition
- End Terminal FHA
- Handrail

UTILITIES

- Gas
- BT
- BT Overhead
- BT Planned
- Electricity
- Electricity Overhead
- Vodafone
- Virgin
- National Grid Electric
- Sky
- Surface Sewer
- Foul Sewer
- UKPD Electric
- Network Rail
- Water
- Telent
- Water Abandoned
- Aqueduct
- OCU

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	27/02/24	SUITABLE FOR ACCEPTANCE	HSO	AKO	GBE	PCO

Designer:

wsp

Client

national highways | smp alliance

Project

NATIONAL EMERGENCY AREA RETROFIT

M1 J23a-25

Annex F GDMS Maps - Site location plan, Superficial geology, Bedrock geology, Geotechnical asset data base, Flood maps (All Extracted from GDMS)

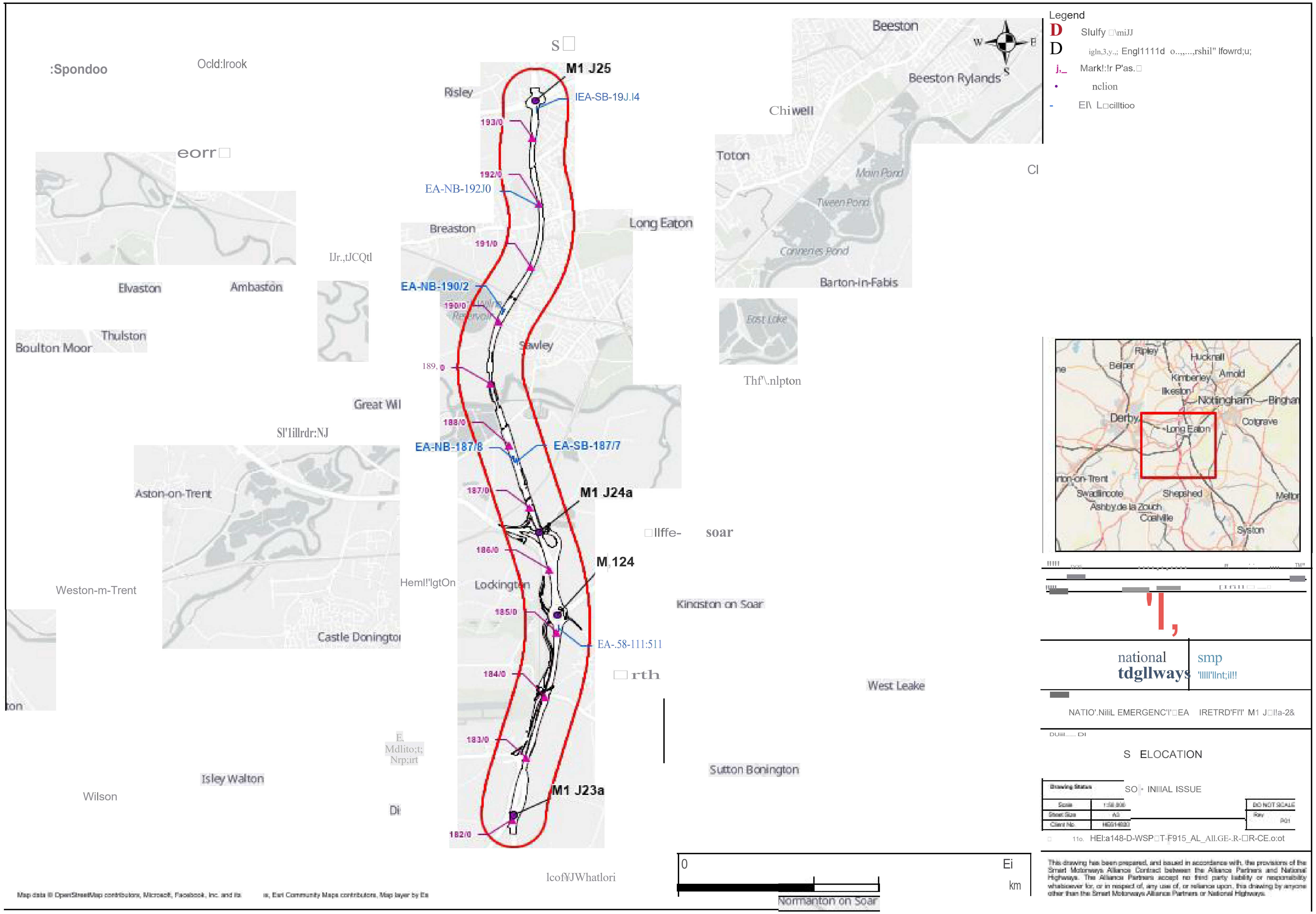


Figure 19-15: Site location and extent (Section 1.3)

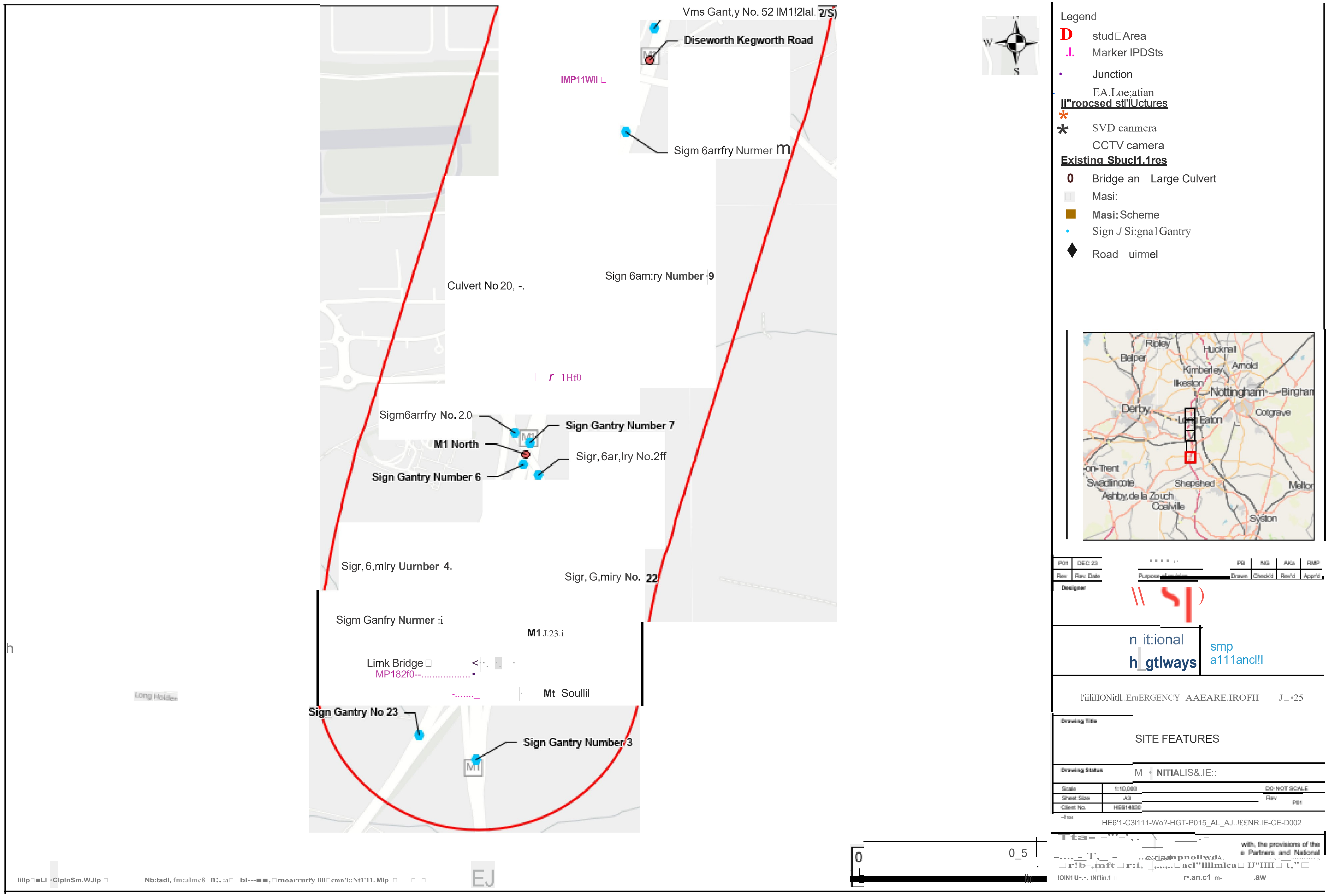


Figure 19-16:Site location and extent (Section 1.3)

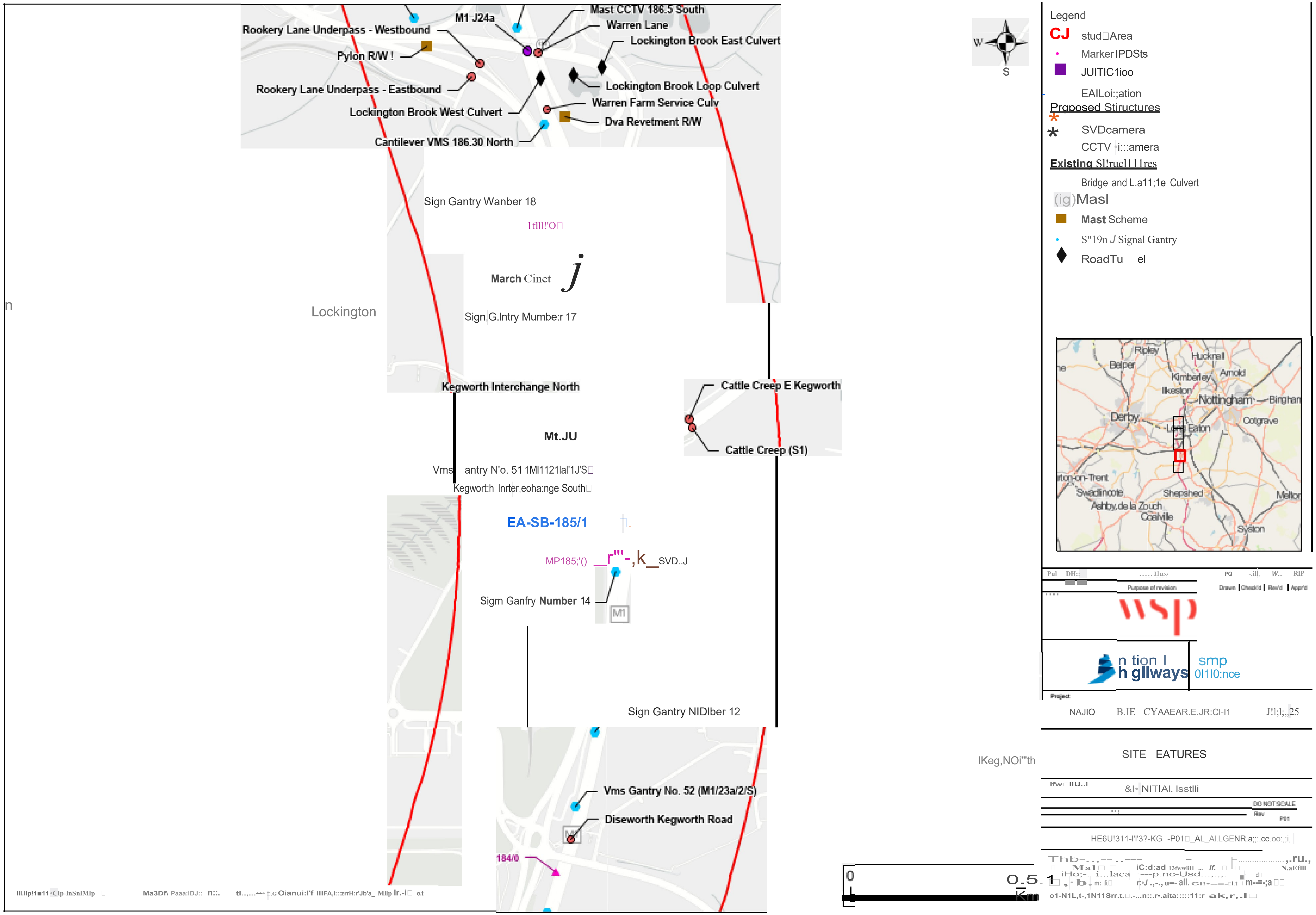


Figure 19-17:Site location and extent (Section 1.3)

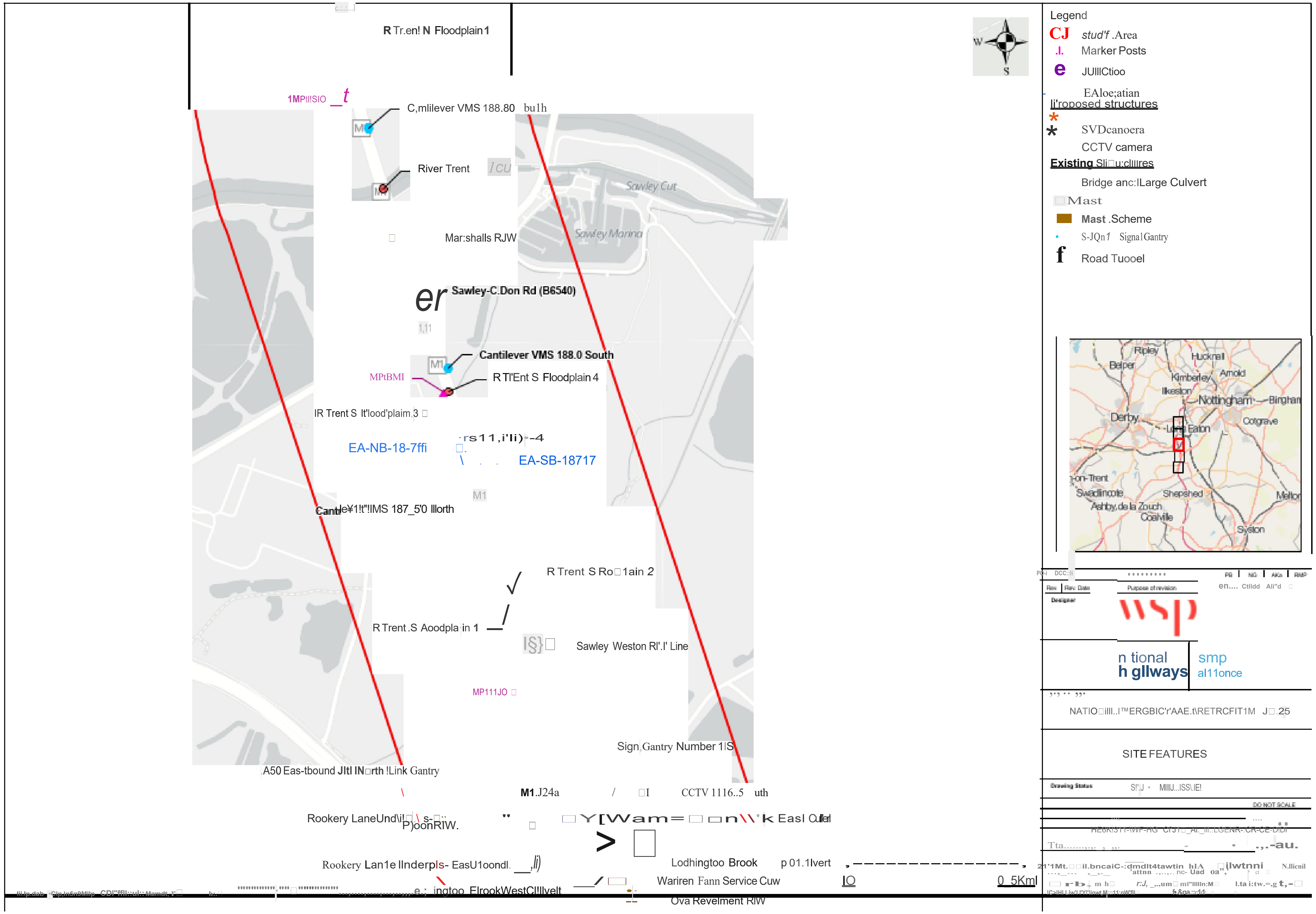


Figure 19-18:Site location and extent (Section 1.3)

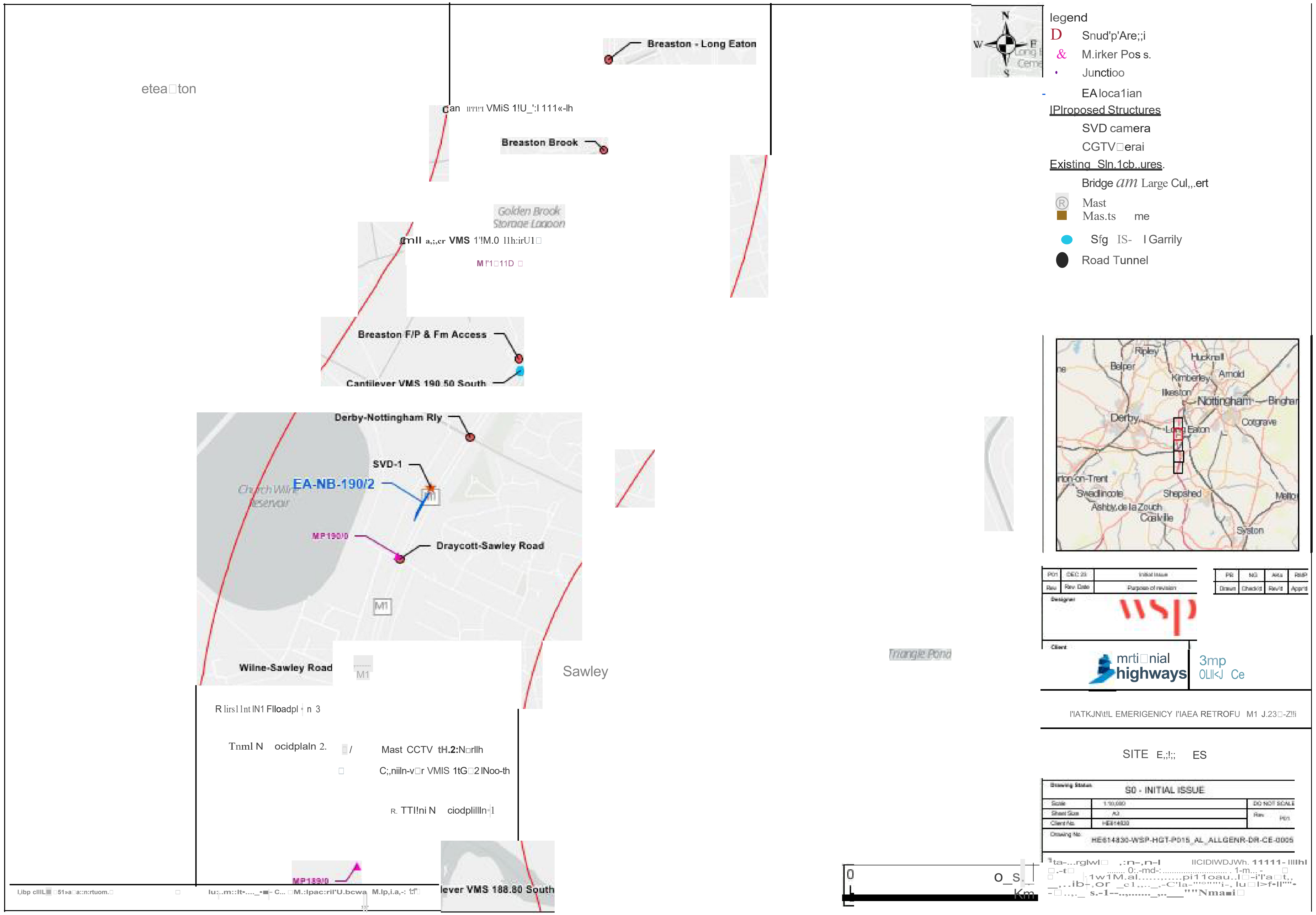


Figure 19-19: Site location and extent (Section 1.3)

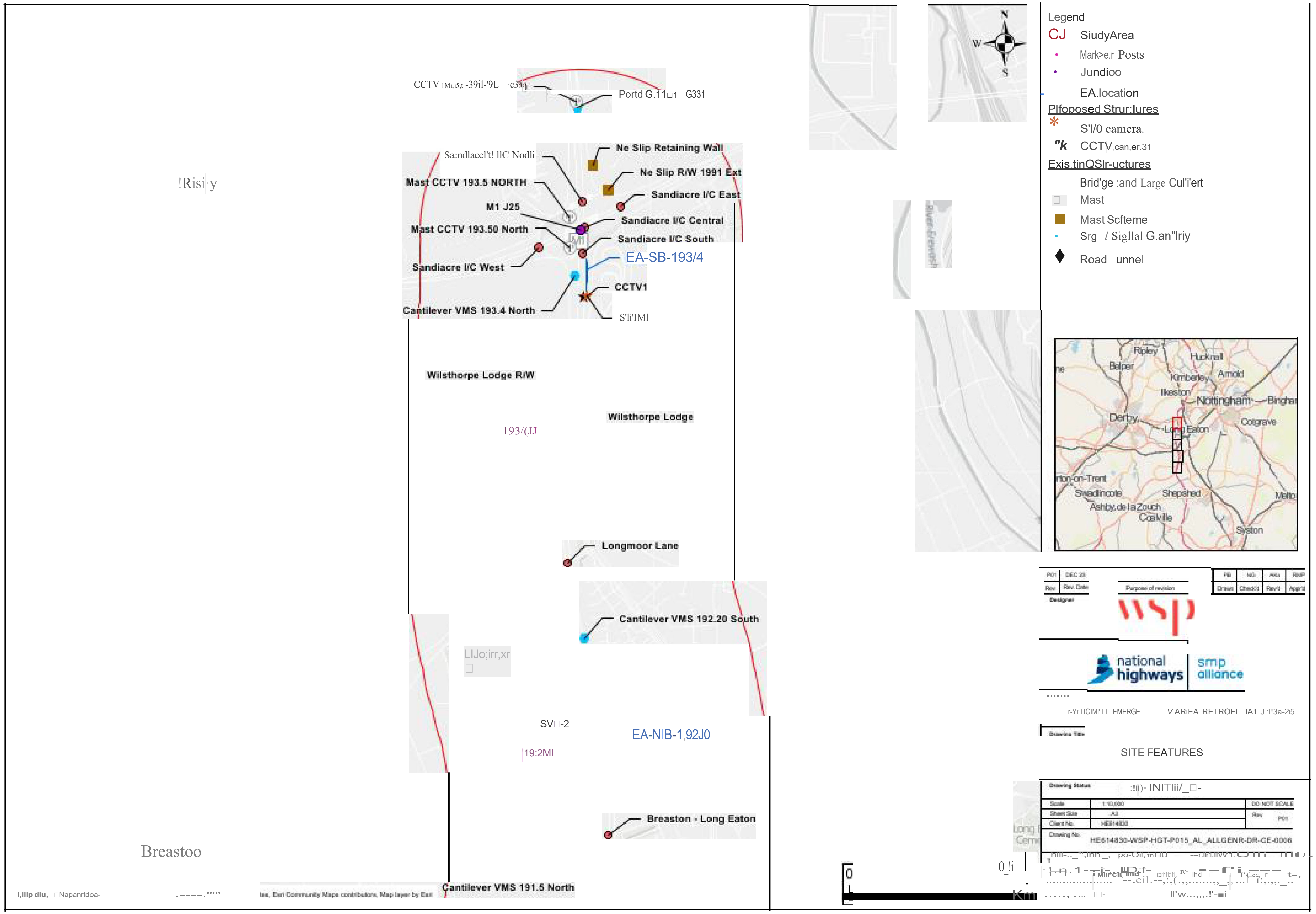


Figure 19-20 :Site location and extent (Section 1.3)

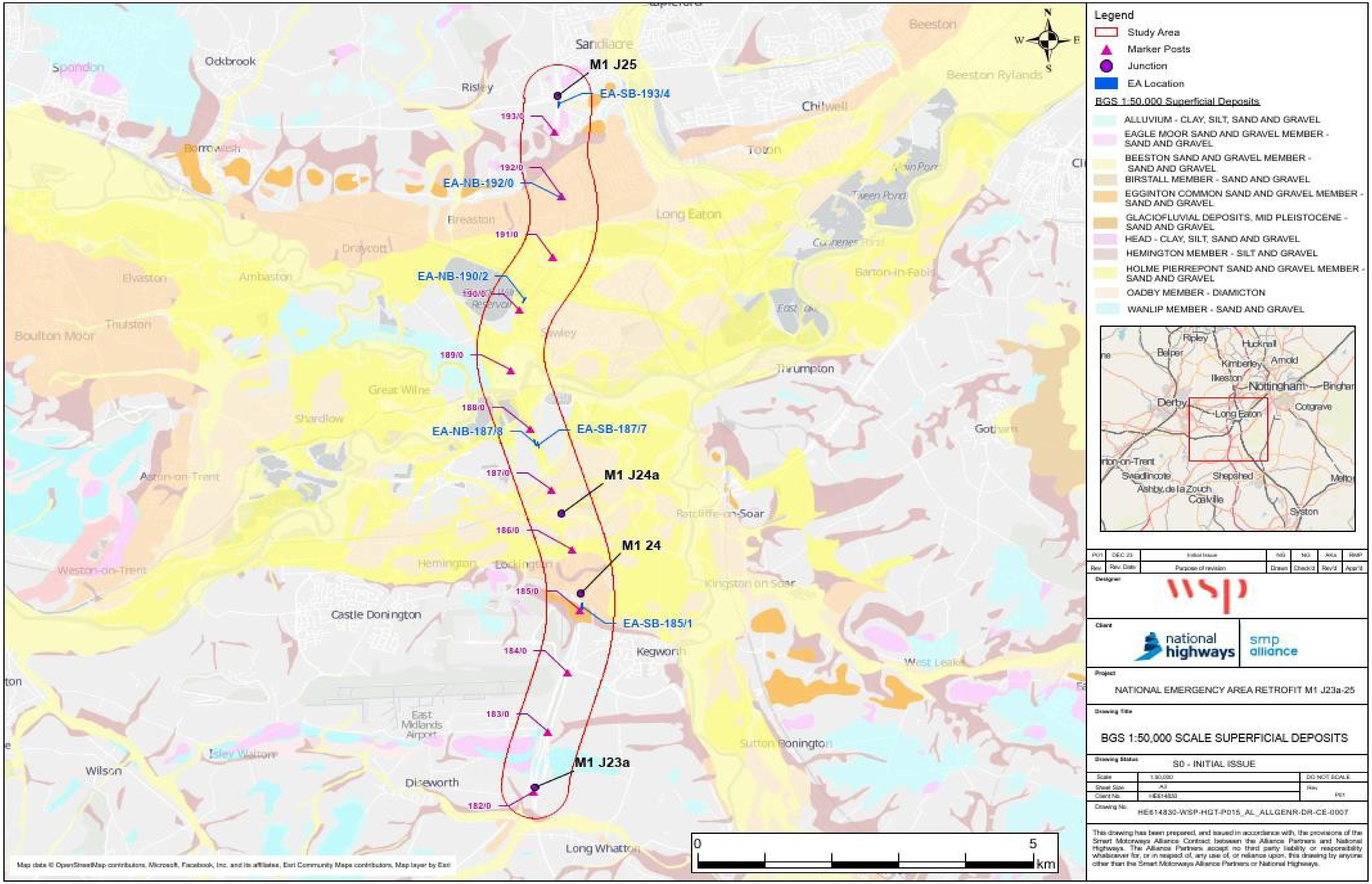


Figure 19-21: Superficial deposits (Section 2.1.4)

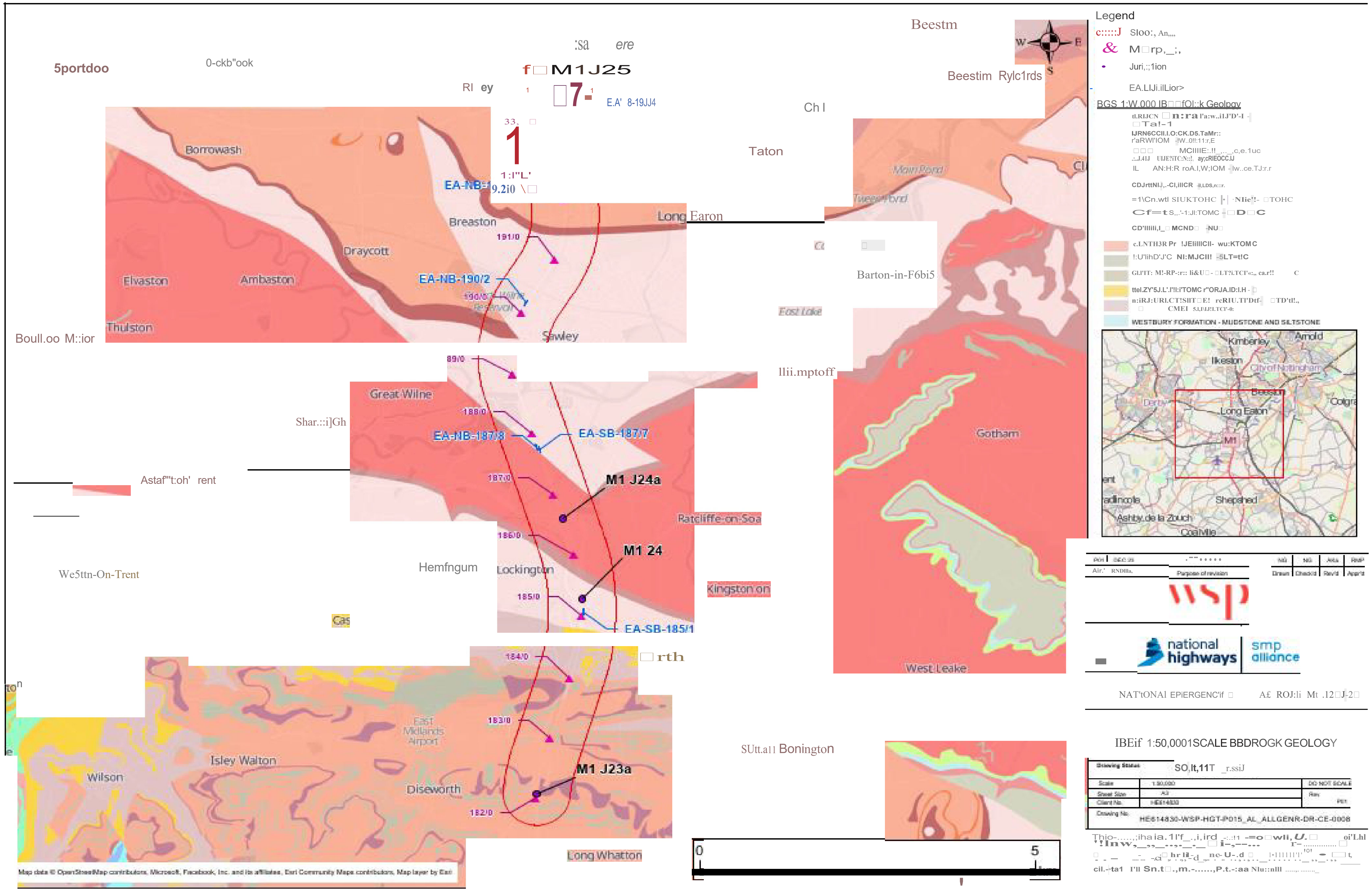


Figure 19-22: Bedrock Geology (Section 2.1.5)

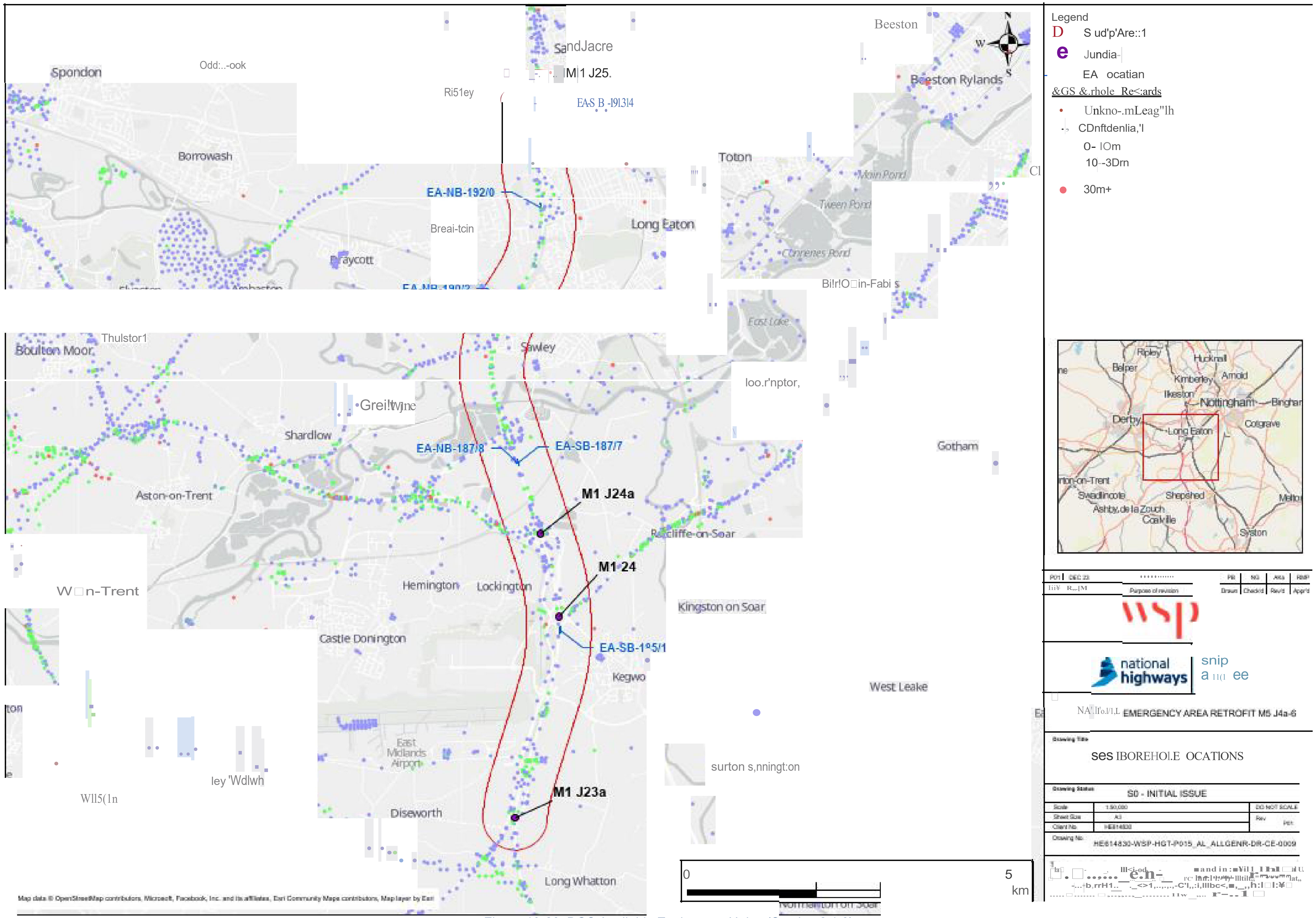


Figure 19-23: BGS Available Exploratory Holes (Section 2.1.6)

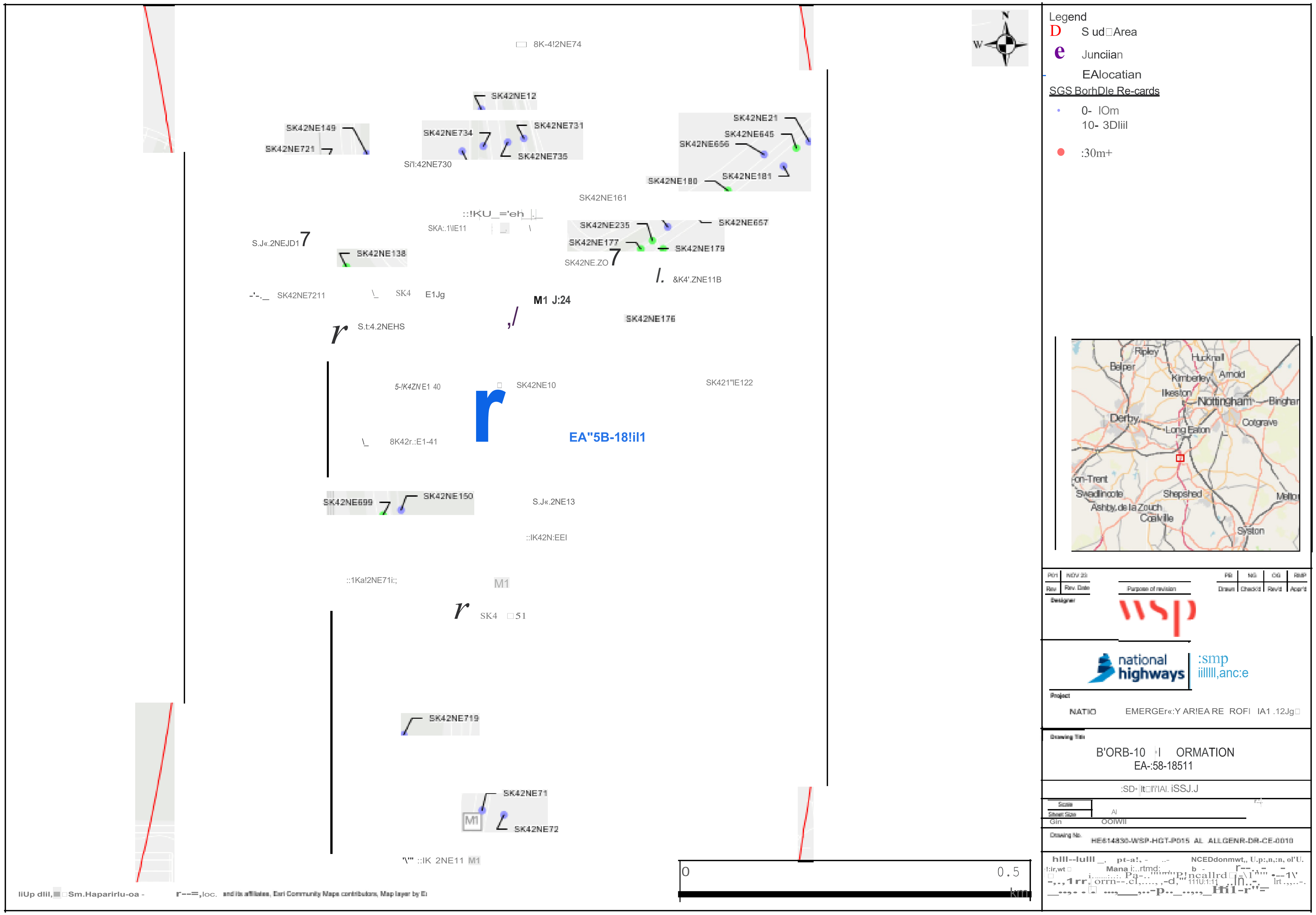


Figure 19-24: BGS Available Exploratory Holes (Section 2.1.6)

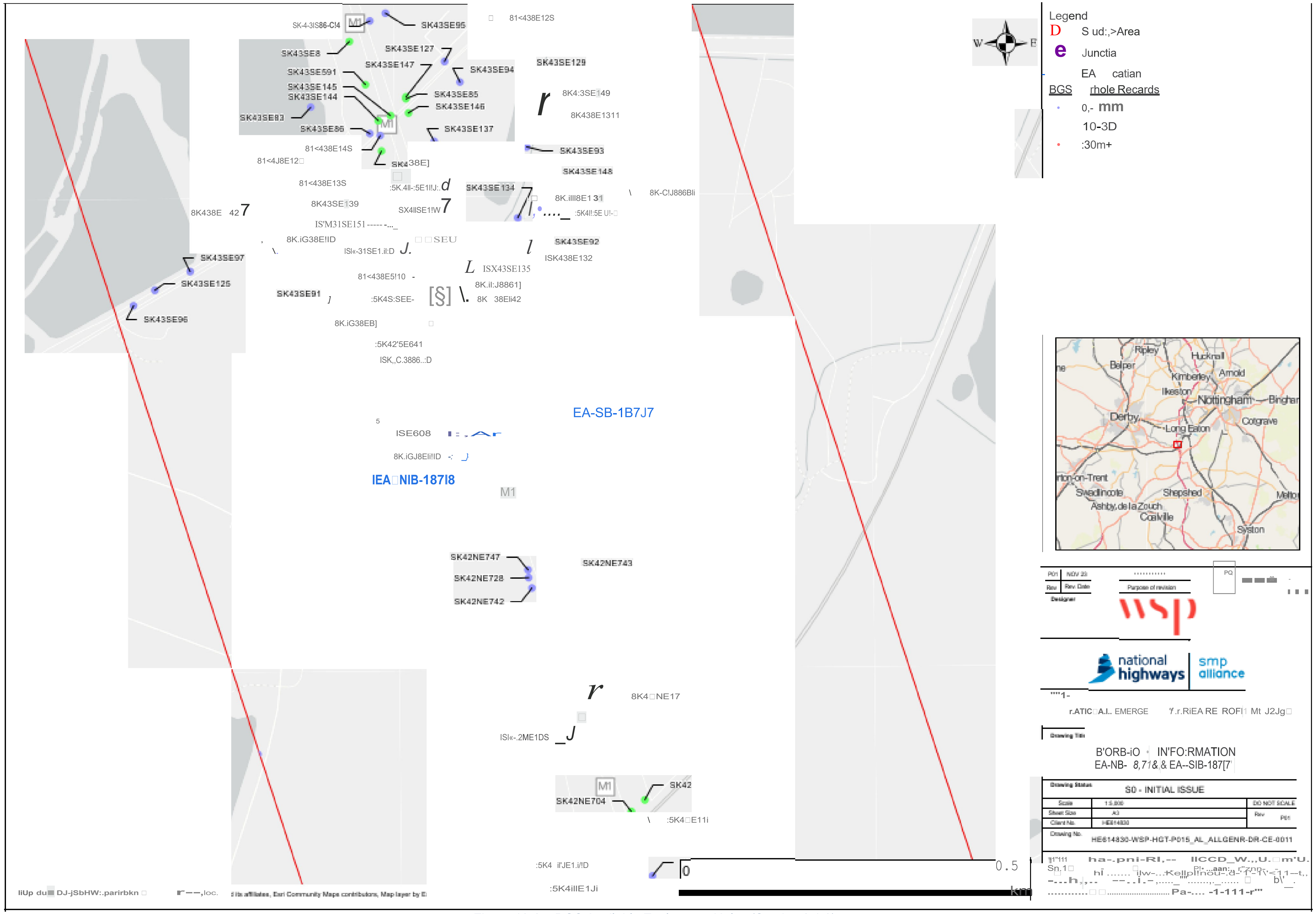


Figure 19-25: BGS Available Exploratory Holes (Section 2.1.6)

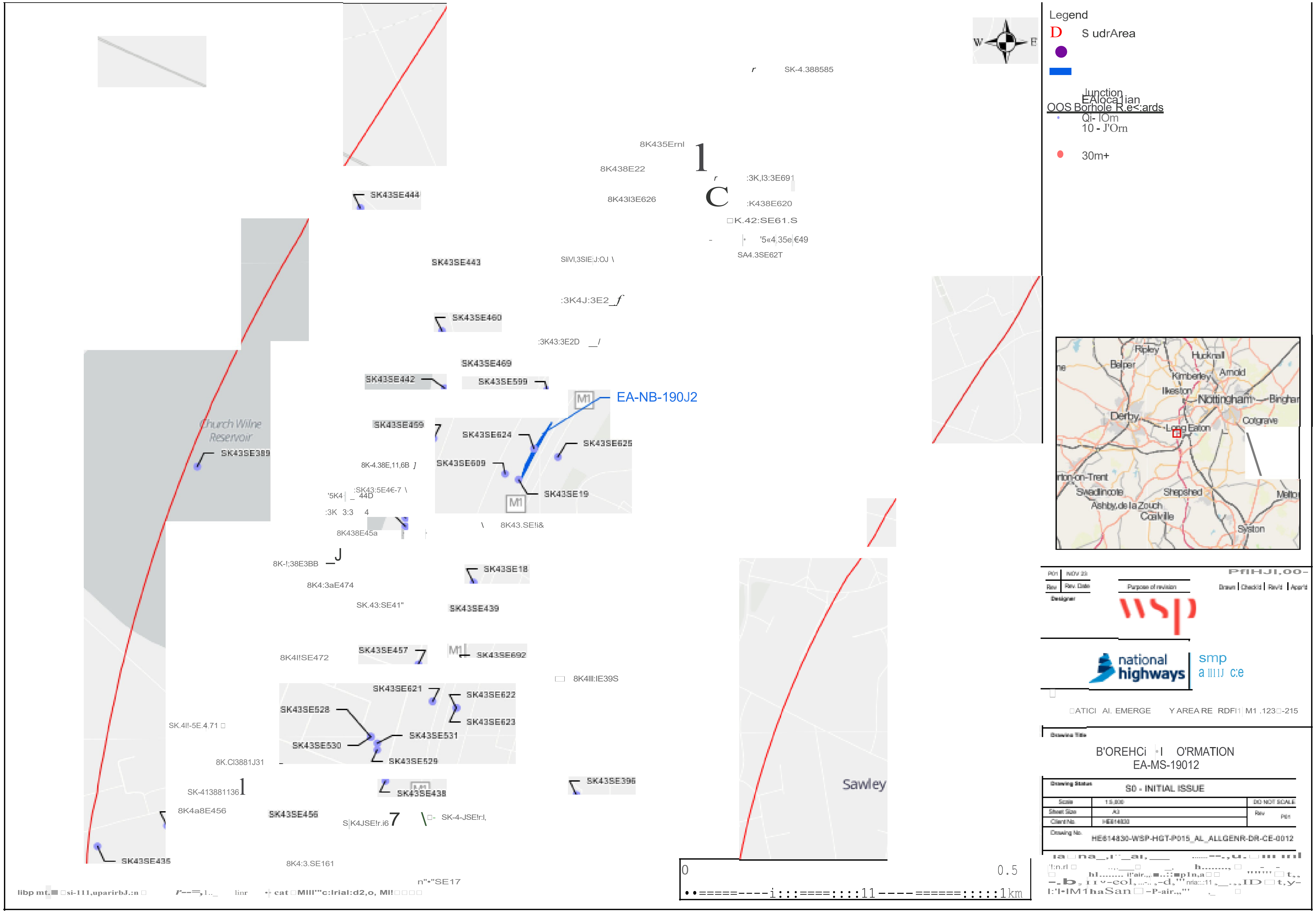


Figure 19-26: BGS Available Exploratory Holes (Section 2.1.6)

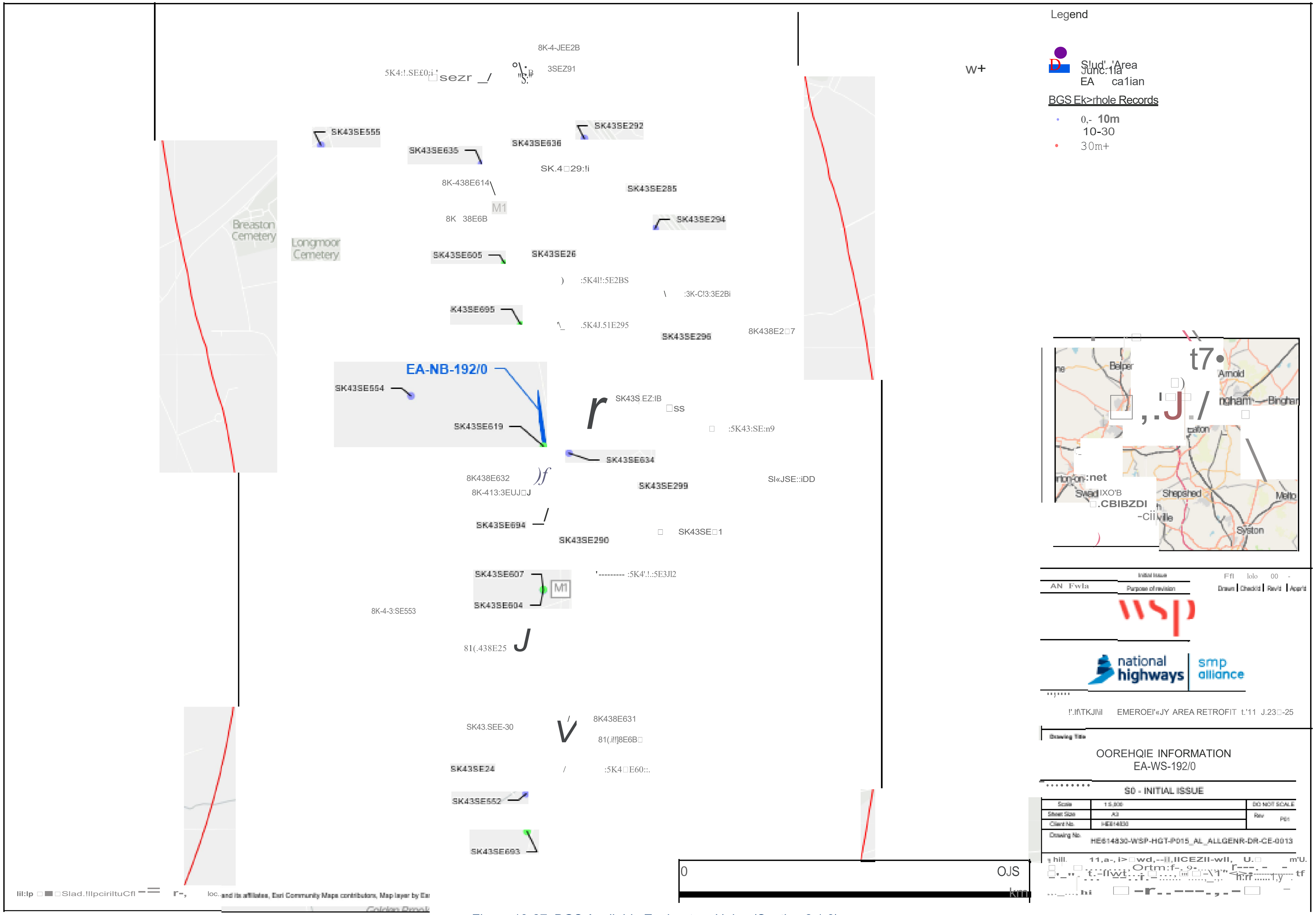


Figure 19-27: BGS Available Exploratory Holes (Section 2.1.6)

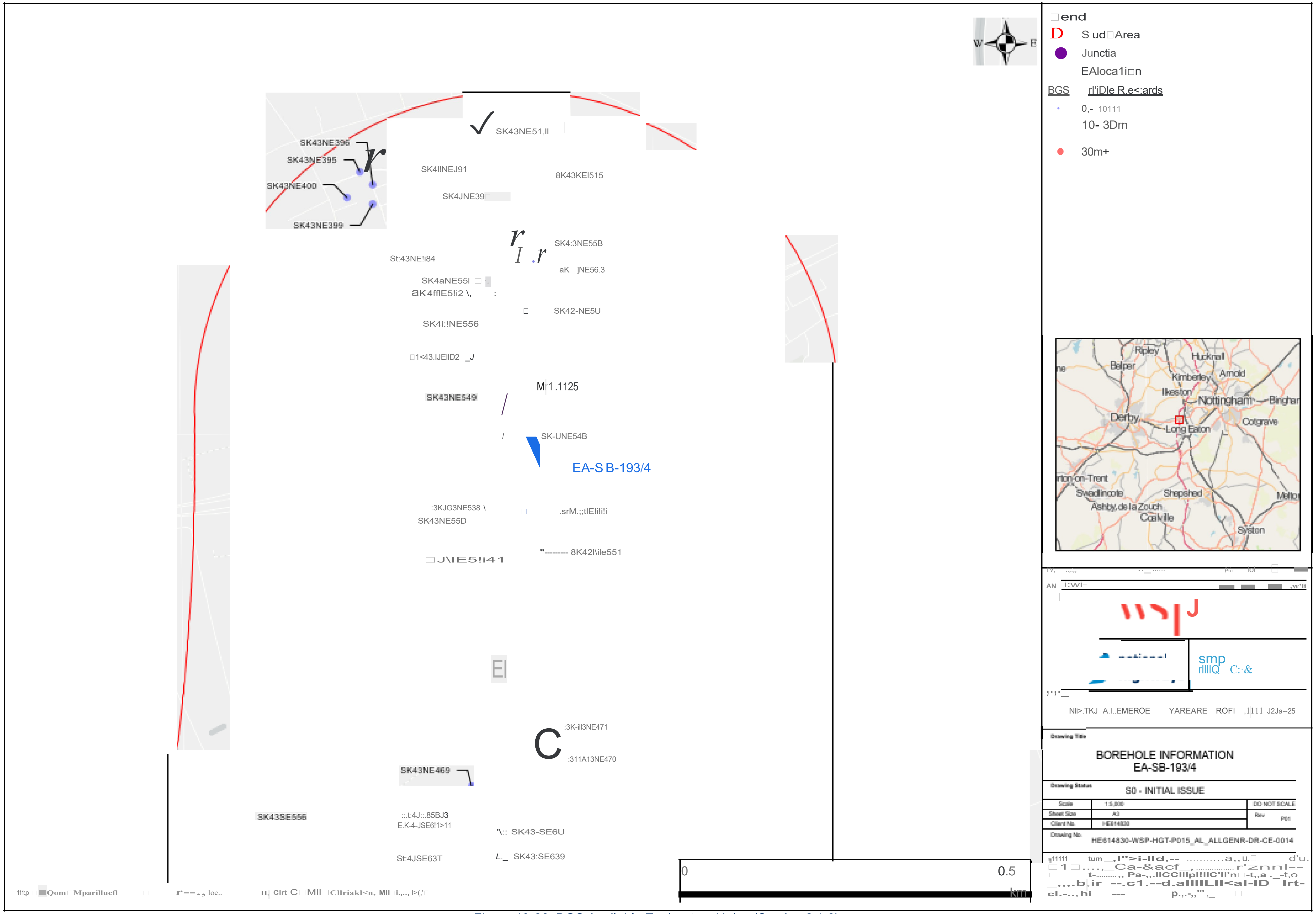


Figure 19-28: BGS Available Exploratory Holes (Section 2.1.6)

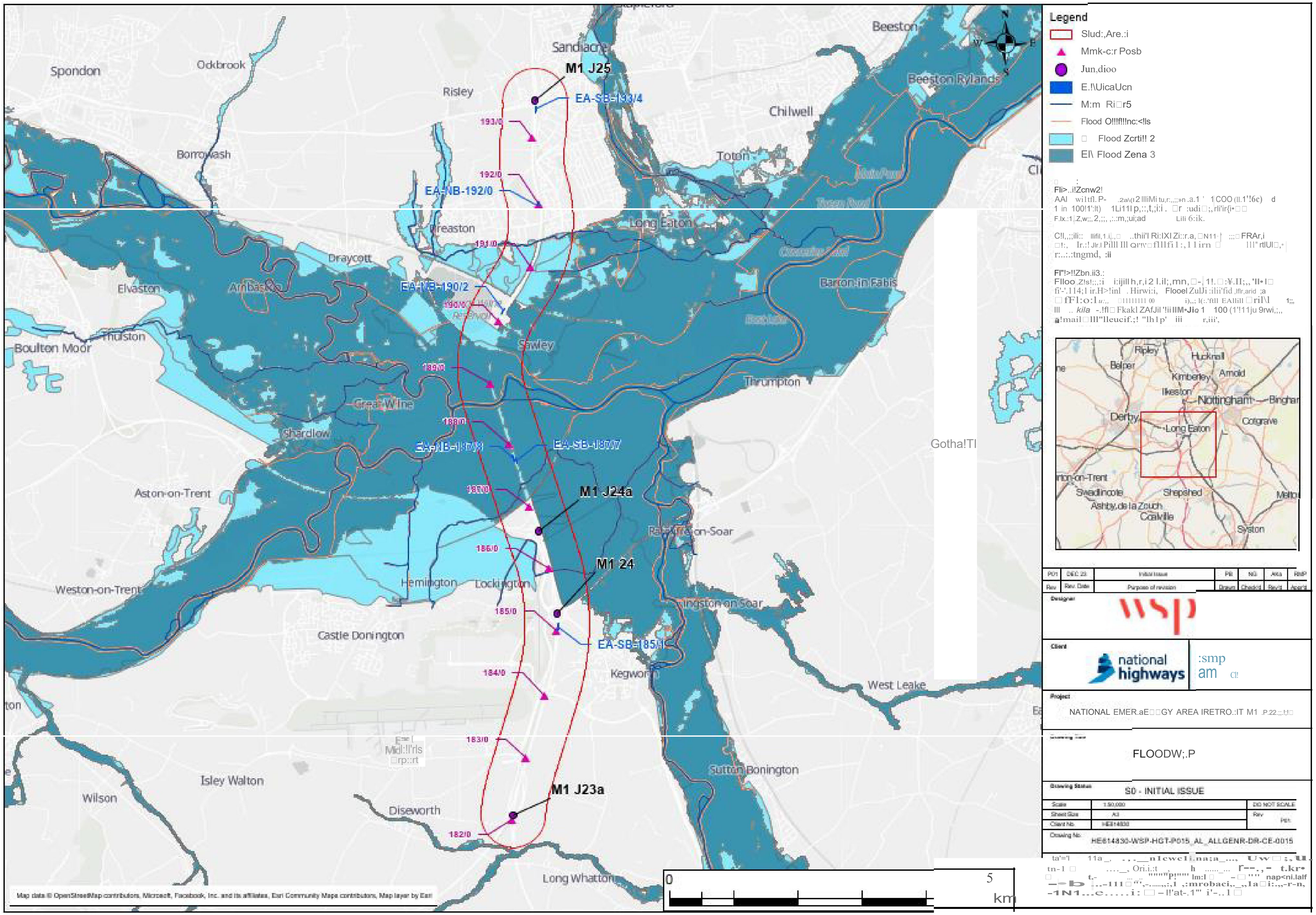


Figure 19-29: Flood Risk Map (Section 2.2.2)

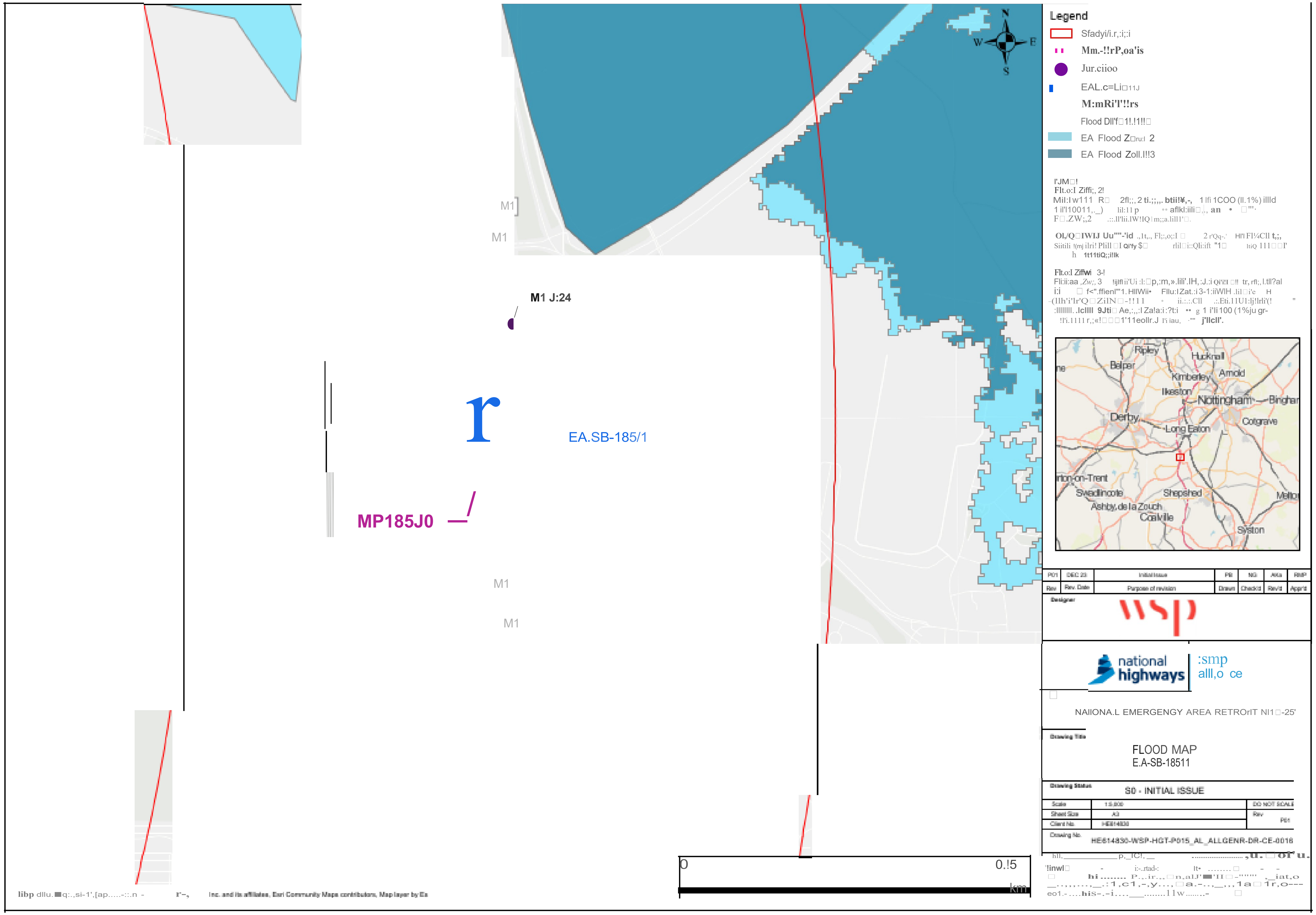


Figure 19-30: Flood Risk Map (Section 2.2.2)

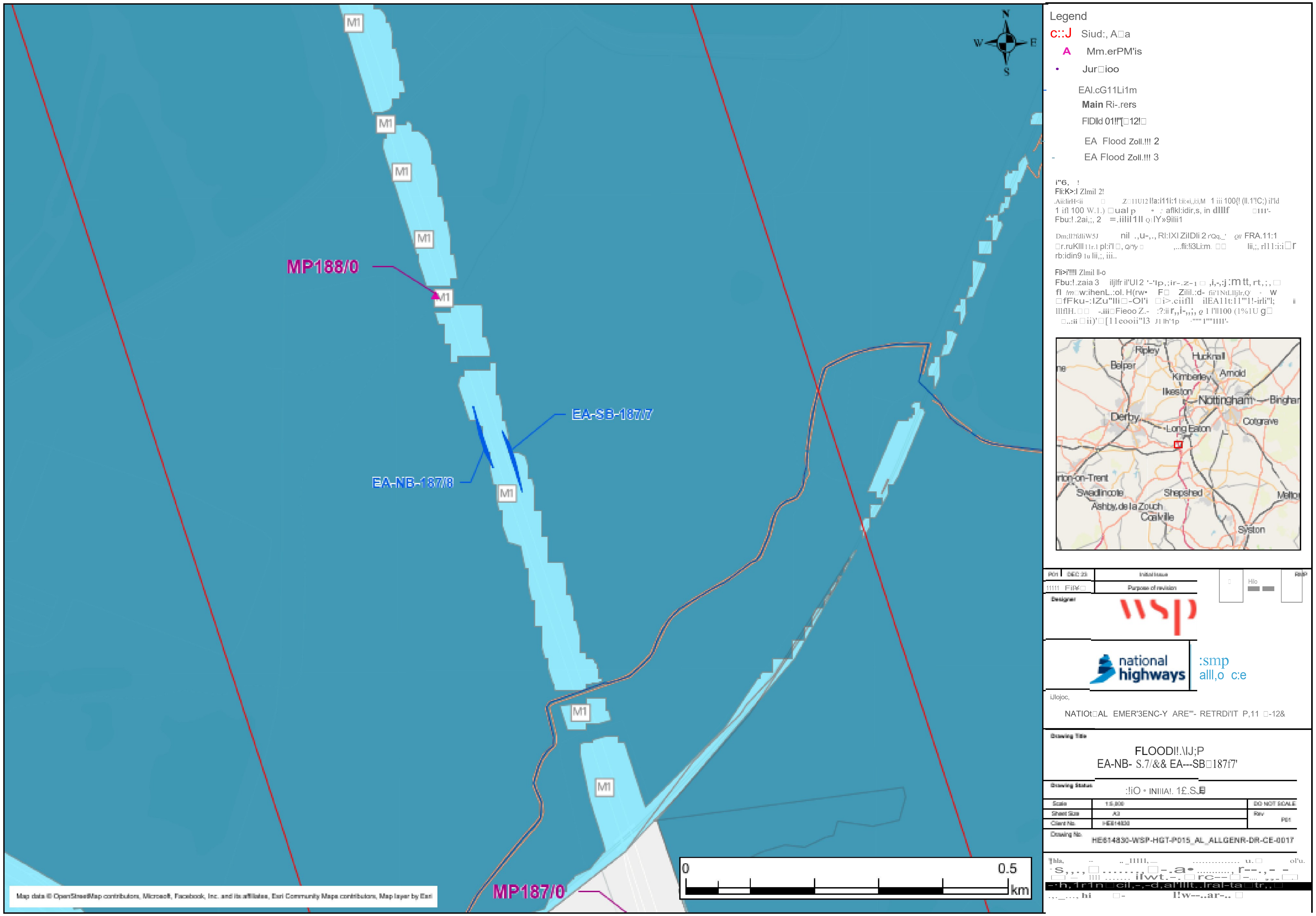


Figure 19-31: Flood Risk Map (Section 2.2.2)

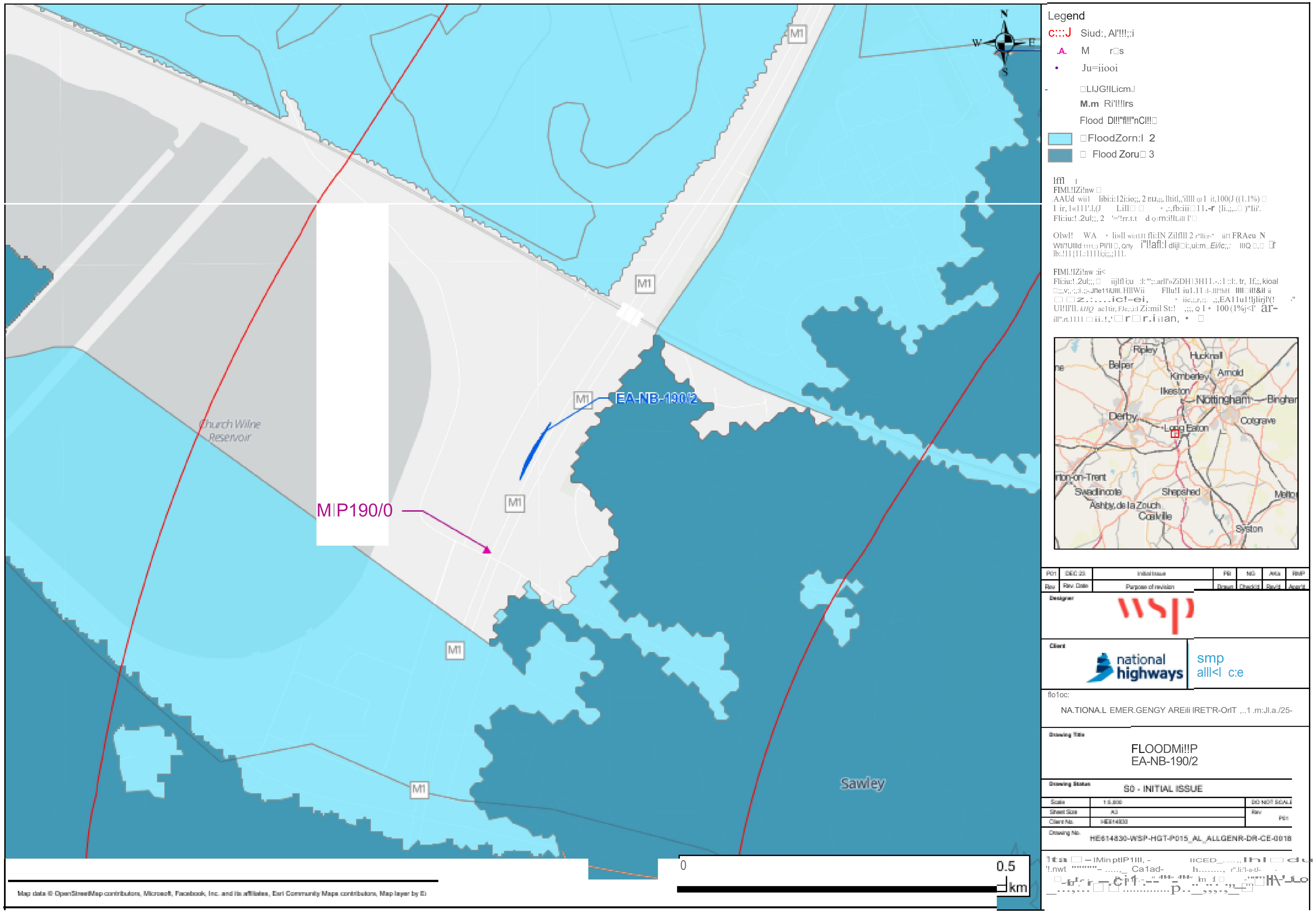


Figure 19-32: Flood Risk Map (Section 2.2.2)

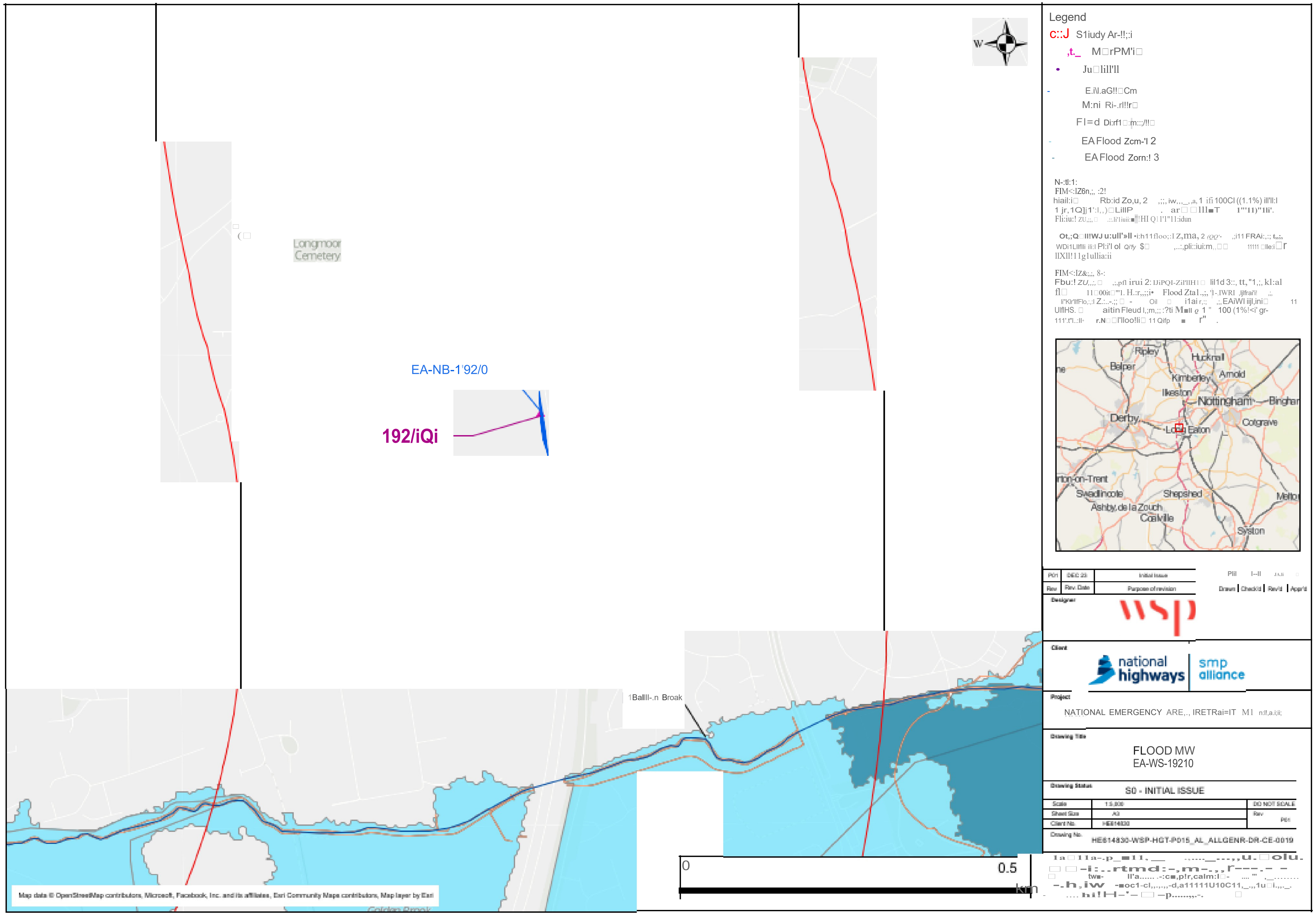


Figure 19-33: Flood Risk Map (Section 2.2.2)

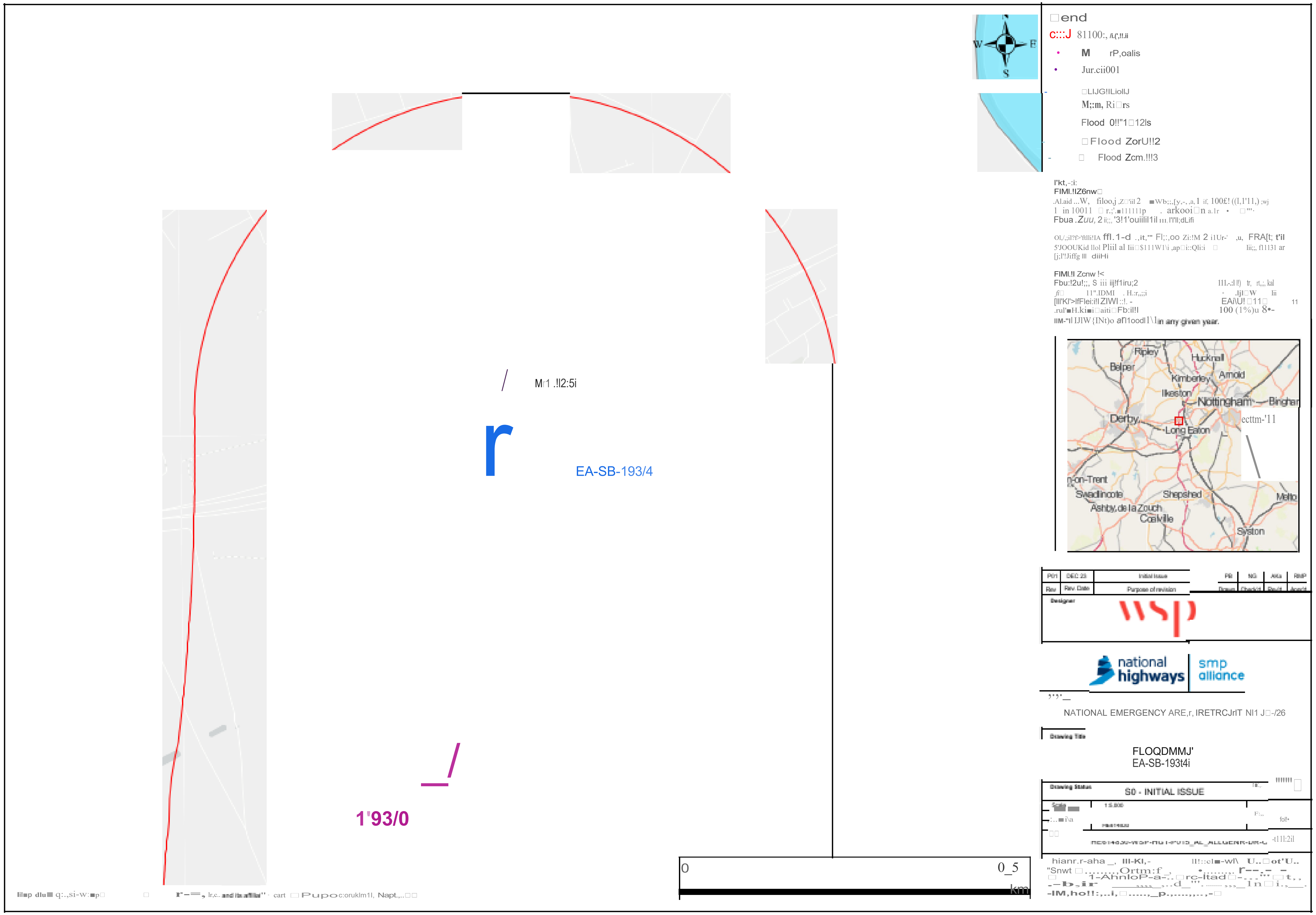


Figure 19-34: Flood Risk Map (Section 2.2.2)

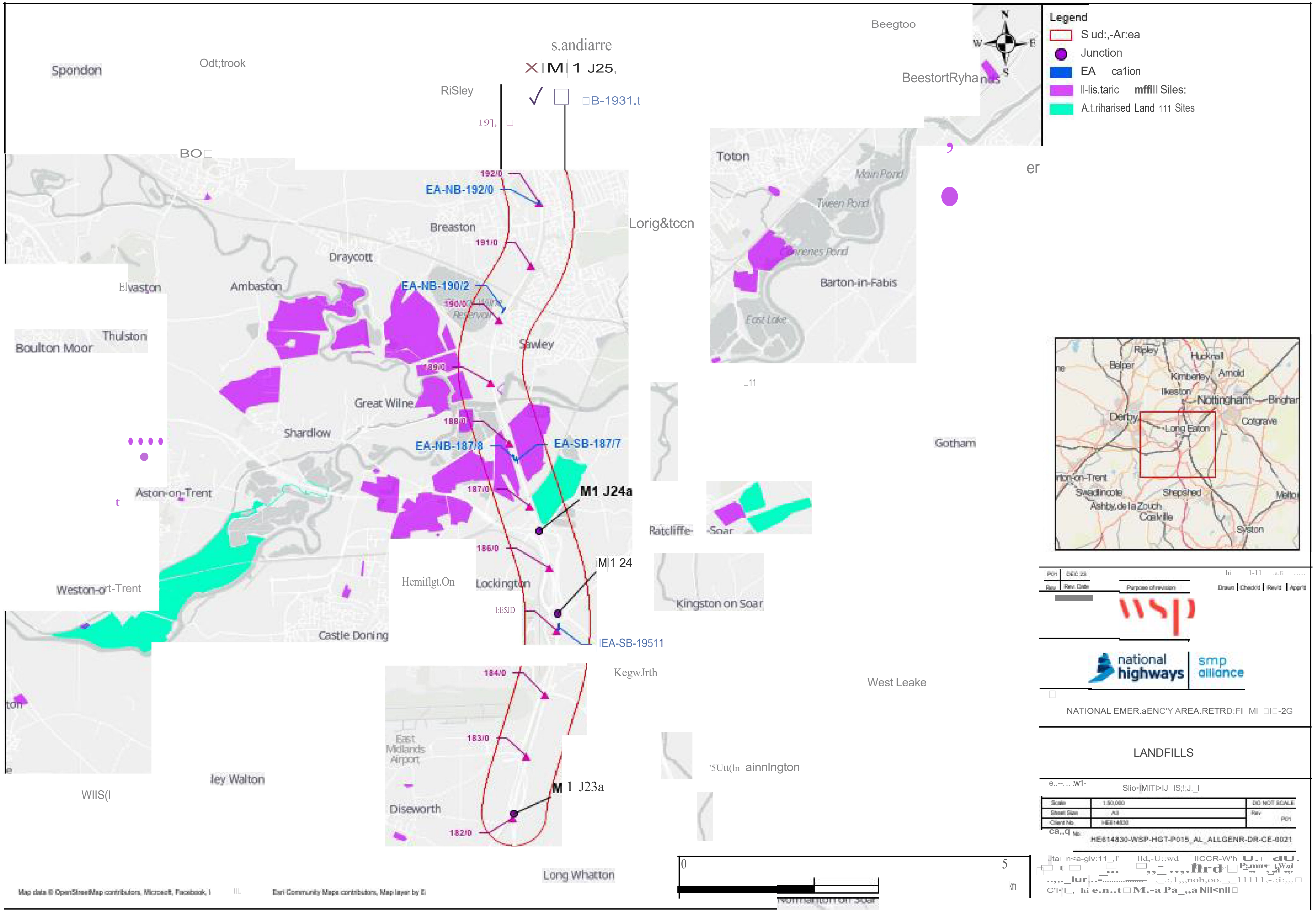


Figure 19-35: Landfill Sites (Section 2.2.3)

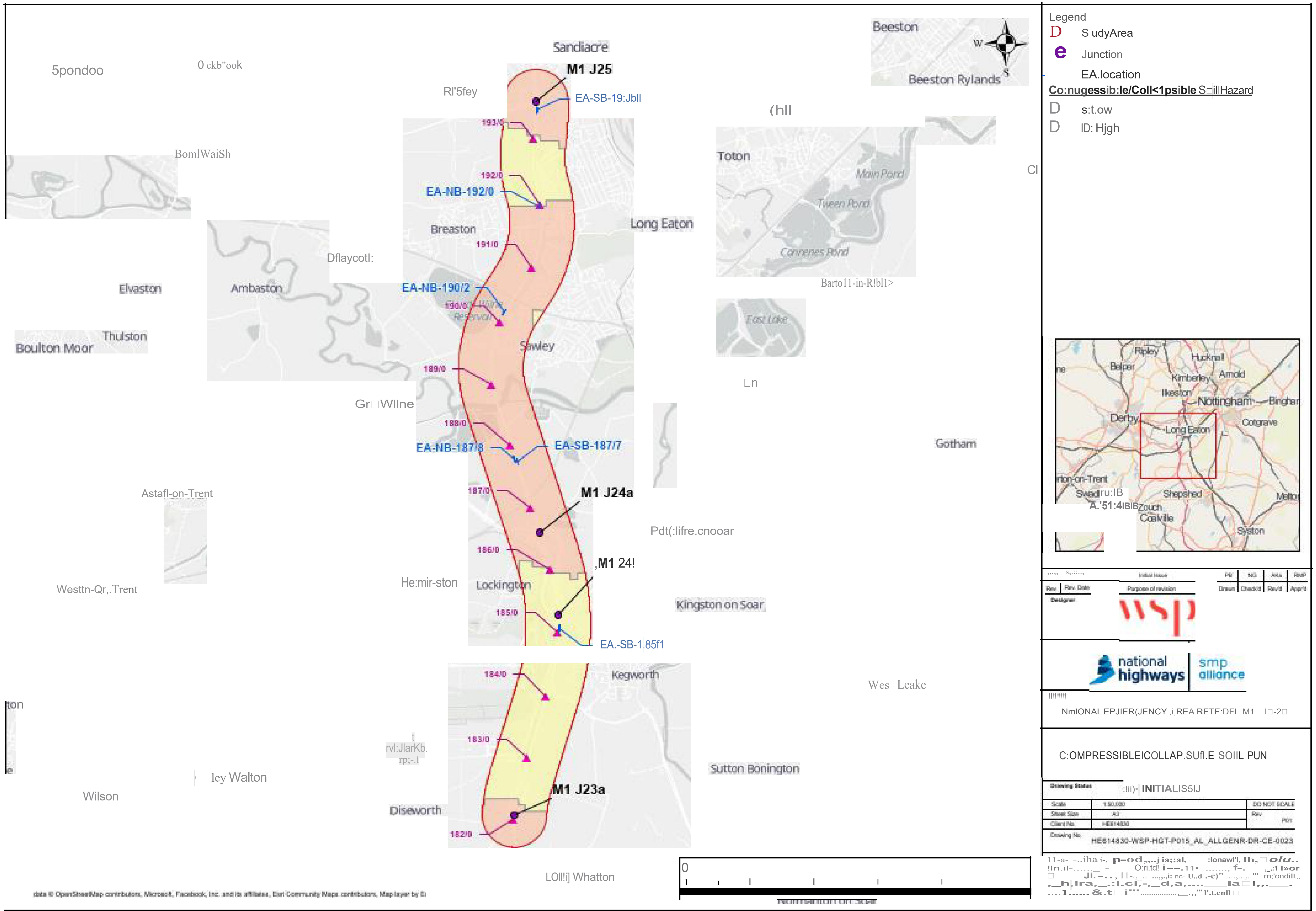


Figure 19-36:Compressible/ Collapsible Soil Plan (Section 2.2.3)

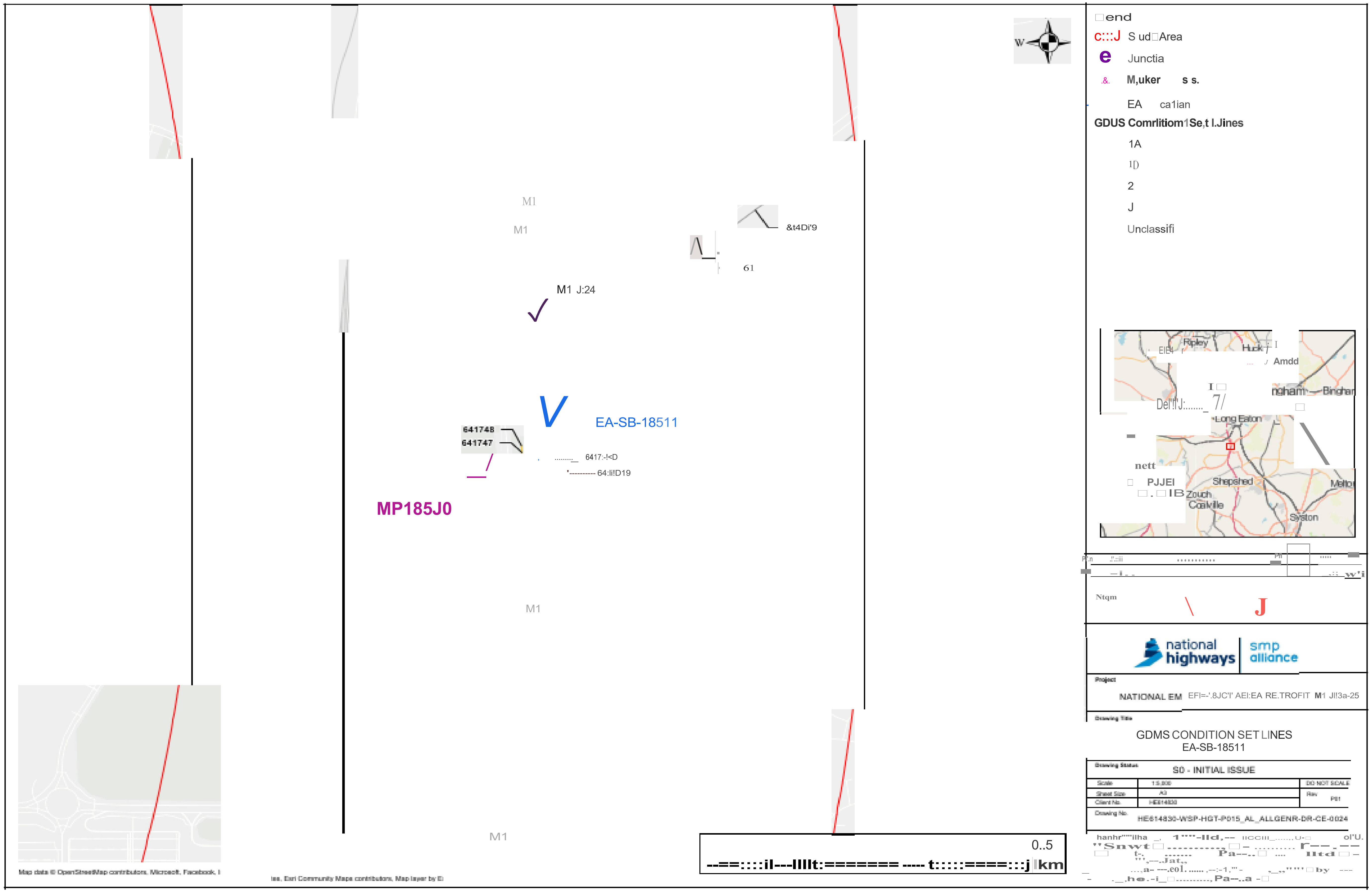


Figure 19-37: GDMS Condition Set Lines (Section 2.4)

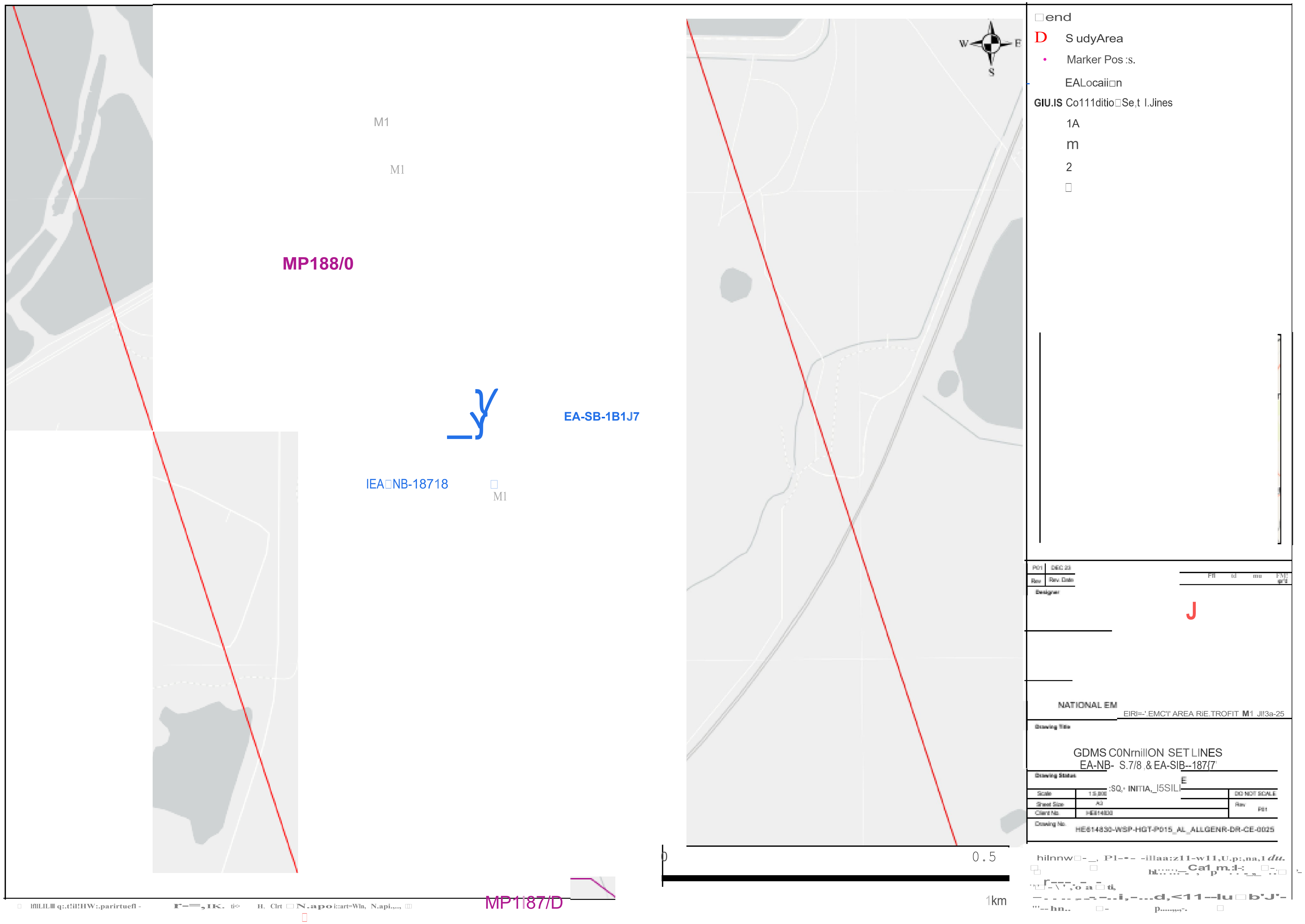


Figure 19-38: GDMS Condition Set Lines (Section 2.4)

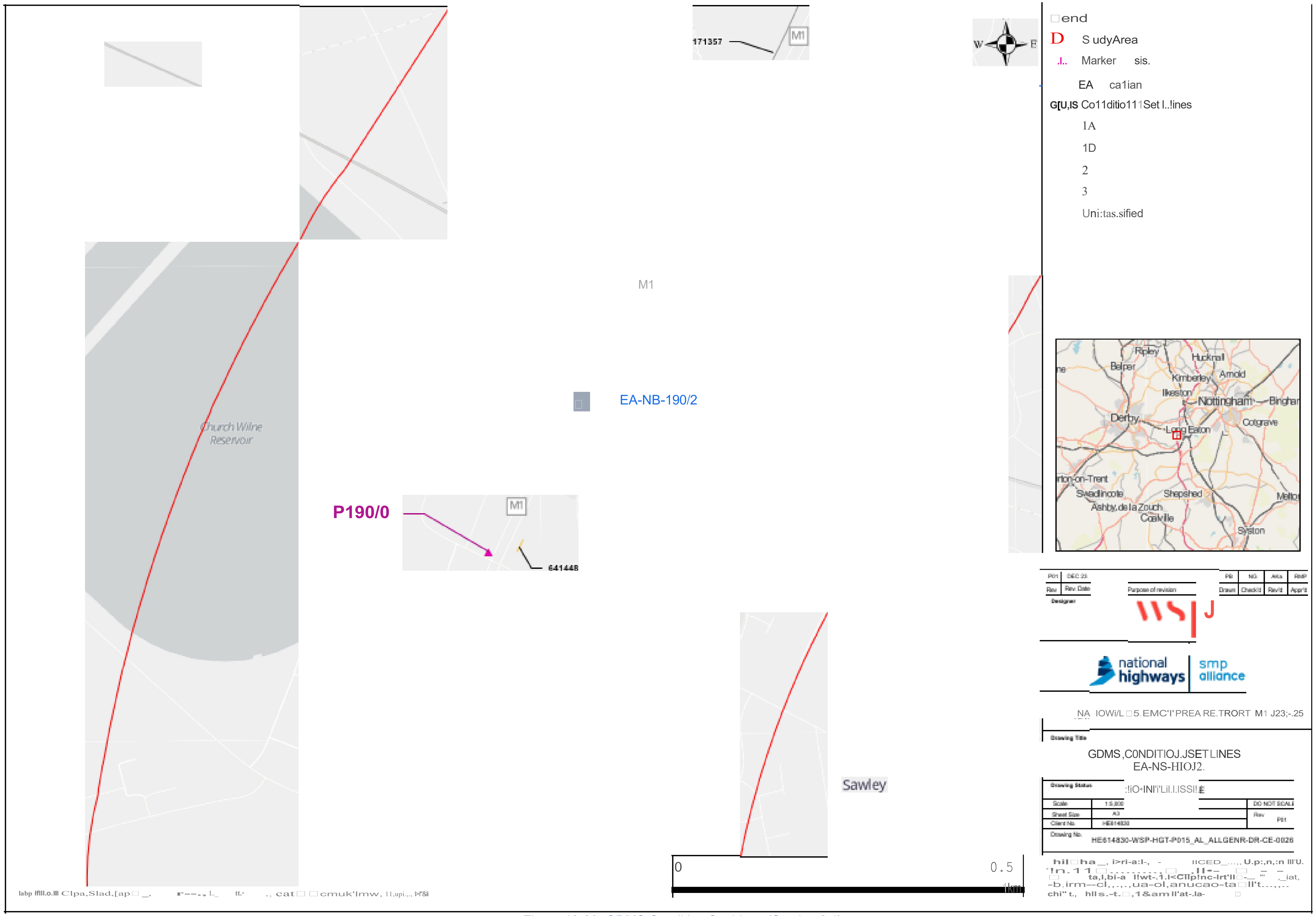


Figure 19-39: GDMS Condition Set Lines (Section 2.4)

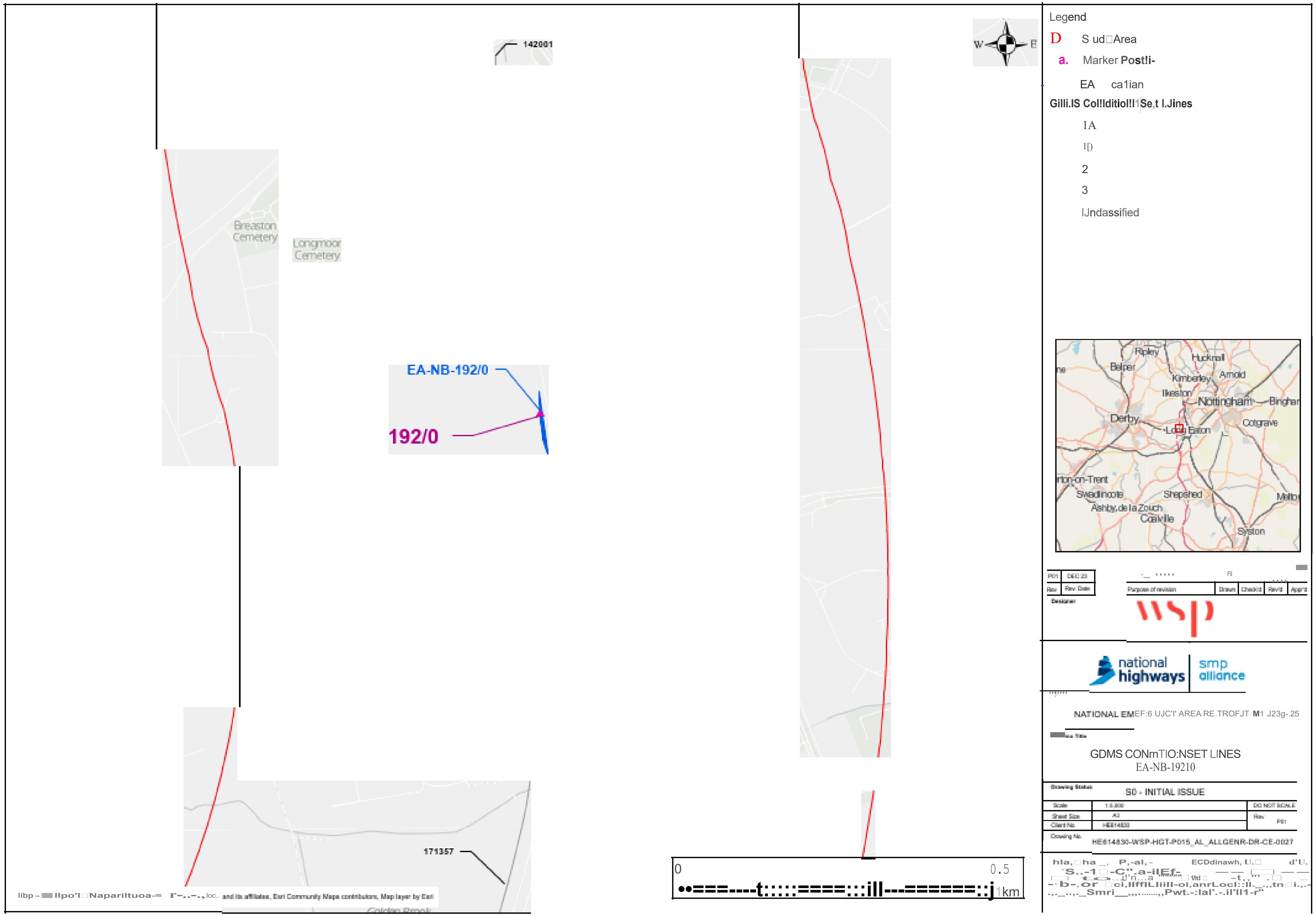


Figure 19-40: GDMS Condition Set Lines (Section 2.4)

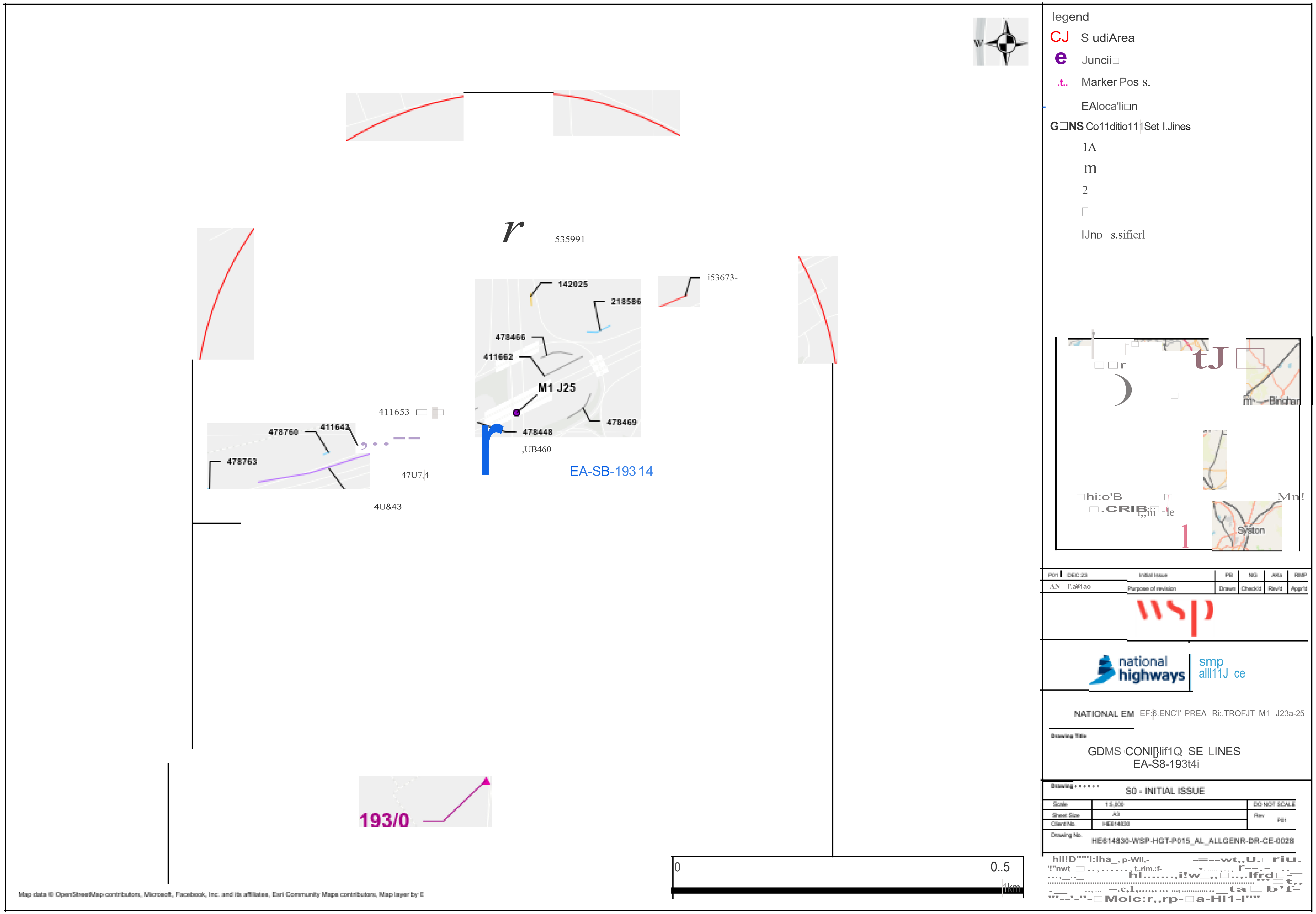


Figure 19-41: GDMS Condition Set Lines (Section 2.4)

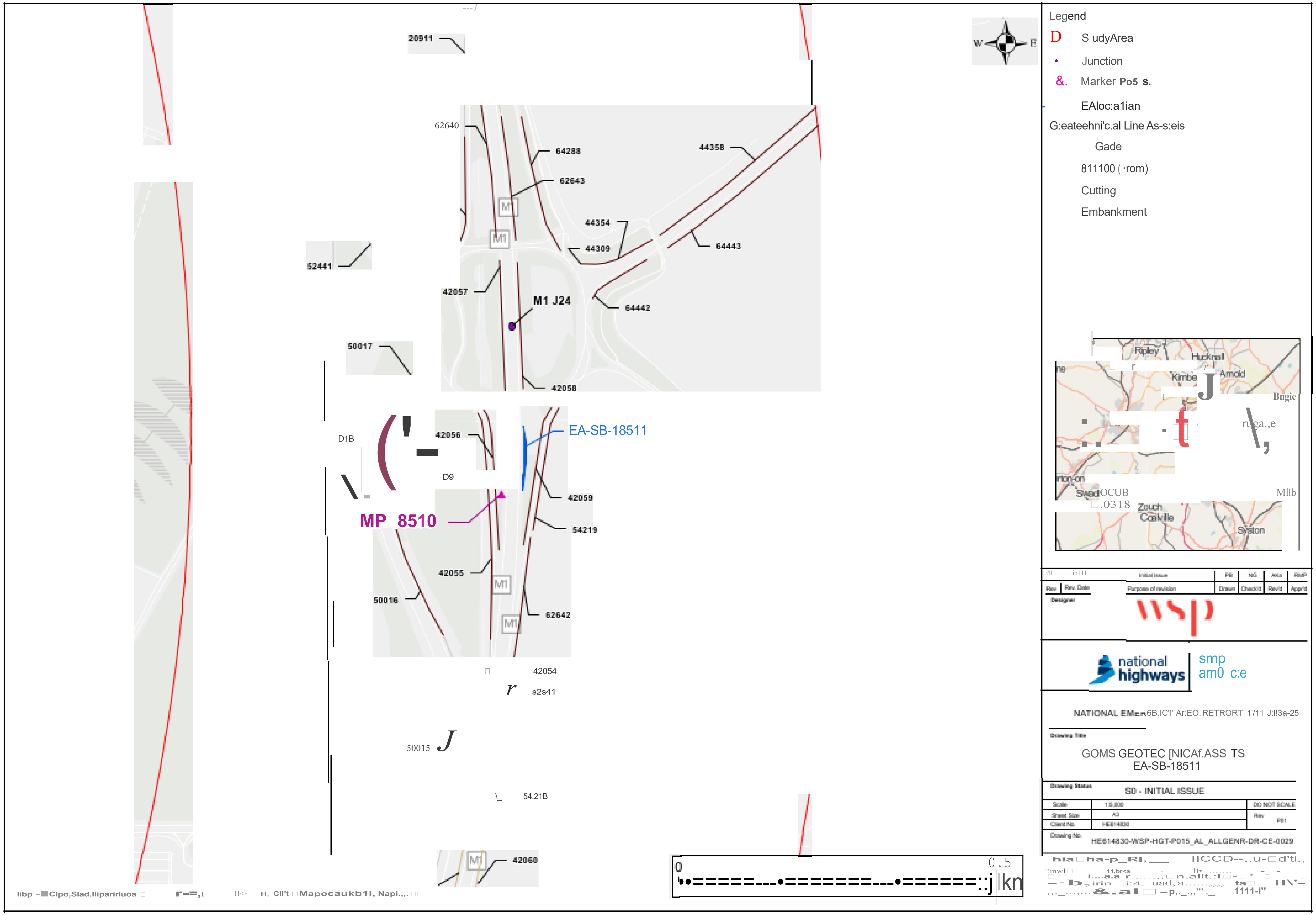


Figure 19-42: GDMS Assets Information (Section 2.4)

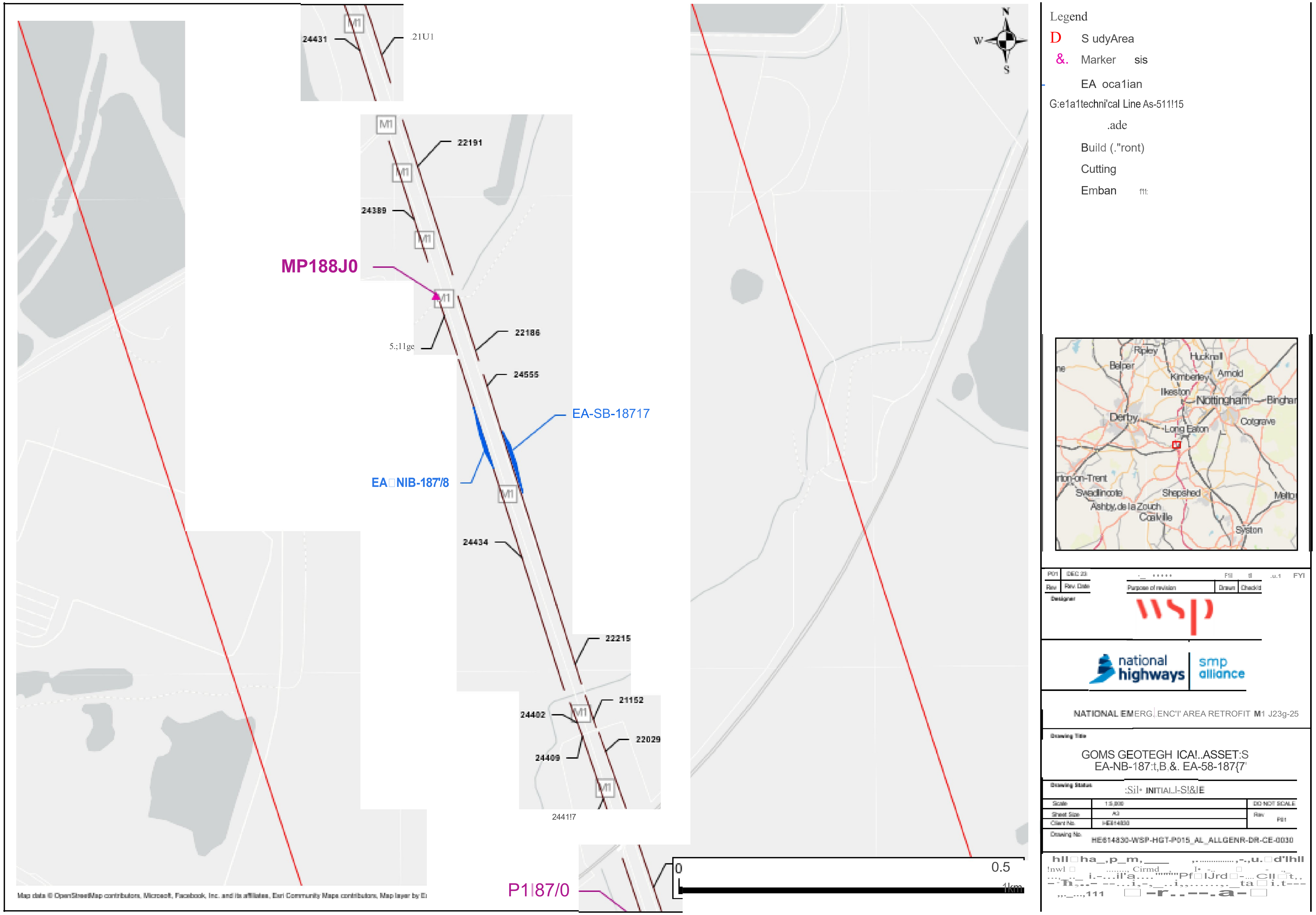


Figure 19-43: GDMS Assets Information (Section 2.4)

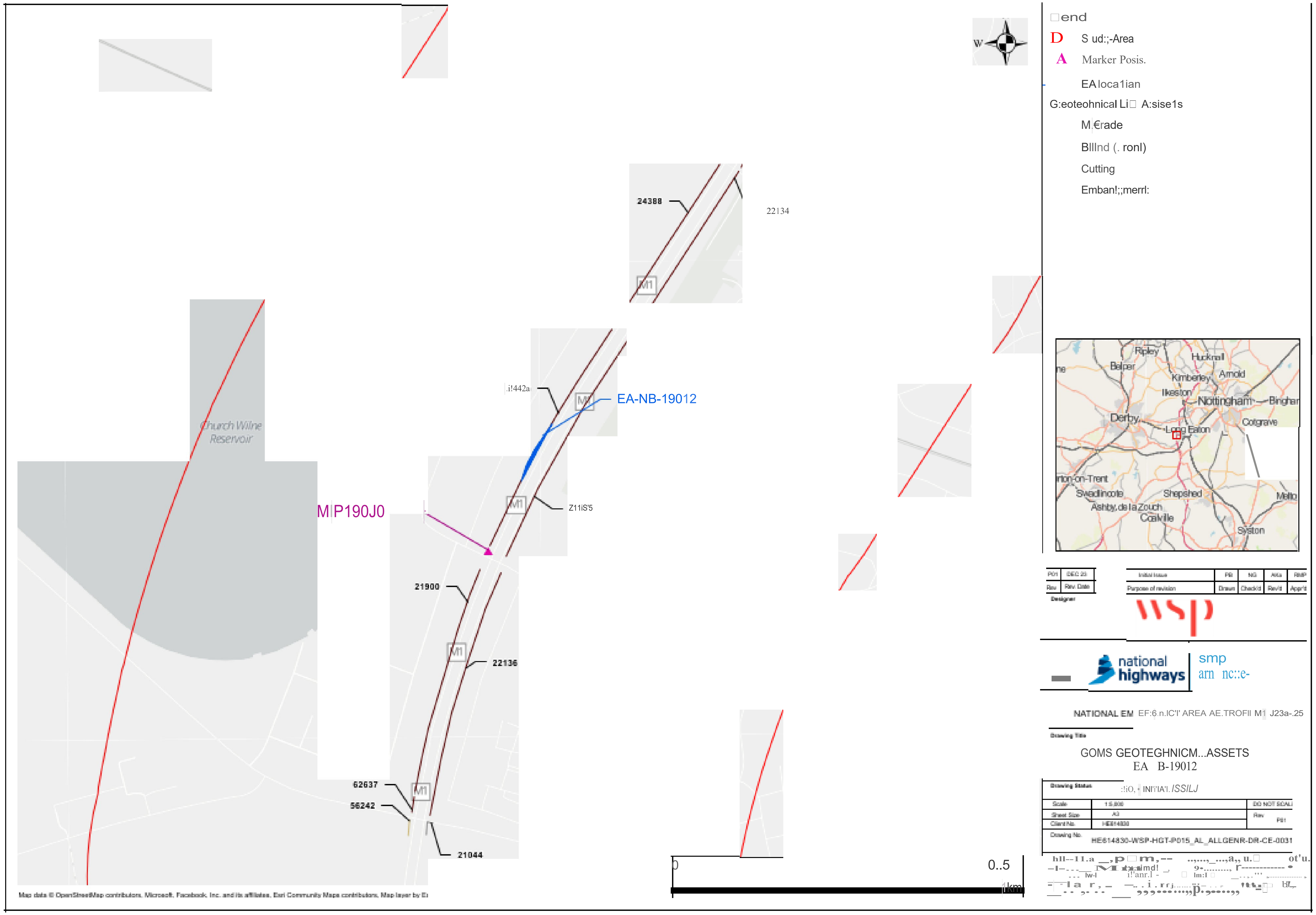


Figure 19-44: GDMS Assets Information (Section 2.4)

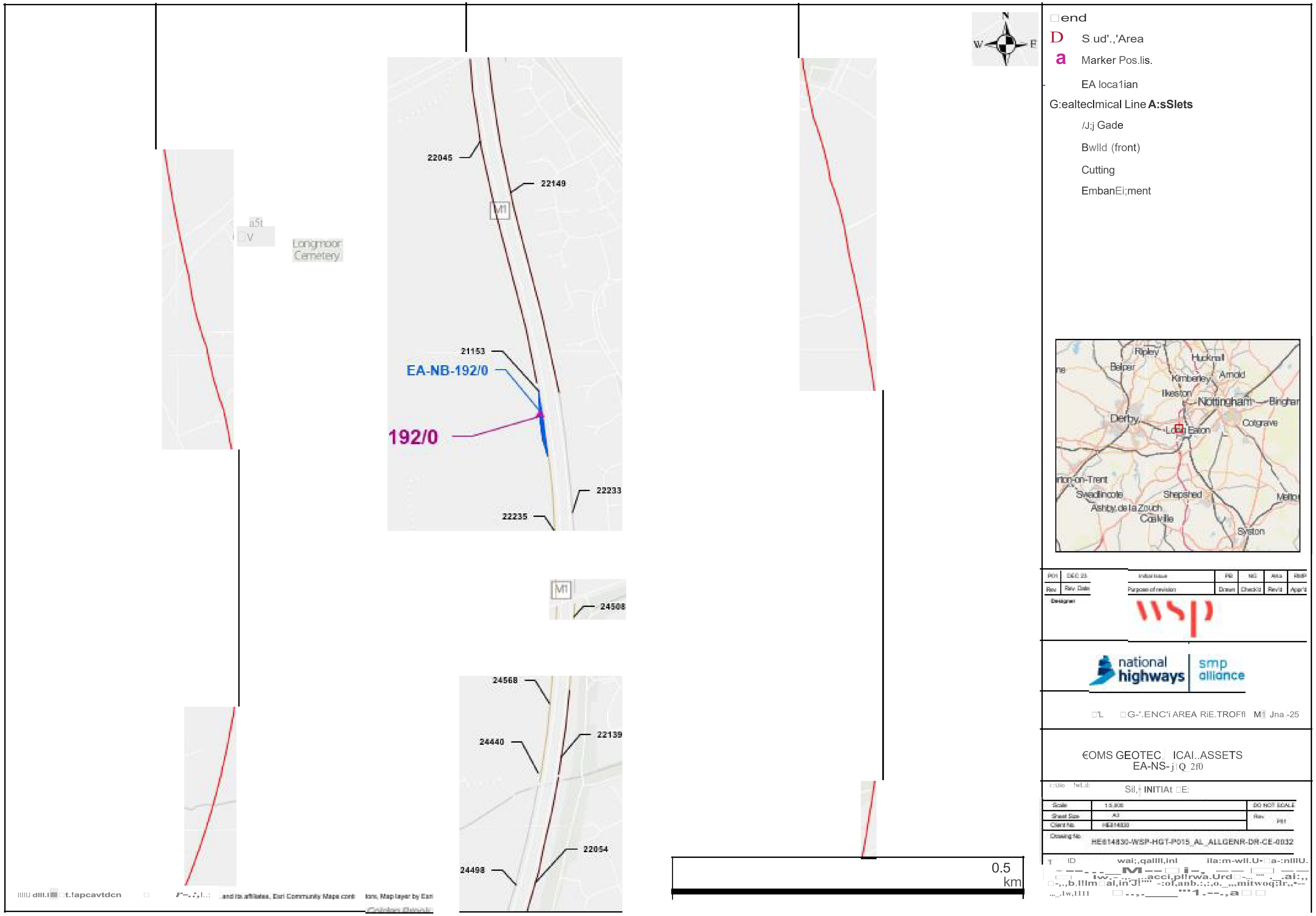


Figure 19-45: GDMS Assets Information (Section 2.4)

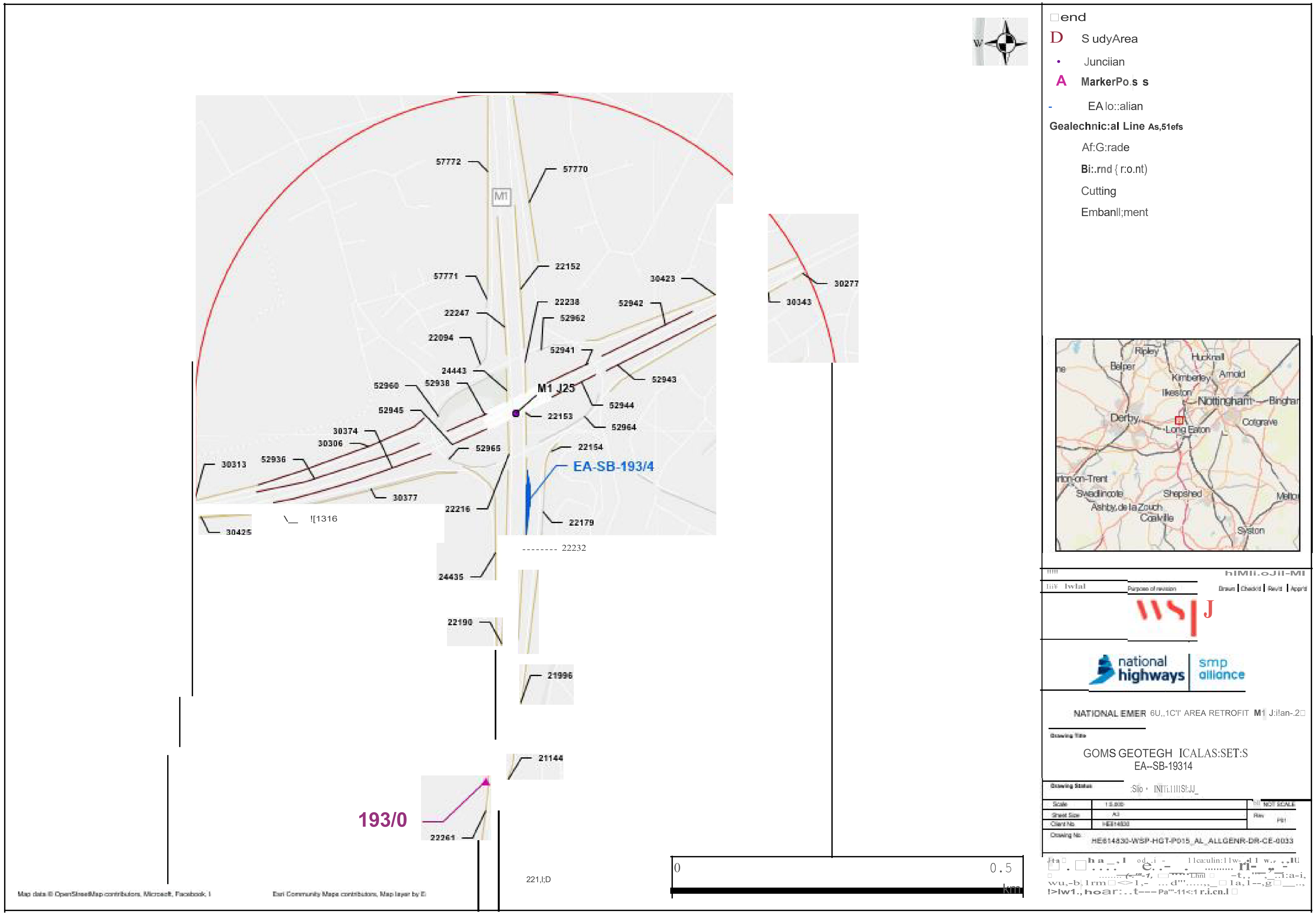


Figure 19-46: GDMS Assets Information (Section 2.4)

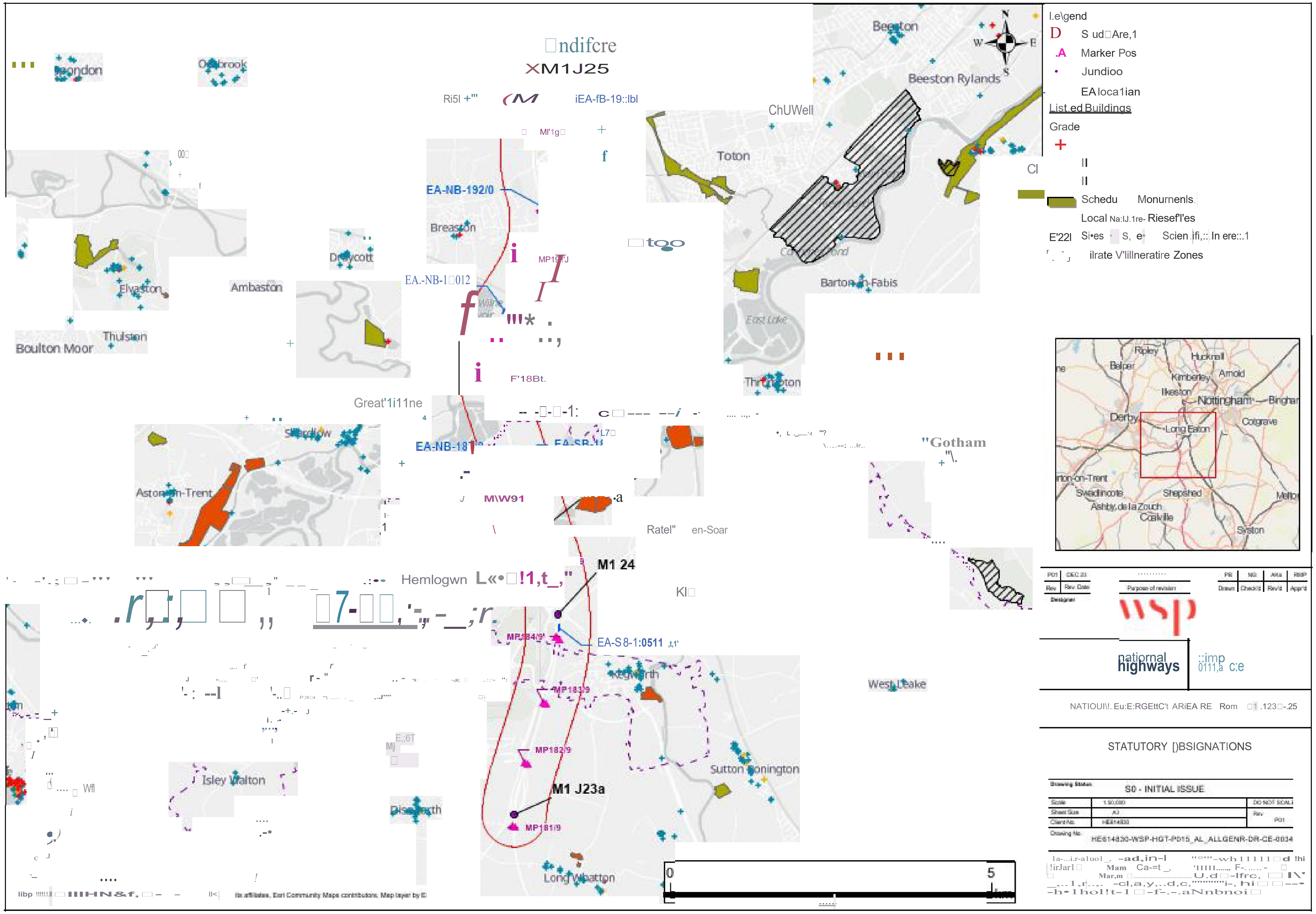
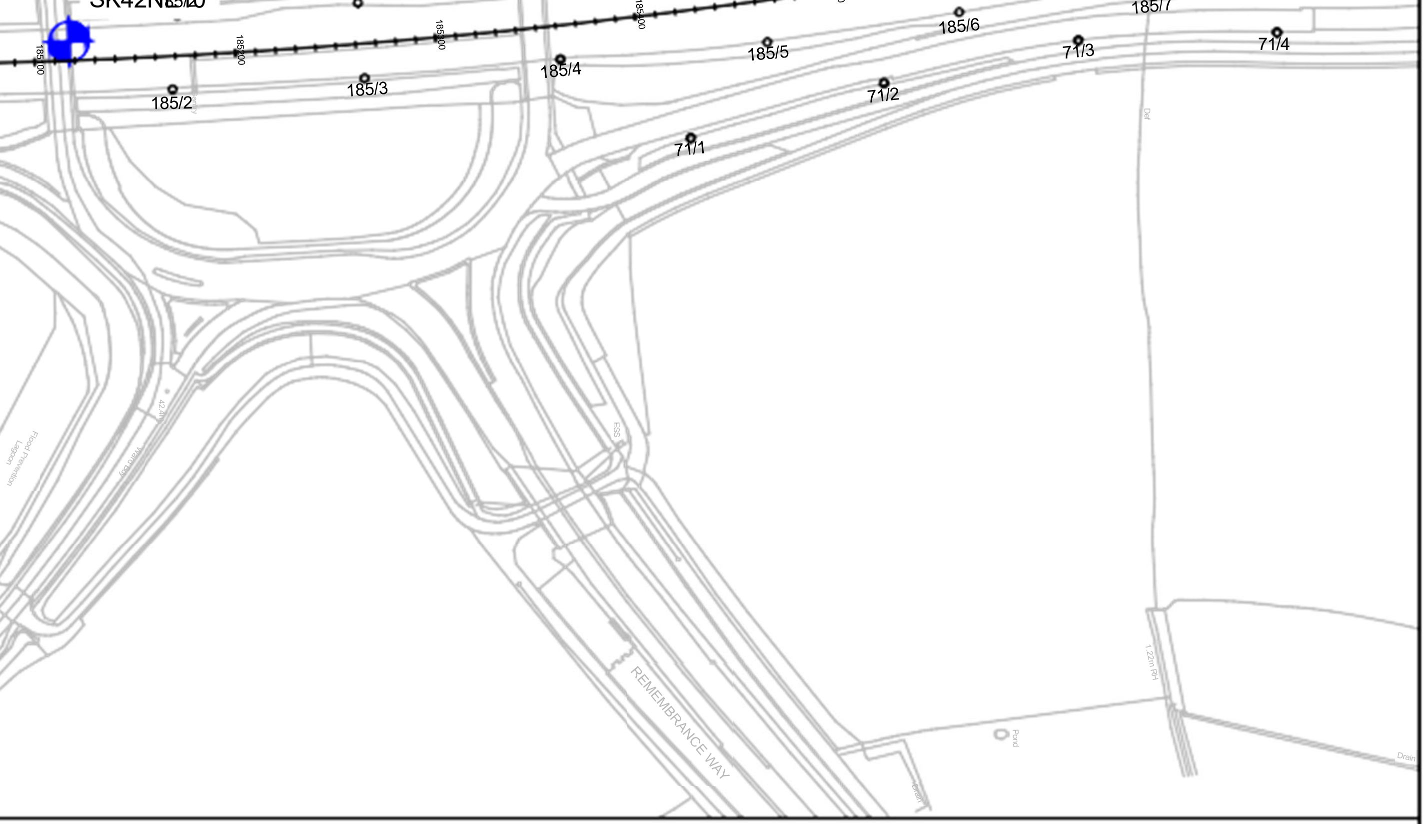
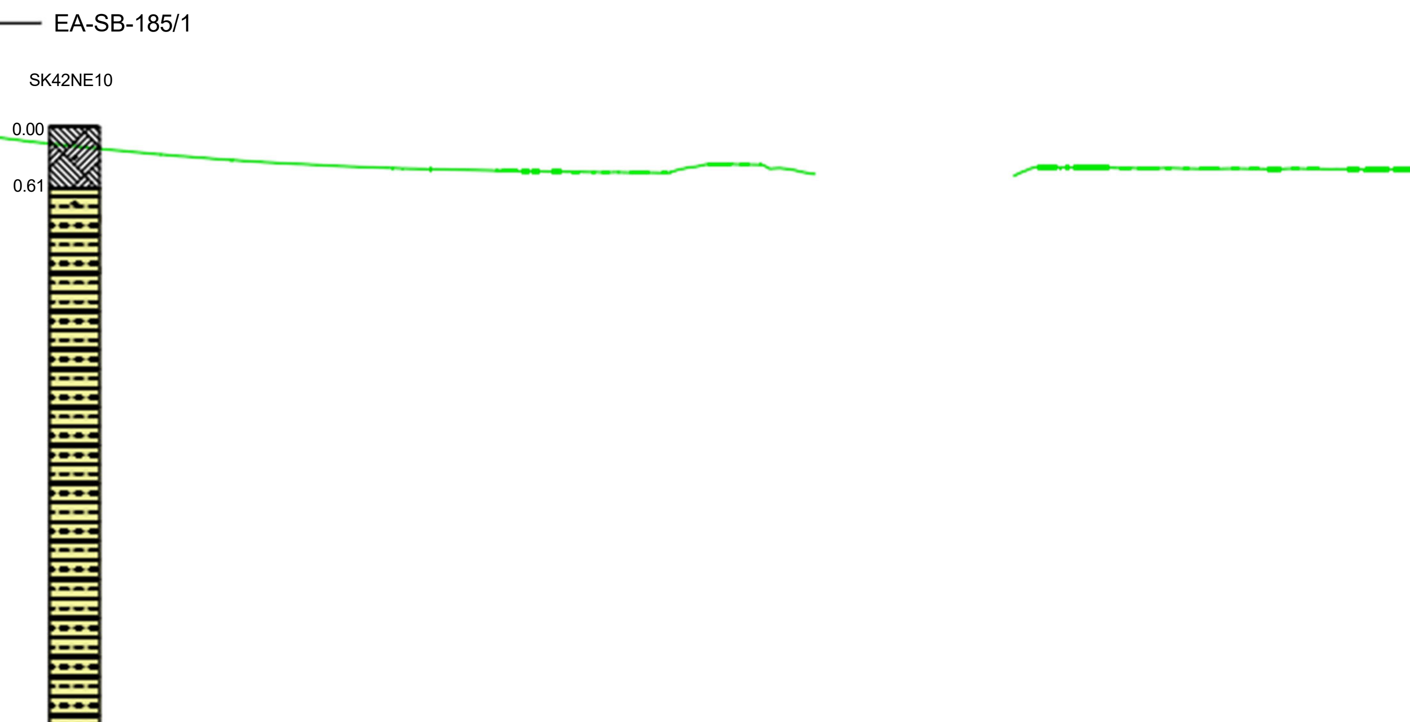


Figure 19-47:Statutory Designations (Section 2.5)

Annex G Geological Long Sections





c. HE614830-WSP-VOS-P015_AL_ALLGENR-M2-CH-0002.
d. HE614830-WSP-GEN-P015_AL_ALLGENR-M2-CH-0004.

3. POOR QUALITY EXPLORATORY HOLES ARE NOT INCLUDED IN GEOLOGICAL LONG SECTIONS.
4. FOR GEOTECHNICAL CONDITION SETS REFER TO FOLLOWING GDMS CONDITION SET LINES PLANS:
   a. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0024.
   b. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0025.
   c. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0026.
   d. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0027.
   e. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0028.
5. RELEVANT GDMS GEOTECHNICAL ASSET DRAWINGS CAN BE REFERRED WITH FOLLOWING REFERENCES:
   a. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0029.
   b. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0030.
   c. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0031.
   d. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0032.
   e. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0033.
6. FOR THE PURPOSE OF THE GROUND MODEL, SUPERFICIAL AND SOLID GEOLOGICAL MEMBERS HAVE BEEN GROUPED TO CREATE A GENERALIZED GROUND MODEL.
7. THIS DRAWING SHOWS EXPLORATORY HOLES WITHIN A 100m BOUNDARY ON EITHER SIDES OF THE MID OF THE EA FOOT PRINT.

LEGEND :

BOREHOLE PERFORMED FOR GI (2023)
EXISTING/HISTORICAL BOREHOLE
EXISTING CENTRE LINE GROUND PROFILE
PROPOSED SVD
PROPOSED CCTV
TOPSOIL
MADE GROUND
EDWALTON MEMBER
RIVER TERRACE DEPOSITS

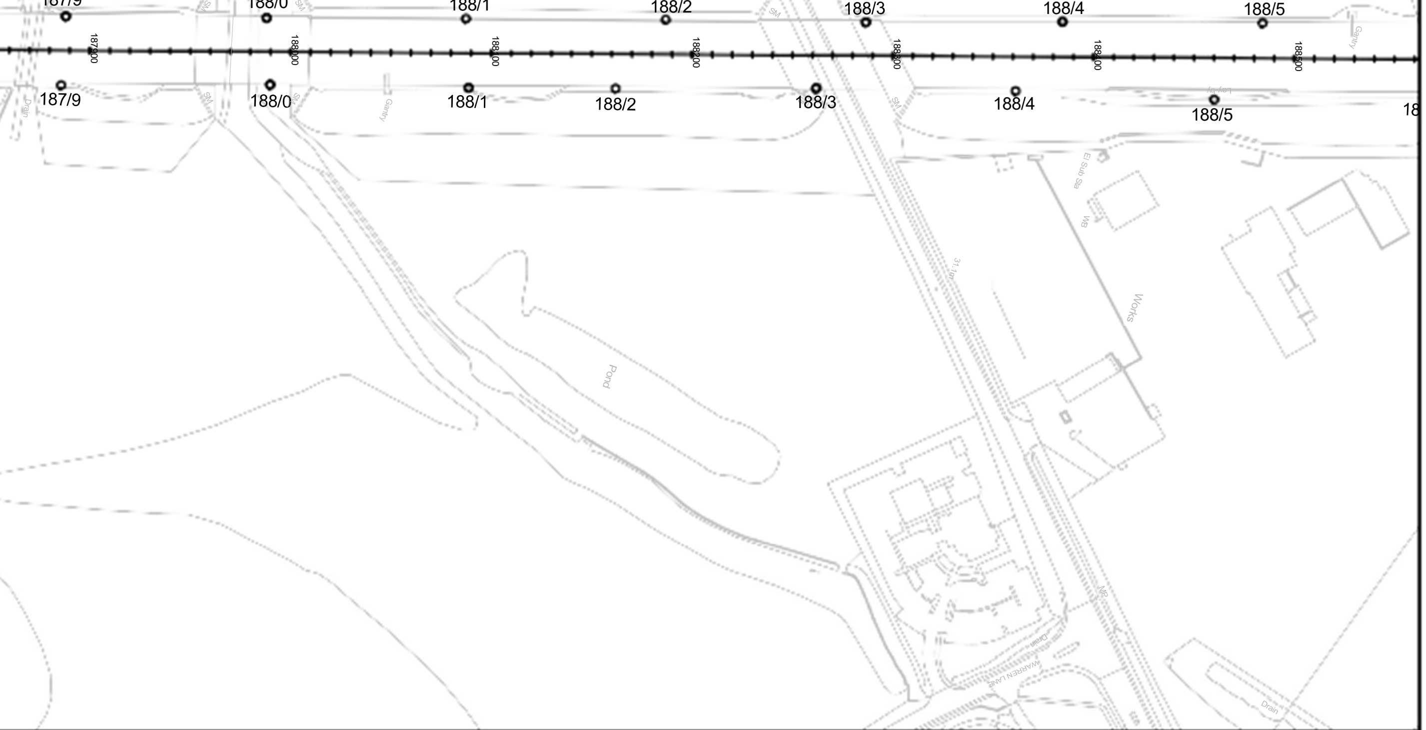
P01	19/01/24	SUITABLE FOR ACCEPTANCE	HSO	AKO	GBE	PCO
Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

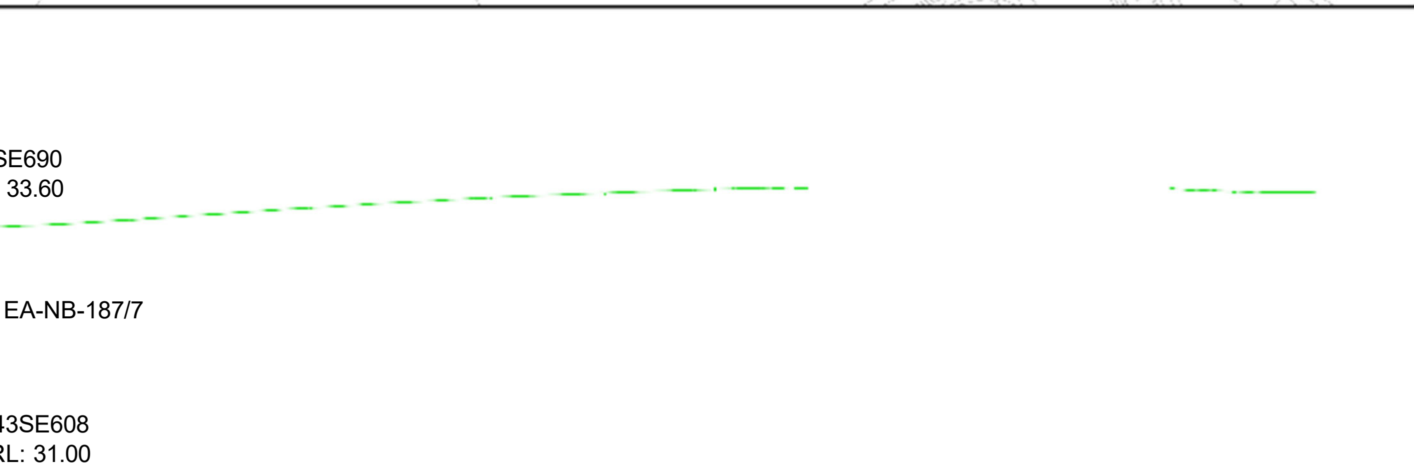
Designer:

Client

Project

NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25





c. HE614830-WSP-VOS-P015_AL_ALLGENR-M2-CH-0002.
d. HE614830-WSP-GEN-P015_AL_ALLGENR-M2-CH-0004.

3. POOR QUALITY EXPLORATORY HOLES ARE NOT INCLUDED IN GEOLOGICAL LONG SECTIONS.
4. FOR GEOTECHNICAL CONDITION SETS REFER TO FOLLOWING GDMS CONDITION SET LINES PLANS:
   a. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0024.
   b. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0025.
   c. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0026.
   d. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0027.
   e. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0028.
5. RELEVANT GDMS GEOTECHNICAL ASSET DRAWINGS CAN BE REFERRED WITH FOLLOWING REFERENCES:
   a. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0029.
   b. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0030.
   c. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0031.
   d. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0032.
   e. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0033.
6. FOR THE PURPOSE OF THE GROUND MODEL, SUPERFICIAL AND SOLID GEOLOGICAL MEMBERS HAVE BEEN GROUPED TO CREATE A GENERALIZED GROUND MODEL.
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LEGEND :

BOREHOLE PERFORMED FOR GI (2023)

EXISTING/HISTORICAL BOREHOLE

EXISTING CENTRE LINE GROUND PROFILE

PROPOSED SVD

PROPOSED CCTV

TOPSOIL

MADE GROUND

HEMINGTON MEMBER

P01	19/01/24	SUITABLE FOR ACCEPTANCE	HSO	AKO	GBE	PCO
Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

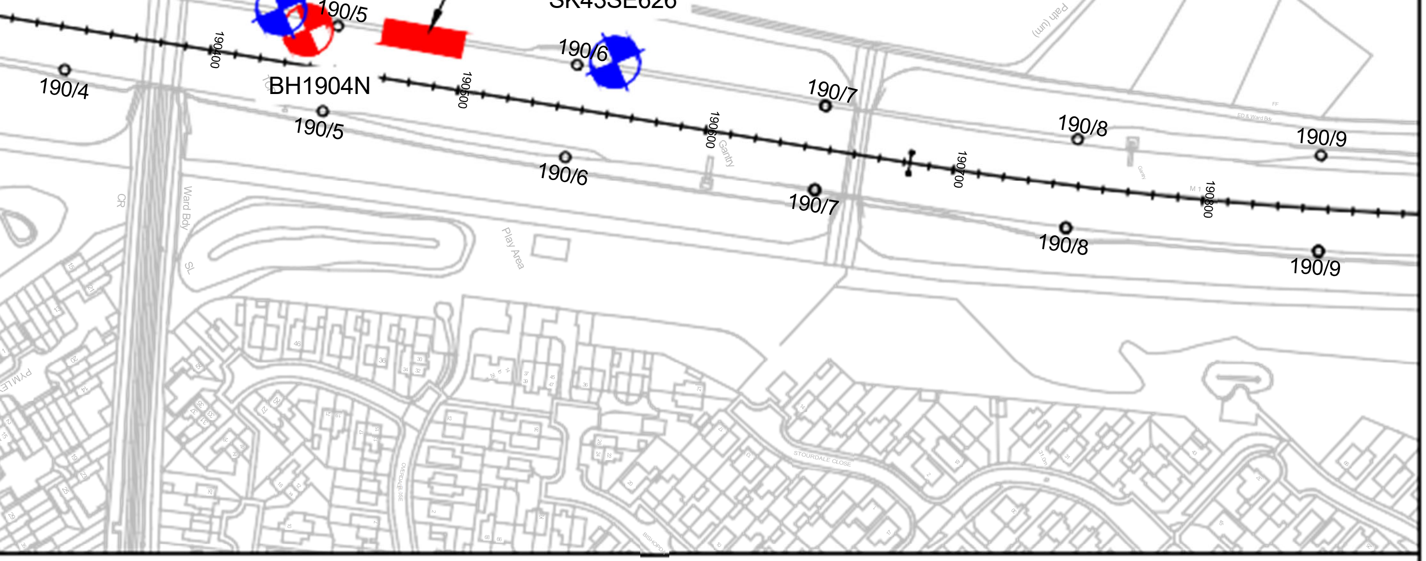
Designer:

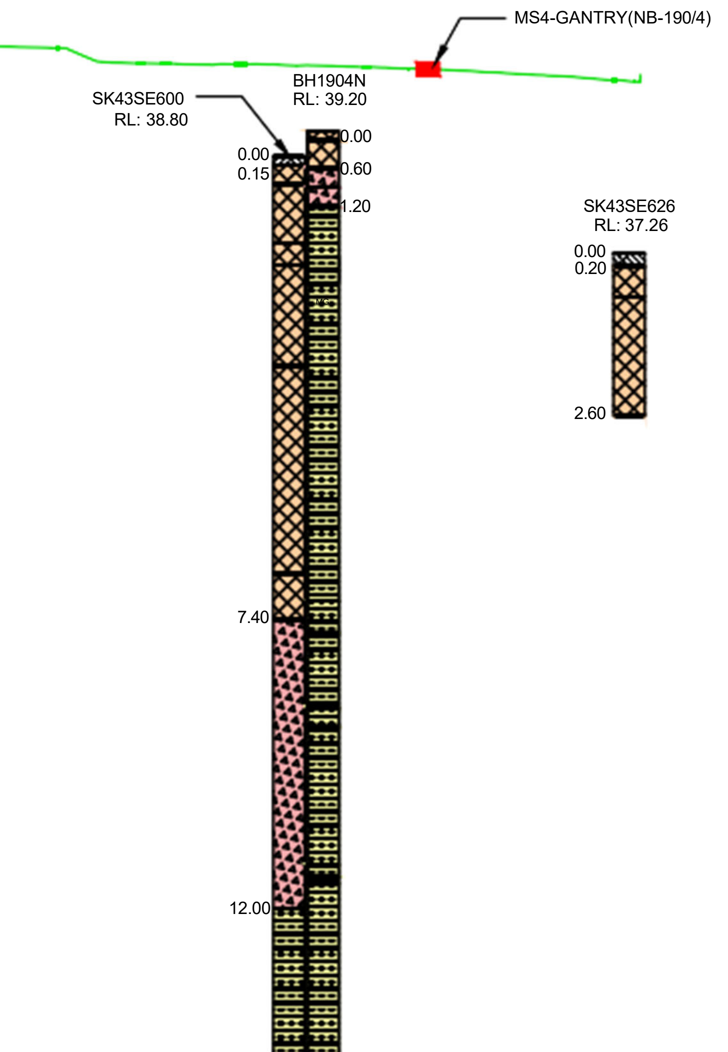
Client

Project

NATIONAL EMERGENCY AREA RETROFIT

M1 J23a-25





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d. HE614830-WSP-GEN-P015_AL_ALLGENR-M2-CH-0004.

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   b. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0025.
   c. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0026.
   d. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0027.
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   b. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0030.
   c. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0031.
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   e. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0033.
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PROPOSED CCTV

TOPSOIL

MADE GROUND

EDWALTON MEMBER

HEMINGTON MEMBER

P01	19/01/24	SUITABLE FOR ACCEPTANCE	HSO	AKO	GBE	PCO
Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer:

Client

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M1 J23a-25

c. HE614830-WSP-VOS-P015_AL_ALLGENR-M2-CH-0002.
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   b. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0025.
   c. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0026.
   d. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0027.
   e. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0028.
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   b. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0030.
   c. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0031.
   d. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0032.
   e. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0033.
6. FOR THE PURPOSE OF THE GROUND MODEL, SUPERFICIAL AND SOLID GEOLOGICAL MEMBERS HAVE BEEN GROUPED TO CREATE A GENERALIZED GROUND MODEL.
7. THIS DRAWING SHOWS EXPLORATORY HOLES WITHIN A 100m BOUNDARY ON EITHER SIDES OF THE MID OF THE EA FOOT PRINT.

LEGEND :

BOREHOLE PERFORMED FOR GI (2023)

EXISTING/HISTORICAL BOREHOLE

EXISTING CENTRE LINE GROUND PROFILE

PROPOSED SVD

PROPOSED CCTV

TOPSOIL

MADE GROUND

GUNTHORPE MEMBER

RIVER TERRACE DEPOSITS

P01	19/01/24	SUITABLE FOR ACCEPTANCE	HSO	AKO	GBE	PCO
Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer:

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Project
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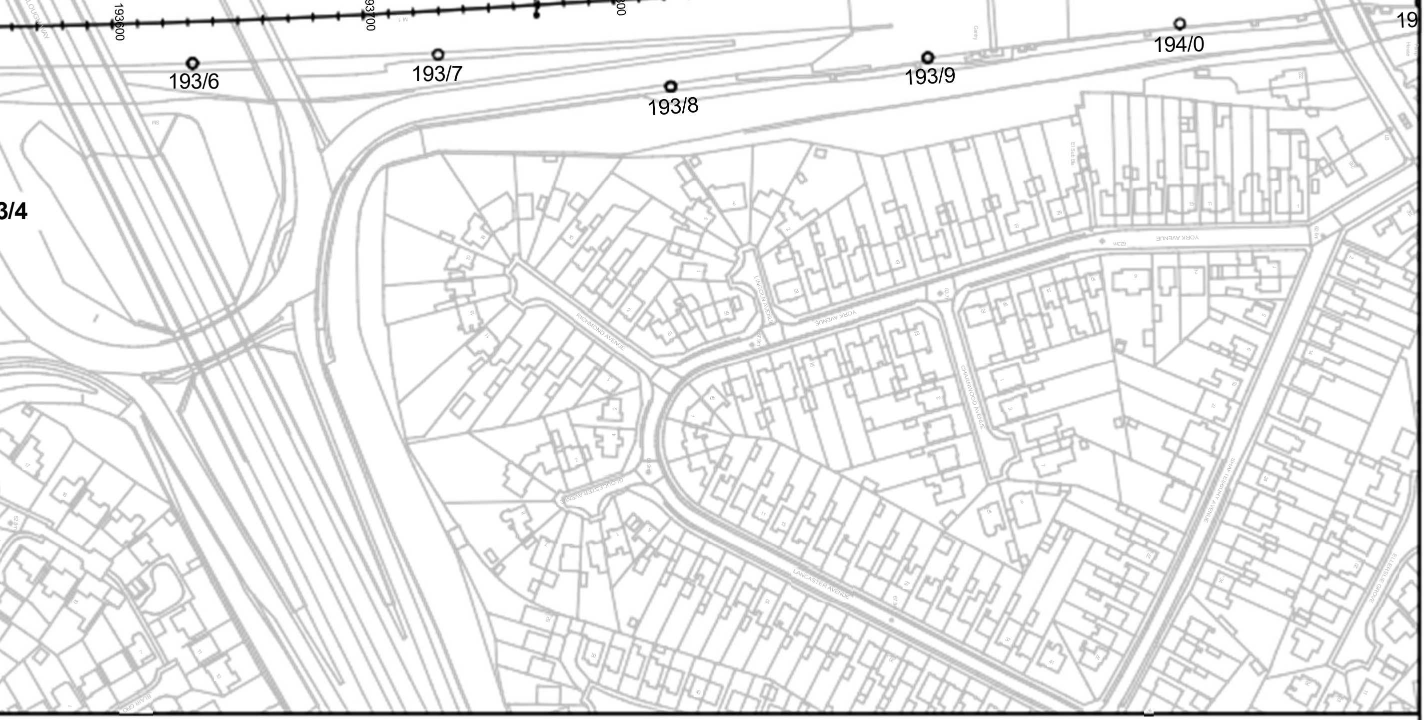

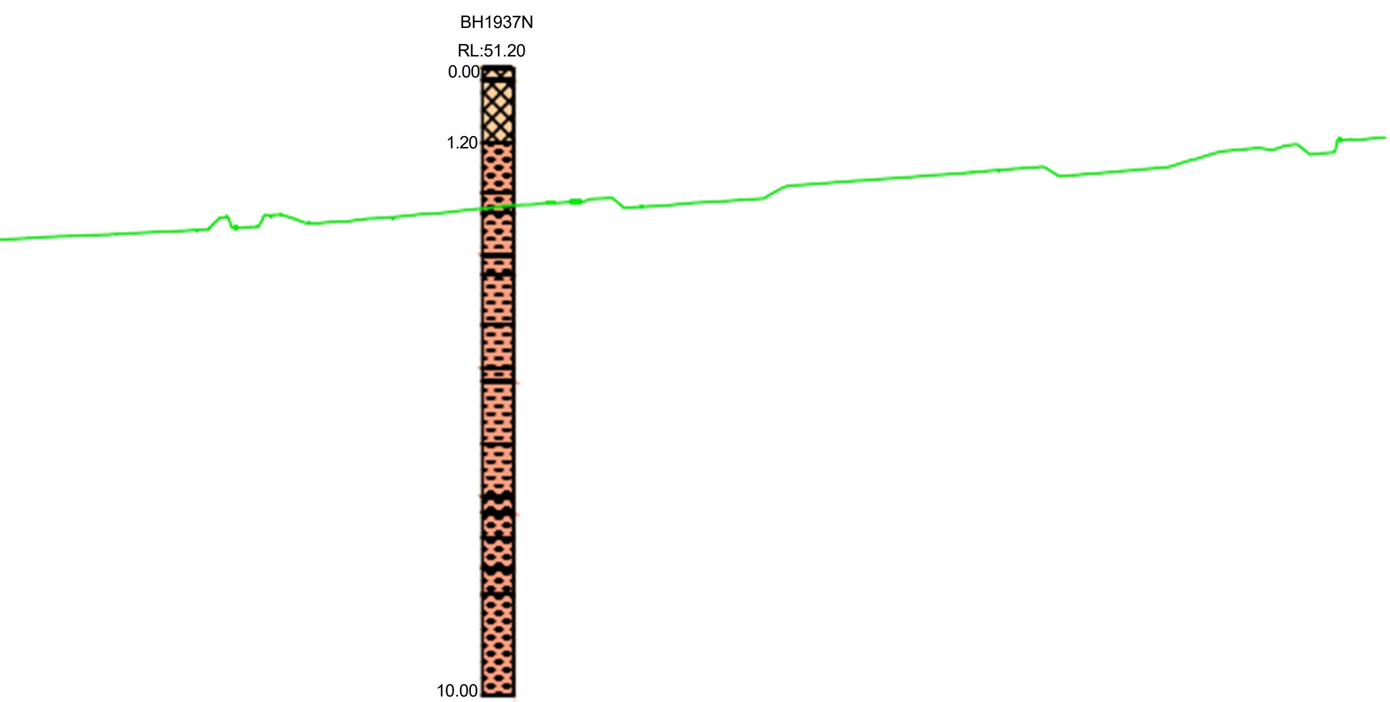

c. HE614830-WSP-VOS-P015_AL_ALLGENR-M2-CH-0002.
d. HE614830-WSP-GEN-P015_AL_ALLGENR-M2-CH-0004.

3. POOR QUALITY EXPLORATORY HOLES ARE NOT INCLUDED IN GEOLOGICAL LONG SECTIONS.
4. FOR GEOTECHNICAL CONDITION SETS REFER TO FOLLOWING GDMS CONDITION SET LINES PLANS:
   a. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0024.
   b. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0025.
   c. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0026.
   d. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0027.
   e. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0028.
5. RELEVANT GDMS GEOTECHNICAL ASSET DRAWINGS CAN BE REFERRED WITH FOLLOWING REFERENCES:
   a. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0029.
   b. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0030.
   c. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0031.
   d. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0032.
   e. HE614830-WSP-HGT-P015_AL_ALLGENR-DR-CE-0033.
6. FOR THE PURPOSE OF THE GROUND MODEL, SUPERFICIAL AND SOLID GEOLOGICAL MEMBERS HAVE BEEN GROUPED TO CREATE A GENERALIZED GROUND MODEL.
7. THIS DRAWING SHOWS EXPLORATORY HOLES WITHIN A 100m BOUNDARY ON EITHER SIDES OF THE MID OF THE EA FOOT PRINT.

LEGEND :

- BOREHOLE PERFORMED FOR GI (2023)
- EXISTING/HISTORICAL BOREHOLE
- EXISTING CENTRE LINE GROUND PROFILE
- PROPOSED SVD
- PROPOSED CCTV
- TOPSOIL
- MADE GROUND
- GUNTHORPE MEMBER

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NATIONAL EMERGENCY AREA RETROFIT
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Annex H Earthwork and Highway Structure Drawings

187680.00	EMBANKMENT	1.213	1:2
187670.00	EMBANKMENT	1.146	1:2
187660.00	EMBANKMENT	0.318	1:2
187650.00	EMBANKMENT	0.940	1:2

190120.00	EMBANKMENT	1.248	1:2
190130.00	EMBANKMENT	1.265	1:2
190140.00	EMBANKMENT	1.138	1:2
190150.00	EMBANKMENT	1.036	1:2
190160.00	EMBANKMENT	0.955	1:2
190170.00	EMBANKMENT	0.331	1:2
190180.00	EMBANKMENT	0.343	1:2
190190.00	EMBANKMENT	1.194	1:2
190200.00	AT GRADE	-	1:2
190210.00	EMBANKMENT	0.139	1:2

3. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HE614830-WSP-HGT-P015_J25_B11GENR-DR-GE-0101.

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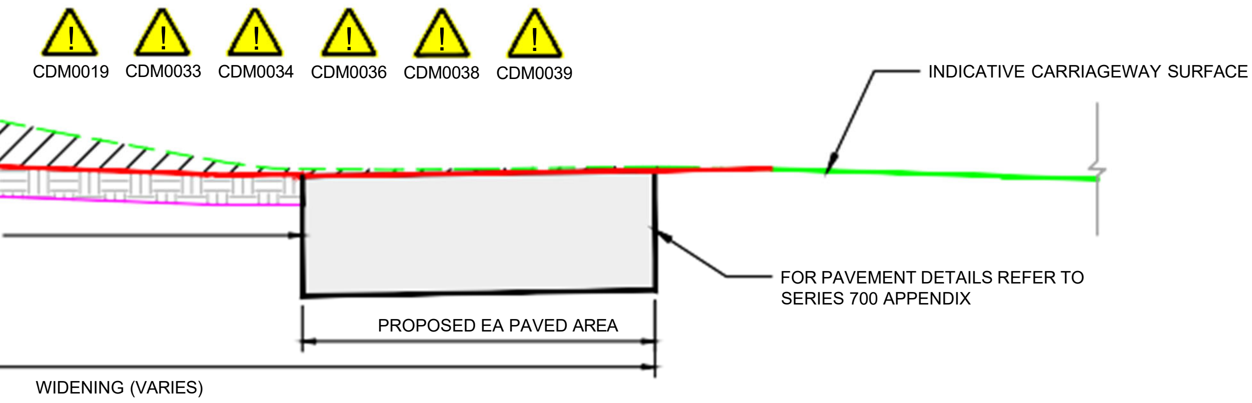

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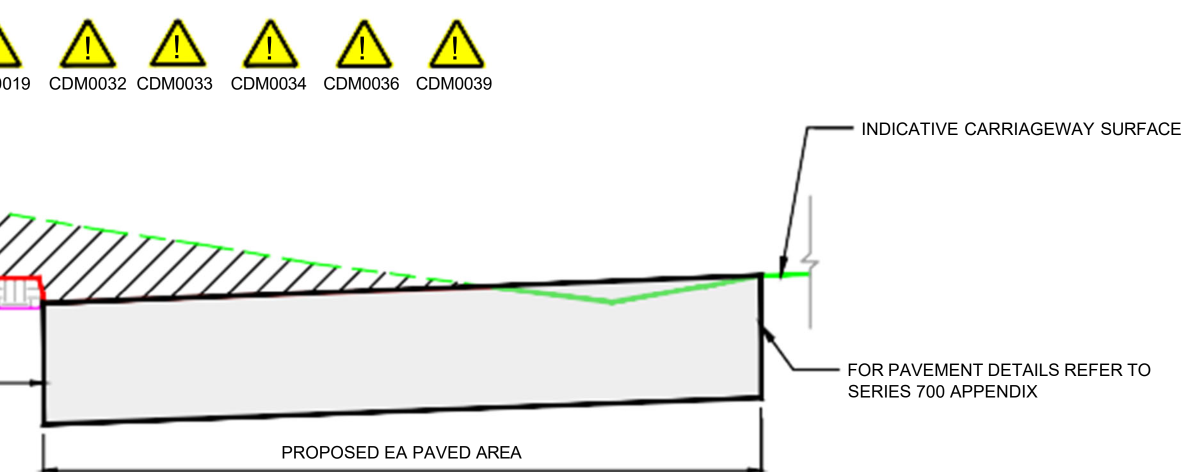

2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. SERIES 600: HE614830-WSP-HGT-P015_AL_ALLGENR-SP-CE-0001).
3. THE PROPOSED EARTHWORK SOLUTIONS ASSUME THAT EXISTING EMBANKMENT AND CUTTING SLOPES ARE STABLE IN THEIR CURRENT CONDITION.
4. FOR DRAINAGE AND SERVICE DUCT DETAILS, 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 NOT THICKER THAN 150mm FOR SLOPES OF 1(V):2(H) OR STEEPER, OR 300mm FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HE614830-WSP-SRW-P015_J25_B11GENR-DR-CB-0001
9. REFER TO TYPICAL VERGE DETAILS (HE614830-JAC-HGN-P001_AL_ALLGENR-DE-CH-0016) FOR TYPICAL DETAILS OF ASSETS IN VERGE.
10. ALL FILL MATERIALS SHALL BE PLACED AND COMPACTED IN ACCORDANCE TO THE SERIES 600 SPECIFICATION: HE614830-WSP-HGT-P015_AL_ALLGENR-SP-CE-0001.
11. THE SECTION DRAWINGS TO DON'T SHOW HIGHWAY INFRASTRUCTURE TELECOMMUNICATION DUCTS AND CHAMBERS, DRAINAGE CHANNELS AND VRS LOCATIONS.

LEGEND :

EXISTING GROUND PROFILE

EXISTING GROUND PROFILE TO BE REMOVED

PROPOSED GROUND PROFILE

INDICATIVE EXCAVATION PROFILE

EARTHWORK TO BE REMOVED

CLASS 5A TOPSOIL

P01	19/01/24	SUITABLE FOR ACCEPTANCE	HSO	AKO	GBE	PCO
P02	27/02/24	SUITABLE FOR ACCEPTANCE	HSO	AKO	GBE	PCO
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Designer:

wsp

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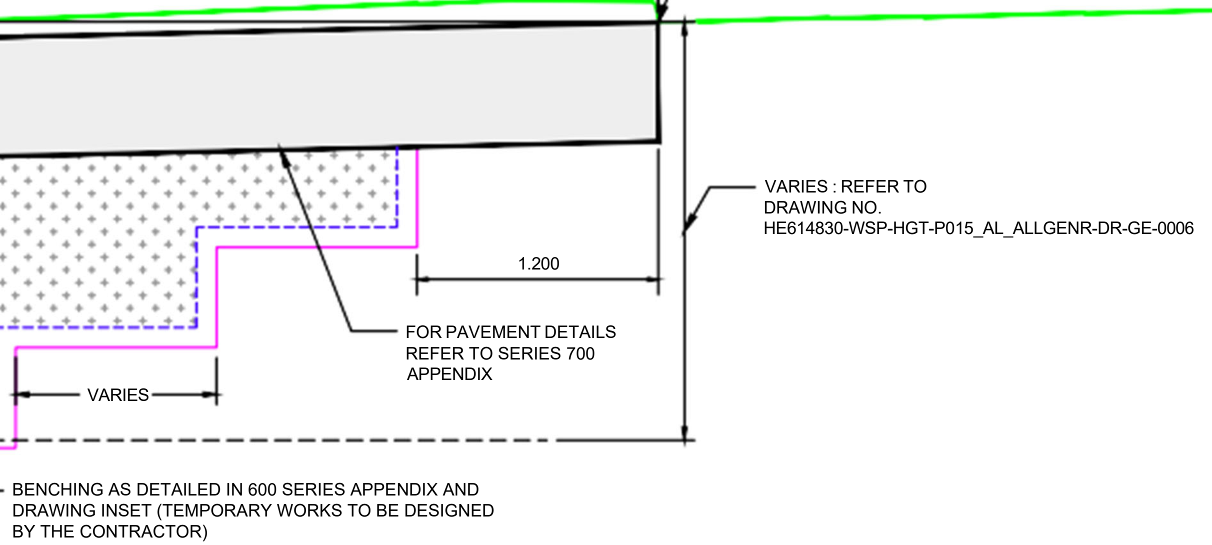

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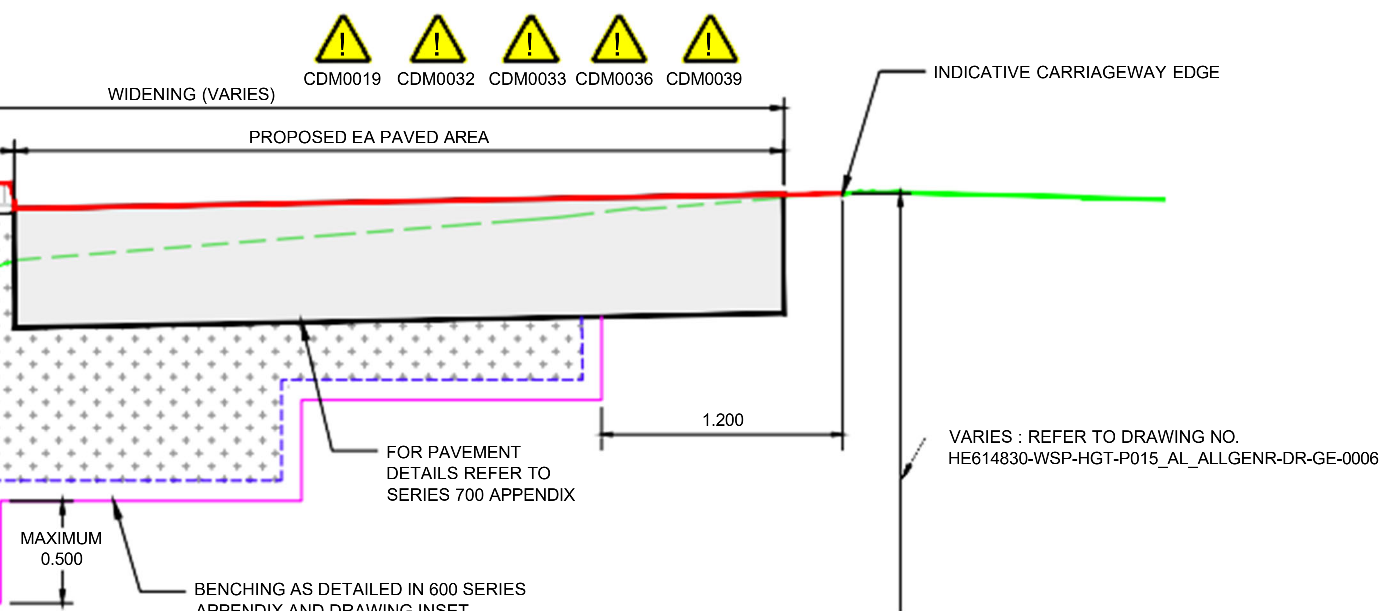

NOTES:

1. ALL DIMENSIONS AND LEVELS ARE IN METRES UNLESS OTHERWISE SPECIFIED STATED.
2. THESE DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE EARTHWORKS SCHEDULE (REF. SERIES 600: HE614830-WSP-HGT-P015_AL_ALLGENR-SP-CE-0001).
3. THE PROPOSED EARTHWORK 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 NOT THICKER THAN 150mm FOR SLOPES OF 1(V):2(H) OR STEEPER, OR 300mm FOR SHALLOWER GRADIENTS.
7. VERTICAL BENCHING NOT TO EXCEED 0.5m IN HEIGHT.
8. FOR TYPICAL DETAILS OF SHEET PILE RETAINING SOLUTIONS REFER TO HE614830-WSP-SRW-P015_J25_B11GENR-DR-CB-0001
9. REFER TO TYPICAL VERGE DETAILS (HE614830-JAC-HGN-P001_AL_ALLGENR-DE-CH-0016) FOR TYPICAL DETAILS OF ASSETS IN VERGE.

LEGEND :

- EXISTING GROUND PROFILE
- EXISTING GROUND PROFILE TO BE REMOVED
- PROPOSED GROUND PROFILE
- INDICATIVE EXCAVATION PROFILE
- GEOTEXTILE SEPARATOR LAYER
- CLASS 1A FILL
- CLASS 5A TOPSOIL

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	19/01/24	SUITABLE FOR ACCEPTANCE	HSO	AKO	GBE	PCO
P02	27/02/24	SUITABLE FOR ACCEPTANCE	HSO	AKO	GBE	PCO

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GRADE 8.8 THREADED RODS, EQUALLY SPACED ON 570 PERIMETER CONTROL DIAMETER (PCD).

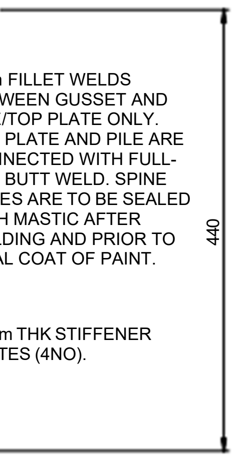
LARGE SERIES WASHERS COMPLYING WITH ISO 7093 SHALL BE USED EITHER SIDE OF FOUNDATION FLANGE PLATE. TAPERED WASHERS SHALL BE USED IF REQUIRED.

THREADED RODS, NUTS, WASHERS AND LOCKUNTS SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURERS SPECIFICATION.LOCK NUTS FITTED TO LOWER AND UPPER NUTS. ALL HOLDING DOWN THREADED RODS TO HAVE AT LEAST 2 FULL THREADS PROTRUDING BEYOND THE OUTER FACE OF THE LOCK NUT FOLLOWING TIGHTENING.

m Dia
KING PLATE
ORT

END 100mm ABOVE TOP OF
PLATE

ATION BUTT WELD
P FLANGE AND CHS,
L CIRCUMFERENCE OF CHS



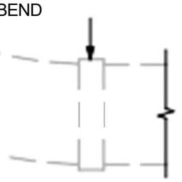
n FILLET WELDS
WEEN GUSSET AND
/TOP PLATE ONLY.
PLATE AND PILE ARE
NECTED WITH FULL-
BUTT WELD. SPINE
ES ARE TO BE SEALED
H MASTIC AFTER
LDING AND PRIOR TO
L COAT OF PAINT.

m THK STIFFENER
TES (4NO).

CONTRACTOR TO ENSURE
NO GROUT/CONCRETE
ENTERS TOP SECTION OF
CHS.

HOLE TO BE SEALED TO
PREVENT INGRESS OF
WATER/SOIL INTO VOID

TO ALLOW Ø118 OD
UPVC CABLE DUCT
WITH CONNECTOR
AT BOTH ENDS OF
BEND



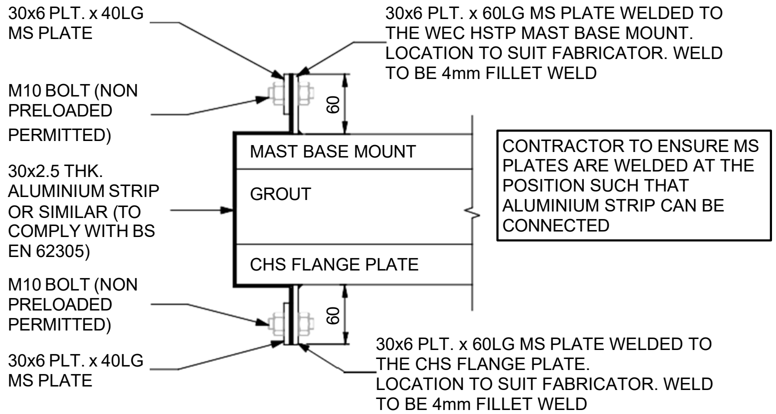
ANK PLATE SHALL BE POSITIONED
50mm FROM THE BOTTOM
G FOR DUCT.

TO ENSURE GROUT INGRESS (IF
HALL NOT DAMAGE THE DUCT.

DIRECTION OF TRAFFIC

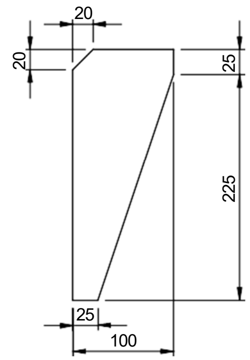
DETAIL PLAN OF BLANK PLATE

SCALE 1 : 5



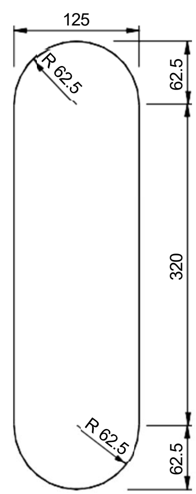
DETAIL 1 - LIGHTNING PROTECTION

SCALE 1 : 5

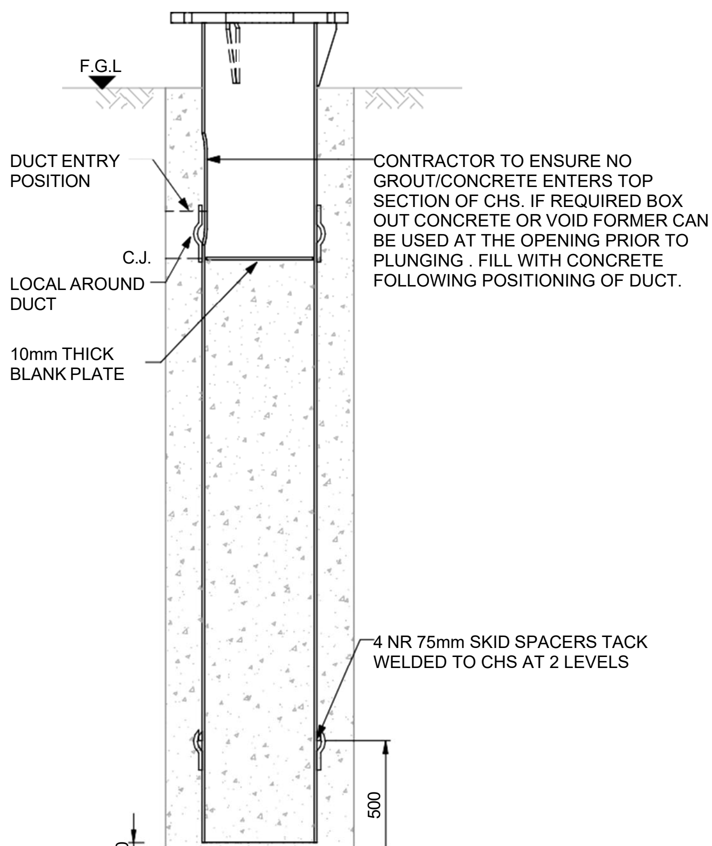


STIFFENER PLATE DETAIL

SCALE 1 : 5



OPENING FOR DUCT



FOLLOWING INSTALLATION TO ENSURE THAT NO DEFORMATION OCCURRED DURING THE INSTALLATION PROCESS.

9. FOR LOCATION PLAN PLEASE REFER TO HIGHWAYS GENERAL ARRANGEMENT M1 J23A - 25 SHEET 10 OF 11 (HE614830-JAC-HGN-P015_AL_ALLGENR-DR-CF-0010)
10. FOR COORDINATES REFER TO SERIES 1500 SCHEDULE.
11. FOR PSB REFER TO SERIES 400 SCHEDULE.
12. POSITIONAL AND VERTICAL TOLERANCES OF THE AUGERED HOLE SHALL BE IN ACCORDANCE TO 1600 AND ITS APPENDIX
13. CCTV MAST, BRACKET ARM, HOLDING DOWN THREADED RODS (INCLUDING NUTS) SHALL BE GALVANISED AND PAINTED IN ACCORDANCE WITH APPENDIX 19/1.

    OVERALL EXTERNAL SURFACES PROTECTION SYSTEMS, TYPE G2A OR G2B, FOR *GROUND SECTION* SHALL COMPLY WITH TABLE 19/4C OF THE 1900 SERIES. THE "*GROUND SECTION*" OF THE PLUNGED PILE SHALL EXTEND FROM TOP PLATE TO 1m BELOW GROUND LEVEL.
14. * - PROJECT INSTRUCTION TO RETAIN REFERENCES ON DRAWINGS TO ALL CCTVS (INCLUDING AT NSSH) AND TO STATE 'IN ABEYANCE'.

    ABBREVIATIONS:

    CHS - CIRCULAR HOLLOW SECTION
    C.J. - CONSTRUCTION JOINT
    PSB - POINT OF SETBACK
    MS - MILD STEEL
    F.G.L - FINISHED GROUND LEVEL
    I.D - INTERNAL DIAMETER
    O.D - OUTER DIAMETER
    HD - HOLDING DOWN
    HSTP - HIGHWAYS SQUARE TROLLEY POLE
    PCD - PITCH CIRCULAR
    PLT. - PLATE
    LG - LONG
    THK - THICK
15. LOCATION OF CHAMBER AND ROUTING OF DUCTS SHOWN ARE TYPICAL AND DETAILS TO BE CONFIRMED WITH RELEVANT TECHNOLOGY DRAWINGS.
16. SETTING OUT POINTS AND FGL TO BE AS SHOWN IN TECHNOLOGY SCHEDULE, REFER TO HMC SERIES. FGLS SHOWN HERE ARE OBTAINED FROM TECHNOLOGY MODEL, IF THERE IS ANY DISCREPANCIES, TECHNOLOGY SCHEDULE SHALL TAKE PRECEDENCE.
17. VRS DETAILS ARE INDICATIVE. FOR DETAILS AND LAYOUT REFER TO THE RELEVANT HIGHWAYS DRAWINGS AND SERIES 400 SPECIFICATION APPENDICIES.
18. FOR MAST SPECIFICATIONS, REFER TO SERIES 1300.

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Designer:

wsp

Client:

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Project:

NATIONAL EMERGENCY AREA RETROFIT
M25 J23-27

Drawing title:

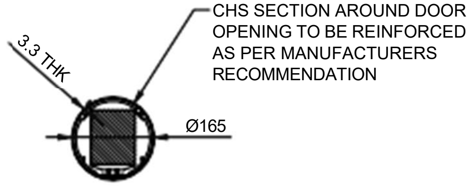
C
-

B
-

CDM 018 CDM 019 CDM 020

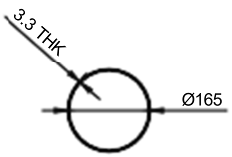
F.G.L

ADAR
OLE



SECTION B-B

SCALE 1:10



SECTION C-C

SCALE 1:10

ACCORDANCE WITH BS4449:2005.

29. REFER TO SCHEME SPECIFICATION APPENDIX 17/1 FOR CONCRETE REQUIREMENTS.

SITE

30. THE CONTRACTOR IS TO UNDERTAKE A THOROUGH VISUAL INSPECTION OF ALL AREAS COVERED IN THE SCOPE OF WORKS TO DETERMINE THE INTEGRITY, STABILITY AND SUITABILITY OF EXISTING ASSETS PRIOR TO PRICING THE ANY DISCREPANCIES OR CONCERNS TO BE IMMEDIATELY HIGHLIGHTED TO THE PROJECT MANAGER.
31. ALL DRAWINGS TO BE PRINTED IN COLOUR.
32. LIFTING EYES ARE TO BE REMOVED AFTER BASE INSTALLATION, LIFTING EYE SOCKETS ARE TO BE FILLED WITH R4 MORTAR TO BS EN 1504-3.LIFTING SOCKET TO BE SSLW16216 PRODUCT OR SIMILAR. MIN 50MM RECESSED LIFTING EYES TO BE USED IN ACCORDANCE WITH THE MANUFACTURERS RECOMMENDATIONS.

HEALTH AND SAFETY

33. SAFETY IS A PRIORITY. IF YOU HAVE ANY CONCERN ABOUT SAFETY IN THE CONSTRUCTION OR ULTIMATE USE OF THE WORKS DESCRIBED, PLEASE RAISE IT IMMEDIATELY WITH THE PROJECT MANAGER.
34. INSPECTION AND MAINTENANCE ACCESS TO BE PROVIDED DURING LANE CLOSURES USING HYDRAULIC ACCESS EQUIPMENT.
35. INSPECTION AND MAINTENANCE ACCESS TO BE PROVIDED DURING LANE CLOSURES USING HYDRAULIC ACCESS EQUIPMENT.
36. CANTILEVER POLE TO BE FABRICATED AND WELDED OFF SITE AND FOUNDATION TO BE PRECAST OFF SITE TO MINIMISE ON SITE WORKING.
37. CONTRACTOR TO UNDERTAKE UTILITY SURVEY PRIOR TO ANY EXCAVATIONS, AND USE EXCAVATION METHODS TO MINIMISE THE RISK OF UTILITIES STRIKE.

9. CANTILEVER POLE TO BE DESIGNED IN ACCORDANCE WITH CD 354 AND THE RELEVANT EUROCODES.
10. THE SUPERSTRUCTURE IS TO BE DESIGN AS STRUCTURAL ALUMINIUM GRADE EN-AW 6060 T66 THAT WILL COMPLY WITH EN 755-1, ALUMINIUM POLE TO HAVE BRUSHED FINISH.
11. CHS SECTION SURROUNDING THE DOOR IS TO BE REINFORCED AS PER THE MANUFACTURERS RECOMMENDATIONS WITH BRUSHED FINISH.
12. M10 A4-80 STAINLESS STEEL DOUBLE LOCK NUT BOLTS WITH ISOLATING WASHERS ARE TO BE USED ON THE LEVELLING PLATE.
13. ALL BOLT HOLES TO BE NORMAL CLEARANCE UNLESS OTHERWISE STATED, ISOLATING WASHERS (NYLON OR SIMILAR) TO BE USED.
14. ALL ALUMINIUM WELDING TO BE IN ACCORDANCE WITH BS EN1011-4.
15. WELDERS AND WELDING PROCEDURES ARE IN ACCORDANCE WITH BS EN 287-2 AND BS EN 288-4 RESPECTIVELY.
16. ALUMINIUM POLE LOCK HINGE TO BE PERMANENTLY LOCKED IN PLACE.
17. ALL 52.54MM X 25MM SLOTTED CABLE ON SECTION C-C (THE UPPER PLATE) SHALL HAVE ROUNDED EDGES.

0 500
SCALE 1:5 MILLIMETRES

0 500 1000
SCALE 1:10 MILLIMETRES

0 2
SCALE 1:20 MILLIMETRES

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Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer:

Client

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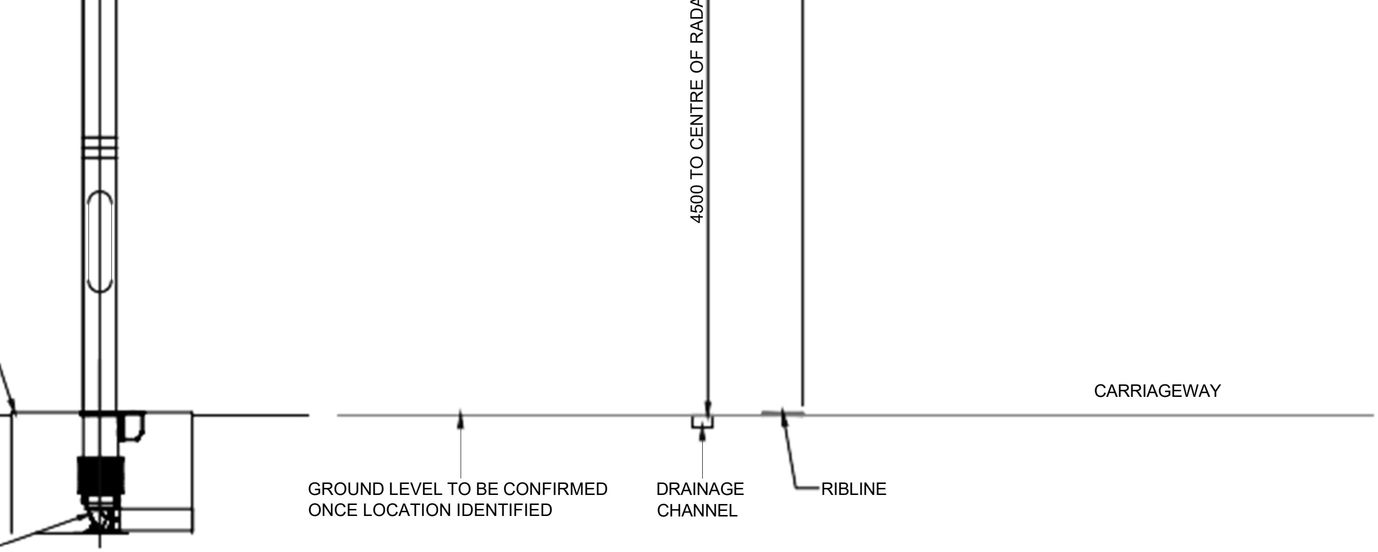
M1 J23a-25



TYPICAL CARRIAGEWAY ARRANGEMENT (WITHOUT VEHICLE RESTRAINT SYSTEM)- ELEVATION

SCALE 1:25

0 0.5 1 2

SCALE 1:25 MILLIMETRES

P01	09/01/24	SUITABLE FOR ACCEPTANCE	OWO	GCO	FQA	PCO
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Designer: wsp

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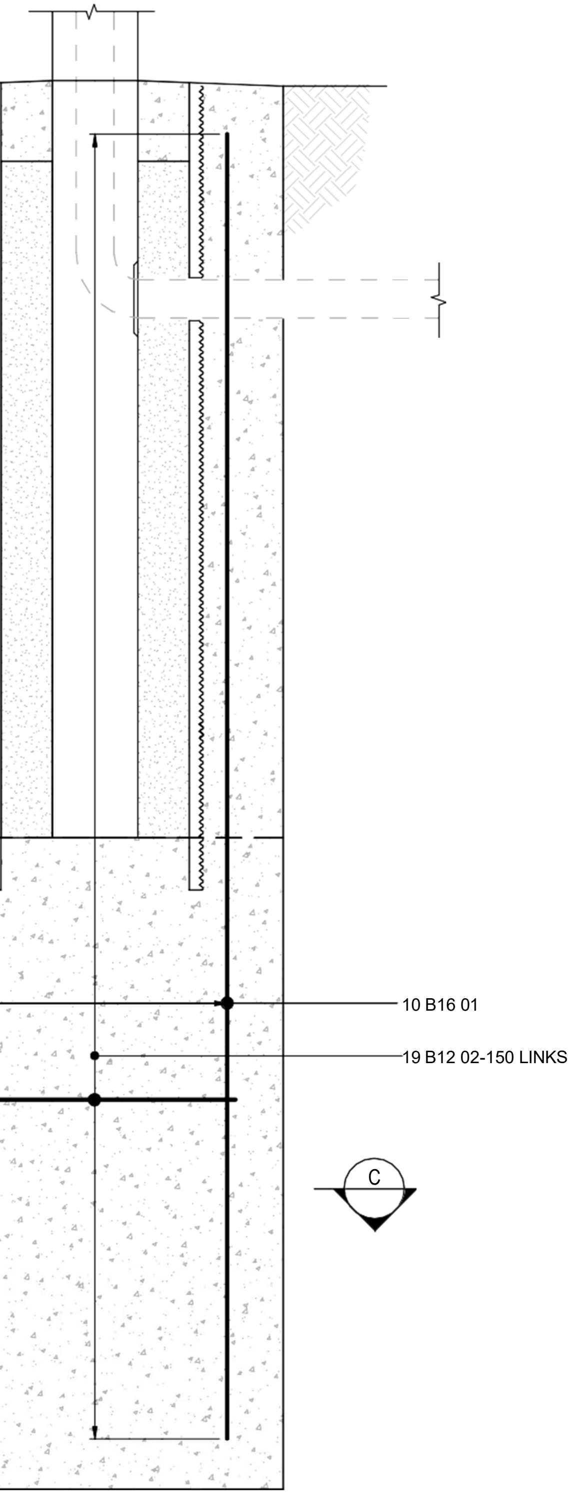
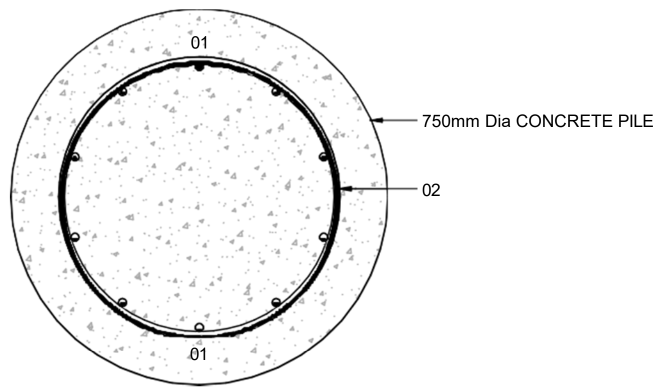


REINFORCEMENT DETAILS



SECTION C-C

SCALE 1 : 10

PLANTED FOUNDATION PERFORMANCE SPECIFICATION	
REQUIREMENT	**PLANTED FOUNDATION**
DIMENSIONS	
MAXIMUM ALLOWED COLUMN HEIGHT, H	8m
DESIGN LOADING	
MAXIMUM ALLOWED NOMINAL BENDING MOMENT	3.73 kNm

APPENDIX.

9. COLUMN SHALL BE GALVANISED AND PAINTED IN ACCORDANCE WITH APPENDIX 19/1.

   OVERALL EXTERNAL SURFACE PROTECTION SYSTEMS G2A OR G2B AND GROUND SECTION REQUIREMENTS SHALL COMPLY WITH TABLE 19/4C OF THE 1900 SERIES.

10. THE ORIENTATION OF THE OPENING AT FOUNDATION POST TO SUIT THE DUCT LAYOUT AND/OR DUCT LAYOUT MAY NEED TO ALTERED TO SUIT THE COULMN OPENING DOOR AND OPENING AT THE FOUNDATION POST.

11. ABBREVIATIONS

    CHS - CIRCULAR HOLLOW SECTION
    CJ - CONSTRUCTION JOINT
    F.G.L - FINISHED GROUND LEVEL
    B.G.L - BELOW GROUND LEVEL
    I.D. - INTERNAL DIAMETER
    PSB - POINT OF SETBACK
    MIDAS - MOTORWAY INCIDENT DETECTION AND AUTOMATIC SIGNALLING

REINFORCEMENT NOTES:

1. ALL DIMENSIONS SHOWN IN MILLIMETRES UNLESS STATED OTHERWISE.
2. NOMINAL COVER SHALL BE 95mm UNLESS NOTED OTHERWISE. BAR BENDING SCHEDULE HAS BEEN PREPARED UPON NOMINAL COVER.
3. REINFORCEMENT IS DETAILED AND SCHEDULED TO BS8666:2020.
4. REINFORCEMENT CALLED UP THUS: -

   15 - B - 16 - 43 - 150 - B1

   NO. OF BARS | TYPE OF BARS | BAR DIA. | BAR MARK | SPACING | LOCATION AND/OR COMMENT
5. REINFORCEMENT GRADE SHALL BE GRADE B500B OR B500C RIBBED BARS IN ACCORDANCE WITH BS4449:2005.
6. ALL REINFORCEMENT SHALL COMPLY WITH ALL RELEVANT BRITISH STANDARD SPECIFICATIONS, AND BE PROVIDED BY FIRMS CERTIFIED UNDER THE U.K. SPECIFICATIONS FOR REINFORCING STEELS (CARES) SCHEME.

Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd
P01	23/02/24	FIRST ISSUE	OWO	GCO	FQA	PCO

Designer: wsp

Client: national highways | smp alliance

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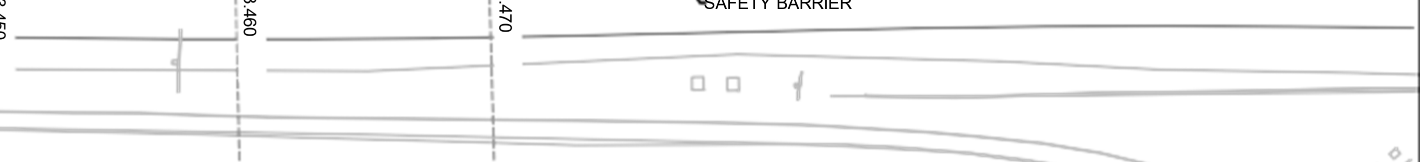
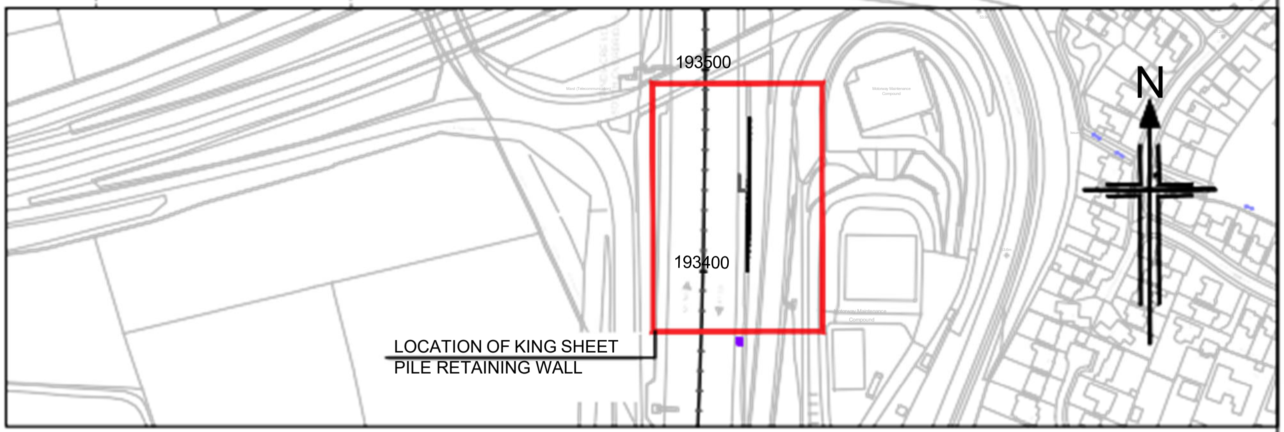
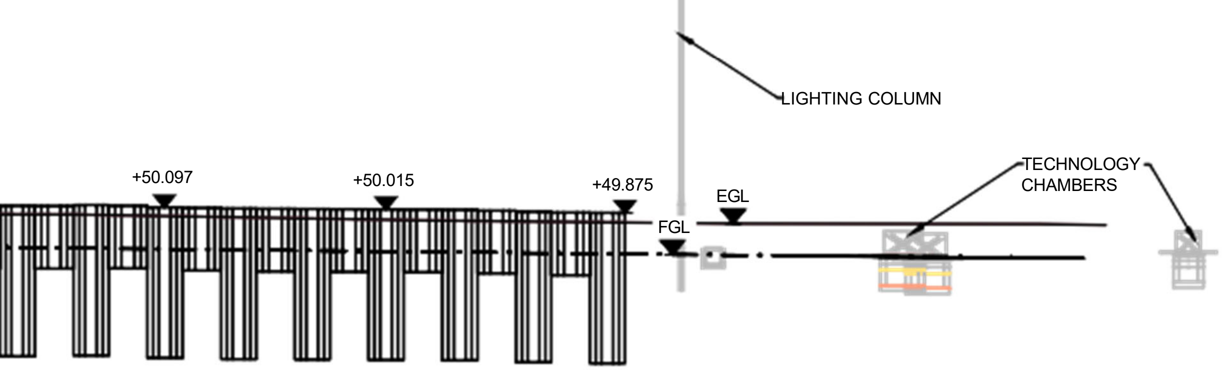
M1 J23a-25

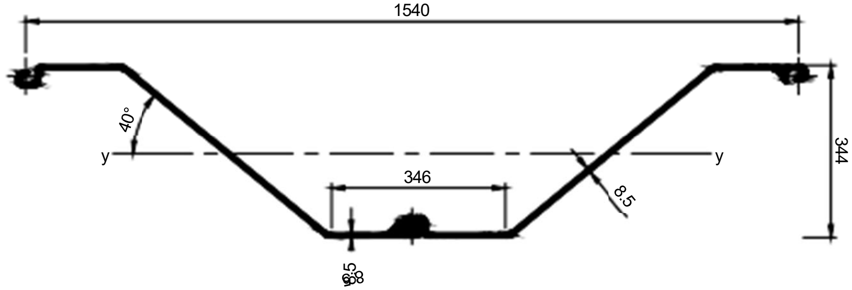




LOCATION PLAN

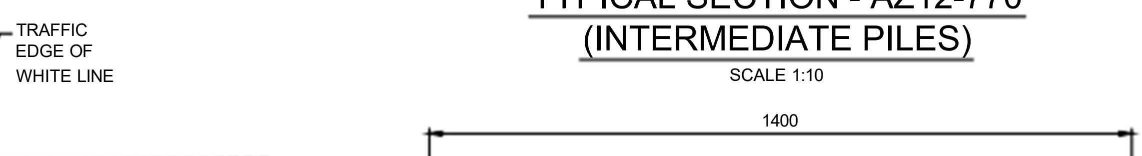
SCALE 1:2500





TYPICAL SECTION - AZ12-770 (INTERMEDIATE PILES)

SCALE 1:10



AUTHORITY OF THE OVERSEEING ORGANISATION AND THE PROJECT MANAGER SHALL BE INFORMED IMMEDIATELY AFTER THE CONTRACTOR IS AWARE THAT A TOE LEVEL CANNOT BE REACHED.

9. CONSTRUCTION TRAFFIC TO BE LIMITED TO LESS THAN 10KPa LOADING AT THE BACK OF THE WALL.

10. THE SEQUENCE FOR CONSTRUCTION FOR ALL MAJOR ELEMENTS OF THIS STRUCTURE SHALL BE AS BELOW, UNLESS AGREED OTHERWISE BY DESIGNER:-

a). ANY TREES THAT ARE CONSIDERED AT RISK OF THE DYING OFF AS A CONSEQUENCE OF THE WALL INSTALLATION SHALL BE REMOVED AS PART OF THE WORKS. THIS SHALL INVOLVE CUTTING THE TREES DOWN AND CORING OUT THE ROOTS.

b). TOPSOIL THICKNESS SHOULD BE AS 3000 SERIES AND 600 SERIES.

c). TREES THAT OBSTRUCT PILE INSTALLATION TO BE REMOVED PRIOR TO PILING.

d). COMPLETE SHEET PILING.

e). BACKFILL WITH 6N MATERIAL AND COMPACT IN ACCORDANCE WITH SHW.

f). INSTALL PEDESTRIAN GUARD RAIL AND ANY OTHER FURNITURE.

11. THIS DRAWING TO BE READ IN CONJUNCTION WITH OTHER RELEVANT DRAWINGS AND SPECIFICATIONS APPENDICES 400, 500, 600, 700,1500, 1600, 1700 AND 1800.

12. MIN. 1.0M HIGH STEEL GUARD RAILS SHALL BE GALVANISED, DESIGN LOADING CLASS: CLASS 1 (500N/M FOR LONGITUDINAL MEMBERS), WITH CLASS: B FULL HEIGHT VERTICAL INFILL, IN ACCORDANCE WITH BS7818:1995.

13. FOR REQUIREMENT OR INCLUSION AND DETAILS OF WEEP HOLE WITHIN SHEET PILE RETAINING WALLS, PLEASE REFER TO GEOTECHNICS SERIES 1600 DRAWINGS.

P01.1		FIRST ISSUE				
Rev	Rev. Date	Purpose of revision	Drawn	Checkd	Rev'd	Apprv'd

Designer: wsp

Client: national highways | amp alliance

Project: NATIONAL EMERGENCY AREA RETROFIT
M1 J23a-25

Annex I Contaminated Land Risk Assessment Methodology

The contamination assessment in this report is based on the Environment Agency's (EA) Land Contamination Risk Management (LRCM) (EA, 2020), which has been developed to provide the technical framework for applying a risk management process when dealing with land affected by contamination. An important thread throughout the overall process of risk assessment is the need to formulate and develop a Conceptual Site Model (CSM) for the site, which supports the identification and assessment of contaminant linkages. Development of the CSM forms the main part of preliminary risk assessment. If an unacceptable risk is determined and warrants further investigation (potentially including ground investigation) to establish what, if any contamination is present and, if possible, its extent, the model will be subsequently refined or revised as more information and understanding is obtained through the risk assessment process.

A risk assessment has been undertaken for the site to identify the main potential land contamination constraints to development based upon review of the site history, ground conditions from historical ground investigation data (BGS) and environmental setting. The method for risk evaluation has been based on guidance by CIRIA 'C552: Contaminated Land Risk Assessment - A Guide to Good Practice' (CIRIA, 2001), which is a qualitative method of interpreting the risks based on the magnitudes of both the potential consequence (severity) and the probability (likelihood) of the risk occurring.

The risk tables used to classify the consequence and likelihood of a risk, alongside descriptions of risk levels identified are presented in below. The risk matrix (see Table 33) has been used to estimate a risk score for each potential constraint to development (hazard) for potential land contamination constraints identified based on the definition outlined in Table 31 and Table 32 .

Table 31 Definitions of Hazard Levels

Level of Hazard	Description
Severe	Acute risk to human health likely to result in "significant harm" as defined by EPA 1990 Part 2A. Short term risk to sensitive water resource. Catastrophic damage to buildings/property. A short-term risk to a particular ecosystem or organism forming part of that system.
Medium	Chronic damage to Human Health. Pollution of sensitive water resource. Significant change to an ecosystem or organism forming part of ecosystem.
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services. Damage to sensitive buildings/structures/ services or the environment.
Minor	Harm, which may not be significant and may result in financial loss, or expenditure to resolve. No permanent health effects to human health (preventable by PPE). Easily repairable effects of damage to buildings, structures and services.

The levels of likelihood of occurrence are defined in Table 32 below.

Table 32 Definitions of Likelihood Levels

Level of Likelihood	Description
High	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.

Level of Likelihood	Description
Low	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period that such an event would take place and is even less likely in the shorter term.
Unlikely	There is a pollution linkage, but circumstances are such that it is improbable that an event would occur even in the very long term.

The calculation of final risk scores is illustrated in Table 33 and the levels of risk defined in Table 34.

Table 33 Risk Matrix

Likelihood		Consequence			
		Severe	Medium	Mild	Minor
Likelihood	High	Very high	High	Moderate	Moderate/low
	Likely	High	Moderate	Moderate/low	Low
	Low	Moderate	Moderate/low	Low	Very Low
	Unlikely	Moderate/low	Low	Very Low	Very Low

Table 34 Definitions of Risk Levels

Level of Risk	Description
Very high	There is a high likelihood of the event occurring and having severe consequences. If the risk is realised it is likely to result in a substantial liability.
High	Likely that an event with medium or even severe consequences could arise. If the risk is realised it may result in a substantial liability.
Moderate	It is possible that an event could occur, and it is either unlikely and consequences may be severe or if it were to occur it is likely that consequences would be relatively mild. Investigation would normally be required to clarify the risk and determine the potential liability.
Low	It is possible that an event could occur, but it is likely that the consequences would be at worst mild.
Very Low	It is unlikely that an event could occur, and if it happened the consequences are likely to be at worst mild.

Annex J Ground Investigation Factual Report

Factual Ground Investigation Report

M1 J23A-J25 NEAR

Client: BMJV

Project Number: G230600

Date of Issue: 04/09/2023

Project Title	M1 J23A-J25 NEAR			Project Ref		G230600
Prepared By	Jade Baxter BSc (Hons) FGS, Deliverables Engineer					[redacted]
Checked By	Jono Wright MEng, Senior Engineering Manager					
Approved By	David Buckley CEng, Divisional Director					
Issue No	Status	Reason	Date	Prep.	Check	Approval
001	DRAFT	Awaiting Client Comment	07/08/2023	JB	JW	DB
002	FINAL	Final Report	04/09/2023	JB	JW	DB

Contents

1 Introduction

1.1 Appointment

Strata Geotechnics were appointed to undertake a ground investigation at the M1 J23A-J25 site in Derbyshire and Leicestershire by BM Joint Venture (BMJV) comprising Bam Nuttall Ltd and Morgan Sindall Construction and Infrastructure Ltd. The specification for the works was provided in the document HE614830-WSP-HGT-P015_AL_ALLGENR-RP-GE-0001, revision P02. Instruction to proceed with the work was received on 24/04/2023 order number S/PRS001/016.

This report presents a site-wide factual account of the site works undertaken.

1.2 Site Location and Description

The site is located on the M1 motorway between junctions 23A and 25, within north Leicestershire and south-east Derbyshire. The site is located between central grid references E447169, N336085 and E447522, N327089.

The site follows the motorway and is broadly rectangular in shape, it is approximately 9.2km in length. At the time of the investigation the site was occupied by the M1 motorway.

A site location plan is included in Appendix A.

1.3 Purpose of Investigation

The purpose of this investigation was to determine the subsurface ground and groundwater conditions at the site of the proposed infrastructure development. It is understood that the development will include new gantries. This information was obtained from a combination of intrusive investigation techniques and laboratory testing.

1.4 Scope of the Investigation

The Ground Investigation was carried out between 2nd May 2023 and 4th July 2023. The works comprised:

- 3 no. dynamic sampling boreholes with rotary core follow-on (denoted as BH1904N, BH1920N and BH1937N) to a maximum depth of 20.00m BGL.
- 7 no. dynamic sampling boreholes to a maximum depth of 10.00m BGL.

The works were undertaken as detailed by specification provided in document HE614830-WSP-HGT-P015_AL_ALLGENR-RP-GE-0001, revision P02.

The original specification detailed 12 no. dynamic sample borehole positions, all with rotary core follow-on once bedrock had been reached. During fieldwork, two of these positions (denoted as BH1850N and BH1825S) were descoped by the designer.

1.4.1 In-situ testing

1.4.1.1 Standard Penetration Tests (SPTs)

In-situ Standard Penetration Tests (SPTs) were conducted within the boreholes to ascertain 'N' values of the various lithologies encountered. This test acts as a proxy to ascertain the relative density of granular material. Relative density is determined in accordance with BS5930 table 10 for granular materials only. For fine grained or cohesive deposits consistency has been derived by hand field tests carried out by the logging engineer rather than from SPT results. SPT 'N' values detailed in this report have not been corrected for overburden pressure or hammer energy efficiency.

1.4.1.2 In-situ Hand Shear Vane and Pocket Penetrometer Testing

In-situ hand shear vane and pocket penetrometer tests were not requested by the client.

1.4.2 Service Clearance

Before any intrusive works, all the locations were scanned utilising a CAT (Cable Avoidance Tool) and associated generator by the main contractor.

1.4.3 Sampling Provision

During the investigation Disturbed (D) and Bulk (B), samples were recovered at specified depths and at every strata change for descriptive purposes and for geotechnical testing. Undisturbed thin-wall 100mm diameter (UT100) samples were also taken from cohesive strata for geotechnical laboratory testing. Liner (L) samples were taken from superficial strata and Core (C) samples were taken from bedrock for both descriptive and geotechnical testing purposes.

When suitable runs of core were present Core Sub-Samples (CSS) were taken to prepare for geotechnical testing. Environmental sampling (ES) was also requested by the client and taken at predetermined intervals and 1m into natural ground. The exploratory hole logs are presented in Appendix B.

1.4.4 Laboratory testing

Laboratory testing was requested by the client comprising of the following:

1.4.4.1 Geo-Environmental

The client has requested the following environmental testing.

- 11 no. Jacobs General Inorganics Suite
- 11 no. Jacobs Metals Suite
- 8 no. Jacobs TPH Suite
- 5 no. Jacobs Asbestos Suite

1.4.4.2 Geo-chemical

The has requested the following geo-chemical testing.

- 19 no. BRE Suite D – Brownfield Pyrite present
- 1 no. Loss On Ignition (LOI)

1.4.4.3 Geotechnical

The client has requested the following geotechnical testing.

- 31 no. Moisture Content (MC)
- 51 no. Atterberg Limits (LL/PL) – 4 Point
- 53 no. Particle Size Distribution (PSD) by wet sieve
- 4 no. PSD Sedimentation via Pipette
- 40 no. Density
- 1 no. Consolidated Undrained Triaxial (50, 100, 200kPa)
- 9 no. Small Shear Box
- 1 no. Large Shear Box
- 7 no. Point Load Index (10 determinations)
- 1 no. Unconfined Compressive Strength (UCS)

All the above tests have been carried out in accordance with the relevant standards at UKAS and MCERTS accredited laboratories. Standards adhered to include: BS1377:1990-2022, BS EN 17892 (where appropriate) and BRE SD1 for sulphate suites.

Samples collected during this investigation will be retained on the premises of Strata Geotechnics until week commencing 16th October 2023. Should any additional laboratory tests be required, please contact Strata Geotechnics prior to the above disposal date.

2 Limitations of Study

Strata Geotechnics are a wholly owned subsidiary of Van Elle Limited (VEL).

This report is for the sole use and benefit of BMJV in accordance with their brief and should not be relied upon or used by other parties without explicit prior written agreement from VEL. VEL disclaim any responsibility to the client and others in respect of any matters outside the above scope.

The investigation has been carried out to our understanding of current legislation and best practice; designed to produce information adequate for the appraisal of potential site conditions in relation to the proposed future use of the site. This investigation generally adhered to the guidelines outlined in BS5930:2015+A1:2020, Code of Practice for Site Investigations. In regard to testing of soils, the investigation generally adheres to guidance outlined in BS1377:1990 to 2022 and Testing of Soils for Civil Engineering Purposes and BS EN 17892 where appropriate.

New information, legislation, local authority planning conditions or changes to best practice may necessitate further fieldworks and revision/reissue of the ground investigation report after the date of this report issue. Further assessment, investigation or construction activities over time may reveal conditions that were not found during the period of these investigations and, therefore, could not have been taken into account in the preparation of the report. VEL reserves the right to amend their conclusions and recommendations in the light of further information that may become available.

Interpretation and recommendations should not be assumed valid for either adjacent areas of land or alternative land uses. Should the proposed site use change, the findings of this report should be re-assessed for the new end-use.

Intrusive investigations can only investigate ground beneath a small proportion of the total site area. Attention is drawn to the fact that the findings are based on data obtained from the borehole samples and in-situ testing. Where comments are made based on information obtained from third parties, VEL assumes that all third-party information is true and correct. No independent action has been undertaken to validate the findings of third-party information, unless specifically stated. The possibility of variation in ground conditions around the borehole should not be overlooked. As such these do not necessarily address all aspects of the ground behaviour on site. Any opinion or diagram of a possible configuration of strata beyond the borehole or extrapolated to greater depth is conjectural and given for guidance only, no responsibility is accepted as to its accuracy. No liability can be accepted for such variations.

This investigation was undertaken in good faith with regards to the request and requirements of BMJV at the time of quotation, it does not constitute a full interpretative report with regards to the geotechnical or environmental status of the site. There may be other sources of information not included in this report that hold data relevant to the site that could materially affect the conclusions made in this report.

Where applicable this report should be presented to the relevant statutory authority, planning body, or design engineers as soon as possible for their review, comment and/or acceptance.

It is possible therefore that the intrusive investigation undertaken by VEL, whilst fully appropriate, may not have encountered all significant subsurface conditions. Consequently, no liability can be accepted for conditions not revealed by the exploratory holes.

3 Results of the Ground Investigation

3.1 Published Ground Conditions

The published geological records available from the British Geological Survey indicates that the site is located upon a number of superficial deposits all of which from the Quaternary Period. The majority of these are sand and gravels. The list of superficial deposits is below.

- Egginton Common Sand and Gravel Member – Sand and gravel
- Wanlip Member – Sand and gravel
- Head – Clay, silt, sand and gravel
- Hemington Member – Silt and gravel
- Holme Pierrepont Sand and Gravel Member – Sand and gravel
- Alluvium – Clay, silt, sand and gravel
- Beeston Sand and Gravel Member – Sand and gravel
- Eagle Moor Sand and Gravel Member – Sand and gravel

The underlying solid bedrock geology is varied, with the site potentially passing through nine different formations, all from the Triassic Period. These bedrocks are listed below.

- Gunthorpe Member – Mudstone (247.1-237 Ma)
- Gunthorpe Member – Dolomitic siltstone (247.1-237 Ma)
- Diseworth Sandstone – Sandstone (247.1-237 Ma)
- Tarporley Silstone Formation – Siltstone, mudstone and sandstone (250-241.5 Ma)
- Helsby Sandstone Formation – Sandstone (247.1-241.5 Ma)
- Edwalton Member – Mudstone (237-228.4 Ma)
- Arden Sandstone Formation – Sandstone (237-228.4 Ma)
- Branscombe Mudstone Formation – Mudstone (228.4-201.3 Ma)
- Cotgrave Sandstone Member – Sandstone (237-228.4 Ma)

3.2 Encountered Ground Conditions

3.2.1 Made Ground

Made Ground was encountered from the surface at all exploratory locations. Black bituminous material was found from ground level in all borehole locations, but BH1920N, to a depth of 0.30m BGL. A concrete bound material is beneath the bituminous material in all locations to a maximum depth of 1.30m BGL. Boreholes BH1877N, BH1902N, BH1904N and BH1933S all have sandy, gravel of quartz and quartzite beneath the concrete to a maximum depth of 1.20m BGL. The remainder of the boreholes, concrete is immediately on top of natural superficial deposits.

The made ground in BH1920N comprises sandy, gravelly clay to a depth of 1.60m BGL. Beneath the clay is silty gravelly sand to a maximum depth of 3.90m BGL.

3.2.2 Cohesive Superficial Deposits

Underlying the made ground reddish brown firm to very stiff, occasionally soft, clay is encountered. The clay is mostly sandy and gravelly, with rare cobbles and boulders. It occurs as shallow as 1.00m BGL, with a deepest occurrence of 16.00m BGL.

3.2.3 Granular Superficial Deposits

Within borehole locations BH1902N and BH1904N, beneath the made ground is loose to medium dense sand and gravel. Further sand and gravels were encountered in a number of borehole locations, noticeable within BH1877S, BH1896S and BH1912S where the gravel was very dense with the need of rotary open hole to penetrate it. BH1877S also contained boulders with the gravel strata. These deposits were recorded at depths ranging from 0.90m BGL to 14.85m BGL.

3.2.4 Solid Geology

During the investigation mudstone and sandstone bedrock were encountered within three and two locations respectively. The mudstone bedrock occurred at depth ranges of 4.80m BGL to 16.90m BGL, with strengths of very weak to weak.

The sandstone was encountered in BH1904N at a depth of 16.90m BGL to 20.00m BGL, it was also encountered in BH1937N at a depth of 3.30m BGL to 4.10m BGL.

Please refer to the exploratory hole logs in Appendix B for a more detailed account of the conditions encountered during the investigation.

3.3 In-situ Tests

3.3.1 In-situ Standard Penetration Tests (SPT)

Standard penetration tests (SPT's) were carried out with the use of a normal solid cone or split spoon sampler in the solid deposits encountered within the boreholes in order to determine the relative strength / density of the materials tested. Where the full penetration depth could not be achieved, the bottom sampling depth is indicated as less than 0.45m from the top (start of test), with the actual depth of penetration being recorded in millimetres. The results are shown as 'N' values on the graphic borehole record sheets, these have not been corrected for hammer efficiency or over burden pressure. Where possible a disturbed sample was collected also.

A summary of SPT results by geological unit is presented below:

Table 3-1 – Summary of SPT results.

Strata	SPT Range ('N')	Notes
Made Ground	15 – 36	Indicative of medium dense to dense strata
Cohesive Superficials	15 - 50	Indicative of firm to very stiff conditions
Granular Superficials	10 – 50+	Indicative of loose to very dense strata
Mudstone	50+	
Sandstone	50+	

3.4 Laboratory Testing

The laboratory test results so far indicate that the soils at the site are:

Table 3-2 – Summary of laboratory testing results.

Geotechnical	Test Results Range
Moisture Content %	2.7 - 24
Plasticity Index %	NP - 22
Effective Cohesion (kPa)	17.29
Effective Friction (deg)	39.7
Density (Bulk Mg/m^3)	2.00 – 2.33
Density (Dry Mg/m^3)	1.61 – 2.19
Point Load Index Is50 (MPa)	0.05 – 3.86
Geochemical	**Test Results Range**
pH	6.1 – 9.7
Water Soluble sulphate (mg/l)	<10 – 81
Total Sulphate (mg/kg)	<100 - 600
Total Sulphur (mg/kg)	<100 - 800
Total Sulphur (%)	<0.01 – 0.08
LOI (%)	3.4

3.5 Groundwater

Groundwater was not encountered during this investigation.

Water strikes are detailed on the exploratory hole logs presented in Appendix B.

Changes in groundwater level may occur for a number of reasons, including seasonal effects and variations in drainage. The long term groundwater elevation may increase or decrease at some time in the future. Groundwater direction has not been determined as part of this report.

3.6 Groundwater and ground gas monitoring

Combined groundwater monitoring installations were not requested by the client.

4 References

- British Geological Survey (BGS – formerly the Institute of Geological Sciences (IGS)) www.bgs.ac.uk and BGS Geoindex: http://mapapps2.bgs.ac.uk/geoindex/home.html.
- BS 5930:2015 A1 - 2020 Code of Practice for Site Investigations.
- BS EN ISO 14688 Identification, Description and classification of soils
- BS EN ISO 14689 Identification, Description and classification of rocks
- BS1377:1990-2022, Methods for Testing of Soils for Civil Engineering Purposes.
- BS EN ISO 17892, Geotechnical investigation and testing. Laboratory testing of soil
- BS 8574:2014- Geotechnical Data Management

APPENDICES

Appendix A: Drawings