A585 Windy Harbour to Skippool Improvement Scheme

TR010035

5.2 Flood Risk Assessment

APFP Regulation 5(2)(e)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Volume 5

May 2019

Page Left Intentionally Blank

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning
(Applications: Prescribed Forms and
Procedure) Regulations 2009

A585 Windy Harbour to Skippool Improvement Scheme

Development Consent Order 201[ ]

FLOOD RISK ASSESSMENT PART 1

Regulation Number:	Regulation 5(2)(e)
Planning Inspectorate Scheme Reference	TR010035
Application Document Reference	TR010035/APP/5.2
Author:	A585 Windy Harbour to Skippool Improvement Scheme Project Team, Highways England

Version	Date	Status of Version
Rev 0	April 2019	DCO submission
Rev 1	May 2019	Deadline 2 Submission

Page Left Intentionally Blank

CONTENTS

1 EXECUTIVE SUMMARY 1
2 INTRODUCTION 4
2.1 Background 4
2.2 Scope of Works 4
2.3 Terminology 5
2.4 Limitations 5
3 BACKGROUND 6
3.1 Site Location 6
3.2 Proposed Development 6
3.3 Catchment Description 8
3.4 Flood History and Defences 10
4 NATIONAL POLICY STATEMENT FOR NATIONAL NETWORKS 15
4.1 General 15
4.2 The Sequential and Exception Tests 15
4.3 EA Flood Zone Categorisation and Development Flood Risk Vulnerability Classification 16
4.4 Application of the Sequential Test and Exception Test 17
5 POTENTIAL SOURCES OF FLOODING 18
5.2 Fluvial 18
5.3 Coastal 18
5.4 Groundwater 19
5.5 Surface Water 19
5.6 Artificial Sources 22
6 ASSESSMENT METHODOLOGY – FLUVIAL AND TIDAL FLOOD RISK 23
6.1 General 23
6.2 Consultation and Data Collection 23
6.3 Hydrology 23
6.4 Baseline Fluvial Hydraulic Modelling 25
6.5 Baseline Tidal Modelling 26
6.6 Option Modelling (Fluvial and Tidal Models) 26
7 MODELLING RESULTS 28
7.1 Fluvial Flooding 28
7.2 Impact of Tide Locking on Fluvial Flood Levels 28

7.3 Tidal Flooding....31
7.4 Implication of Results for the Scheme....33
7.5 Construction Phase Flood Risk....37
7.6 Pool Foot Creek....43
7.7 Limitations of the Model....44
8 SURFACE WATER RUNOFF....45
9 FLOOD RISK MANAGEMENT MEASURES....46
9.1 Protection of Third Parties....46
9.2 Protection of the Scheme....48
9.3 Management of Residual Risks....48
10 SUMMARY AND CONCLUSIONS....50
11 RECCOMENDATIONS....52

APPENDICES

APPENDIX A – EA PRODUCT 4 DATA....55
APPENDIX B – HYDRAULIC MODELLING TECHNICAL DETAILS....57
APPENDIX C – FEH CALCULATION RECORD....59
APPENDIX D – MAPPED FLOOD EXTENTS AND IMPACTS....61
APPENDIX E – DRAINAGE DESIGN DEVELOPMENT REPORT....64
APPENDIX F – MEETING MINUTES....66

LIST OF TABLES

Table 1: Flood Zones (Source: PPGNPPF (2014), Table 1)....15
Table 2: Flood Risk Vulnerability Classification (Source: PPGNPPF Table 3)....16
Table 3: Sources of Flooding....18
Table 4: Greenfield Runoff Rate Calculations....20
Table 5: Summary of design flow estimates (m^3/s)....24
Table 6: Peak Flow through Skippool Bridge....33
Table 7: Peak Stage at the Proposed A585 Crossing for all Option Model Runs....34
Table 8: Modelled Tidal Flood Levels and Risk to the Scheme....36
Table 9: Change in Predicted Flood Levels Grouped by Property Level Impact....47

LIST OF FIGURES

Figure 1: Site Location Plan (Contains Ordnance Survey data © Crown copyright and database right 2016)....6
Figure 2: Scheme Proposals and Constraints (Contains Ordnance Survey data © Crown copyright and database right 2017)....7
Figure 3: Watercourses (Contains Ordnance Survey data © Crown copyright and database

right 2017).....8
Figure 4 Location of EA Flood Defences (supplied by the EA, data request ref CL5227).....11
Figure 5: Tidal Gates at Main Dyke Outfall to Wyre Estuary (Source: Arcadis, 2017).....12
Figure 6: Tidal Gates at existing A585 Bridge (Source: Arcadis, 2017).....13
Figure 7: Skippool Clough Culvert (Source Arcadis, 2017).....13
Figure 8 EA Surface Water Flood Map (© Crown copyright and database rights 2017 OS 100024198).....21
Figure 9 Catchments Draining to Flow Estimation Points ((Contains OS data © Crown copyright [and database right] (2016)).....24
Figure 10: Fluvial Hydraulic Model Schematisation (Contains Ordnance Survey data © Crown copyright and database right 2017).....26
Figure 11: Main Dyke Tidal Flap Flow Hydrograph.....29
Figure 12: Main Dyke: Impact of Tide Locking.....30
Figure 13: Ground Levels East of Breck Road (Baseline in Red, with Scheme in Purple).....31
Figure 14: Cross Section Location (blue line) and Change in Peak Flood Depth as a result of the Scheme, 0.5% AEP (Contains Ordnance Survey data © Crown copyright and database right 2019).....32
Figure 15: Overtopping Flows West of Skippool Roundabout, 0.5% AEP plus Climate Change.....33
Figure 16: 1% AEP Comparison of Flows Downstream of Skippool Bridge (MAIN02_0147) for the Baseline and Option Model Runs.....34
Figure 17: Proposed Surface Water Drainage Pond (shown in green).....35
Figure 18: Proposed Construction Access Routes shown against the Maximum Flood Extent for a 1% AEP (+30% Climate Change Allowance) Flood Event (Embankment in place, Main Dyke A585 Crossing not upgraded, FCAs in place).....40
Figure 19: Location of the proposed Site Compounds in relation to the maximum tidal option modelled flood extent (0.5% AEP).....42
Figure 20: Location of the proposed Site Compounds in relation to the EA Flood Map for Planning.....43

Page Left Intentionally Blank

1 EXECUTIVE SUMMARY

1.1.1 This report documents the approach taken to assess sources of flood risk to the A585 Windy Harbour to Skippool Improvement Scheme ("the Scheme") and to quantify any flood risk impacts of the proposals. The Scheme is located to the south of the estuary of the River Wyre and crosses a number of tributaries of the Wyre, including the main river Main Dyke and Horsebridge Dyke, as well as several ordinary watercourses.

1.1.2 The Environment Agency Flood Map for Planning (Rivers and Sea) shows that the majority of the Scheme is located in Flood Zone 1. However, a small portion of the Scheme is located in Flood Zone 3 (when the presence of flood defences is ignored, land with a 1 in 100 (1%) or greater chance of flooding each year from rivers; or with a 1 in 200 (0.5%) or greater chance of flooding each year from the sea). Flood defences, comprising raised walls/embankments and flap gates, are present and these provide protection against fluvial and tidal flooding.

1.1.3 With regard to flood risk vulnerability, the Scheme is classified as Essential Infrastructure. The location of this type of development is deemed appropriate in Flood Zones 1, 2 and 3, subject to satisfaction of the National Planning Policy Framework Exception Test in Zone 3. Environmental assessments have demonstrated the wider sustainability benefits of the Scheme, satisfying part 1 of the Exception Test. The findings of this assessment help demonstrate that, within the design constraints of tying into the existing road network at each end, the Scheme would in the majority be flood free over its development lifetime. Also the Scheme would contribute to reducing flood risk overall (Exception Test Part 2).

1.1.4 The assessment has considered flood risk from a range of possible sources, namely river flooding, flooding from tides, surface water and groundwater flooding, as well as flooding from reservoirs, canals and other artificial sources. The assessment has used published data sources, as well as the results of bespoke hydraulic and hydrological modelling studies to quantify river and tidal flood risk. Consultation with the Environment Agency and Lead Local Flood Authority (Lancashire County Council) has been ongoing during the preparation of this report and assessment methodologies have been agreed with the Environment Agency.

1.1.5 The assessment has concluded that there is limited risk of flooding from groundwater and artificial sources. Land within the study area is also, mostly, at very low risk of surface water flooding. Implementation of a suitable surface water drainage strategy would manage rainfall runoff to ensure that the risk from surface water flooding would not increase across the Scheme. A suitable drainage design would be implemented to ensure that there would be no increase in surface water run-off from the Scheme to the local land drainage system and that there would be no increase in third party flood risk from this source.

1.1.6 Rivers and the tidal Wyre have been identified as the primary sources of flood risk to the Scheme, warranting detailed assessment. A linked 1D-2D model of the Horsebridge Dyke and Main Dyke was developed to quantify baseline fluvial flood risk and to enable an assessment of the potential impacts of the Scheme on this baseline status. The model represents open channel and culverted reaches of these watercourses, as well as key hydraulic structures and their floodplains.

1.1.7 Model results have demonstrated that the Scheme is not at risk of fluvial flooding from the Main Dyke or the Horsebridge Dyke. Modelled design events have included a range up to and including the 1% (1 in 100) annual chance flood, inclusive of 70% uplift in peak flow as an allowance for climate change.

1.1.8 Incorporating the Scheme into the model demonstrates that replacing the existing Skippool Bridge culverts with a 12.5m clear span bridge significantly reduces upstream flood extents in all modelled events. The flow regimes of these watercourses are subject to tide locking when high water levels in the Wyre Estuary prevent them from freely discharging. Tide locked conditions have also been modelled and results demonstrate that the Scheme is not at risk of flooding. Furthermore, the Scheme does not increase flood risk to third parties during either the free discharge or tide locked scenarios.

1.1.9 The preferred construction methodology for the Scheme necessitates that the road embankment is built before work to increase the capacity of the A585 crossing of the Main Dyke is commenced. Modelling of this scenario indicates that only minor increases in flood levels and extents would occur during smaller, more commonplace events and that these increases are constrained to open fields, rather than impacting any existing property or infrastructure. These effects would be mitigated through design, by provision of temporary compensatory storage on the right bank of the Main Dyke, immediately to the north of the A586.

1.1.10 A qualitative assessment of flood risk from the Pool Foot Creek, which is crossed by the Scheme towards its eastern end, also indicates that the Scheme would not be at risk of fluvial flooding from this source.

1.1.11 An Environment Agency 2D only model of the River Wyre Estuary was enhanced and used to assess both the risk of tidal flooding to the Scheme and any change in tidal flood risk to third parties resulting from the Scheme, assuming that existing flood defences on the Wyre remain in place. Model results show that immediately east of Skippool Junction the Scheme is at risk of tidal flooding during a 0.5% AEP event with and without an allowance for climate change (based on the UK Climate Impacts Programme 2018 predictions) When climate change is considered baseline flood risk depths in the order of 900mm are predicted locally. There are significant design constraints linked to the need for the Scheme to tie in to the existing road network. To protect this small part of the Scheme from flooding during this extreme event, it is considered that there is no practicable mitigation that would not cause detriment to flood risk on third party land. With the Scheme in place, during the 0.5% AEP event there is a localised benefit in terms of a reduction in flood risk to an area of existing residential development to the south east of Skippool Junction. This is due primarily to the inclusion of a dwarf wall along the eastbound carriageway of the A585 immediately to the east of Skippool Roundabout which limits the volume of water overtopping the road and flooding areas to the south. When climate change allowance is included the Scheme is predicted to increase baseline flood depths locally by up to 10cm. Although baseline flood depths are increased, changes in flood extents are negligible due to the nature of the topography. The increase in the context of baseline floodwater depths of over 1m is relatively small.

1.1.12 Residual tidal flood risk would be managed through notifying road users via appropriate signage and social media, giving warnings, and where necessary enforcing road closures, implemented using intelligence provided by the

Environment Agency flood warning service. Procedures and protocols are set out in the draft Flood Warning and Evacuation Plan, included as an appendix to the outline Construction Environmental Management Plan (document reference TR010035/APP/7.2).

1.1.13 This FRA, and the detailed modelling assessments that have informed it, have been reviewed by the Environment Agency. The comments received and responses to them are detailed in Appendix B and F.

2 INTRODUCTION

2.1 Background

2.1.1 Arcadis Consulting (UK) Ltd (Arcadis) has been commissioned by Highways England (HE) to undertake a Flood Risk Assessment (FRA) to inform the design and Environmental Impact Assessment (EIA) of the proposed A585 Windy Harbour to Skippool Improvement Scheme, in Lancashire (hereinafter referred to as the Scheme). The Scheme is described in Section 3.2.

2.1.2 The Environment Agency (EA) Flood Map shows that parts of the alignment of the Scheme are located in Flood Zone 3 (high probability of flooding). In line with the requirements of the National Networks National Policy Statement (NN NPS)1 and the supporting National Planning Policy Framework (NPPF)2, all proposals for new development in Flood Zone 3 should be accompanied by a site-specific FRA.

2.1.3 This report documents the approach taken to assess sources of flood risk to the Scheme and to quantify any flood risk impacts of the proposals. The findings of the assessment have both informed Scheme design and flood risk mitigation requirements.

2.2 Scope of Works

2.2.1 The agreed scope of works comprises the following tasks:

- Consult with the EA and Lancashire County Council, in their role as Lead Local Flood Authority (LLFA), to obtain baseline flood risk information, including the EA 1D hydraulic models of the Main Dyke and Horsebridge Dyke and the 2D tidal model of the River Wyre
- Appraise relevant documents and data (e.g. Strategic Flood Risk Assessment, Local Flood Risk Management Plan, EA Product 4 Data Pack)
- Use existing information to qualitatively assess flood risk from surface water, groundwater and artificial sources
- Update existing EA models of the Main Dyke and Horsebridge Dyke to produce a linked 1D/2D domain hydraulic model and update the design flow hydrology for subject watercourses for input into model
- Use the model to define baseline flood risk in the study area from fluvial flood events, including the tide locked scenario
- Enhance the existing EA Wyre tidal model to include watercourse and structure details in the vicinity of the Scheme and use the model to define baseline flood risk in the study area from tidal flooding
- Incorporate the proposed Scheme into the river and tidal models in order to quantify any flood risk impacts and mitigation requirements both during construction and on completion of the Scheme
- Prepare an FRA report to illustrate the findings of the study

[1] *National Networks National Planning Statement (Department for Transport, 2014)*
[2] *National Planning Policy Framework (Communities and Local Government, 2019)*

2.3 Terminology

2.3.1 Flood risk is a product of both the likelihood and consequences of flooding. Throughout this report, flood events are defined according to their likelihood of occurrence. Floods are described according to an 'annual chance', meaning the chance of a particular flood occurring in any 1 year. This is directly linked to the probability of a flood. For example, a flood with an annual chance of 1 in 100 (a 1 in 100 chance of occurring in any 1 year on average), has an annual exceedance probability (AEP) of 1%.

2.4 Limitations

2.4.1 This report has been informed by a number of data sources which Arcadis believe to be trustworthy. However, Arcadis is unable to guarantee the accuracy of information provided by others. The report is based on information available at the time of writing. Further details regarding the modelling assumptions and limitations are included in Section 7.7.

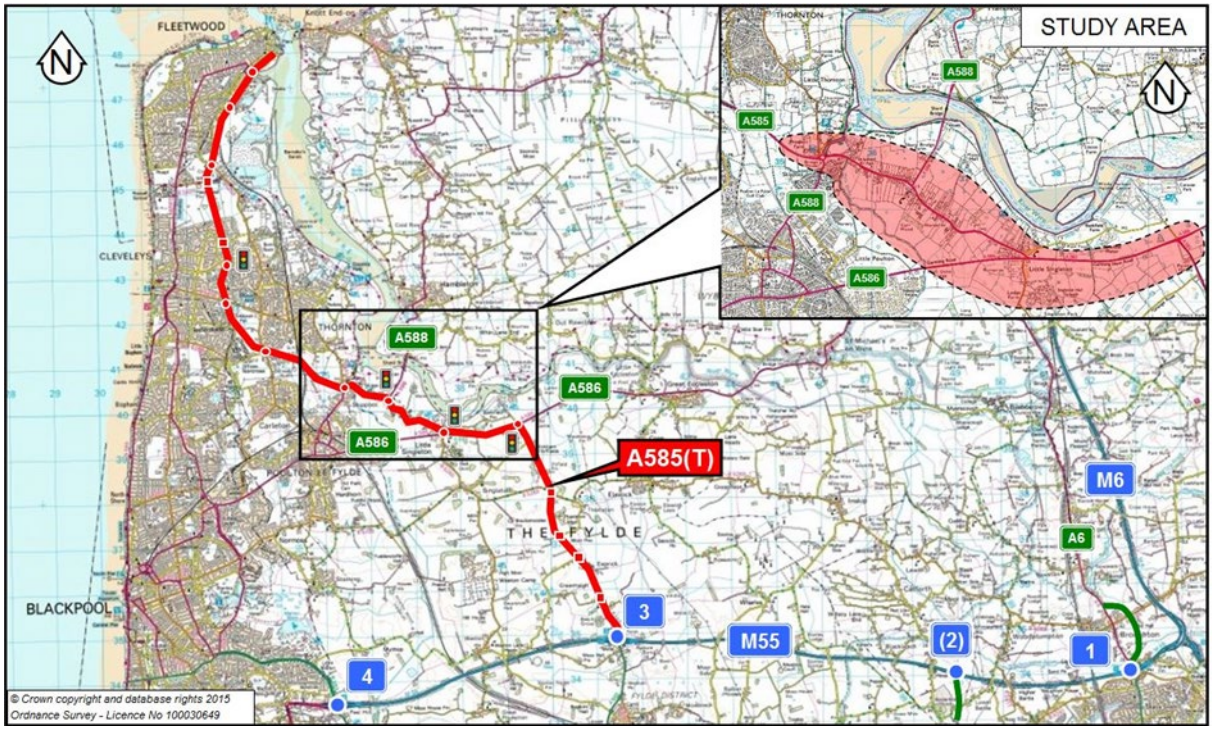
3 BACKGROUND

3.1 Site Location

3.1.1 The A585 is a single carriageway trunk road, which provides the only viable access from the motorway network, in particular the M6 and M55, into Fleetwood and surrounding urban areas in west Lancashire. As a result, the A585 suffers from congestion, in particular during peak travel times. The congestion is particularly severe at the A585/A586 signalised junction (Little Singleton) and the A585/A588 signalised junction (Shard Road).

3.1.2 The Government's Autumn Statement in 20143 identified the need for an Improvement Scheme along the A585 between Windy Harbour and Skippool to ameliorate the impact of traffic on the route between these 2 locations, illustrated in Figure 1.

Figure 1: Site Location Plan (Contains Ordnance Survey data © Crown copyright and database right 2016)



3.2 Proposed Development

3.2.1 The general arrangement of the Scheme is shown on document 2.5 (document reference TR010035/APP/2.5). The A585 Windy Harbour to Skippool Improvement Scheme ("the Scheme") consists of:

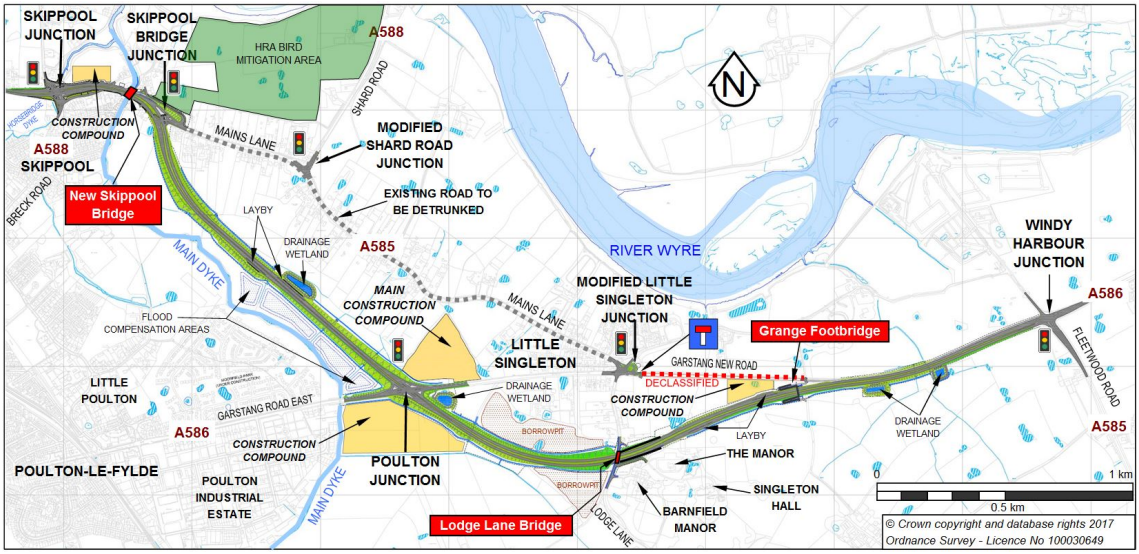
- A 4.85km (3 miles) long dual 2-lane carriageway bypass from Windy Harbour Junction to the Skippool Junction
- Four new junctions including: conversion of Skippool Junction to a traffic signal-controlled crossroads with A588 Breck Road and B5412 Skippool Road;

[3] https://www.gov.uk/government/topical-events/autumn-statement-2014

Skippool Bridge Junction in the form of a 3-arm traffic signal-controlled junction with the existing Mains Lane; Poulton Junction in the form of a signal-controlled crossroads connecting the new bypass to A586 Garstang Road East and modification to Little Singleton Junction (also known as Five Lane Ends) to accommodate U-turning traffic including buses. Between Skippool Bridge Junction and Poulton Junction the bypass is on embankment. East of Poulton Junction through to east of Lodge Lane the bypass is mostly in cutting

- Three new major structures including: replacement of Skippool Bridge; Lodge Lane Bridge and Grange Footbridge
- Alterations to the existing road network on completion of the bypass include: detrunking the A585 between Skippool Bridge Junction and the end of Garstang New Road east of Little Singleton; applying a reduction in speed limit to 30mph and providing a combined footway/cycleway along Mains Lane between Shard Road Junction and Little Singleton; altering Garstang New Road east of Little Singleton to allow restricted access to farmers' fields and provide a shared footway/cycleway route between Windy Harbour Junction and Little Singleton; applying a reduced speed limit of 30mph along Garstang Road East between the proposed Poulton Junction and Little Singleton and upgrading the lighting along Mains Lane and Garstang Road East

Figure 2: Scheme Proposals and Constraints (Contains Ordnance Survey data © Crown copyright and database right 2017)



A description of the key elements of the Scheme which impact on flood risk, and how the impacts have been assessed is included in Appendix B.

Design Life

3.2.2 The design life of the different components of the Scheme varies; these components would be repaired or replaced as they approach their normal design life. Examples include:

- Road surfacing would be removed and replaced after between 10 to 20 years;
- Steel safety fences would typically be replaced after 25 years;

- Lighting columns, road signs and traffic signals would be replaced after between 25 and 30 years;
- Electrical cables for lighting, signs and traffic signals would be replaced after typically 30 years;
- Drains, chambers and culverts may need repairs after 40 years but these would normally not require full replacement; and
- Structural concrete and steelwork for bridges and retaining walls have extended design lives of up to 120 years.

3.3 Catchment Description

3.3.1 The Scheme is located to the south of the estuary of the River Wyre, as illustrated in Figure 3. The River Wyre is designated by the EA as main river and, rising in the Forest of Bowland in central Lancashire, follows a southerly then westerly flow path, becoming tidally influenced below the weir at St Michael's. The tidally influenced reach of the river drains a catchment area of approximately 320km^2 and the river discharges into the Irish Sea at Fleetwood.

3.3.2 Tributaries of the Wyre are crossed by the Scheme. The Main Dyke is not a naturally occurring watercourse having been constructed to aid drainage of neighbouring farmland in the 18th or 19th Century. The Main Dyke is approximately 10.6km in length and drains into the Wyre via the Skippool Creek (see Figure 3), with gates operated to limit the upstream propagation of the tide. This watercourse is a designated main river and has a catchment extending from Marton Mere in Blackpool covering an area of approximately 30km^2. The watercourse has a very limited gradient and during dry weather periods localised ponding of water can be observed throughout its length. The Dyke is also reported to be subject to siltation and vegetation overgrowth, and the hydraulic regime is generally controlled by a relatively large number of road and rail crossings of varying length and geometry[4].

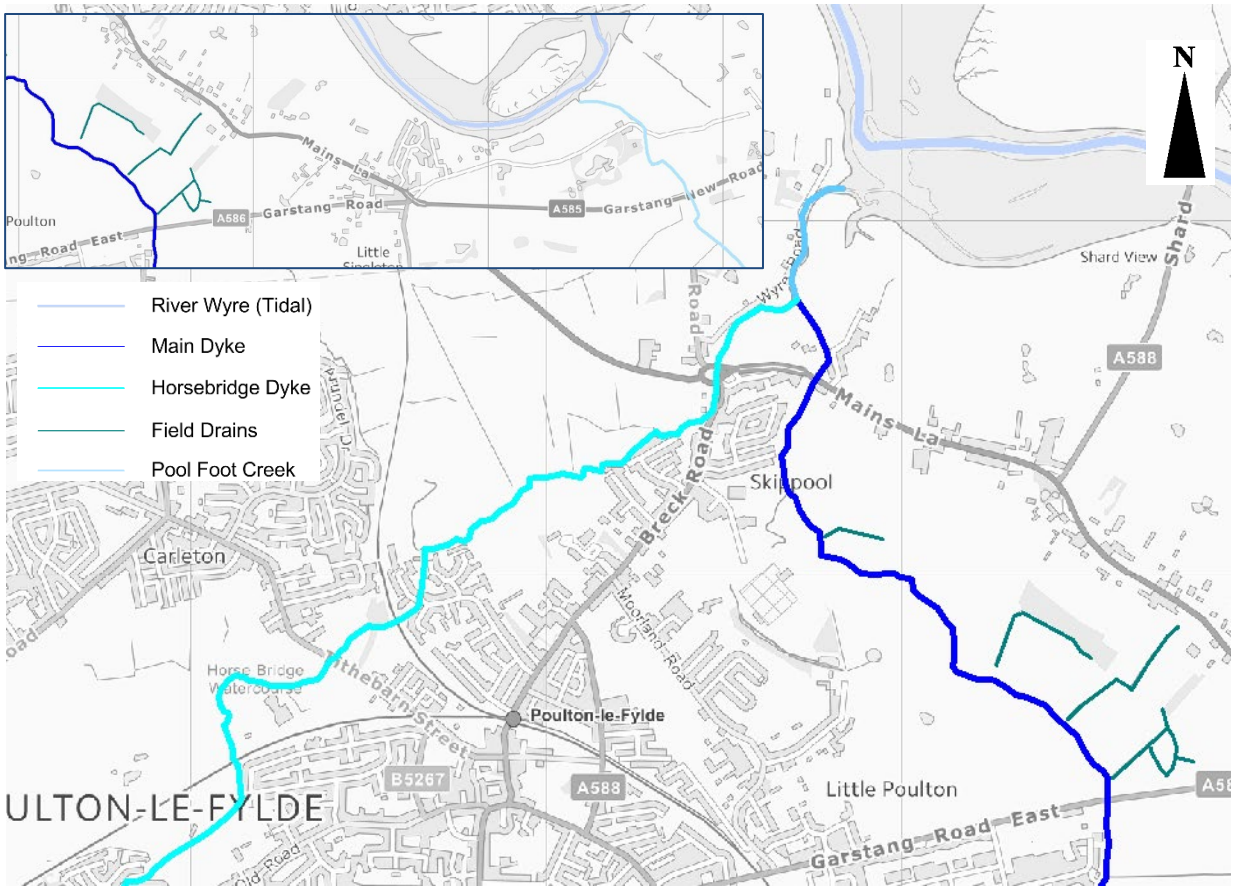
3.3.3 The Horsebridge Dyke also drains to the Skippool Creek / Wyre estuary via a flap valve structure. The Horsebridge Dyke is designated as a main river and drains a total catchment area of approximately 10km^2.

3.3.4 To the east of the Little Singleton Junction, the Scheme crosses an unnamed stream that discharges to the Wyre downstream of Bankfield Farm. This watercourse, known as the Pool Foot Creek, drains a catchment area of approximately 1.6km^2 and has a flapped outfall to the Wyre, in the form of a flood gate that is integrated into a headwall for a farm access track that crosses the creek.

3.3.5 Upstream of the A585, a network of small land drainage ditches cross open fields to the east of the Main Dyke, discharging into the Main Dyke.

Figure 3: Watercourses (Contains Ordnance Survey data © Crown copyright and database right 2017)

[4] *River Wyre, River Brock, Main Dyke & Horsebridge Dyke Flood Risk Mapping Investigation (Atkins, 2003)*



Geology and Soils

3.3.6 With reference to public data provided by the British Geological Survey (BGS) Geology of Britain Viewer[5], the bedrock geology underlying the Scheme comprises the Sidmouth Mudstone Formation. The superficial geology consists primarily of Devonian Till, with small areas of Tidal Flat Deposits along Garstang New Road and in the vicinity of Skippool roundabout.

3.3.7 The Soilscapes Viewer[6] characterises the dominant soils in the study area as slightly acid loamy and clayey soils with impeded drainage. To the east of the Scheme, along Garstang New Road, there are also small areas of slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils. There are also areas of loamy and clayey soils of coastal flats with naturally high groundwater.

Topography and Land Use

3.3.8 Within the study area the general topography grades towards the Wyre Estuary. Existing ground levels are lowest towards the western end of the Scheme, around Skippool, at around 5m Above Ordnance Datum (AOD), with a general increase in elevation to the east towards Garstang New Road (approximately 12m AOD) and Little Singleton (approximately 20m A0D). Land use is a mixture of urban development and agriculture.

[5] *Geology of Britain Viewer (British Geological Survey, 2016). Accessed via* http://mapapps.bgs.ac.uk/geologyofbritain/home.html
[6] *Soilscapes map viewer (Cranfield Soil and Agrifood Institute, 2016) Accessed via* http://www.landis.org.uk/soilscapes/

3.4 Flood History and Defences

Flood History

3.4.1 The British Hydrological Society (BHS) Chronology of British Hydrological Events website[7] is a public repository for hydrological facts. It attempts to provide as much material as possible so that the spatial extent of flood events, and their relative severity, can be assessed. A search of the website has been undertaken and no records of flooding local to the Scheme have been identified.

3.4.2 Consultation with the EA has highlighted that there have been historical reports of flooding downstream of Skippool Bridge associated with the Main Dyke, however no specific details of the dates and extents were available.

3.4.3 Anecdotal flooding information was also collected during a public consultation event in September 2016, with a number of local residents referring to flooding along the Main Dyke being severe and extending some distance to the south. It was also reported that flooding has much reduced since the new tidal gates were installed, but a lack of maintenance of the Main Dyke in certain reaches was highlighted as a concern.

3.4.4 The joint Lancashire and Blackpool Local Flood Risk Management Strategy[8] has been reviewed and highlights that in the low-lying areas of west Lancashire, the risk of flooding is predominantly linked to the capacity of the drainage networks, including piped networks in urban areas and open drainage ditches in both urban and rural areas. In the lowest lying areas near the coast high tides and storm surges can increase water levels in channels and cause drainage systems to stop discharging to the sea. However, the report does not identify any historical flooding incidents having occurred in the area of the Scheme.

3.4.5 The SFRA[9] documents a flood event dating to winter 1998 when a large tree bough jammed in the tidal door on the Main Dyke and a road gully discharging to the Main Dyke was also without a flap as the casing had corroded. During this event there was flooding of the A585 carriageway, the garage/service station adjacent to Skippool Bridge and the gardens of properties in the local area.

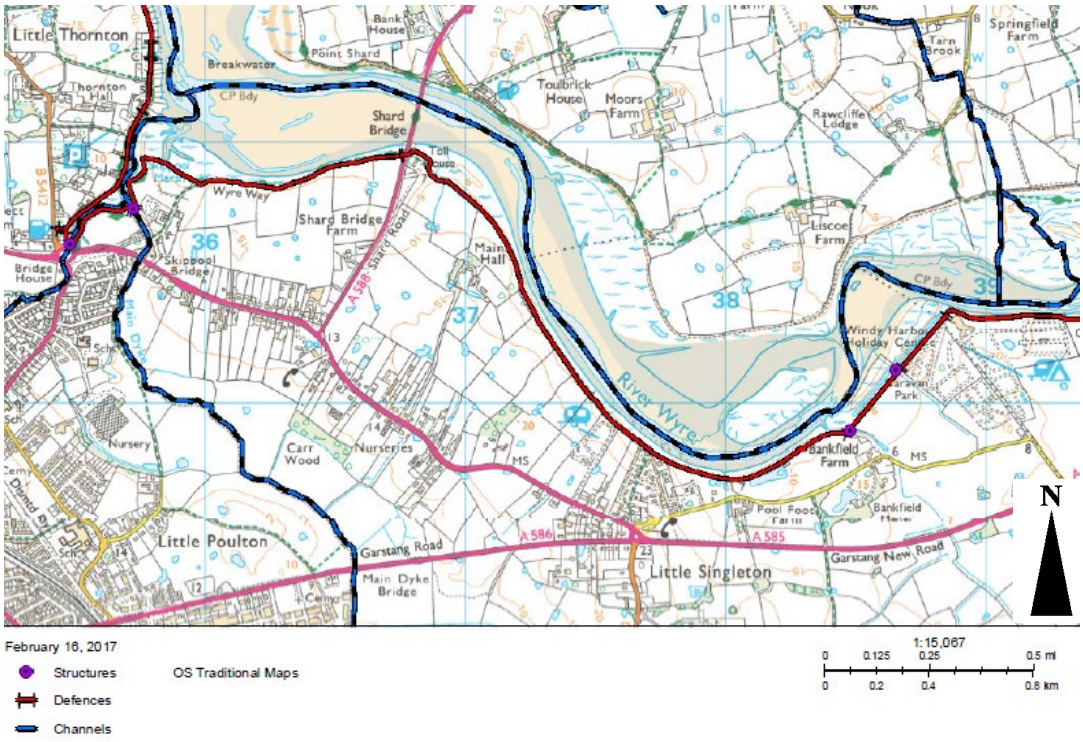
3.4.6 During public consultation events, held in September 2016, the issue of flooding of agricultural land adjacent to the Main Dyke was raised. It was reported that adjacent fields are prone to accumulating standing water during the winter months, due to waterlogged soil conditions. Further to the east, a landowner in the vicinity of the Pool Foot Creek reported that during periods of substantial rainfall combined with a high tide, his lower fields adjacent to the Wyre Estuary can experience flooding due to tide locking of the watercourse.

[7] *Chronology of British Hydrological Events (British Hydrological Society, 2016). Accessed via http://cbhe.hydrology.org.uk/*
[8] *Lancashire and Blackpool Local Flood Risk Management Strategy (Lancashire County Council & Blackpool Council, 2013)*
[9] *Strategic Flood Risk Assessment (Wyre Council, 2007)*

Defences

3.4.7 Information on local flood defences has been collected from the EA and from an FRA report prepared for a proposed residential development scheme in the Main Dyke catchment, off Garstang Road East in Poulton-le-Fylde[10]. Flood defences providing protection against fluvial and tidal flooding are illustrated in Figure 4 and described below.

Figure 4 Location of EA Flood Defences (supplied by the EA, data request ref CL5227)



Fluvial Defences

3.4.8 Defences are present along the Main Dyke downstream of the Skippool Tidal Sluice (see below). Upstream of this point, the Main Dyke between the downstream tidal gates and the A585 crossing at Skippool Bridge is defended by earth embankments (not shown in the EA Defence database). Crest levels on the left bank (west side) of the watercourse are at approximately 5.2m AOD and are similar on the east side, with a low point at Old Mains Lane, 70m downstream of the A585 on the right bank (5.1m AOD).

3.4.9 The Skippool Tidal Sluice, illustrated in Figure 5 has been recently upgraded and is designed to reduce the impact of a storm surge in the Wyre Estuary propagating up the Main Dyke during a significant tidal event. The level of the top of the tidal gates, as recorded in the EA Defence database, is 5.21mAOD. However, inspection of point cloud LiDAR data gives a parapet level across the structure of 6.6mAOD.

[10] *Garstang Road East Flood Risk Assessment and Drainage Strategy (Ironside Farrar Limited, 2015)*

Figure 5: Tidal Gates at Main Dyke Outfall to Wyre Estuary (Source: Arcadis, 2017)



3.4.10 The Skippool Tidal Sluice is owned and maintained by the EA not Highways England. The Scheme will not result in a change to this current arrangement.

3.4.11 Upstream of the A585 bridge there are no continuous defences alongside the Main Dyke. Neighbouring fields and properties are vulnerable to flooding if the water levels exceed around 5m AOD. Small wooden doors on the upstream side of the existing A585 bridge (as shown in Fifure 6) are now virtually obsolete as the new flap gates downstream control the downstream levels.

Figure 6: Tidal Gates at existing A585 Bridge (Source: Arcadis, 2017)



3.4.12 The Horsebridge Dyke passes beneath the A585 at Skippool roundabout via the Skippool Clough culvert. The EA Horsebridge Dyke hydraulic model states that this culvert has a diameter of 1.7m. However, survey data obtained as part of the A585 Scheme indicates that the first 20.7m of the culvert has a diameter of 1.6m and the following 43.8m run has a diameter of 1.52m. A final 1.6m diameter section 21m in length discharges to Skippool Creek via a flap valve, illustrated in Figure 7. This provides protection against tides propagating upstream.

Figure 7: Skippool Clough Culvert (Source Arcadis, 2017)



Tidal Defences

3.4.13 Raised defences along the Wyre Estuary were built or improved in the 1980s. In the study area, defences comprise flood walls and embankments which are maintained by the EA. Review of the EA's asset database for the area shows that the Standard of Protection (SoP) offered by these structures ranges from 25 years in the immediate vicinity of the Main Dyke and Horsebridge Dyke, to 50 years at the Windy Harbour Holiday Park some 3.5km to the east. Located in sub-area 5 (Wyre Urban), the EA Catchment Flood Management Plan sets out a preferred policy of continued maintenance of existing defences and major assets to their current standard, taking action to improve them to an appropriate standard where they fail to meet target conditions.

4 NATIONAL POLICY STATEMENT FOR NATIONAL NETWORKS

4.1 General

4.1.1 The National Networks National Policy Statement (NN NPS)[11] sets out the need for and Government's policies to deliver Nationally Significant Infrastructure projects (NSIPs) on the national road and rail networks in England.

4.1.2 With regard to flood risk and surface water drainage, the NN NPS supports the National Planning Policy Framework (NPPF)[2] and its accompanying Planning Practice Guidance (PPGNPPF)[12]. Paragraphs 5.92 to 5.94 explain that essential transport infrastructure is permissible in areas of high flood risk, subject to satisfaction of the NPPF Exception Test. An objective of the NN NPS is for schemes to contribute towards reducing the risk of flooding, stating that considerations should include design standards for drainage systems, interactions with floodplains and watercourses and maintenance standards. Applications for all projects in Flood Zones 2 and 3 and projects of 1 hectare or greater in Flood Zone 1, should be accompanied by an FRA. Projects should adhere to any national standards for Sustainable Drainage Systems (SuDS).

4.1.3 Projects should be subject to a detailed FRA that considers all sources of flood risk. The FRA should be informed by consultation with the EA and relevant LLFA. The FRA should also be informed by the results of any hydrological and hydraulic modelling undertaken to define baseline flood risk, quantify any impacts on this baseline, and to inform the design of any necessary flood risk management measures. A drainage strategy should also be prepared that centres on the application of SuDS, appropriate to local conditions, to manage surface water runoff.

4.1.4 Early adoption of, and adherence to, the principles set out in the NN NPS with respect to flood risk, can ensure that detailed designs and plans for transport schemes take due account of the importance of flood risk and the need for appropriate mitigation, if required.

4.2 The Sequential and Exception Tests

4.2.1 The PPGNPPF identifies 4 Flood Zone classifications, detailed in Table 1.

Table 1: Flood Zones (Source: PPGNPPF (2014), Table 1)

Flood Zone	Annual Probability of Flooding (%)
1. Low Probability	Fluvial and Tidal <0.1% AEP
2. Medium Probability	Fluvial 0.1-1.0% AEP Tidal 0.1-0.5% AEP
3a. High Probability	Fluvial > 1% AEP Tidal > 0.5% AEP

[11] *National Policy Statement for National Networks December (Department for Transport, 2014)*
[12] *Flood Risk and Coastal Change Planning Practice Guidance (Ministry of Housing, Communities and Local Government, 2014) Accessed via https://www.gov.uk/guidance/flood-risk-and-coastal-change*

Flood Zone	Annual Probability of Flooding (%)
3b. The Functional Floodplain	Fluvial and Tidal > 5.0% AEP * Starting point for consideration. LPAs should identify Functional Floodplain, which should not be defined solely by rigid probability parameters

4.2.2 The NPPF specifies that the suitability of all new development in relation to flood risk should be assessed by applying the Sequential Test. This Test should be used to demonstrate that there are no reasonably available sites in areas with a lower probability of flooding that would be appropriate to the type of development proposed. The PPGNPPF provides guidance on the suitability of each land use classification in relation to each of the Flood Zones as summarised in Table 2.

Table 2: Flood Risk Vulnerability Classification (Source: PPGNPPF Table 3)

Flood Zone	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception Test required	✓	✓
Zone 3a	Exception Test required	✓	×	Exception Test required	✓
Zone 3b	Exception Test required	✓	×	×	×
Key: ✓ Development is appropriate × Development should not be permitted					

4.3 EA Flood Zone Categorisation and Development Flood Risk Vulnerability Classification

4.3.1 The EA Flood Map for Planning (Rivers and Sea)[13] (provided in Appendix A) shows that the majority of the Scheme is located in Flood Zone 1. However, a small portion of the Scheme is located in Flood Zone 3 (when the presence of flood defences are ignored, land with a 1 in 100 (1%) or greater chance of flooding each year from rivers; or with a 1 in 200 (0.5%) or greater chance of flooding each year from the sea). With regard to flood risk vulnerability, the Scheme is classified as Essential Infrastructure. The location of this type of development is deemed appropriate in Flood Zones 1, 2 and 3, subject to satisfaction of the NPPF Exception Test in Zone 3.

[13] *Environment Agency. Flood Map for Planning. Accessed via http://maps.environment-agency.gov.uk/wiyby/*

4.4 Application of the Sequential Test and Exception Test

Sequential Test

4.4.1 The aim of the Sequential Test is to steer development to areas of lowest flood risk and should demonstrate that alternative locations in areas of lower flood risk have been considered first. Three route corridors were considered during optioneering stages of the project, online, southern and northern corridors. Five options were identified for the southern corridor, while 2 options were identified for both the northern and online corridors. A total of 9 options were therefore considered.

4.4.2 During the options stage, Environmental Assessment Reports (EARs) were prepared which assessed the options in accordance with the Design Manual for Roads and Bridges Volume 11 (DMRB). The EARs provided an assessment of air quality, cultural heritage, landscape effects, noise, biodiversity, geology and soils, road drainage and the water environment, people and communities and materials. The conclusions of the assessments within the EARs informed sifting workshops to determine a preferred route. Through this process it is demonstrated that the Scheme has thoroughly considered alternatives in line with the requirements of the Sequential Test.

Exception Test

4.4.3 The Scheme provides the greatest potential to unlock growth potential in the area, offers the best journey times and is considered to improve the overall experience for road users. Environmental assessments undertaken to date have also demonstrated the wider sustainability benefits of the Scheme, satisfying part 1 of the Exception Test.

4.4.4 The findings of this FRA help demonstrate that the development would be safe for its lifetime and that the Scheme would contribute to reducing flood risk overall (Exception Test Part 2).

4.4.5 Therefore, it is asserted that the Scheme passes the Exception Test.

5 POTENTIAL SOURCES OF FLOODING

5.1.1 In line with best practice, this section of the FRA considers flood risk from the range of possible sources listed in Table 3.

Table 3: Sources of Flooding

Source of Flooding	Description
1. Flooding from rivers (Fluvial)	Floodwater originating from a nearby watercourse when the amount of water exceeds the channel capacity of that watercourse
2. Flooding from the sea (Coastal)	High tides, storm surges and wave action, often acting in combination, flooding low-lying coastal land
3. Flooding from groundwater	Flooding caused when groundwater levels rise above ground level following prolonged rainfall
4. Flooding from land (Surface Water)	Flooding caused by intense rainfall exceeding the available infiltration and/or drainage capacity of the ground
5. Flooding from reservoirs, canals and other artificial sources	Failure of infrastructure that retains or transmits water or controls its flow

5.2 Fluvial

5.2.1 As indicated by the EA Flood Map for Planning, and confirmed through EA consultation, the Scheme crosses land that is considered at high risk of flooding from rivers (Flood Zone 3). This source of flood risk has therefore been assessed in detail using bespoke hydraulic and hydrological modelling. The assessment methodologies and results are summarised in Sections 6 and 7, with further information provided in Appendices A, B, C and D.

5.3 Coastal

5.3.1 The study area is defended from regular direct inundation from the Wyre Estuary by EA maintained, raised flood defences, described in Section 3.4.2, and areas of higher ground along the estuary frontage. Information supplied by the EA as part of their Product 4 Data Pack indicates that the existing alignment of the A585 is at risk of tidal flooding during a 0.5% AEP event (plus climate change) in 3 locations; Skippool Junction, alongside the Main Dyke between Garstang Road and Mains Lane, and west of the Windy Harbour Junction (near Pool Foot Creek). In order to refine the assessment of tidal flood risk, the Wyre Tidal Model was obtained from the EA. Further discussion on tidal flood risk is included in Sections 6.5, 7.3 and 9.

5.3.2 The tidal nature of the Wyre is also an influence on the flow regimes of the Main Dyke, the Horsebridge Dyke and the Pool Foot Creek and is consequently a factor in defining fluvial flood risk to the proposed Scheme. The interaction between fluvial

and tidal flood risk sources has therefore been considered in this assessment by representing a tidal boundary condition in the fluvial hydraulic model. Further details are provided in Section 7.2.

5.4 Groundwater

5.4.1 Groundwater flooding occurs when groundwater rises to the ground surface. This may happen during winter and/or after prolonged or heavy rain storms. Ground investigations have included monitoring of groundwater levels at 17 locations across the study area during the period between January and July 2018.

5.4.2 The data collected confirms the presence of a shallow water table within the superficial deposits. Across the study area groundwater levels were found to vary from 0.1m below ground level (bgl) to 6.1m bgl, with an average level of 2.4m bgl. Local to the proposed Lodge Lane cutting an average groundwater level of 3m bgl was recorded, with levels ranging between 1m bgl and 6m bgl. The groundwater level around the Main Dyke was recorded at approximately 1m bgl and is likely to be in hydraulic connection with the Main Dyke through the quaternary tidal flat deposits.

5.4.3 BGS mapping[14] is also available that defines groundwater flood risk susceptibility into 3 categories:

- Limited potential for groundwater flooding to occur
- Potential for groundwater flooding of assets located below the ground surface
- Potential for groundwater flooding to occur at the surface

5.4.4 The mapping shows that the majority of the Scheme is classified as having limited potential for groundwater flooding to occur at the surface. The majority of the superficial deposits comprise a secondary aquifer undifferentiated, meaning the strata are generally of low permeability, but with local potential for small scale water supply where more permeable layers are locally encountered. Within the area of Lodge Lane, a small area of a secondary A aquifer is mapped which indicates more water bearing potential, but this is limited in extent.

5.4.5 The Scheme includes a section of relatively deep cutting at Lodge Lane (up to 8.6m deep) and the investigations undertaken to date indicate the potential for groundwater seepage into the cutting. A retaining wall is proposed to minimise groundwater ingress and the results from a programme of geotechnical surveys would inform the next stage of the Scheme design and identify any further measures necessary to control groundwater. **Therefore, through detailed Scheme design, groundwater flooding as a source of risk to the Scheme would be mitigated and any measures necessary to ensure no increase in groundwater flood risk on third party lands would be incorporated**.

5.5 Surface Water

Existing Drainage Regime – Land Drainage

5.5.1 Within the area directly affected by the Scheme proposals, land is predominantly agricultural. Fields either side of the Main Dyke either drain directly into the watercourse, perpendicular to the contours, or via a network of field boundary

[14] *BGS (2015) Risk of flooding from groundwater maps accessed via* http://www.bgs.ac.uk/research/groundwater/flooding/home.html

ditches. Sub-surface mole drains may also be present to assist with draining the land. Anecdotal evidence indicates that fields adjacent to the Main Dyke are prone to waterlogging and standing water during wet winter periods.

5.5.2 Existing (greenfield) rates of runoff have been calculated using current best practice methodologies, as set out in the EA Flood Estimation Guidelines[15]. These are summarised in Table 4.

Table 4: Greenfield Runoff Rate Calculations

Event AEP	Greenfield Runoff Rate (l/s/ha)
50%	4.8
20%	6.3
3.33%	9.3
1%	11.9

Existing Drainage Regime – Highway Drainage

5.5.3 The existing highway drainage regime has been characterised using records from Highways England's HADDMS inventory system and by inspection during a site walkover. Findings indicate that the highway is generally served by a system of gullies and carrier drains in the road verges. Outfalls discharge to the Skippool Clough Culvert, the Horsebridge Dyke, the Main Dyke (both directly and indirectly via a number of drainage ditches) and to the watercourse named the Pool Foot Creek.

5.5.4 The existing highway drainage infrastructure is subject to routine maintenance and in September 2015 a major scheme of works was undertaken along the A585 between Skippool roundabout and the Singleton junction to clean and make repairs to the drainage system.

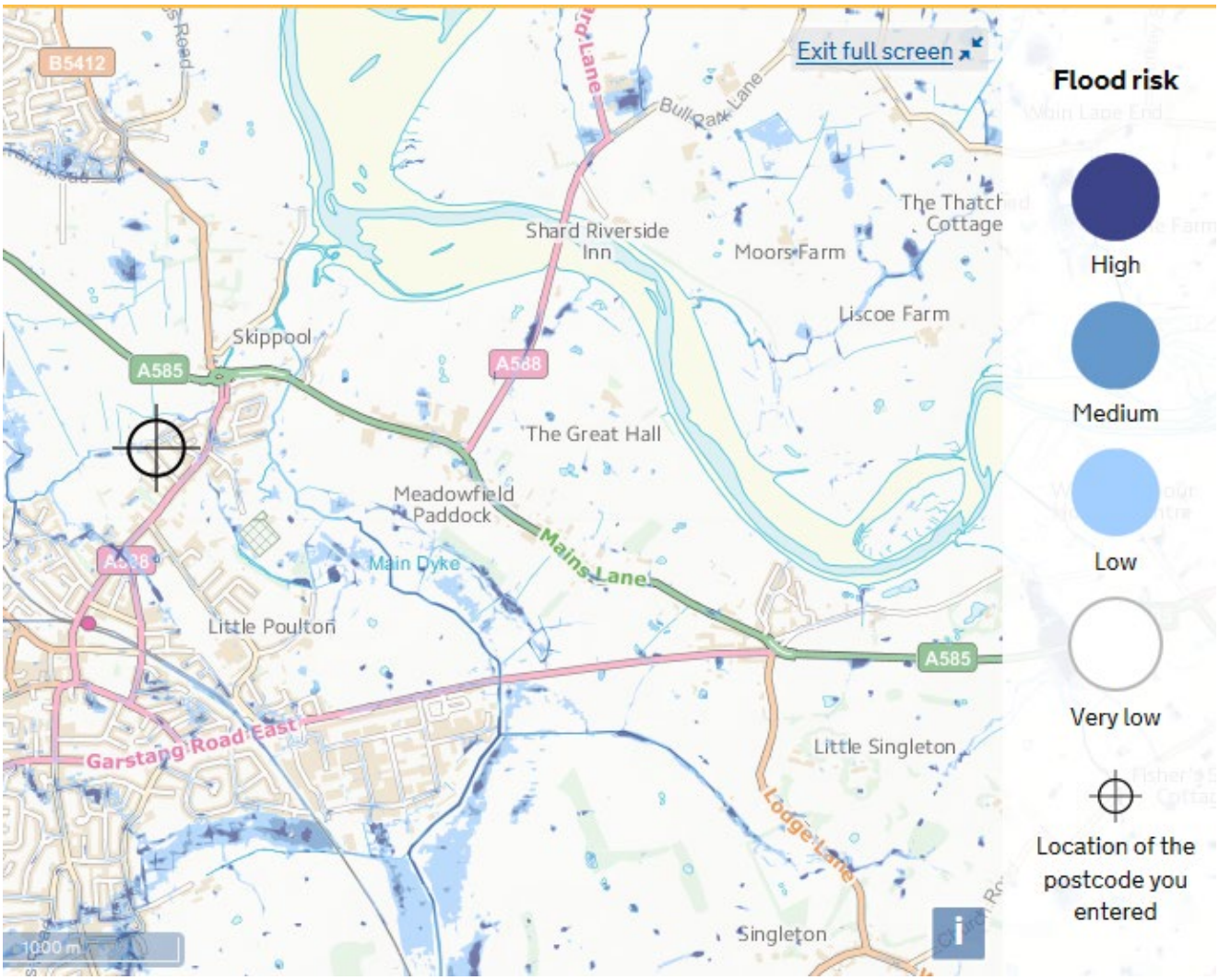
Existing Surface Water Flood Risk

5.5.5 The risk of flooding from surface water is defined by EA mapping[16] , reproduced in Figure 8 as very low (land assessed as having a less than 0.1% AEP of flooding from this source) along the majority of the existing alignment of the A585 between Skippool and Windy Harbour.

5.5.6 There are localised areas at high risk (greater than 3.3% AEP), for example, an area that spans the existing A585 alignment near Bankfield Manor.

[15] *Environment Agency (2015) Flood Estimation Guidelines*
[16] *Environment Agency. Risk of flooding from surface waters. Accessed online via https://flood-warning-information.service.gov.uk/long-term-flood-risk/*

Figure 8 EA Surface Water Flood Map (© Crown copyright and database rights 2017 OS 100024198)



5.5.7 The Scheme is therefore mostly at very low risk of surface water flooding however areas of agricultural land in the Main Dyke valley are reported to be prone to waterlogging during the winter months in response to prolonged periods of wet weather, co-incident with high tides.

Proposed Surface Water Management Strategy

Policy Requirements

5.5.8 The NPPF stipulates that development should be safe from flooding during its lifetime, should not cause any flood risk detriment and where possible should make a contribution to reducing flood risk in its local catchment. As the Scheme involves construction of built development on existing greenfield land, changing the existing land drainage regime, management of surface water runoff from the highway is key to satisfying these requirements of the NPPF.

5.5.9 Standards for highway drainage design are set out in HD33/16 Design of Highway

Drainage Systems[17]. These standards stipulate that peak discharge rates must be controlled, and appropriate attenuation storage provided within the system to accommodate the design 1% AEP storm, inclusive of an allowance for climate change. The consequences of exceedance during storms with a magnitude in excess of the 1% AEP must also be considered.

Drainage Proposals

5.5.10 The Scheme would introduce impermeable land cover and has the potential to impact on the current land drainage regime. To ensure that the Scheme does not impact on flood risk from this source a drainage strategy has been developed (Appendix E). The Strategy is summarised below.

The road would be drained:

- At junctions by combined kerb and drainage units/gully pots discharging to carrier pipes
- Along the bypass by concrete "V" channels discharging to carrier pipes
- Along the bypass where it is in cutting by filter drains
- On Lodge Lane (side road) by gully pots.

5.5.11 These systems would discharge to the Main Dyke, Horsebridge Dyke (under Skippool Junction) and Pool Foot Creek. Where existing outfalls are being re-used, their existing discharge rate would be maintained and at all new outfalls discharge rates would be restricted to greenfield. To achieve this, storage and orifice plate flow controls would be provided. Storage would take the form of oversized pipes or wetlands where there is adequate space to provide them. Where the water quality of the receiving waterbody could be affected, treatment systems would be included, and provision would also be made for containment in the event of an accidental spillage. All proposed outfalls to existing watercourses would be installed with flap valves to prevent flooding of the drainage networks under tide locked conditions.

5.5.12 **Surface water flood risk would therefore be managed through design such that the risk of flooding from this source is assessed as low.**

5.6 Artificial Sources

5.6.1 The EA's maximum extent of flooding from reservoirs[18] does not extend into the area of the Scheme. A review of OS mapping highlights that there are no canals or bodies of stored water located in the vicinity of the Scheme. **It is therefore considered that the risk of flooding from artificial sources is negligible**.

[17] *Highways England, 2016 http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol4/section2/hd3316.pdf*
[18] *Environment Agency. Risk of flooding from reservoirs. Accessed online via https://flood-warning-information.service.gov.uk/long-term-flood-risk/*

6 ASSESSMENT METHODOLOGY – FLUVIAL AND TIDAL FLOOD RISK

6.1 General

6.1.1 This section summarises the methodology that was adopted in order to quantify:

- The extent of flooding from the Main Dyke and the Horsebridge Dyke, accounting for the influence of the tidal regime of the Wyre Estuary. To meet this requirement a linked Flood Modeller Pro (FMP) -TUFLOW (1D-2D) hydraulic model has been constructed.
- The extent of flooding from the tidal River Wyre. To meet this requirement, an existing EA TUFLOW (2D only) model has been refined.

6.1.2 Full details of the modelling carried out is included in the Appendix B; a brief summary is set out in Sections 6.4 to 6.6 below.

6.2 Consultation and Data Collection

6.2.1 The study has been informed by:

- 1m resolution LiDAR data
- Ordnance Survey mapping
- Consultation with the EA
- Horsebridge Dyke and Main Dyke Hydraulic Model and Reporting, Atkins, 2003
- River Wyre Tidal Model, JBA, 2015
- EA Flood Product 4 Fluvial and Tidal Mapping for Skippool Roundabout, EA, 2015.
- Existing Skippool Bridge Survey, Arcadis, 2016
- Existing Skippool Roundabout Culvert Survey, Arcadis, 2016
- Satellite Imagery, Google, 2018
- Scheme design drawings

6.3 Hydrology

6.3.1 A hydrological assessment was undertaken to derive design flow hydrographs for the Main Dyke, Horsebridge Dyke and its tributary, using current best practice Flood Estimation Handbook (FEH) methodologies[15]. Design flood hydrographs have been produced for the 50%, 20%, 10%, 5%, 2%, 1.33%, 1%, 1% plus 30%, 35% and 70% Climate Change (CC) allowances and 0.1% events.

6.3.2 Full details of the analysis are provided in the Flood Calculation Record in Appendix C and the results are briefly summarised below. The EA has been consulted regarding the acceptability of these flow estimates and have confirmed (See Appendix A) that the design flows are appropriate for use in this FRA.

6.3.3 Catchments draining to the flow estimation points assessed are illustrated in Figure 9 and a summary of the adopted flow estimates are provided in Table 5.

Figure 9 Catchments Draining to Flow Estimation Points ((Contains OS data © Crown copyright [and database right] (2016))

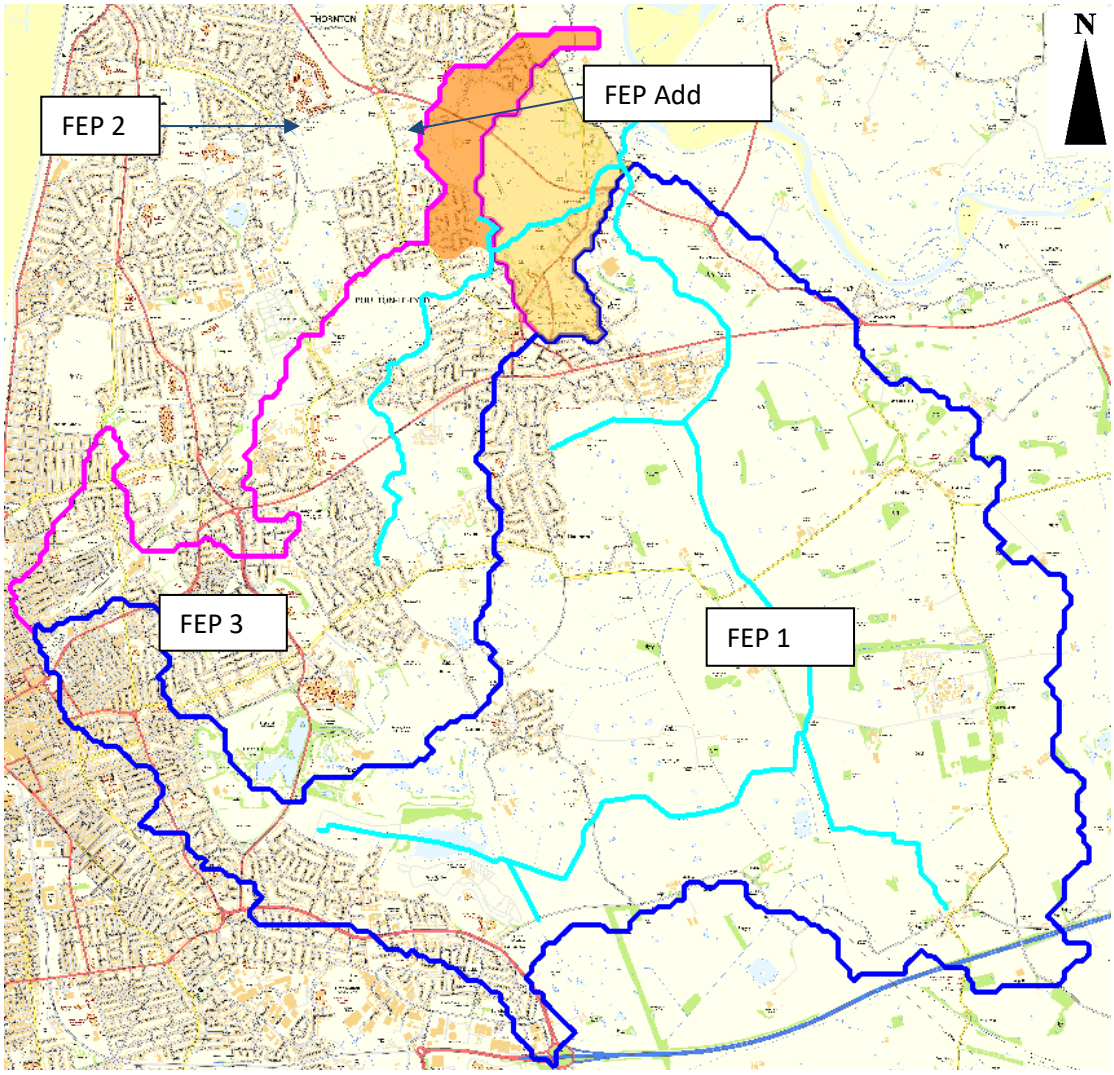


Table 5: Summary of design flow estimates (m^3/s)

Event AEP	Flow Estimation Point			
	FEP1[a]	FEP2[b]	FEP3[c]	Add[d]
50%	11.23	0.95	6.61	1.03
20%	15.16	1.23	12.28	1.36
10%	17.48	1.47	14.58	1.61
5%	19.54	1.72	17.13	1.88
2%	21.95	2.13	21.24	2.30
1.33%	23.22	2.34	23.20	2.52

Event AEP	Flow Estimation Point			
	FEP1[a]	FEP2[b]	FEP3[c]	Add[d]
1%	23.60	2.50	24.79	2.70
1% plus 30% CC	30.68	3.25	32.23	3.51
1% plus 35% CC	31.86	3.38	33.47	3.64
1% plus 70% CC	40.12	4.25	42.14	4.59
0.1% year	28.20	4.30	42.32	4.79

Where a – Main Dyke to confluence with the Horsebridge Dyke; b – unnamed tributary of the Horsebridge Dyke; c – Horsebridge Dyke to confluence with the Main Dyke; d – direct catchment draining to the Horsebridge Dyke downstream of the Main Dyke confluence.

6.3.4 Adopted flows are those derived from the FEH Statistical method for FEP1 and from the urban extension to the Revitalised Flood Hydrograph (ReFH) model for the other FEPs, due to the degree of urban development in their catchments.

6.4 Baseline Fluvial Hydraulic Modelling

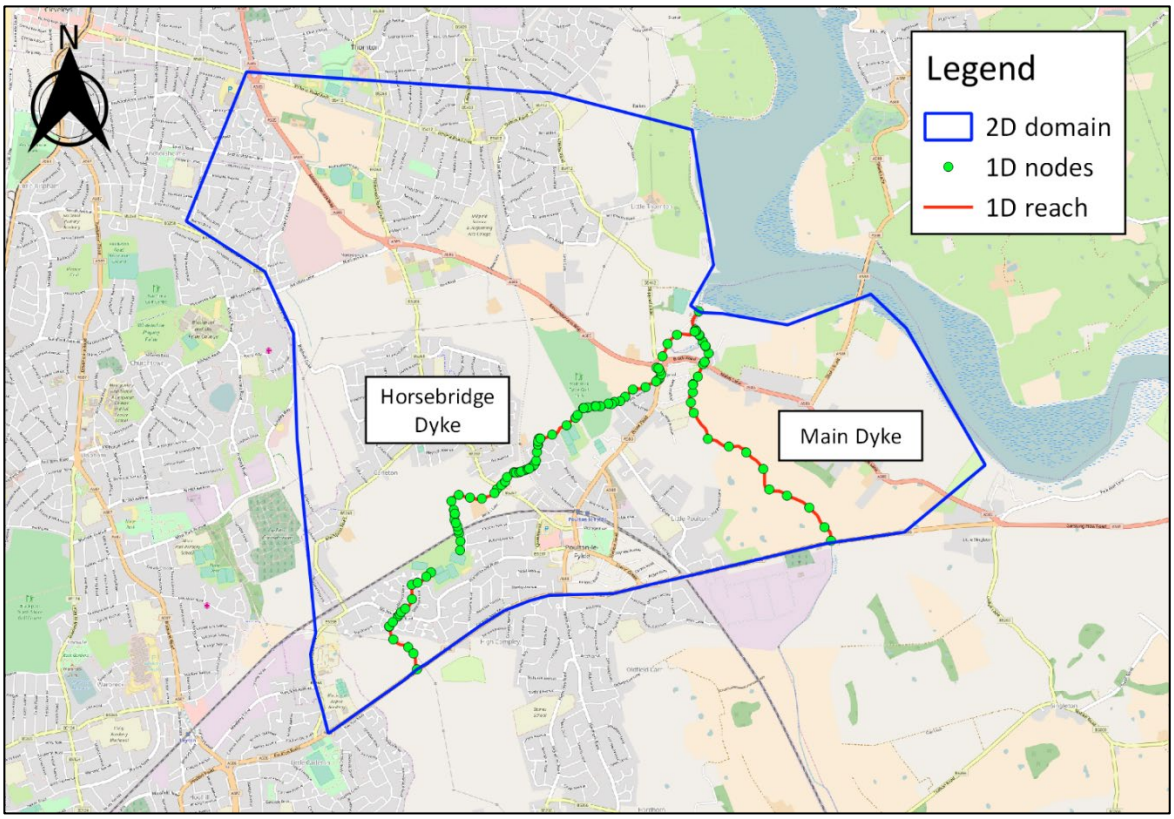
6.4.1 A linked 1D-2D hydraulic model for the Horsebridge Dyke and the Main Dyke based upon existing EA 1D only models for both watercourses has been constructed. This revised 1D-2D model has been used to establish a baseline for flood risk in the study area and to understand the impacts of the Scheme on surrounding flood risk.

Existing Model Review

6.4.2 The findings of a comprehensive review of the existing EA 1D only Horsebridge Dyke and Main Dyke models are documented in Appendix B. The recommended improvements have been implemented and an updated linked Flood Modeller Pro (FMP) TUFLOW model has been developed specifically to inform this study.

6.4.3 Figure 10 shows the overall schematisation of the model; full details of the model build process are included in the Appendix B.

Figure 10: Fluvial Hydraulic Model Schematisation (Contains Ordnance Survey data © Crown copyright and database right 2017)



6.5 Baseline Tidal Modelling

Supplied River Wyre Model

6.5.1 The River Wyre tidal model (defended and undefended) was developed by JBA Consulting and submitted to the EA in 2015. This model was supplied for use in this FRA. Results from the JBA modelling were used to assess the defended and undefended flood risk to the Scheme in the vicinity of Pool Foot Creek, whereas results from the enhanced tidal model (see below) were used to assess the flood risk to the Scheme as it crosses the Main Dyke floodplain. This decision was made as the interaction between the Scheme and the tidal flood extents is very minimal at Pool Foot Creek compared to the interaction across the Main Dyke floodplain.

Tidal Model Enhancements

6.5.2 The supplied tidal model was reviewed as part of this FRA and it was noted that, for the most part, channels and structures in the vicinity of the Scheme were not modelled explicitly in the tidal model. Whilst this is acceptable for the purposes for which the tidal model was developed, in order to assess in more detail, the impact of the Scheme on tidal flood risk, a number of enhancements were made, as described in the Modelling Annex.

6.6 Option Modelling (Fluvial and Tidal Models)

6.6.1 The Scheme, as illustrated in Figure 2, has been assessed. The Scheme would impact both the Main Dyke floodplain and the existing A585 crossing of the Main

Dyke at Skippool Bridge. The following elements of the Scheme were schematised in the option flood models:

- Proposed Skippool Bridge Main Dyke crossing
- Replacement of the Skippool Clough Culvert on the Horsebridge Dyke
- Proposed A585 embankment
- Proposed wetland area
- Proposed temporary floodplain compensation areas
- Proposed dwarf wall along the eastbound carriageway east of Skippool Roundabout to maintain road crest levels in line with the existing A585 (Section 9.1.

6.6.2 Full details on how these elements were included in the hydraulic models are provided in the Appendix B.

7 MODELLING RESULTS

7.1 Fluvial Flooding

7.1.1 Eleven design events have been assessed as part of this FRA; 50% AEP, 20% AEP, 10% AEP, 5% AEP, 2% AEP, 1.33% AEP, 1% AEP, and 0.1% AEP fluvial floods, all in combination with a mean high water springs (MHWS) tidal condition. Climate change was assessed by adding 30%, 35% and 70% to the 1% AEP flows.

7.1.2 Baseline flood extents are shown in Appendix D, Figures D1 – D11. Results demonstrate that although the Scheme is proposed in an area currently predicted to be at risk of flooding, by increasing the capacity of the existing A585 crossing as part of the Scheme proposals, upstream flood extents are reduced. Therefore, the Scheme is not at risk of flooding for any of the design events assessed.

7.1.3 Difference grids which show the impact of the Scheme on flood extents and levels are shown in Appendix D, Figures D12 to D22. These show that the Scheme proposals reduce flood depths and extents upstream of the A585 for all modelled events. There are increases in flood levels on the Main Dyke downstream of the A585 and upstream of the Skippool tidal gates resulting from additional water passing through the A585 bridge which cannot then pass as rapidly through the tidal gates. However, flood extents are not increased as a result. There is a negligible change (less than 1cm across all modelled events) in flood levels on the Horsebridge Dyke downstream of the Skippool Clough culvert. For all events assessed, peak water levels remain in channel and no increases in flood extents are predicted due to the topography of the channel in this location.

7.1.4 An assessment was carried out to ensure that the proposed development was not at increased risk of flooding over its lifetime, as described in Section 3, due to climate change. Three climate change scenarios have been modelled, uplifting peak fluvial inflows in the 1% AEP event by +30%, +35% and +70%. Figures D8, D9 and D10 in Appendix D show that for all allowances assessed the Scheme is not predicted to be inundated.

7.2 Impact of Tide Locking on Fluvial Flood Levels

Methodology

7.2.1 The EA requested that the impact of the tide locking of the outfalls on the Horsebridge Dyke and Main Dyke be assessed. Tide locking of the outfalls is predicted to occur when water levels in the Wyre rise above the water levels on the upstream side of these outfalls.

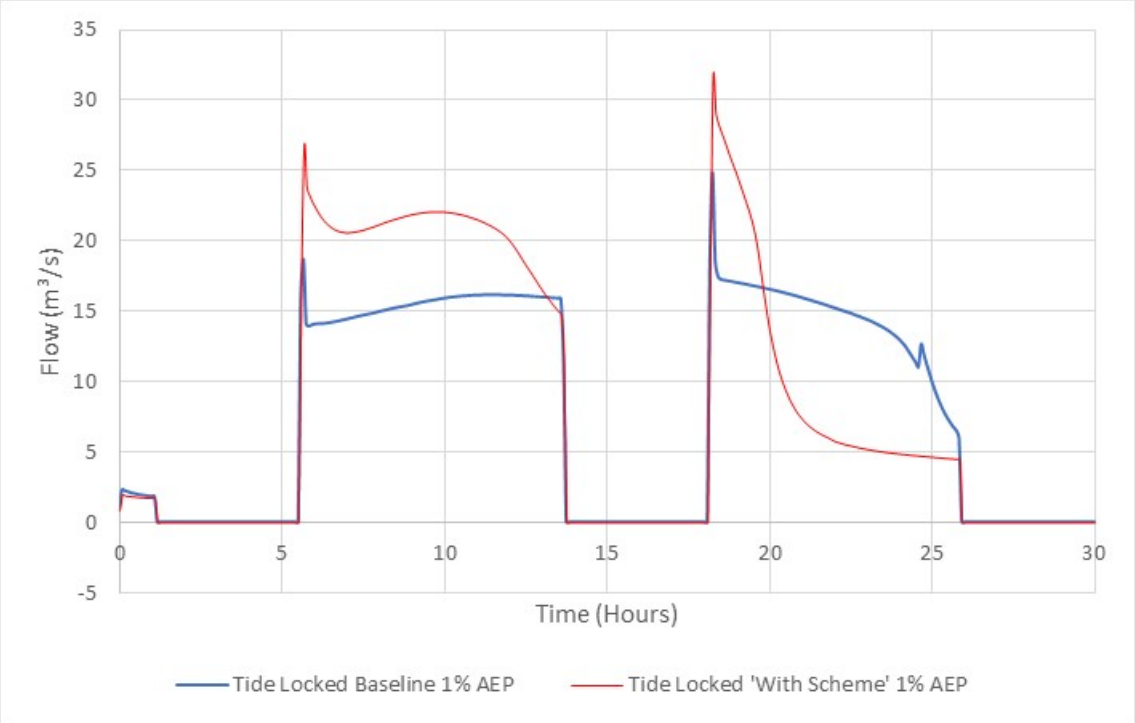
7.2.2 Details on how the tide locking impacts on upstream water levels in the Horsebridge Dyke and Main Dyke were modelled are included in Appendix B.

Tide Locking Results

7.2.3 The results from the 22 modelled runs are discussed below. Section 7.1 identifies that the replacement of the existing culverts at the A585 crossing (Skippool Bridge) with a clear span bridge has a significant impact on flood extents along the Main Dyke. Figure 11 shows flows through the tide locked sluice for the 1% AEP baseline and option model runs. It illustrates that the proposed structure allows greater flow through the tidal flaps once the sluice has reopened following a drop in tidal levels in the Wyre. An increase in flow through the tidal gates allows the reach upstream of

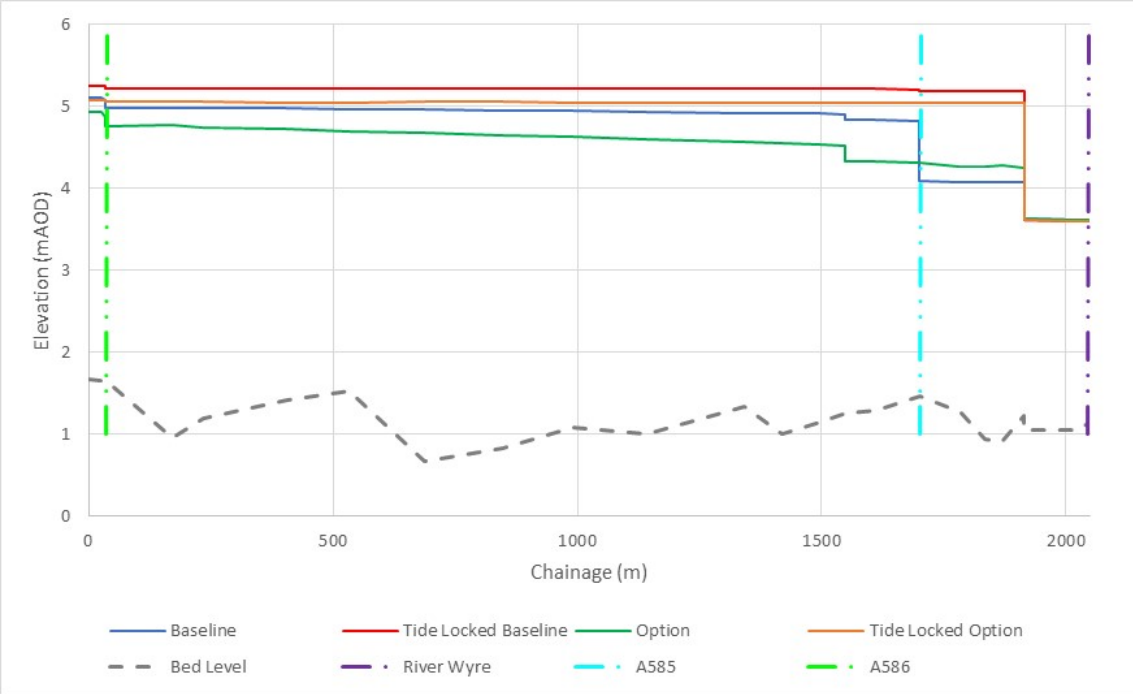
the Main Dyke flaps to drain down faster.

Figure 11: Main Dyke Tidal Flap Flow Hydrograph



7.2.4 Figure 12 shows the water level profile along the Main Dyke for the 1% AEP tide locked baseline, 1% AEP tide locked 'with Scheme' and the 1% AEP MHWS baseline. The tide locking mechanism is shown to increase water levels by a maximum of 1.12m immediately upstream of the tidal flaps for the baseline scenario. When comparing the 2 tide locked scenarios, water levels are an average of 160mm lower for the 'with Scheme' run. Water levels remain unchanged for the Horsebridge Dyke from the tide locked 'with Scheme' run when compared against the tide locked baseline.

Figure 12: Main Dyke: Impact of Tide Locking



7.2.5 Impacts on the Scheme during a tide locked scenario have been reviewed for all design events assessed. The flood extents for baseline and 'with Scheme' models are included in Appendix D Figures D31 to D41. The results indicate that the Scheme is not at risk of fluvial flooding during any of the modelled tide locked scenarios. The flood waters do not overtop the proposed Scheme embankment or the proposed Scheme crossing of the Main Dyke.

7.2.6 These figures also demonstrate that during the tide locked scenario, flood extents are reduced for the 'with Scheme' model and hence, the Scheme does not have a detrimental impact on flood risk to the surrounding area.

7.3 Tidal Flooding

7.3.1 Two events were assessed using the tidal model; the 0.5% AEP and the 0.5% AEP inclusive of an allowance for climate change. The climate change scenario was based on the UK Climate Impacts Programme 2018 (UKCP18) data. The uplift applied to the tidal boundary was agreed with the EA.

7.3.2 Modelled flood extents are shown in Appendix D; Figures D43 and D44 demonstrate that the Scheme is at risk of flooding immediately to the east of Skippool Junction. Difference grids which show the impact of the Scheme on flood extents and levels are included in Appendix D, Figures D45 and D46. Discussion on the results is included in paragraphs 7.3.3 to 7.3.6 below.

0.5% AEP

7.3.3 With the Scheme in place, during the modelled events increases in baseline maximum flood depths occur immediately east of Breck Road at the southbound slip from the roundabout. This occurs because the Scheme proposals create a small depression in ground levels (Figure 13), which causes water to pond to a greater depth in this location (Figure 14).This situation also occurs along Skippool Road, north of the roundabout.

Figure 13: Ground Levels East of Breck Road (Baseline in Red, with Scheme in Purple)

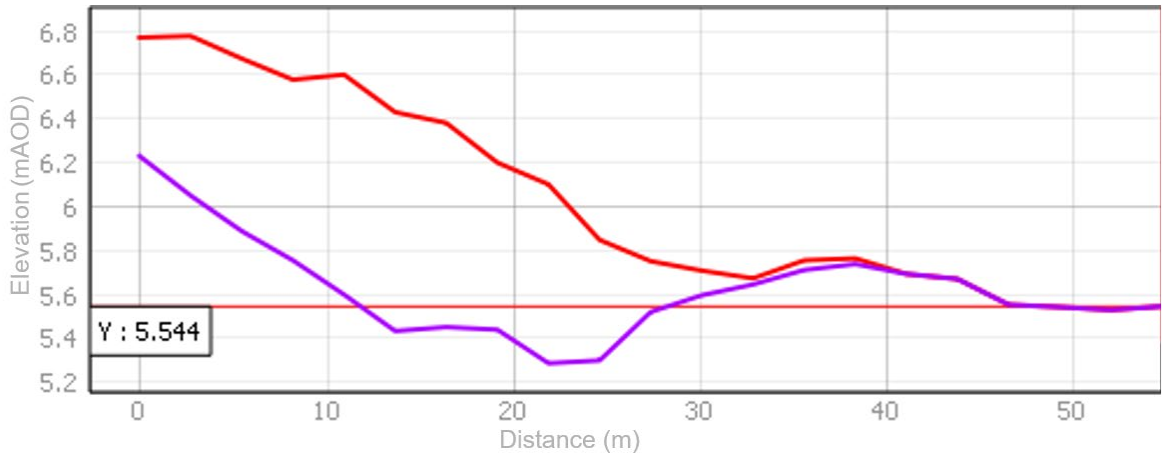
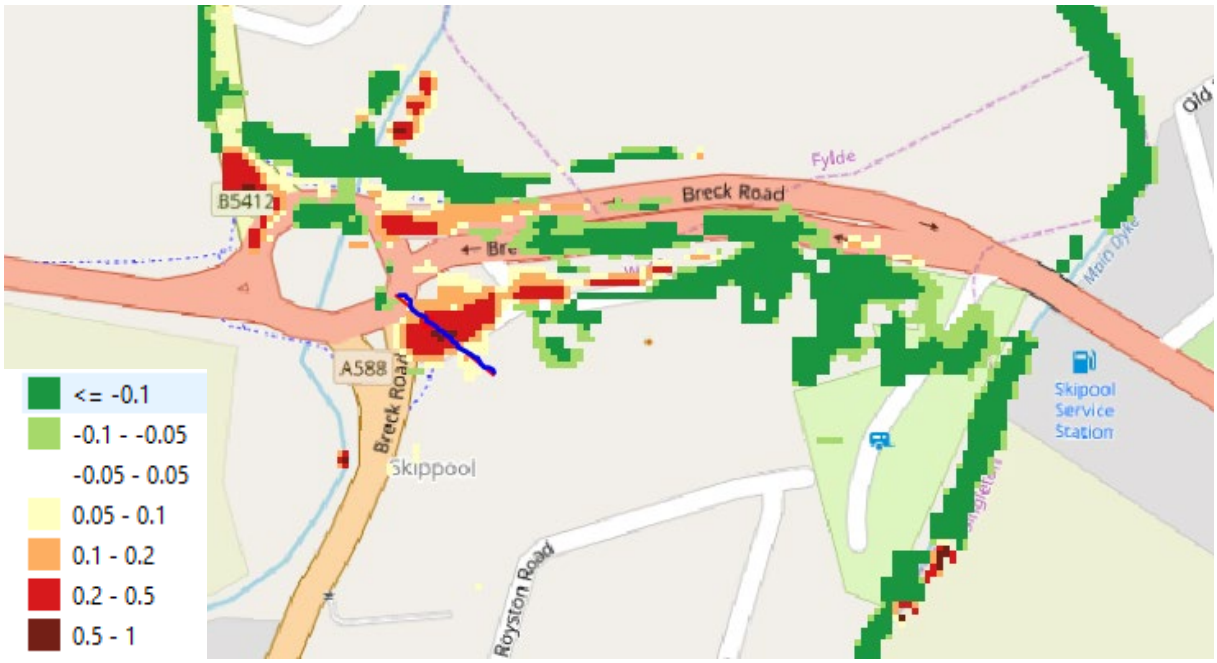


Figure 14: Cross Section Location (blue line) and Change in Peak Flood Depth as a result of the Scheme, 0.5% AEP (Contains Ordnance Survey data © Crown copyright and database right 2019)

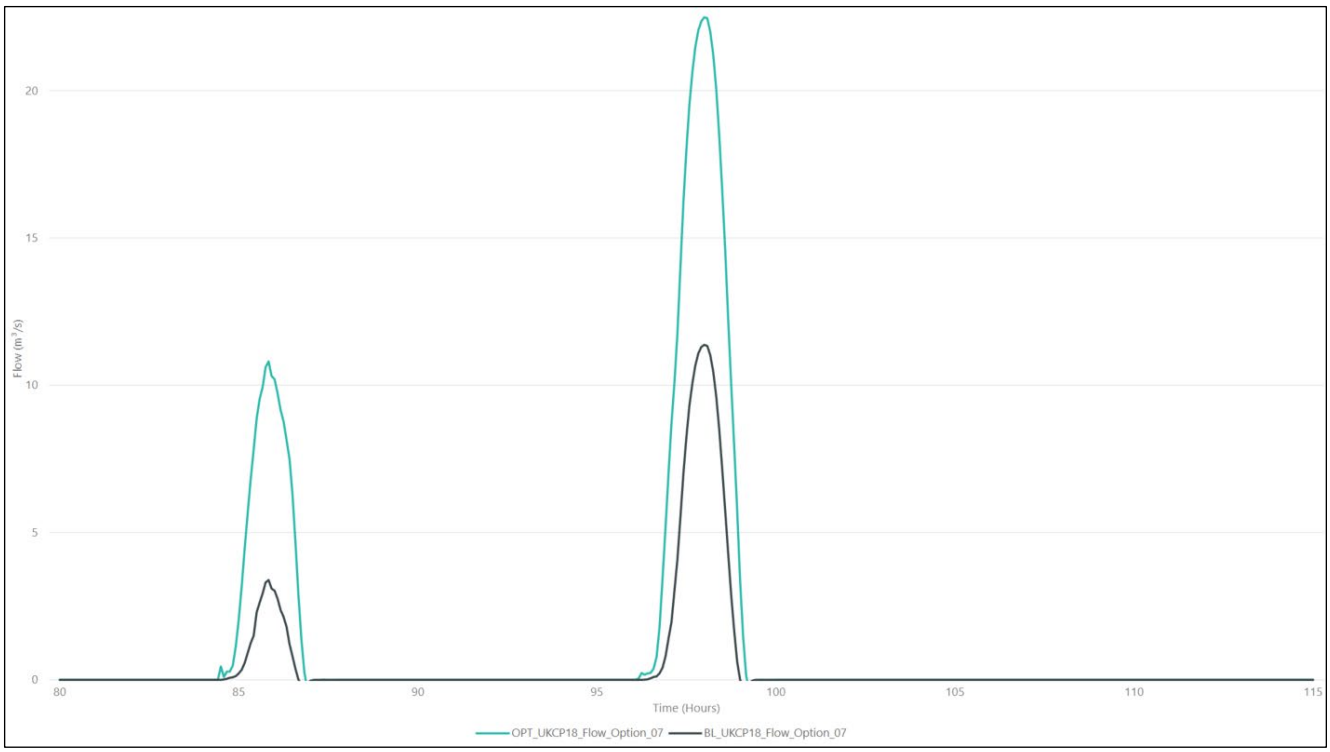


7.3.4 Reductions in baseline maximum flood depths are observed south of the A585 between Main Dyke and Horsebridge Dyke and along the Main Dyke itself. This is due in part to the inclusion of a dwarf wall along the eastbound carriageway of the A585 (See Figure 22 in Appendix B) which limits flood water overtopping the road into areas to the south. As discussed in Section 9.1, this brings benefit in terms of reducing existing flood risk to properties.

0.5% AEP plus Climate Change

7.3.5 As a result of the extensive flooding predicted during the UKCP18 climate change event, impacts of the Scheme are more widespread than those for the 0.5% AEP flood. Maximum flood depths are predicted to increase along the Main Dyke and Horsebridge Dyke as well as along the Skippool Creek to the north of the Scheme. Although less flow is predicted to overtop the Scheme east of Skippool Roundabout in the 'with Scheme' model, additional floodwater is pushed to the west and overtops the A585 immediately to the west of Skippool Roundabout. Figure 15 shows the flow hydrograph for a plot output line positioned to the west of Skippool Roundabout.

Figure 15: Overtopping Flows West of Skippool Roundabout, 0.5% AEP plus Climate Change



7.3.6 Upstream on the Main Dyke, immediately north of Garstang Road East, the temporary floodplain compensation areas can be seen to fill, increasing flood depths in these locations. As a result, flows passing upstream through Garstang Road East are reduced and reductions in flood depths are predicted south of this location.

7.4 Implication of Results for the Scheme

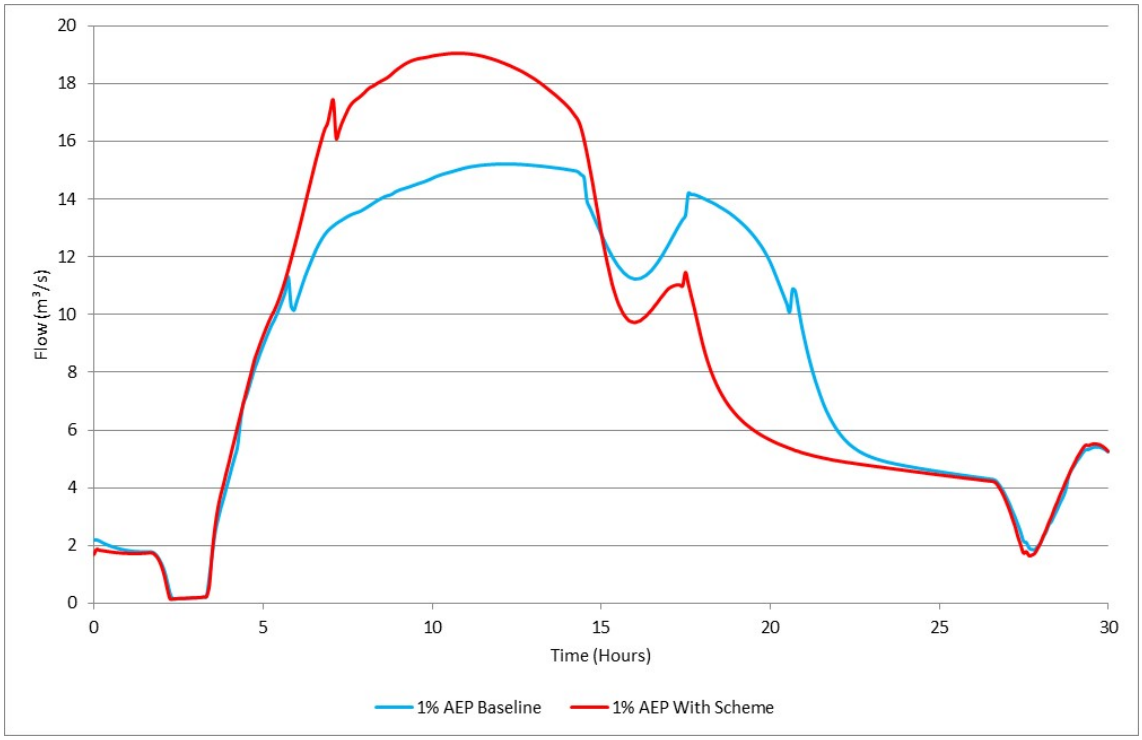
Fluvial Flood Risk

Figures D1 to D11 in Appendix D show that for all modelled fluvial events, flood extents are reduced as a result of implementing the Scheme. This is due to the alteration of the existing Skippool Bridge from two 1.8m diameter culverts to a single 12.5m wide bridge, increasing conveyance and reducing flood levels upstream of the structure. Table 6 shows the change in peak flow through Skippool Bridge, with the 1% AEP hydrograph shown in Figure 16: 1% AEP Comparison of Flows Downstream of Skippool Bridge (MAIN02_0147) for the Baseline and Option Model Runs

Table 6: Peak Flow through Skippool Bridge

Scenario	Peak Flow 1% AEP	Peak Flow 0.1% AEP
Baseline	15.2 m³/s	16.0 m³/s
With Scheme in Place	19.0 m³/s	21.0 m³/s

Figure 16: 1% AEP Comparison of Flows Downstream of Skippool Bridge (MAIN02_0147) for the Baseline and Option Model Runs



7.4.1 Modelled peak water levels for all assessed events up to and including the 1% AEP plus a 35% allowance for climate change are below the minimum soffit level (5.0mAOD) of the new A585 Main Dyke crossing. Although the peak 1% AEP plus 70% climate change water level is above the minimum soffit level, the EA have confirmed that this is acceptable due to the existing site constraints. Table 7 summarises these results.

Table 7: Peak Stage at the Proposed A585 Crossing for all Option Model Runs

Event	Peak Stage (mAOD)
50% AEP	3.68
20% AEP	3.73
10% AEP	3.84
5% AEP	4.05
2% AEP	4.20
1.33% AEP	4.28
1% AEP	4.31

Event	Peak Stage (mAOD)
1% AEP + 30% CC	4.77
1% AEP + 35% CC	4.80
1% AEP + 70% CC	5.21
0.1% AEP	4.66

7.4.2 Given that the implementation of the Scheme results in a reduction in baseline flood extents, it is not considered that, based on the model results, additional permanent floodplain compensation measures would be required once the Scheme is fully constructed. However, as discussed in Section 7.5, some mitigation would be required for the duration of the construction period.

Surface Water Drainage Ponds

7.4.3 It is a requirement of the highway drainage design that any surface water drainage ponds are not flooded during events up to and including the 1% AEP. Figure 17 shows the only proposed drainage pond located within the fluvial model domain. This pond is set at an elevation of 6.5mAOD compared to a peak 1% AEP water level of 4.74mAOD.

Figure 17: Proposed Surface Water Drainage Pond (shown in green)



Tidal Flood Risk

7.4.4 Table 8 summarises the modelled tidal levels which are available to inform the assessment of flood risk to the Scheme, in both defended and undefended scenarios. The assessment focuses on three locations, where the Scheme crosses

the Main Dyke floodplain between Garstang Road and Mains Lane, the area east of Skippool Junction and thirdly to the west of Windy Harbour Junction (immediately to the south of Pool Foot Creek). In summary, the Scheme is not at risk of tidal flooding where it crosses the Main Dyke floodplain. However, it is at risk of flooding east of Skippool Junction during a 0.5% AEP event (with and without an allowance for climate change) in a defended and undefended scenario. The Scheme is also at risk of shallow flooding west of Windy Harbour Junction during a 0.5% AEP event (inclusive of an allowance for climate change), for the undefended scenario only.

Table 8: Modelled Tidal Flood Levels and Risk to the Scheme

Scenario	Crossing the Main Dyke Floodplain	East of Skippool Junction	West of Windy Harbour Junction
Arcadis Modelled 0.5% AEP (defended)	Not at risk of flooding	At risk of flooding to a depth of approximately 300mm. (Peak stage 6.7mAOD minimum road elevation 6.4mAOD)	N/A (Outside Arcadis model domain)
Arcadis Modelled 0.5% AEP plus UKCP18 climate change (defended)	Not at risk of flooding	At risk of flooding to a depth of approximately 900mm (peak stage 7.3mAOD minimum road elevation 6.4mAOD)	N/A (Outside Arcadis model domain)
JBA Modelled 0.5% AEP plus UKCP09 climate change (defended)	Results superseded by Arcadis enhanced tidal model	Results superseded by Arcadis enhanced tidal model	Not at risk of flooding (peak stage of 6.4mAOD minimum road elevation of approximately 7.2mAOD)
JBA Modelled 0.5% AEP (undefended)	Not at risk of flooding (peak stage of 5.6 to 5.7mAOD. Minimum road elevation of approximately 6.7mAOD)	At risk of flooding to a depth of approximately 100mm (peak stage 6.5mAOD minimum road elevation 6.4mAOD)	Not at risk of flooding (peak stage of 6.6mAOD minimum road elevation of 7.2mAOD)

Scenario	Crossing the Main Dyke Floodplain	East of Skippool Junction	West of Windy Harbour Junction
JBA Modelled 0.5% AEP plus UKCP09 climate change (undefended)	Not at risk of flooding (peak stage of 6.1 to 6.2mAOD. Minimum road elevation of approximately 6.7mAOD)	At risk of flooding to a depth of approximately 600mm (peak stage 7.0mAOD minimum road elevation approximately 6.4mAOD)	At risk of flooding to a depth of approximately 100mm (peak stage of 7.3mAOD minimum road elevation of approximately 7.2mAOD)

7.5 Construction Phase Flood Risk

Construction Sequence

Assessment of Impacts on Flood Risk

7.5.1 The proposed widening of the existing A585 crossing has been demonstrated to reduce baseline flood extents on the Main Dyke. However, the programme of works for the Scheme construction requires that the embankment is in place before works are carried out to the bridge. Therefore, an assessment of the impact of the Scheme (embankment only, no bridge widening) has been carried out. The resulting changes in baseline in flood levels and extents are illustrated in Figures D23 to D30 in Appendix D.

7.5.2 For the 50% AEP flood, no change is observed as there is negligible out of bank flooding, none of which extends as far as the proposed Scheme embankment.

7.5.3 In the 20% AEP flood, a minor reduction in flood levels to the east of the proposed Scheme embankment is observed. This is due to the proposed culverts under the Scheme embankment providing a slight restriction on flow compared to the baseline, open channel condition.

7.5.4 During the 10% AEP event, small increases in flood levels and extents are observed however, these are constrained to areas of open land in close proximity to the Scheme.

7.5.5 During the 5% AEP flood, increases in flood levels across the Main Dyke floodplain are observed. However, only small increases in flood extents occur on areas of open fields between the Main Dyke and the Scheme embankment, approximately 1km upstream of the A585. In addition, there are very small increases in flood extent on open fields between the Main Dyke and The Breck Primary School.

7.5.6 During the 2% AEP event, increases in flood levels across the Main Dyke floodplain are observed. Increases in flood extents occur in open fields on the left bank of the Main Dyke behind Little Poulton Lane. A natural depression in the topography controls the extent of flooding in this location.

7.5.7 A similar pattern of impacts is observed for the 1.33% AEP flood. However, during this event flood extents increase marginally along Fouldrey Avenue outside The

Breck Primary School.

7.5.8 During the 1% and 0.1% AEP events, increased flooding in both the baseline and 'with Scheme embankment' models limits the relative increases in flood levels. However, increases in flood extents are observed in line with the 1.33% AEP flood.

7.5.9 During the 1% AEP inclusive of both 30% and 35% for climate change events, widespread flooding in the baseline situation limits the relative increases in both flood level and extent. Notable increases in flood extents occur in the vicinity of Royston Road and Kevin Avenue.

7.5.10 For the 1% AEP plus 70% for climate change, flooding from the Main Dyke reaches the Horsebridge Dyke and hence impacts are observed within the floodplain of the Horsebridge Dyke. Increases in flood extents occur predominantly in open fields opposite Skippool Avenue.

7.5.11 In summary, for the smaller magnitude events that would generally be considered to be more likely to occur during the relatively short duration of the construction phase, the impact of building the Scheme embankment prior to widening the A585 crossing is minimal. Impacts on third parties are, in the main, constrained to open fields rather than property, with the latter only observed in the higher magnitude, less probable, events.

7.5.12 Based on these model results, the EA were consulted on the flood risk associated with the construction phase and confirmed that mitigation would be required to ensure that increases in flood risk to third parties were minimised for all events up to and including the 1% AEP plus 30% for climate change flood event. Paragraphs 7.5.13 to 0 discuss the work carried out to assess mitigation requirements.

Mitigation

7.5.13 An area of land on the right bank of the Main Dyke immediately downstream of the A586 was identified as having potential to accommodate temporary floodplain storage to offset that removed by the road embankment during construction. Information on how the floodplain compensation storage was incorporated within in the model is included in the Appendix B.

7.5.14 Model results for this scenario demonstrate that the provision of compensation storage in this location reduces the increases in flood risk to third parties (Figure D47 in Appendix D).

7.5.15 The design and construction of the proposed floodplain compensation area will adhere to the following requirements:

- Submission of a Flood Risk Activity Permit (FRAP) for all works within 16m of the top of the Main Dyke bank;
- Retention of an 8m wide (as a minimum) unrestricted buffer zone to allow future access to the Main Dyke for EA maintenance vehicles and staff;
- Maintenance of the structural integrity of the Main Dyke banks;
- Maintenance, as far as is practicable, of existing Main Dyke bank levels with any sudden changes in elevations avoided; and
- Design and implementation of a mechanism for draining down the

compensation areas following a flood event. This would ensure that the full storage volume is available should a further flood event occur.

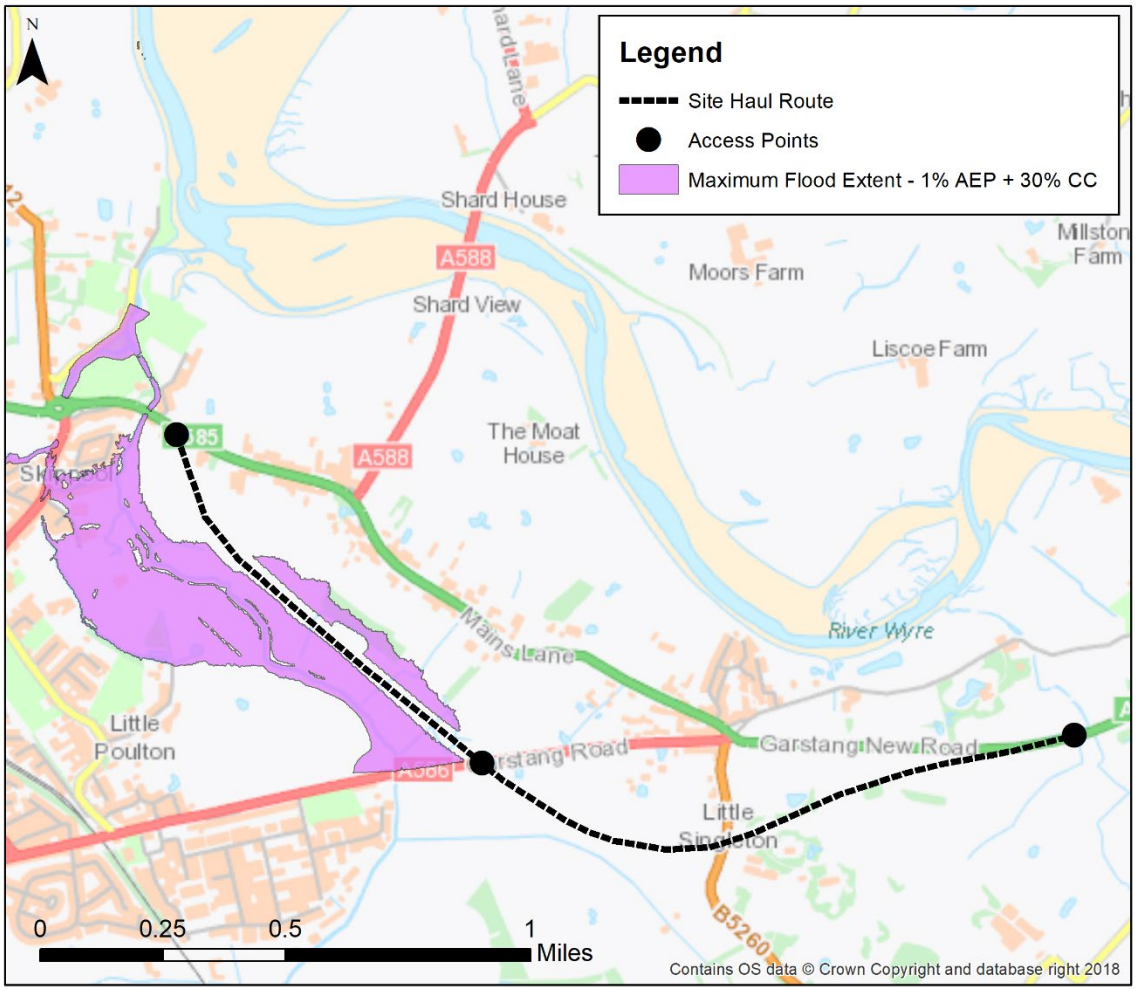
7.5.16 The temporary compensation storage area is illustrated as work items 98, 109, 110 and 111 on the Works Plans (document reference T010035/APP/2.3). Furthermore, the above design and construction requirements are reiterated in the outline Construction Environmental Management Plan (CEMP) (document reference TR010035/APP/7.2 – Rev 1) and in the Record of Environmental Actions and Consents (REAC) (document reference TR010035/APP/7.3 – Rev 1).

7.5.17 During detailed design of the proposed temporary floodplain compensation area, due consideration should be given to the Reservoirs Act 1975, as amended for England by the Flood and Water Management Act 2010. Further discussion on this is included within the Appendix B.

Haul Roads

7.5.18 Figure 18 shows the proposed construction access route (haul road) to be used during the Scheme construction. This confirms that there are no new additional routes currently proposed that are in the floodplain, and thus there is no change in flood risk as a result of any haul roads. Should there be a requirement in future to construct a haul road across an area of floodplain, these would be designed to ensure no impediment to floodplain flow paths, and appropriate consent for their construction would be secured in consultation with the EA. This commitment is set out in the REAC (document reference TR010035/APP/7.3 – Rev 1).

Figure 18: Proposed Construction Access Routes shown against the Maximum Flood Extent for a 1% AEP (+30% Climate Change Allowance) Flood Event (Embankment in place, Main Dyke A585 Crossing not upgraded, FCAs in place).



Site Compounds

7.5.19 A number of site compounds are proposed for use during the Scheme construction; Figure 19 shows those that are within the areas covered by the fluvial and tidal models. The site compound immediately to the north of the A586 (Garstang Road) is outside all modelled fluvial and tidal flood extents. The site compound immediately to the east of Skippool Junction and north of the A585 is outside all modelled fluvial events, although it is within all modelled tidal flood extents as shown in Figure 19. In this location, the peak 0.5% AEP flood level is 6.78mAOD.

7.5.20 A construction compound and laydown area is planned further east on the A585 at the proposed Grange footbridge. This location is outside the fluvial and tidal model extents and is shown to be in Flood Zone 1 as defined by the EA Flood Map for Planning (Figure 20).

7.5.21 A site compound is also to be located on the right bank of the Main Dyke immediately south of the A586 (Garstang Road). This is outside the area covered by the hydraulic models, however the EA Flood Map for Planning shows it to be located within Flood Zone 3, which is assessed as land having a 1 in 100 or greater annual probability of

river flooding (Figure 20). The actual probability of flooding of these areas during the construction period is therefore low. Residual risks will be managed through implementation of an Emergency Flood Response Plan informed by the EA flood warning service, that would be prepared by the contractor, in consultation with the EA.

7.5.22 For those compounds, identified above, that are located in the floodplain, a number of measures will be put in place to manage the risk of flooding and minimise potential for impacts on third party land in the very unlikely scenario of flooding during the construction period:

- No ground raising to avoid loss of floodplain storage;
- Securing of compounds via open link fencing so as not to impede the flow of floodwater across the sites;
- Set back of boundary fencing at a minimum distance of 8m from the banks of any main river (Main Dyke, Horsebridge Dyke) to ensure unrestricted access for the Environment Agency; and
- Consultation with the EA to determine is any activities proposed constitute a flood risk activity under the Environmental Permitting Regulations, and submission of any consent applications deemed necessary.

At the larger Garstang Road East compound approximately 40% of the site is situated outside of the floodplain (Flood Zone 1)). Any welfare or office facilities within this compound would be located in Flood Zone 1.

Figure 19: Location of the proposed Site Compounds in relation to the maximum tidal option modelled flood extent (0.5% AEP).

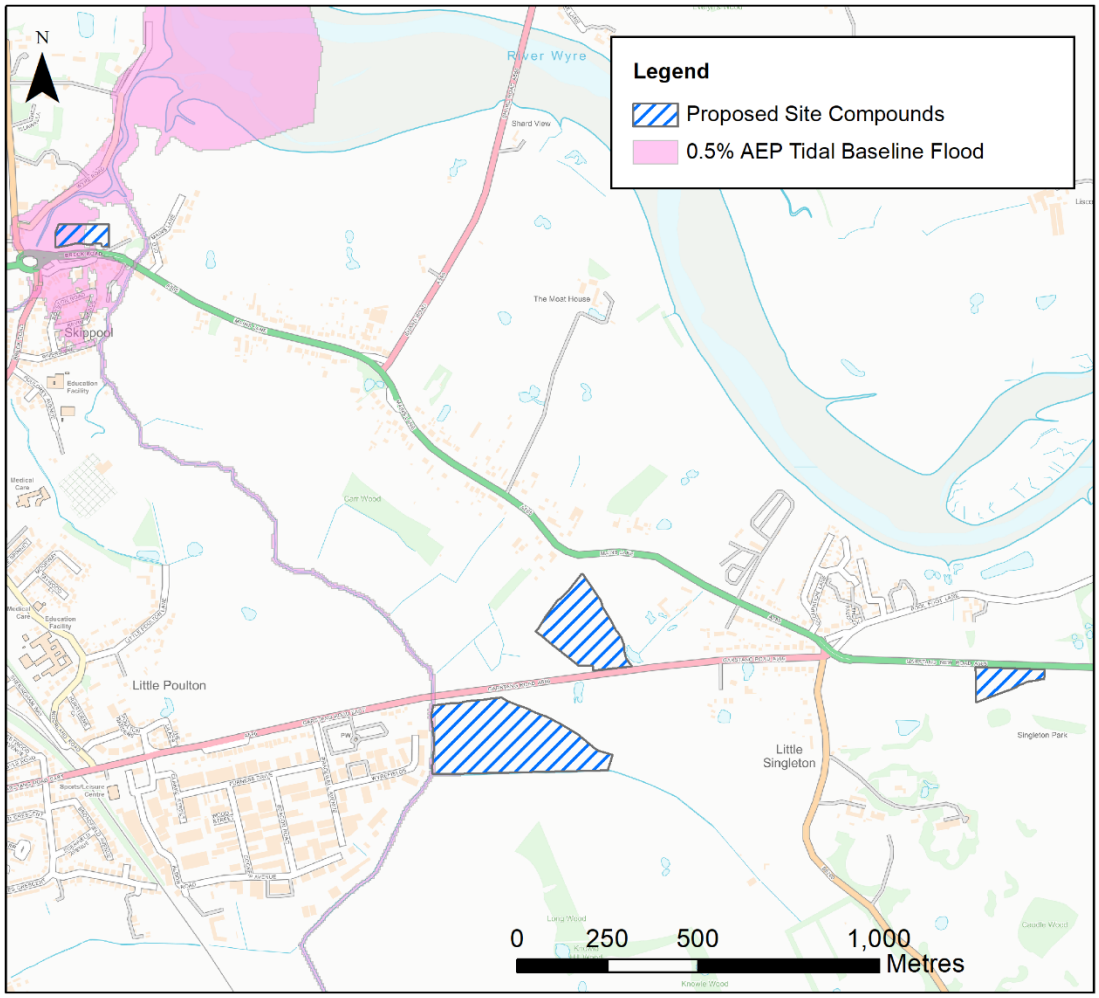
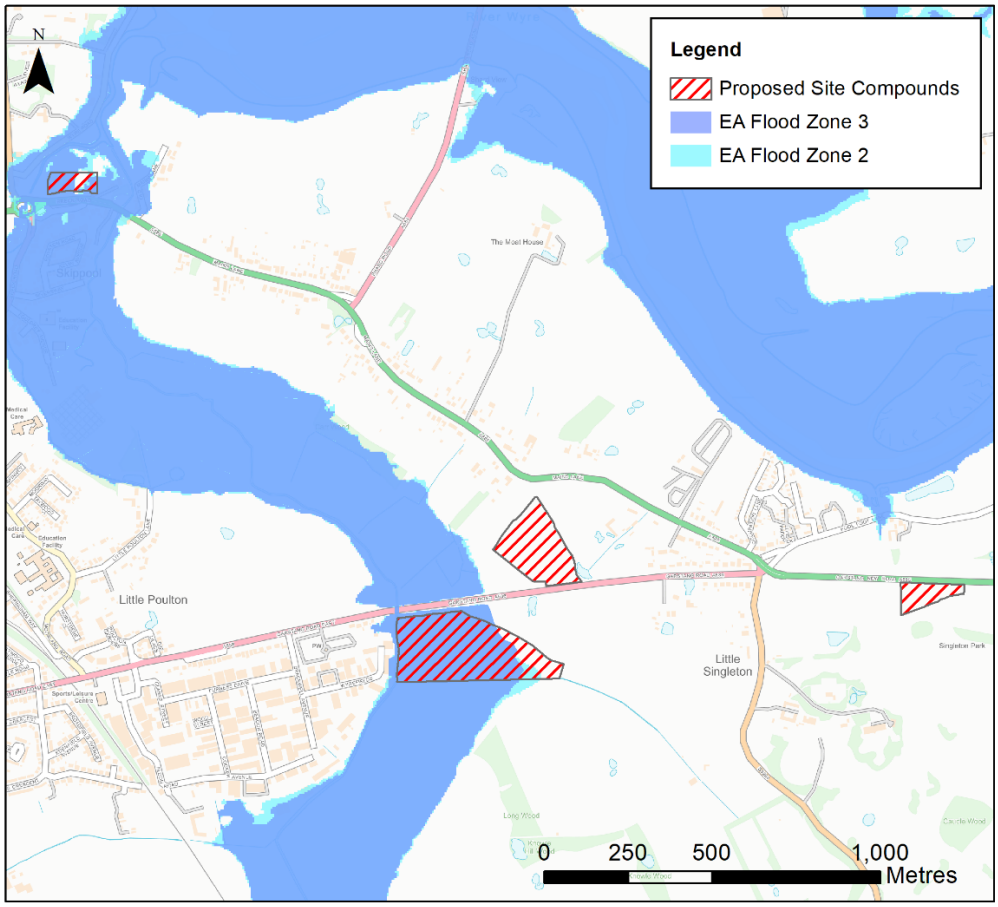


Figure 20: Location of the proposed Site Compounds in relation to the EA Flood Map for Planning



7.6 Pool Foot Creek

7.6.1 The Pool Foot Creek is outside of the area included in the fluvial models. Defence data from the EA lists the outfall from this watercourse as asset ID 01209WYRE0301L02001 with a condition grade 3 (where 1 is excellent and 5 is very poor). The party responsible for maintaining this asset is listed as unknown.

7.6.2 The Pool Foot Creek has a small catchment area; peak flows range from 0.4m³/s for the 50% AEP to 2.3m³/s for the 0.1% AEP event. The base level of the channel is around 4.9mAOD compared to a road crest elevation of around 8.2mAOD. A high-level capacity assessment of the Pool Foot Creek channel indicates that assuming a base width of 1m, channel invert of 4.9mAOD and bank height of 5.9mAOD, the channel would be capable of passing the 0.1% AEP flow without spilling onto the floodplain. It is therefore not anticipated that the Scheme would be at risk of fluvial flooding from this watercourse. Any changes made to the existing culvert as part of the Scheme design would ensure that conveyance is maintained as existing and therefore no detrimental impacts on third parties would be experienced.

7.6.3 Flood risk linked to overtopping of the tidal defences in this area has been covered in Section 7.3.

7.6.4 Management of any residual risks which might arise as a result of tide locking of the outfall to the Wyre is discussed in Section 9.

7.7 Limitations of the Model

7.7.1 Model limitations are discussed in the Appendix B included as Appendix B.

8 SURFACE WATER RUNOFF

8.1.1 A drainage design development report is shown in Appendix E and drainage proposals are illustrated in the Outline Drainage Works Plans (document reference TR010035/APP/2.9). The strategy uses a combination of pipes, swales and wetland areas to manage surface water runoff in line with the requirements of planning policy and current design standards. Climate change resilience is also included for in the drainage design. It is therefore concluded that there would be no detriment to baseline flood risk from surface water runoff.

9 FLOOD RISK MANAGEMENT MEASURES

9.1 Protection of Third Parties

9.1.1 The removal of the two restrictive culverts at the existing A585 crossing of the Main Dyke delivers a reduction in fluvial flood extents upstream. This provides a benefit to existing landowners in this locality.

9.1.2 During construction, the placement of the road embankment on the Main Dyke floodplain has the potential to temporarily increase flood risk to third parties should a large flood event occur. However, modelling has shown that there is the potential to mitigate this through the provision of temporary compensation floodplain storage on the right bank of the Main Dyke, immediately to the north of the A586. This solution will be further developed during detailed design, in consultation with the EA, and would be subject to consenting under the Environmental Permitting Regulations 2016.

9.1.3 The proposed A585 crossing of the Main Dyke allows additional flow to pass downstream; the Skippool Tidal flaps restrict the rate at which this flow can discharge into the Wyre which marginally increases flood levels on the Main Dyke between the A585 and the tidal flaps. However, these increases in flood level do not result in any change to baseline flood extents and so do not increase flood risk to adjacent properties on Old Mains Lane.

9.1.4 Tidal modelling has demonstrated that the elevation of the A585 immediately east of Skippool Junction is critical in controlling the extent to which the road is overtopped by a tidal flood event, and thus the extent and depth of flooding in the area to the south of the A585. In order to mitigate for the slight lowering in elevation of the Scheme, a dwarf wall is proposed alongside the eastbound carriageway (north side of the road). Where gaps in the wall are required either side of the Horsebridge Dyke / Skippool Clough culvert to maintain disability access to the Wyre Way, it is proposed that flood boards would be deployed to maintain the required level of protection during a tidal flood event. The Appendix B gives details of how this was included in the enhanced tidal model.

9.1.5 A detailed description of the changes in tidal flood extents and levels is included in Section 7.3. The changes in flood levels triggered by the Scheme at properties at risk of flooding in the 0.5% AEP tidal event (with and without a UKCP18 climate change allowance) have been calculated. MasterMap building polygons for all properties within the areas shown to experience an impact on flood risk as a result of the Scheme were extracted; Figure D48 in Appendix D shows the extent of the area considered for this property level analysis. For each building polygon, the average peak flood level (mAOD) was extracted for the baseline and ‘with Scheme’ model results using ArcMap Spatial Analyst and results compared for each flood event. Impacts have been grouped (Table 9:) with the intention of providing clarity on the scale of impacts whilst not identifying individual properties.

Table 9: Change in Predicted Flood Levels Grouped by Property Level Impact

Change in Flood Level	0.5% AEP	0.5% AEP (UKCP18)
More than 6cm decrease	12	3
5cm – 6cm decrease	1	2
1cm – 5cm decrease	2	7
Less than 1cm decrease	7	4
No Change	223	3
Total properties experiencing benefit or neutral impact	**245**	**19**
Less than 1cm increase	32	7
1cm – 5cm increase	16	14
5cm – 6cm increase	0	5
More than 6cm increase	7	255
Total properties experiencing detriment	**55**	**281**

9.1.6 Table 9: shows that overall, the Scheme delivers a benefit in terms of reducing flood risk to properties that are, in the baseline situation, at risk of flooding in the 0.5% AEP tidal event.

9.1.7 However, some properties have been identified as potentially at increased risk of flooding in the 0.5% AEP event. Predicted increases in floodwater elevations are largely limited to less than 5cm, this in context of average baseline floodwater depths of around 70 – 80cm. For the five properties where an increase in floodwater elevations more than 6cm is predicted, property level protection could be considered.

9.1.8 During the 0.5% AEP event inclusive of the UKCP18 climate change allowance, the Scheme results in a benefit to 19 properties and a detriment to 281. Of the 281 properties, 255 experience an increase of more than 6cm; on average this equates to an increase of 9.6cm on top of predicted flood depths of over 1m in the majority of cases. The scale of the UKCP18 climate change event is such that, should it occur, vast areas of Thornton, Cleveleys and Fleetwood are predicted to become inundated. As a result, flooding at significantly more properties is anticipated and hence what is only a small impact in a less extreme event is accentuated in an event as extreme as a UKPC18 tidal flood. Mitigation for an event of this magnitude is not practical as the benefits experienced from the provision of a solution to directly mitigate for the impacts of the Scheme i.e. to maintain existing flood depths of over 1m, would be far outweighed by the costs of providing the mitigation.

9.1.9 To manage the potential for the Scheme to increase surface water flood risk, as

outlined in Section 8, a highway drainage strategy has been formulated (Appendix E). The strategy is centred on Sustainable Drainage (SuDS) principles in that attenuation storage and treatment of discharges to improve runoff quality would be provided for, such that there would be no increase in existing rates of discharge to the Main Dyke, Horsebridge Dyke or other receiving waterbodies. This strategy would ensure no increase in surface water flood risk to third party land.

9.2 Protection of the Scheme

9.2.1 Bespoke hydraulic modelling has shown that the Scheme is not at risk of flooding from a purely fluvial flood event inclusive of an allowance of 70% for climate change. However, as discussed in Section 7.3, two locations along the proposed Scheme are at risk of tidal flooding during its design lifetime.

9.2.2 Immediately east of Skippool Junction, the A585 is predicted to flood during the 0.5% AEP event with and without an allowance for climate change in both the defended and undefended scenarios. In the 0.5% AEP defended scenario, predicted flood depths on the road reach a maximum of around 30cm.

9.2.3 The section of the Scheme at risk of flooding increases to include the Skippool Junction roundabout for the two climate change scenarios. Flood depths of up to 90cm are predicted.

9.2.4 The UKCP18 scenario applies an increase of 1.253m on the 0.5% AEP present day tidal boundary in the Wyre Estuary. However, the impact on peak stage along the Scheme, east of Skippool Junction, is just 0.35m.

9.2.5 West of Windy Harbour Junction (immediately south of Pool Foot Creek) is at risk of flooding to a depth of around 100mm in the undefended scenario for the 0.5% AEP plus climate change event. When flood defences are accounted for, there is no risk of flooding of the Scheme in this location.

9.2.6 It is not possible to fully design out the risk of tidal flooding at these locations as it is necessary for the Scheme to tie into existing road levels. Protocols to manage the residual tidal flood risk are set out in the draft Flood Warning and Evacuation Plan which is appended to the outline CEMP (document reference TR010035/APP/7.2 – Rev 1).

9.3 Management of Residual Risks

Third Parties

9.3.1 Residual risks to third parties include:

- Potential for small and temporary increases in flood depths during construction. As discussed in Section 7.5, a temporary floodplain compensation scheme would be implemented to reduce this risk as far as practicable.
- Increase in flood depths during a significant tidal flood event, most notably towards the end of the design life of the Scheme when UKCP18 climate change projections are simulated. As discussed in Section 7.2, the increases in flood depths are on top of a significant depth of baseline inundation that effects a large area in the Wyre estuary hinterland. Any long term, policy led, flood risk management measures for such a serious incident, would also address the small relative increases in flood depths caused by the Scheme.

The Scheme

9.3.2 Residual risks to the Scheme include:

- Failure of the Skippool Tidal Flaps - this is considered unlikely due to their recent construction and an inspection / maintenance regime overseen by the EA. These structures are a designated critical flood defence asset
- Overtopping of the tidal defences - Section 7.3 discusses the potential for inundation of the Scheme due to tidal defence overtopping. Residual risk has been identified and although these residual risks cannot be designed out, as discussed above, implementation of suitable flood warning and evacuation procedures would ensure that danger to life is avoided
- Lack of maintenance of the Main Dyke Channel - the Main Dyke is a main river which is maintained by the Environment Agency in accordance with its statutory powers contained in the Water Resources Act 1991. The Environment Agency's funding for undertaking maintenance activities are prioritised, accordingly Highways England should work with the Environment Agency to understand what maintenance is currently carried out at this location and if necessary explore opportunities for securing funding to ensure that maintenance is carried out.
- Lack of maintenance of the proposed A585 alignment and associated drainage features - Highways England would adopt maintenance responsibility for all drainage features associated with the development

10 SUMMARY AND CONCLUSIONS

10.1.1 An FRA has been prepared to inform the design and Environmental Impact Assessment (EIA) of a proposed Improvement Scheme along the A585 between Windy Harbour and Skippool, in Lancashire.

10.1.2 The EA Flood Map for Planning (Rivers and Sea) shows that the majority of the Scheme is located in Flood Zone 1. However, a small portion of the Scheme between Windy Harbour Junction and the Grange Junction is located within Flood Zone 3 (land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) in any year). This source of flood risk has therefore been assessed in detail by bespoke hydraulic and hydrological modelling.

10.1.3 The Scheme is located in an area identified as at risk of tidal flooding. In order to quantitatively assess this risk, the Wyre Tidal model was obtained from the EA and enhanced for use in this FRA.

10.1.4 Additional sources of flood risk have also been reviewed within the FRA. It is considered that there is a limited risk of groundwater flooding and negligible risk of flooding from artificial sources to the Scheme.

10.1.5 The site is mostly at very low risk of surface water flooding and, with the implementation of a suitable surface water drainage strategy, the risk from surface water flooding would not increase across the Scheme. A suitable drainage design (shown in Appendix E and illustrated on the outline drainage works plans provided in document reference TR010035/APP/2.9) will be implemented to ensure that there will be no increase in surface water run-off from the Scheme to the local land drainage system and that there would be no increase in third party flood risk from this source.

10.1.6 A linked 1D-2D model of the Horsebridge Dyke and Main Dyke has been developed in order to assess baseline fluvial flood risk and to enable an assessment of the potential impacts of the Scheme on flood risk.

10.1.7 Model results demonstrate that the Scheme is not at risk of fluvial flooding from the Main Dyke or the Horsebridge Dyke during any of the modelled design events. When climate change is taken into account, the 1% AEP plus allowances of up to 70% do not result in flooding of the Scheme.

10.1.8 Incorporating the Scheme into the model demonstrates that replacing the existing Skippool Bridge culverts (2 1.8m diameter) with a 12.5m clear span bridge significantly reduces upstream flood extents in all modelled events.

10.1.9 Outfalls from the Main Dyke and Horsebridge Dyke are at risk of tide locking due to high tide levels in the River Wyre. Model results have demonstrated that the Scheme is not at risk of flooding during a tide locked scenario. Furthermore, the Scheme does not increase flood risk to third parties during a tide locked scenario.

10.1.10 The preferred construction methodology for the Scheme necessitates that the embankment is built before work to increase the capacity of the A585 crossing of the Main Dyke is commenced. Modelling of this scenario indicates that only minor increases in flood levels and extents would occur during smaller, more commonplace events and that these increases were constrained to open fields rather than property.

10.1.11 The EA requested that any increases in flood risk to third parties during construction be mitigated for all events up to and including the 1% AEP plus a 30% allowance for climate change. Modelling has shown that provision of some temporary compensatory storage on the right bank of the Main Dyke immediately to the north of the A586 has the potential to mitigate this risk. This features is included as items 98, 109, 110 and 111 on the Works Plans (document reference TR10035/APP/2.3) and commitment to its provision is documented in the Register of Environmental Actions and Commitments (document reference TR010035/APP/7.3). A detailed design for the compensation storage will be developed during the next stage of design and the compensation area would be consented in accordance with the requirements of the Environmental Permitting Regulations 2016.

10.1.12 A qualitative assessment of flood risk from the Pool Foot Creek also indicates that the Scheme would not be at risk of fluvial flooding from this source.

10.1.13 The EA 2D only model of the River Wyre was enhanced and used to assess both the risk of tidal flooding to the Scheme and any change in tidal flood risk to third parties resulting from the Scheme, assuming that existing flood defences on the Wyre remain in place.

10.1.14 Model results from the enhanced tidal model (defended scenario) show that immediately east of Skippool Junction the Scheme is at risk of tidal flooding during a 0.5% AEP event with and without an allowance for climate change.

10.1.15 Results from the supplied (JBA) undefended scenario indicate that the Scheme would be at risk of shallow flooding to the west of Windy Harbour Junction (south of Pool Foot Creek) during only the undefended 0.5% AEP plus climate change flood event.

10.1.16 It is considered that the residual flood risks both to third parties as a result of the Scheme construction, and to the Scheme itself can be appropriately managed, by adopting the measures described in Section 9.

11 RECCOMENDATIONS

Securing of Commitments

11.1.1 Mitigation measures and the associated requirements must be included in the following key documents:

- Works Plans (document reference T010035/APP/2.3).
- Construction Environmental Management Plan (CEMP, document reference TR010035/APP/7.2 – Rev 1)
- Register of Environmental Actions and Consents (REAC, document reference TR010035/APP/7.3 – Rev 1)

Flood Warning and Evacuation Plan

11.1.2 All contractors and operatives should be made aware of the procedures set out in the Flood Warning and Evacuation Plan (FWEP).

Floodplain Compensation Areas

11.1.3 Detailed design of the proposed floodplain compensation areas should be undertaken and adhere to the following requirements:

- Submission of a Flood Risk Activity Permit (FRAP) for all works within 16m of the top of the Main Dyke bank;
- Retention of an 8m wide (as a minimum) unrestricted buffer zone to allow future access to the Main Dyke for EA maintenance vehicles and staff;
- Maintenance of the structural integrity of the Main Dyke banks;
- Maintenance, as far as is practicable, of existing Main Dyke bank levels with any sudden changes in elevations avoided; and
- Design and implementation of a mechanism for draining down the compensation areas following a flood event is in place. This should ensure that the full storage volume is available should a further flood event occur.

11.1.4 When designing the proposed floodplain compensation areas, due consideration should be given to the Reservoirs Act 1975. Specialist advice should be sought from an All Reservoirs Panel Engineer.

11.1.5 Detailed design of the floodplain compensation areas should be agreed with the EA and supported by appropriate hydraulic modelling.

11.1.6 Prior to constructing the Scheme embankment, the floodplain compensation areas should be in place.

11.1.7 Replacement of the existing twin culverts on the Main Dyke beneath the A585 with the proposed Main Dyke clear span crossing should be carried out to reduce upstream flood extents.

Dwarf Wall

11.1.8 The proposed dwarf wall along the east bound carriageway of the A585 should be constructed in order to maintain road crest levels and limit any increases in tidal flood risk occurring as a result of constructing the Scheme.

Haul Roads

11.1.9 Should there be a requirement in future to construct a haul road across an area of floodplain, these would be designed to ensure no impediment to floodplain flow paths, and appropriate consent for their construction would be secured in consultation with the EA. This commitment is set out in the REAC (document reference TR010035/APP/7.3 – Rev 1).

Site Compounds

11.1.10 The two site compounds located in areas at risk of flooding must be subject to the procedures set out in the Flood Warning and Evacuation Plan (FWEP).

11.1.11 For all site compounds, the following measures will be put in place to ensure that there are no flood risk impacts on third party land in the very unlikely scenario of flooding during the construction period:

- No ground raising;
- Securing of compounds via open link fencing; and
- Set back of boundary fencing at a minimum distance of 8m from the banks of any Main River.

11.1.12 At the larger Garstang Road East compound any welfare or office facilities should be located in Flood Zone 1.

Pool Foot Creek Crossing

11.1.13 Any changes made to the existing culvert as part of the Scheme design must ensure that conveyance is maintained as existing.

Skippool Clough Culvert

11.1.14 The proposed changes to the Skippool Clough Culvert must be agreed with the EA prior to construction.

Tidal Flood Risk to Properties

11.1.15 Some properties have been identified as potentially at increased risk of flooding; where practical property level protection should be considered for those properties at risk.

Surface Water Drainage

11.1.16 To ensure that the Scheme does not impact on flood risk from this source a drainage strategy has been developed; this should be implemented.

Groundwater

11.1.17 To prevent groundwater seepage at the Lodge Lane cutting a retaining wall should be constructed to minimise groundwater ingress. Design of this should be informed by the results from a programme of geotechnical surveys during the next stage of the Scheme design.

11.1.18 Results from the geotechnical surveys should also be used to identify any further measures necessary to control groundwater.

Asset Maintenance

11.1.19 Highways England should work in conjunction with the EA to ensure that maintenance on the Main Dyke is carried out.

11.1.20 Highways England should adopt maintenance responsibility for all drainage features associated with the development.

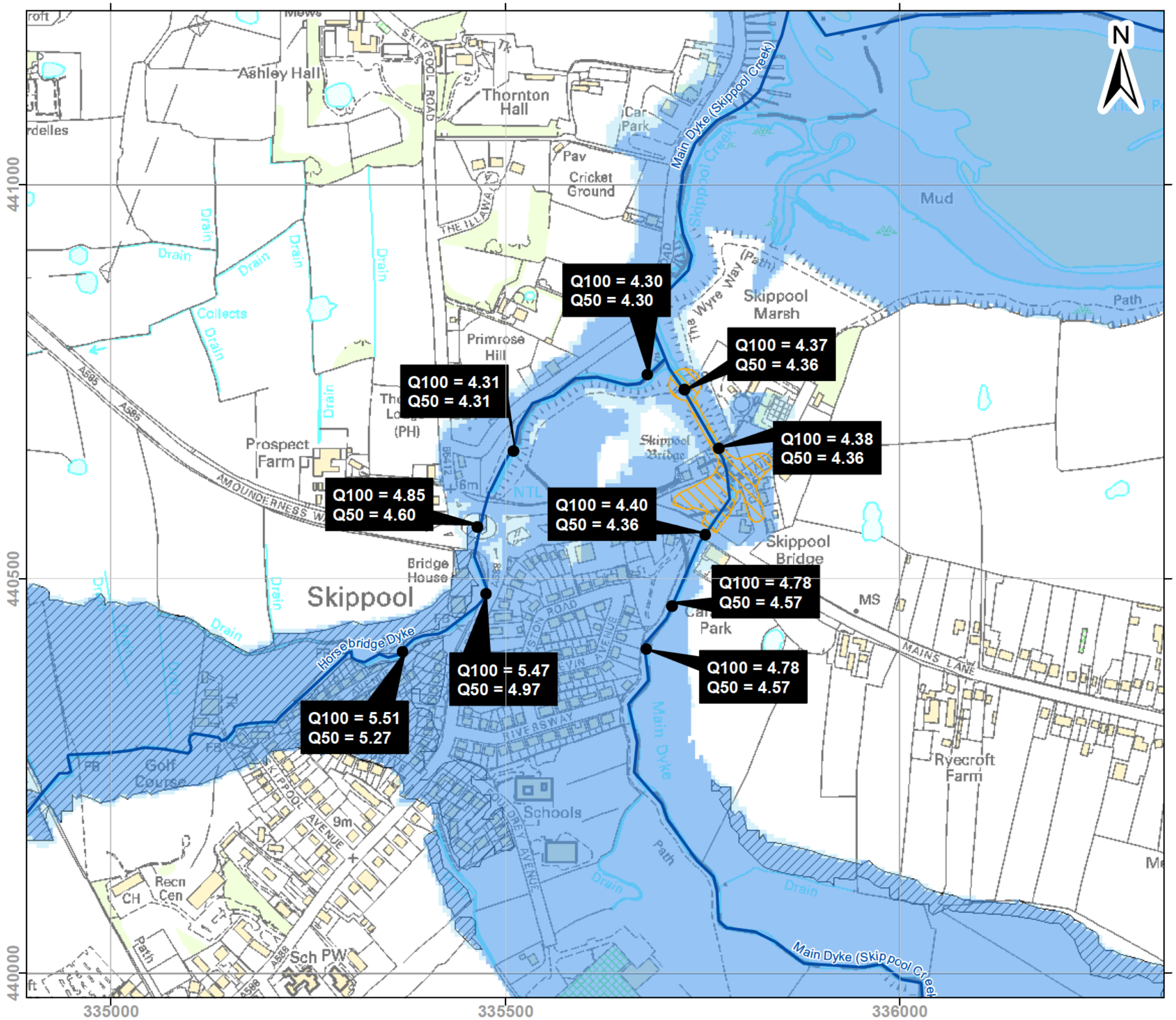
11.1.21 Ownership and maintenance regimes for the Skippool Clough Culvert should be agreed with the EA.

APPENDIX A – EA PRODUCT 4 DATA

Page Left Intentionally Blank

Fluvial Flood Level Map: A585, Skippool

Produced: 24 November 2015
Our Ref: CL5227HR
NGR: SD 35465 40565



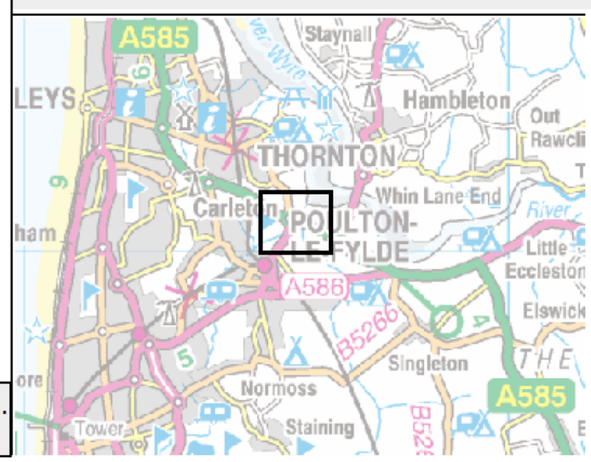
Key

- Main River
- Historic Flooding
- Flood Zone 3
- Flood Zone 2
- Areas Benefitting from Defences

Flood Zone 3 shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 1 in 200 tidal, or 1 in 100 fluvial flood event.



© Environment Agency copyright and database rights 2013. All rights reserved. © Crown Copyright and database rights 2013. Ordnance Survey licence number 100024198.
Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Environment Agency

Tidal Flood Level Map: Skippool - Windy Harbour

Produced: 25 November 2015
Our Ref: CL5227HR

Key

Main River

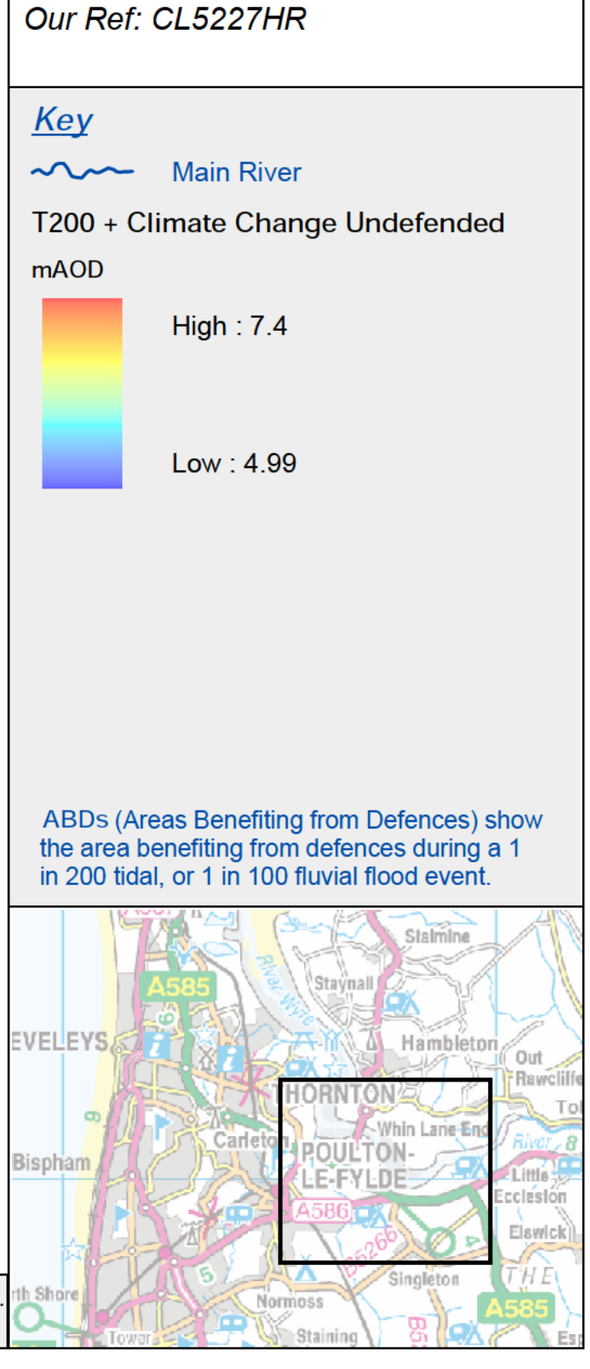
T200 + Climate Change Undefended

mAOD

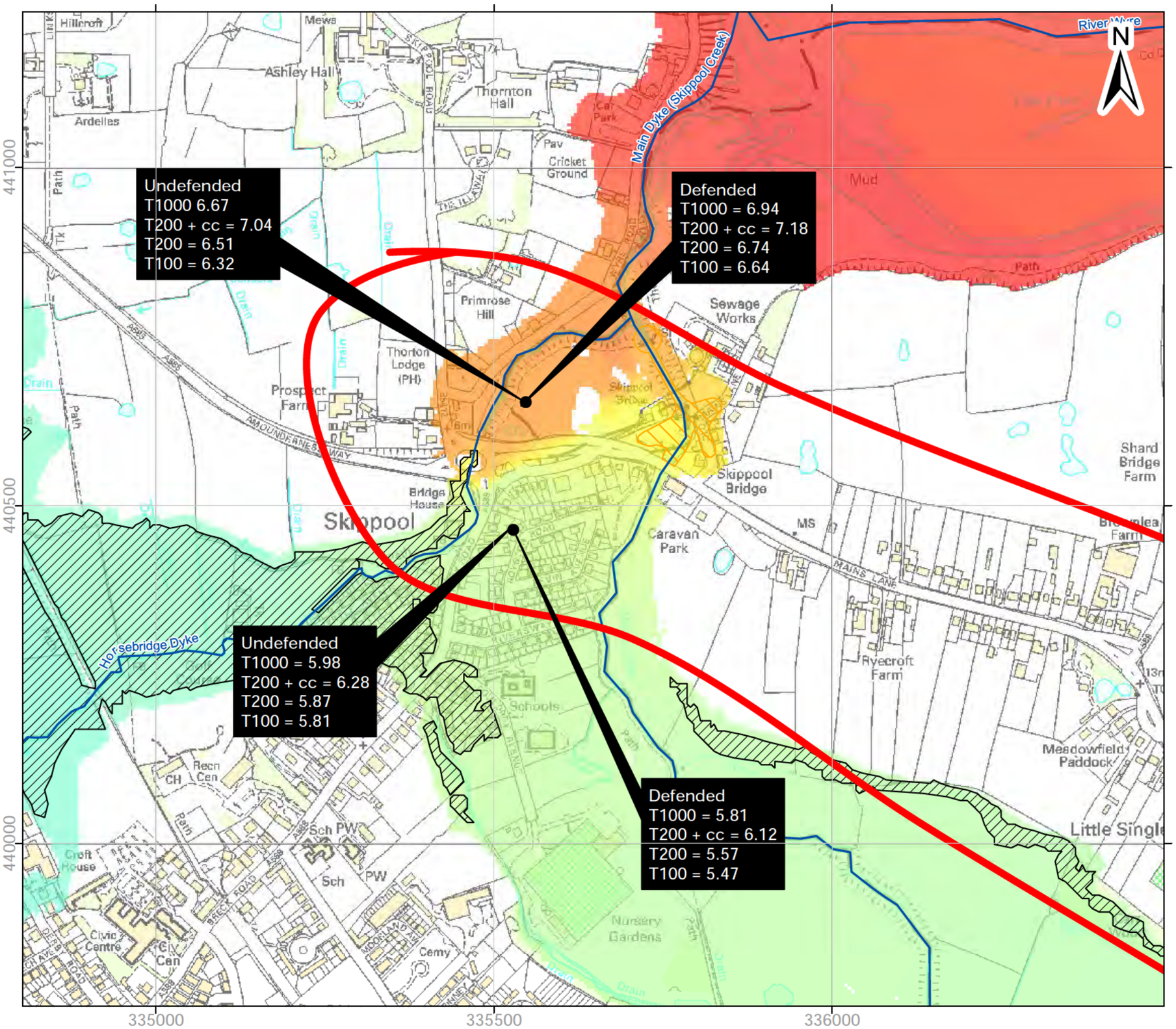
High : 7.4

Low : 4.99

ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 1 in 200 tidal, or 1 in 100 fluvial flood event.



© Environment Agency copyright and database rights 2013. All rights reserved. © Crown Copyright and database rights 2013. Ordnance Survey licence number 100024198.
Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk



Tidal Flood Level Map: A585, Skippool

Produced: 25 November 2015
Our Ref: CL5227HR
NGR: SD 35536 40571

Key

- Main River
- Historic Flooding
- Areas Benefitting from Defences

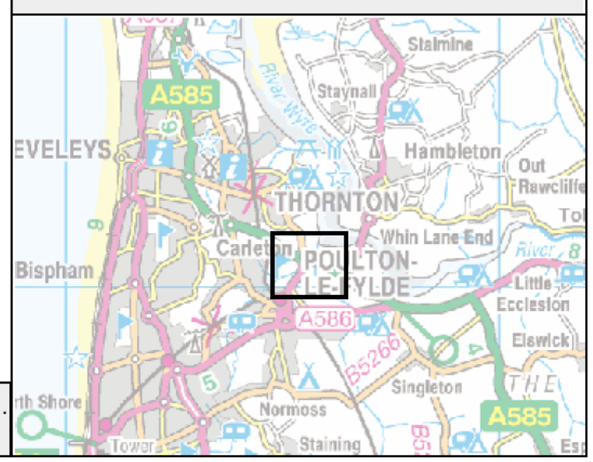
T200 + Climate Change Undefended

mAOD

High : 7.4

Low : 4.99

ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 1 in 200 tidal, or 1 in 100 fluvial flood event.



© Environment Agency copyright and database rights 2013. All rights reserved. © Crown Copyright and database rights 2013. Ordnance Survey licence number 100024198.
Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Tidal Flood Level Map: A585, Windy Harbour

Produced: 25 November 2015
Our Ref: CL5227HR
NGR: SD 38815 39480

Key

Main River

Areas Benefitting from Defences

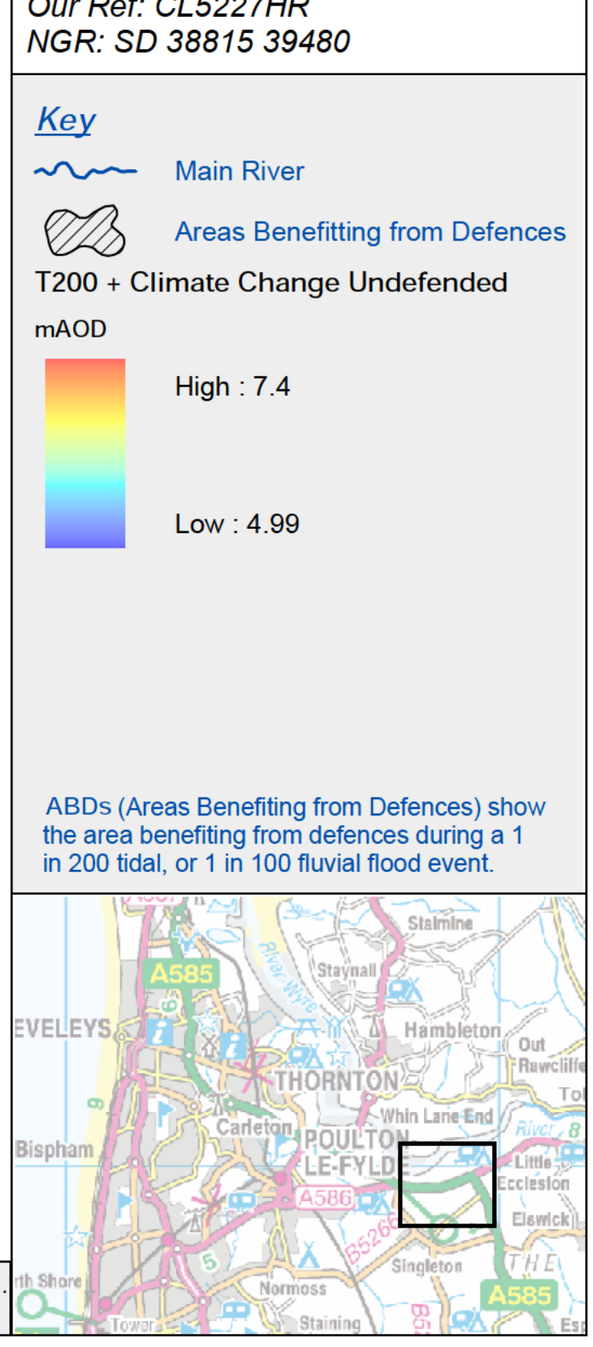
T200 + Climate Change Undefended

mAOD

High : 7.4

Low : 4.99

ABDs (Areas Benefiting from Defences) show the area benefiting from defences during a 1 in 200 tidal, or 1 in 100 fluvial flood event.



© Environment Agency copyright and database rights 2013. All rights reserved. © Crown Copyright and database rights 2013. Ordnance Survey licence number 100024198.
Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Lisa [redacted]

From: [redacted]
Sent: 12 January 2017 11:40
To: [redacted]
Subject: RE: A585 mod[redacted]ling study

Hello Lisa

The revised flows will be acceptable for the Flood Risk Assessment without the need for a detailed EA review. As you point out the increased flows for climate change will provide a much more conservative flood estimation.

With regards
Ian

From: [redacted]
Sent: 11 January 2017 14:44
To: [redacted]
Cc: [redacted]
Subject: A585 modelling study

Hello Ian

I am working with C[redacted]on the A585 scheme and one of the actions that was agreed during one of your calls was for us to check our new design flow hydrology against the hydrology in the existing EA models of the Main and Horsebridge Dykes. Please see below a summary comparison table.

Flow Estimation Location	2 year flow - Arcadis	2 year flow – EA 2003	100 year flow - Arcadis	100 year flow –EA 2003
Main Dyke at DS limit	11.23	10.09	23.7	24.6
Horsebridge Dyke at DS limit	6.55	3.66	13.95	10.2

In the main our new flows are higher than the EA 2003 model flows, with the exception of a slightly lower flow at the 100yr on the Main Dyke. However, the scenario we are modelling is the 100 year plus climate change event, incorporating a +30% factor for CC (so arriving at a more conservative flow).

I light of these findings I was hoping you could agree that our design hydrology is acceptable without detailed EA review.

Kind Regards

Lisa

[redacted]
Arcadis | Arcadis House Cymru, Fortran Road, St Mellons Business [redacted], Cardiff | CF3 0EY | Wales
T. 02920 926742 | M. + 07947 221117
www.arcadis.com

ARCADIS Design & Consultancy for natural and built assets

Be green, leave it on the screen.

Arcadis Consulting (UK) Limited is a private limited company registered in England & Wales (registered number 02212959). Registered office at Arcadis House, 34 York Way, London, N1 9AB. Part of the Arcadis Group of Companies along with other entities in the UK.
This e-mail and any files transmitted with it are the property of Arcadis. All rights, including without limitation copyright, are reserved. This e-mail contains information which may be confidential and may also be privileged. It is for the exclusive use of the intended recipient(s). If you are not the intended recipient(s) please note that any form of distribution, copying or use of this communication or the information in it is strictly prohibited and may be unlawful. If you have received this communication in error please return it to the sender and then delete the e-mail and destroy any copies of it. Whilst reasonable precautions have been taken to ensure no software viruses are present in our emails we cannot guarantee that this e-mail or any attachment is virus-free or has not been intercepted or changed. Any opinions or other information in this e-mail that do not relate to the official business of Arcadis are neither given nor endorsed by it.

This message has been scanned and no issues discovered.
Click here to report this email as spam

Information in this message may be confidential and may be legally privileged. If you have received this message by mistake, please notify the sender immediately, delete it and do not copy it to anyone else.

We have checked this email and its attachments for viruses. But you should still check any attachment before opening it.
We may have to make this message and any reply to it public if asked to under the Freedom of Information Act, Data Protection Act or for litigation. Email messages and attachments sent to or from any Environment Agency address may also be accessed by someone other than the sender or recipient, for business purposes.
Click here to report this email as spam

APPENDIX B – HYDRAULIC MODELLING TECHNICAL DETAILS

Initial Model Review Report

Technical Modelling Annex

Page Left Intentionally Blank

MEMO

ARCADIS Design & Consultancy for natural and built assets

SUBJECT
Main Drain and Horsebridge Dyke Hydraulic Model Review

DATE
23 March 2016

DEPARTMENT
Rivers Marine and Coastal

COPIES TO

TO

OUR REF
5000-UA008015-BMR-01

PROJECT NUMBER
UA008849

FROM
[redacted]

A review of the Environment Agency (EA) hydraulic models of the Main Drain and Horsebridge Dyke has been carried out on behalf of Highways England. The objective of the review was to identify the work required to update and adapt these models to make them suitable for use to inform the design of the Southern Option of the A585 Improvement Scheme, including assessing the flood risk impacts of this Option.

The EA supplied separate ISIS models of the Main Drain and Horsebridge Dyke. These models were constructed in 2002/2003.

The model review findings are summarised under the headings 'Must Do' and 'Should Do'. It is recommended that both the 'Must Do' and 'Should Do' items be actioned in order to develop an appropriately robust baseline model.

Applicable to Both Models

Must Do

1) Panel Markers need to be added to the ISIS channel sections at points where the bank slope changes. At the moment they are predominantly located at the left and right banks which is creating jumps in the conveyance curve.
2) Glass walling and minor levees in the model cross sections need to be removed by creating a 1D-2D linked model which allows flows to spill onto the floodplain.
3) A review of the channel roughness should be carried out; justification for the choice of coefficients (with survey photos) is required.
4) The Main Drain and Horsebridge Dyke ISIS models should be linked in order to assess the interaction between the two watercourses dynamically. This will impact on the backwater effects experienced at the A585 / Breck Road roundabout, the A585 road bridge and on the combined floodplain to the south of the A585.
5) The combined model should be converted to a linked 1D - 2D model in order to improve the modelling of floodplain flows.
6) A detailed hydrological review is required to ensure that the latest flood flow estimation methods are taken into account. This review will also identify whether a single lumped inflow is appropriate or whether additional point / lateral inflows are required.

Should Do

7) A check survey would be useful to ensure that the 2002 data is fit for purpose and that no new structures have been constructed in the intervening period.

8) The supplied model is now 13 years old and therefore the Environment Agency / Lead Local Flood Authority should be consulted to determine if any new data is available for calibration of either the Main Drain or Horsebridge Dyke.
9) IED files have not been used to apply inflows and boundary conditions. This approach is not recommended.
10) Separate initial conditions files have not been used. This is not the recommended approach.

Main Drain

Must Do

11) The spill unit representing overtopping flows need to be added for the Mains Lane culvert and the bridge near the pumping station.
12) The two USPBR bridge units in the model need to be changed to Arch Bridges as this unit is hydraulically more appropriate for the situation being modelled.
13) The same HT (stage time) boundary is used as the downstream boundary condition for all the design events. This represents 24 hours of tidal data which has been extracted from a 'typical' spring tide cycle. Given that this analysis was carried out 13 years ago, it is recommended that further analysis is carried out to re-project the tide levels to the current day. It is also highlighted that the peak fluvial inflow currently coincides with the lowest tidal level. Additional discussion with the EA is recommended to ensure that the most appropriate combinations of inflow and tidal boundaries are being used.
14) The existing A585 crossing of the Main Drain is 373m upstream of the model downstream boundary. Sensitivity testing carried out on the downstream boundary (results supplied by the Environment Agency) indicated that effects of this were significant at the existing A585 bridge. This adds further weight to the requirement to improve the downstream boundary conditions used in the model.
15) The accompanying model report, supplied by the Environment Agency, states that *'the fluvial flow is allowed to flow through the tidal outfall when the water level in the river is higher than the tidal level in the estuary. The tidal outfall is closed when the tidal level is higher than the river water level'*. The model contains a sluice at the downstream boundary which has been modelled with a fixed opening of 2m. Data for the sluice should be located and used to improve the representation of the control mechanisms at the downstream extent of the Main Drain.

Horsebridge Dyke

Must Do

16) Some of the spill coefficients for the spill units representing the structure overtopping flow routes are not appropriate and require review and amendment.
17) The seven USPBR Bridge units in the model need to be changed to Arch Bridge units as this unit is hydraulically more appropriate for the situation being modelled.
18) A fixed stage of 4.3 mAOD has been used at the downstream boundary. This is not consistent with the boundary condition applied to the Main Drain and should be reviewed. Consultation with the Environment Agency will be required to determine the most appropriate set of downstream boundary conditions.
19) Based on the photos supplied in the model report, it is likely that some amendments will be required to the structures in 1D, although the extent of these amendments cannot be finalised as no survey data has been provided for the Horsebridge Dyke.
20) Photographs in the model report suggest that three structures are missing from the model;

HRBD02_3296 (footbridge downstream of A586 Garstang Road), HRBD02_0759 (Poulton Le Fylde golf course footbridge no. 2) and HRBD02_0180 (footbridge crossing no. 7 downstream of Skipool Avenue). It is recommended that these structures are added to the model.

Should Do:

21) Initial water levels are out of bank at the start of the simulation; this does not reflect reality and may result in the over estimation of flooding.

Conclusion

The Environment Agency models of the Main Dyke and Horsebridge Dyke are in excess of ten years old and significant advances in hydraulic and hydrological modelling software and methodologies have been made since these models were built. A number of actions are recommended to update the existing models to create a robust tool to both inform the design and assess the impacts of the Southern Option.

1 INTRODUCTION

1.1.1 Two hydraulic models, one fluvial and one tidal, have been developed to inform the Flood Risk Assessment (FRA) (document reference TR010035/APP/5.2 – Rev 1) for the proposed A585 Windy Harbour to Skippool Improvement Scheme (henceforth referred to as 'the Scheme'). This Technical Memo, as an annex to the FRA, describes the modelling undertaken and documents key consultations and correspondence with the Environment Agency (EA) to date. Discussion and analysis of the model results is contained within the FRA report.

2 EXISTING MODEL REVIEWS

2.1 Fluvial Model

2.1.1 Arcadis, on behalf of Highways England, undertook a comprehensive review of the existing EA 1D only Horsebridge Dyke and Main Dyke models. This review is available in Appendix B of the FRA (document reference TR010035/APP/5.2 – Rev 1). A summary of key issues identified as part of the review is provided in Table 1.

Table 1: Fluvial Model Review Key Findings

Item	Description of Issue
ISIS Panel Markers	Panel Markers need to be added at changes in section slope. At the moment, they seem to be in line with left and right banks. This is creating jumps in the conveyance curve. In addition, several of the bank markers have been incorrectly placed.
Cross section Geometry	Glass walling and minor levees in the model cross sections need to be removed by creating a 1D-2D linked model.
Model Schematisation	The model should be converted to a linked 1D-2D model in order to improve the modelling of floodplain flows.
Model Schematisation	The Main Dyke model should be linked to the Horsebridge Dyke model to assess the interaction between the two watercourses dynamically. This would impact on the backwater effects at the A585 bridge and on the combined floodplain to the south of the A585.
Model Schematisation	Spill units representing overtopping flows need to be added for the Mains Lane culvert and the bridge near the pumping station.

Item	Description of Issue
Model Schematisation	The 2 USPBR bridge units in the model need to be changed to Arch Bridges as this unit is hydraulically more appropriate for the situation being modelled.
Roughness	Channel roughness needs review, justification (with survey photos) and amending.
Downstream Boundary	A detailed hydrological review is required to ensure that the latest estimation methods are considered. This review would also identify whether a single lumped inflow is appropriate or whether additional point / lateral inflows are required.
Model Schematisation	The A585 crossing of the Main Dyke is 373m upstream of the model downstream boundary. Sensitivity testing carried out on the downstream boundary indicated that effects of this are significant at the existing A585 bridge. The same HT (stage time) boundary was used as a downstream boundary for all the design events. This represents 24 hours of tidal data which has been extracted from a 'typical' spring tide cycle. Given that this analysis was carried out 13 years ago, it is recommended that further analysis is carried out to re-project the tide levels to the current day. Additional discussion with the EA is recommended to ensure that the most appropriate combinations of inflow and tide boundaries are being used. It is highlighted that the peak fluvial inflow currently coincides with the lowest tidal level.

2.2 Tidal Model

2.2.1 The River Wyre tidal model (defended and undefended) was developed by JBA Consulting and submitted to the EA in 2015[1]. This model was supplied for use in the Scheme FRA (document reference TR010035/APP/5.2 – Rev 1). A high-level review of the tidal model was carried out prior to its use and it was noted that, for the most part, channels and structures in the vicinity of the Scheme were not modelled explicitly. Whilst this is acceptable for the purposes for which the tidal model was developed, it was considered that some enhancements were required; these are described in Section 4.1.

2.2.2 Two discrete areas of the Scheme were identified as potentially at risk of tidal flooding. Results from the JBA modelling (2015) were used to assess the defended and undefended flood risk to the Scheme in the vicinity of Old Bankfield House and Pool

[1] *JBA (2015) North West Region - Lancashire Tidal Areas Benefitting from Defences Revisited*

Foot Lane, a very localised area of risk, with no highly vulnerable third party receptors within the EA mapped extent of Flood Zone 3.

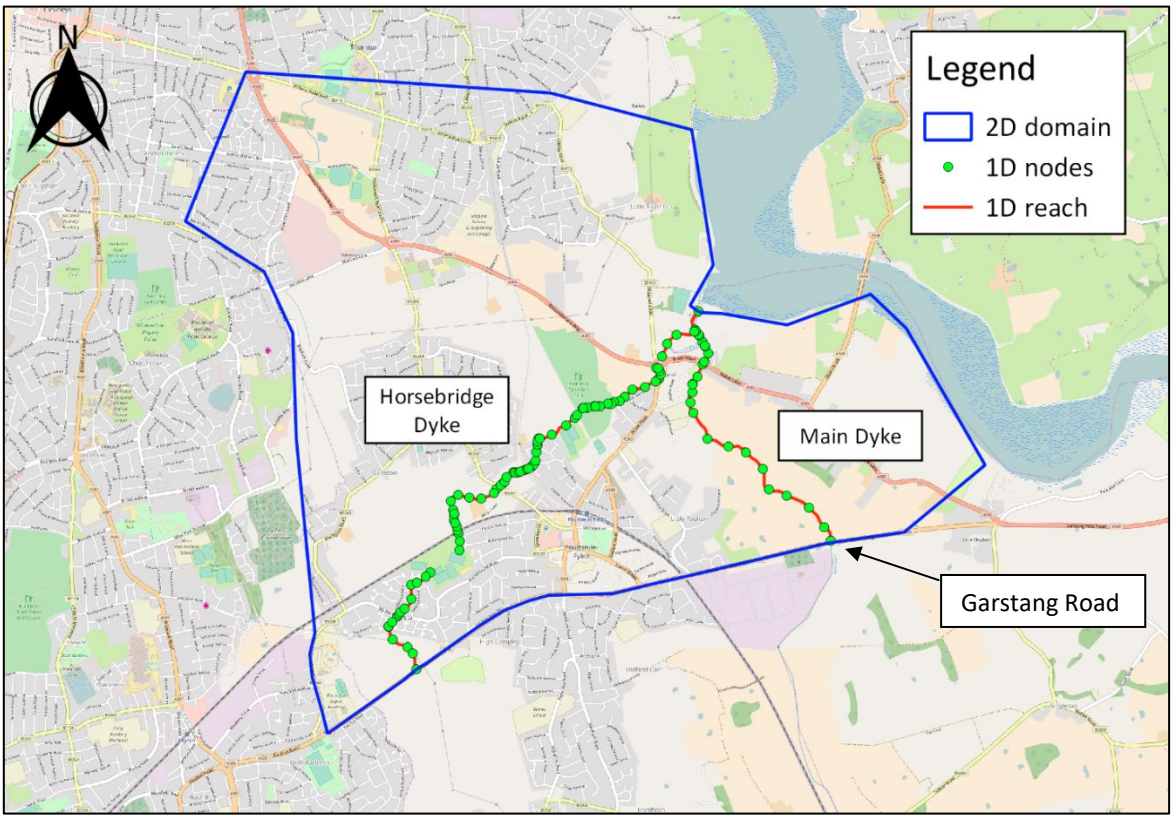
2.2.3 Results from the enhanced tidal model (Section 4) were used to assess flood risk to the Scheme as it crosses the floodplains of the Main Dyke and Horsebridge Dyke in Skippool. This decision was made as the interaction between the Scheme and the tidal flood extents (Flood Zone 3) is more extensive here and there are vulnerable third party receptors in this location.

3 BASELINE FLUVIAL MODEL BUILD

3.1 1D Domain

3.1.1 To facilitate assessment of the Scheme, the two EA 1D models of the Horsebridge Dyke and Main Dyke were improved and combined into a 1D-2D linked model. The model was run using TUFLOW version 2016-03-AD-iSP-w64 and Flood Modeller Pro Version 4.2. Figure 1 shows the overall schematisation of the model.

Figure 1: Hydraulic Model Schematisation (Contains Ordnance Survey data © Crown copyright and database right 2017)



3.1.2 Upstream of the A586 Garstang Road crossing, the Scheme turns east, away from the Main Dyke and crosses much higher ground which is outside the floodplain associated with the Main Dyke. Therefore, this was deemed an appropriate location for the upstream model extent on the Main Dyke. The Scheme alignment was overlain onto the EA Flood Zone data to determine the extent to which the Scheme would encroach into Flood Zone 3 on the right bank of the Main Dyke. Figure 2 confirms that this encroachment is minimal, and, along with the fact that land on the right bank is lower than the developed land on the left bank (Figure 3), the impact of this small encroachment would be negligible.

3.1.3 In addition, the supplied EA model of the Main Dyke stopped just upstream of the Garstang Road. Given the issues discussed above, it was not considered of sufficient benefit to procure additional survey to extend the model of the Main Dyke further upstream. The model schematisation and extents were agreed with the EA as being appropriate at a meeting in October 2018 (meeting minutes included in Appendix F of the FRA (document reference TR010035/APP/5.2 – Rev 1).

Figure 2: EA Flood Zone data and the Scheme (outlined in red) (Contains Ordnance Survey data © Crown copyright and database right 2017)

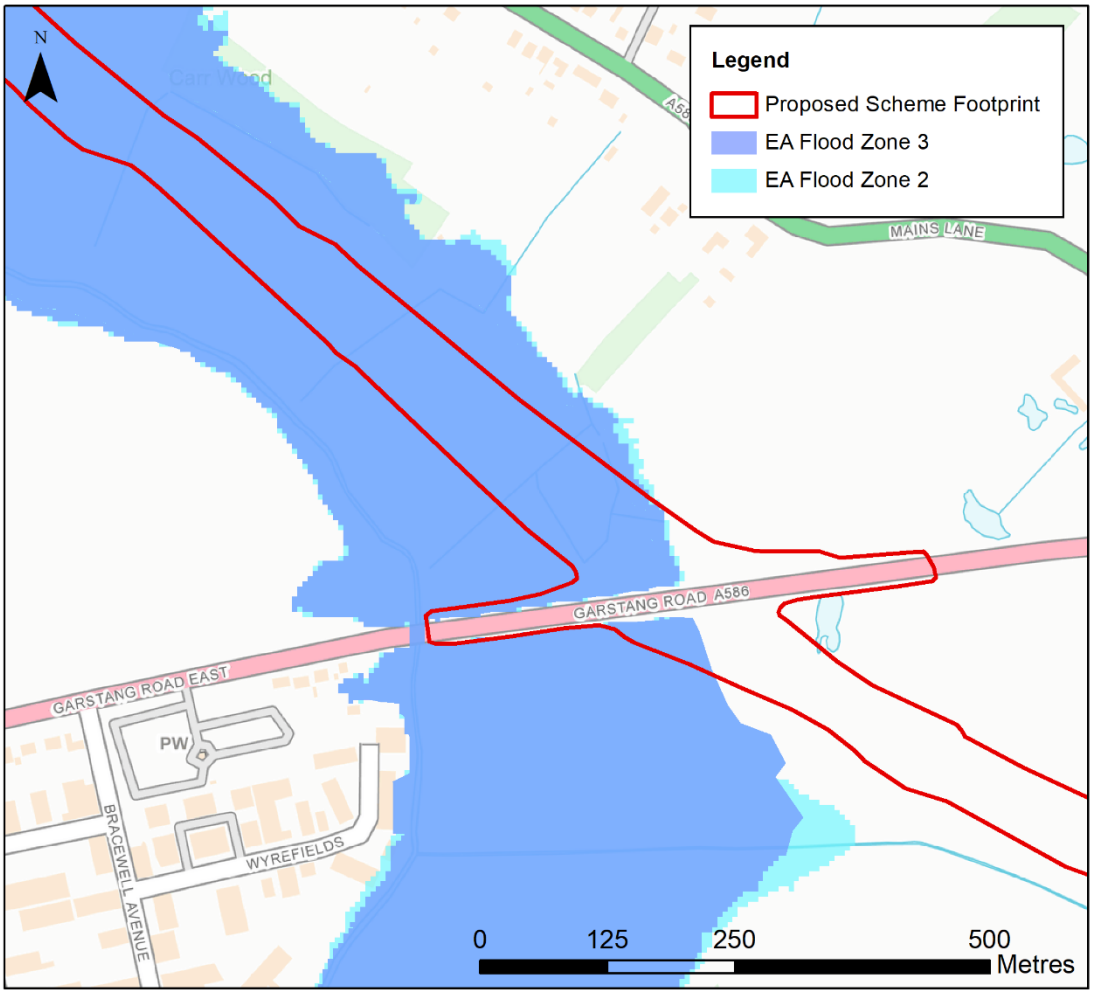


Figure 3: View south along the Main Dyke from Garstang Road (source Google Street View)



3.1.4 The upstream extent of the model of the Horsebridge Dyke was extended 100m upstream (node HRBD02_3444) in order to utilise the existing Garstang Road embankment as an effective 2D model boundary.

Structures

3.1.5 The structure improvements identified in Section 2.1 were applied. Structures were verified using the latest available survey data, satellite imagery and photography where available. Those structures that have been modified so that the overtopping routes are modelled in 2D in order to provide more accurate floodplain extents are listed in Table 2.

Table 2: Structures which have been modelled with overtopping routes in 2D

Structures which have been modelled with overtopping routes in 2D
HBRD02_3006A
HRBD02_2591
HRBD02_2236
HRBD02_1641
HRBD02_1464
HRBD02_1409
HRBD02_1318
HRBD02_0838
HRBD02_0152
HRBD02_0078
MAIN02_0230

3.1.6 Additional modifications were made to the key tidal structures at the downstream ends of both the Horsebridge Dyke and Main Dyke to incorporate the flapped outfalls which are present.

3.1.7 As built information for the existing Skippool Clough Culvert (on the Horsebridge Dyke) was obtained from the design team. This was used to correct the schematisation of the culvert from a three-part structure with diameters of 1.6m, 1.7m and 1.7m (upstream to downstream) to one with diameters of 1.6m, 1.52m, 1.6m (upstream to downstream).

3.1.8 The EA defence database records the crest level of the Skippool tidal flaps as 5.21mAOD. However, inspection of point cloud LiDAR combined with aerial photography and a site inspection indicated that the top of the wall was in fact higher and ties into higher ground on the left and right banks (Figure 4). Therefore, the crest elevation for the purposes of the modelling was taken to be 6.6mAOD.

Figure 4: Wall across the top of Skippool tidal flaps tying into higher ground beyond (Arcadis 2018)



Geometry

3.1.9 The two watercourses within the study area have been modified by trimming cross sections to end at the bank top and creating 1D-2D HX links along the channel edges. The upstream end of the Horsebridge Dyke was extended 100m upstream (node HRBD02_3444) to utilise the existing Garstang Road embankment as an effective 2D model boundary.

3.1.10 The 2D model orientation has been set to approximately 45 degrees in order to be perpendicular to the predominant direction of floodplain flow.

Roughness

3.1.11 Roughness values for the FMP channels included in the supplied model were updated, these updates were informed by photographs taken in 2002, supplied with the existing model report. However, these photographs were limited to areas where structures had been surveyed.

Initial Conditions

3.1.12 1D initial conditions were supplied by a Flood Modeller initial conditions file (IIC), these were generated during a steady state run.

Boundaries

3.1.13 Point inflows are applied to the upstream of the Main Dyke, the Horsebridge Dyke and to represent a small tributary on the left bank of the Horsebridge Dyke at Shirley Heights / The Oaks. Inflows from the intervening catchments are applied to the 1D model as lateral inflows. These fluvial inflows have been generated for the 50%, 1%, 1% plus 30%, 1% plus 70% and 0.1% AEP events, as detailed in the FEH Calculation Record provided in Appendix C of the FRA (document reference TR010035/APP/5.2 – Rev 1). The 1D model downstream boundary occurs where the Main Dyke joins the tidal River Wyre and is represented using a stage time (HT) boundary unit. Tidal

boundaries were derived specifically for this study using the methodology set out below.

3.1.14 Tidal water levels were extracted at the mouth of the River Wyre (Lat 53.93, Lon -3.01) from the MIKE21 Global Tidal Model[2], which has a resolution of 0.125º x 0.125º. The Global Tidal Model includes 10 harmonic constituents, Semidiurnal: M2, S2, K2, N2, Diurnal: S1, K1, O1, P1, Q1 and Shallow Water: M4. A tidal curve was extracted from this data which has the closest peak value to mean high water spring (MHWS).

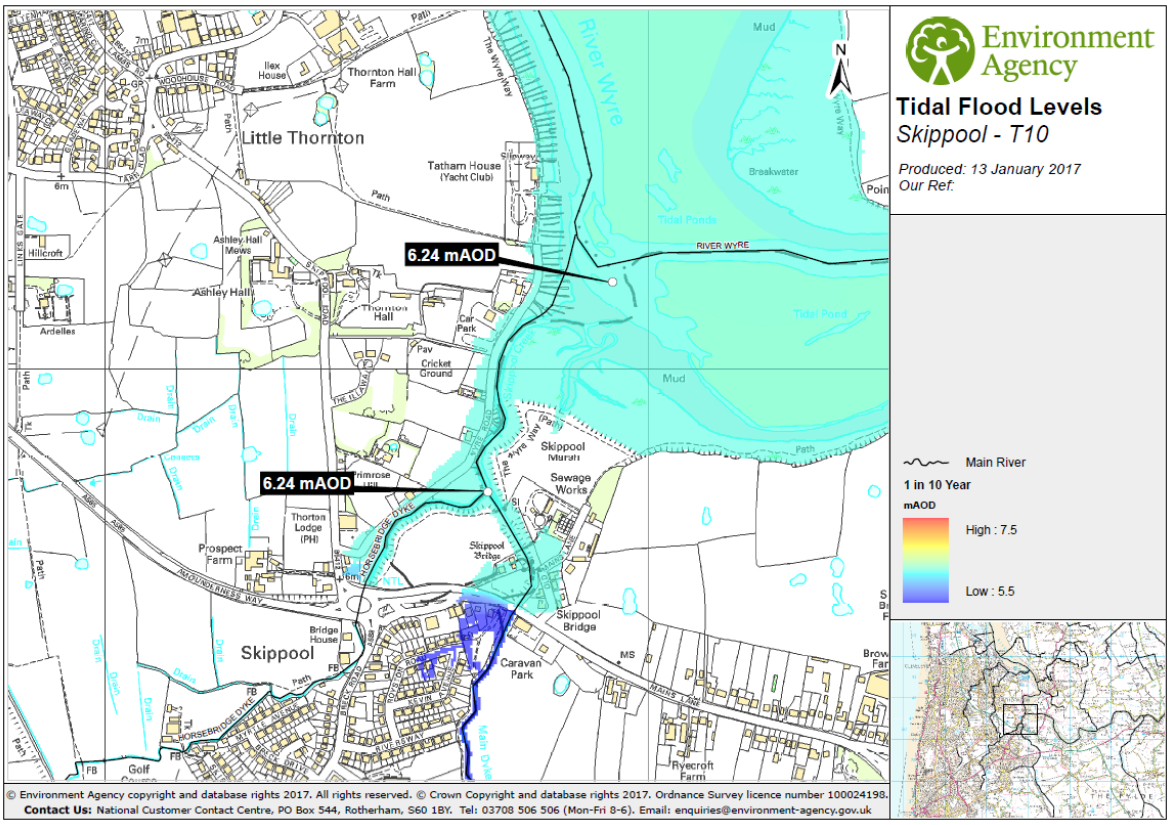
3.1.15 High tidal levels in the Wyre would close the flaps on the outfalls which would otherwise enable the Horsebridge Dyke and Main Dyke to discharge into the estuary. This is referred to as 'tide locking'. In order to assess the impact of 'tide locking' on water levels in the Main Dyke and Horsebridge Dyke, tidal analysis was carried out to generate tidal curves at the fluvial model downstream boundaries, as described below.

3.1.16 Water levels for the 10% AEP and 0.5% AEP events at locations within the estuary towards Skippool were supplied by the EA and are shown in Figure 5 and

3.1.17 Figure **6** respectively. Values from the offshore positions labelled in Figure 5 and

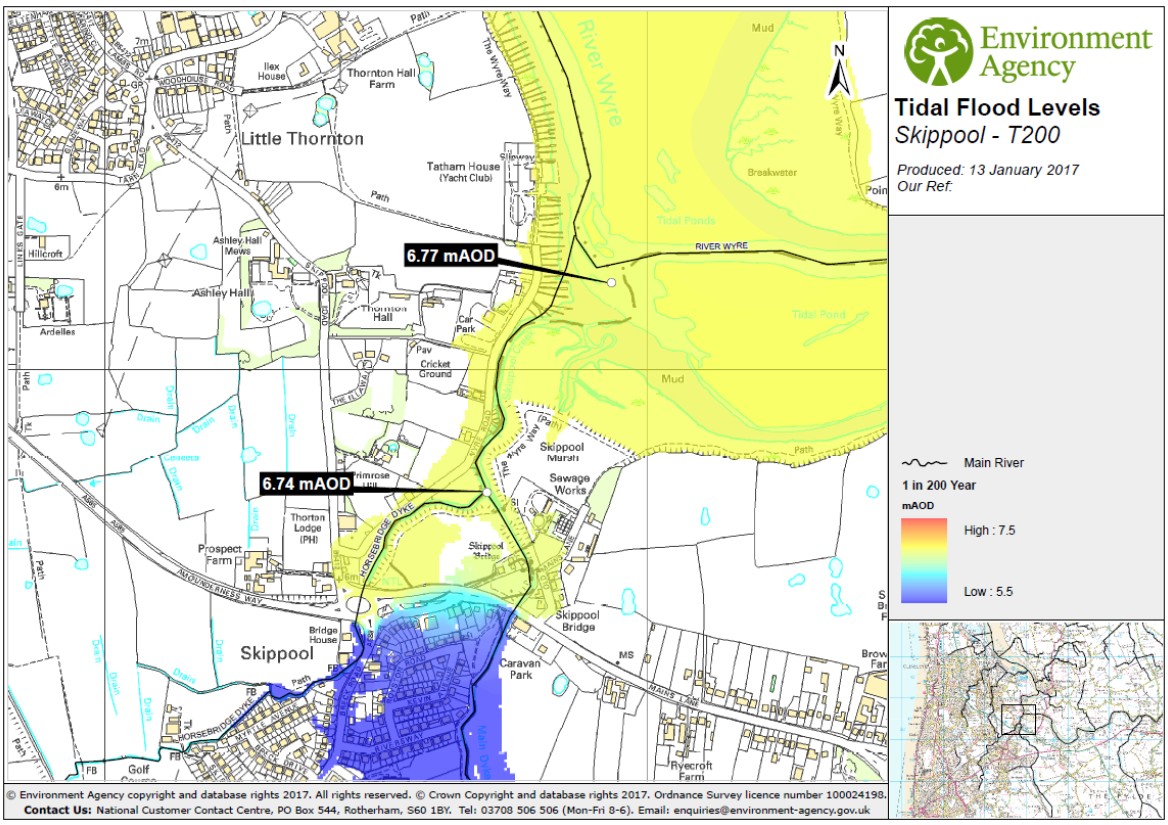
3.1.18 Figure **6** were used to derive tidal curves.

Figure 5: 10% AEP water levels in the Wyre Estuary (Supplied by the EA. OS licence: 100024198)



[2] *http://www.dhigroup.com/download/mike-by-dhi-tools/coastandseatools/global-tide-model*

Figure 6: 0.5% AEP water levels in the Wyre Estuary (Supplied by the EA, OS licence: 100024198)



3.1.19 Tidal curves were generated for the 10% AEP and 0.5% AEP events at three climate epochs: 2016 (present day), 2069 and 2115. The event water levels are referenced to a base year of 2014[1] and uplifted to the desired climate epoch using UK Climate Change Impacts Programme 2009 (UKCP09) medium emissions scenario 95th percentile sea level rise figures (see paragraph 3.1.24 for further discussion).

3.1.20 The EA practical guidance[3] for generating a storm tide curve was followed. For this process, the closest available surge curve data was obtained for Heysham from the EA Coastal Flood Boundary (CFB) dataset. Tidal data from the Heysham tide gauge was processed to identify a base astronomical tide between highest astronomical tide (HAT) and MHWS.

3.1.21 The three components of the design tide curve (extreme sea level, base astronomical tide curve and surge shape) were then combined to produce the resultant design tide curve, where the peak in astronomical tide and surge shape are set to coincide at the same time.

3.1.22 Figure 7 and Figure 8 show the design tide curves for 2016 10% AEP and 0.5% AEP events respectively.

[3] *Environment Agency, (2011). Coastal flood boundary conditions for UK mainland and islands. Project: SC060064/TR4: Practical guidance design sea levels*

Figure 7: Design tide curve for a 2016 10% AEP event

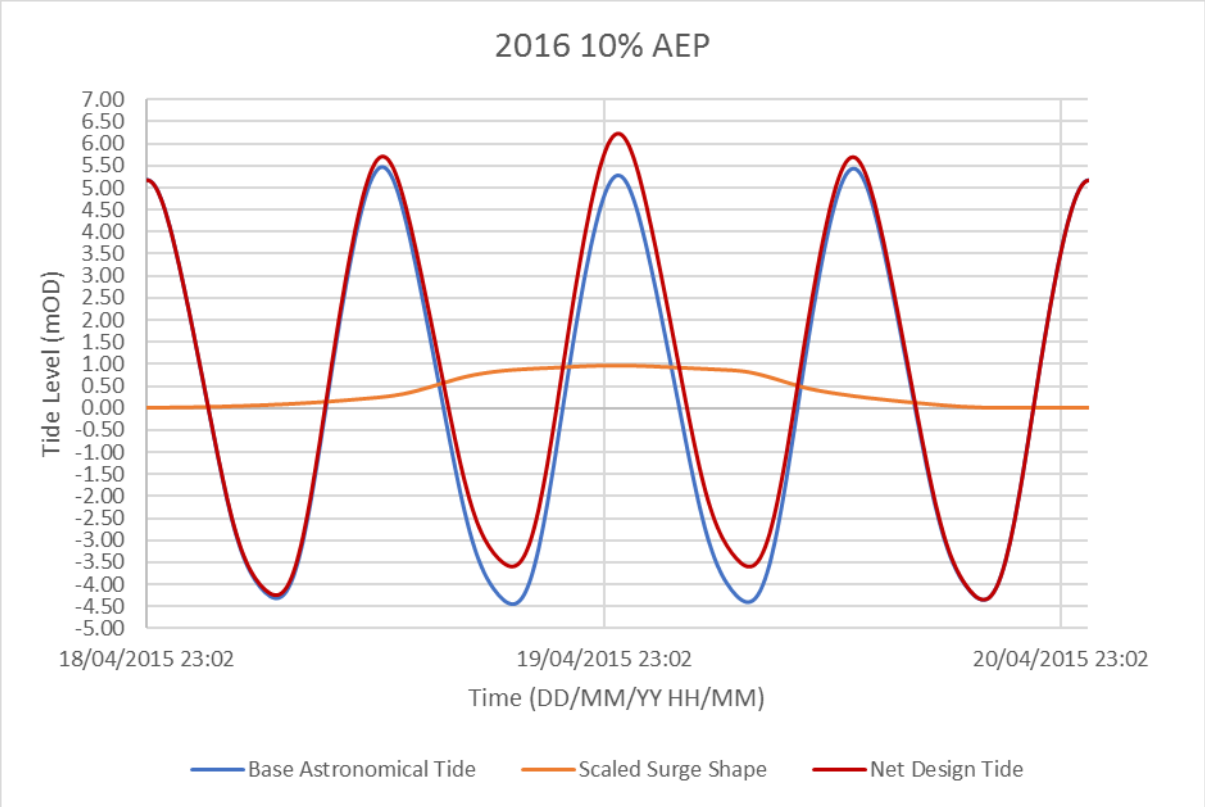
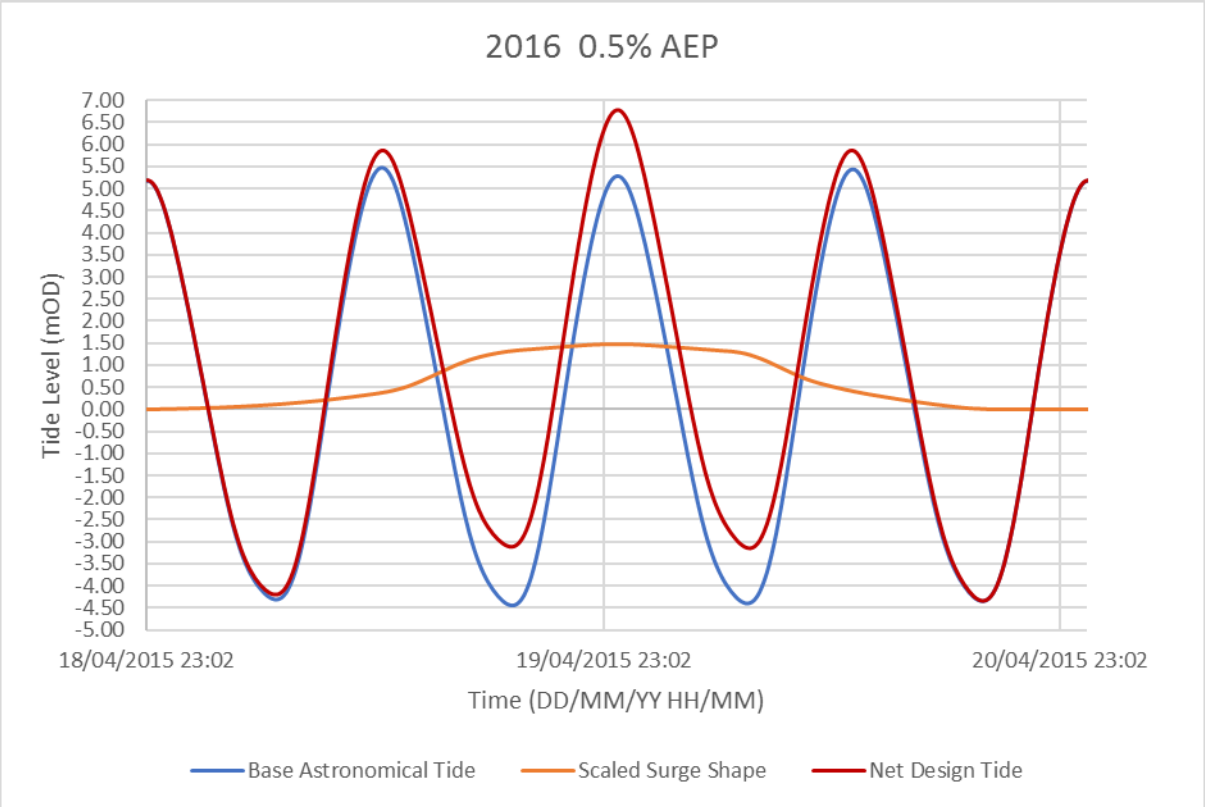


Figure 8: Design tide curve for a 2016 0.5% AEP event



3.1.23 Further detail on how these tidal curves were used to assess the impact of tide locking is given in Section 6.

3.1.24 During the 2018 EA model review process (Section 11.4), it was noted by the EA that the tidal boundary generated in 2016 was out of date. In order to assess any potential impacts of this on the conclusions of the FRA, data for the mean sea level at Heysham was downloaded in October 2018. This indicated that between the years 2000 and 2014, the mean sea level increased by 19mm, although in some intervening years the annual increase was greater (Figure 9 and Table 3). It was agreed with the EA (Section 11.1) that a 19mm increase on a peak tide level of between 6mAOD and 7mAOD would have a negligible impact on the overall FRA conclusions.

Figure 9: Sea level trends for Heysham[4]

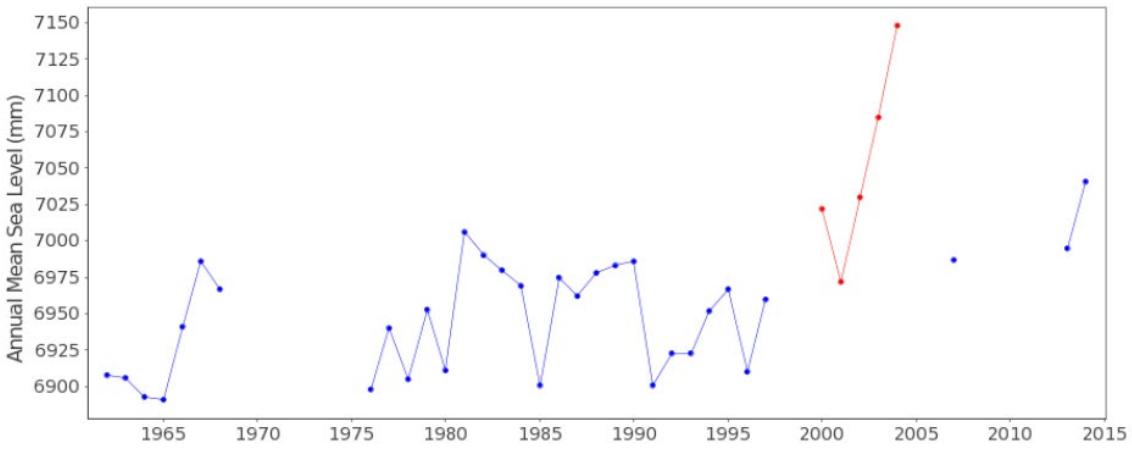


Table 3: Mean sea levels at Heysham 2000 - 2014[4]

Year	Annual Mean Sea Level (mm)	Change from Previous Recorded Data (mm)
2000	7022	
2001	6972	-50
2002	7030	58
2003	7085	55
2004	7148	63
2005	Not available	
2006	Not available	
2007	6987	-161
2008	Not available	
2009	Not available	

[4] *The National Oceanography Centre / Natural Environment Research Council. National Tidal and Sea Level Facility. https://www.ntslf.org/products/sea-level-trend-charts?name=Heysham&freq=annual*

Year	Annual Mean Sea Level (mm)	Change from Previous Recorded Data (mm)
2010	Not available	
2011	Not available	
2012	Not available	
2013	6995	8
2014	7041	46

3.1.25 In addition, sensitivity testing to assess the impact of tide locking on the Main Dyke outfall (Skippool Tidal Flaps) was carried out. The results of this are discussed in Section 6 and demonstrate that a small increase in the levels applied at the tidal boundary of the model would have a negligible impact on the overall conclusions of the FRA.

3.2 2D Domain

Geometry

3.2.1 The baseline DTM utilises a combined tile set of 1m LiDAR; this data was surveyed in November 2010 and downloaded from the Geomatics Group website at the start of this study in 2015. Discussions with the EA during the 2018 model review process raised concerns over whether this LiDAR dataset would account for development within the catchment in the intervening period.

3.2.2 Consequently, a review of aerial mapping and the latest LiDAR download was carried out. This did not identify any development occurring since 2015 that would be likely to impact on the overall conclusions of the FRA. MasterMap data (updated in 2016) was used to define roughness and hence it was agreed that any buildings present at this time would be included within this data set and therefore represented in the model.

3.2.3 The Moorfields Park development (Figure 10) is currently under construction however, no development is proposed within the currently modelled fluvial flood outline. Furthermore, modelling carried out by Edenvale Young to inform the Moorfields Park FRA did not identify a risk to the development from the Main Dyke[5]. It was therefore agreed with the EA that the model accounts for all key topographical features up to the present day that would have the potential to impact on flood predictions.

[5] *Ironside Farrar Limited (March 2015) Flood Risk Assessment Garstang Road East, Poulton Le Fylde.*

Figure 10: Proposed Moorfields Park development layout[5]



3.2.4 The LiDAR elevation data was read directly into the model as an ASCII grid file. The TUFLOW grid was created using a cell size of 4m orientated at approximately 45 degrees from a north south line in order to better capture the flow pathways in the vicinity of the Scheme. Several files were read into the TGC in order to enforce key features within the model domain and thus create the final underlying DTM.

Table 4: Geometry files used in fluvial model

Model File	Description
2d_bc_Main_Dyke_L_21.SHP 2d_bc_main_dyke_P_21.SHP	Link between Main Dyke 1D FMP model and 2D TUFLOW domain.
2d_bc_Horsebridge_Dyke_L_12_tide_01.SHP 2d_bc_horsebridge_dyke_P_12_tide_01.SHP	Link between Horsebridge Dyke 1D FMP model and 2D TUFLOW domain.
2d_zsh_main_dyke_correction_R_01.SHP 2d_zsh_main_dyke_correction_P_01.SHP	2D domain on the left bank of the Main Dyke behind The Breck Primary School, where the LiDAR had been incorrectly filtered resulting in a 'hole' in the DTM

Model File	Description
2d_zsh_horsebridge_dyke_correction_R_11.SHP 2d_zsh_horsebridge_dyke_correction_P_11.SHP 2d_zsh_ExistingSkippoolBridge_01.SHP	Six polygons: Where structures were large enough to justify a spilling mechanism within the 2D domain, usually at large roads, spill levels based on LiDAR derived road deck levels were 'stamped' using Z shapes in order to correctly modify flow pathways: Railway crossing over the Horsebridge Dyke at Chester Avenue. Blackpool Old Road crossing of the Horsebridge Dyke. Minor bridge crossing of the Horsebridge Dyke at Poulton-le-Fylde golf club Smooth over a hole in the LiDAR data in parkland west of Chester Avenue. Two culverts beneath the Poulton and Wyre railway line on the floodplain to the north of Horsebridge Dyke were represented using 2d_zsh to ensure that flood flows could pass through the embankment rather than incorrectly constraining flood extents.
2d_zsh_ExistingSkippoolBridge_01.SHP	Deck of existing Skippool Bridge
2d_fcsh_main_dyke_L_15.shp (Baseline runs) 2d_fcsh_main_dyke_P_15.shp (Baseline runs) 2d_fcsh_main_dyke_MGN_L_32.mif (Option, Mitigation, Construction Phasing runs) 2d_fcsh_main_dyke_MGN_P_32.mif (Option, Mitigation, Construction Phasing runs)	Four drainage ditches on the right bank of the Main Dyke; these allow flood water from the Main Dyke to propagate north east towards Mains Lane.

Model File	Description
2d_zsh_tidal_defences_L.SHP mi\2d_zsh_tidal_defences_P.SHP	The tidal defences (as described in the FRA) were schematised using Z shapes with elevation data being derived from the EA asset record for the structures.
DEM_a585_S1b_01.asc (Option, Mitigation, Construction Phasing runs)	Road embankment
2d_ztin_Wetland_4.mif (Option, Mitigation, Construction Phasing runs)	Creates TIN to add Proposed Wetland 4
2d_zsh_Wetland_Height_28_L.mif (Option, Mitigation, Construction Phasing runs)	Enforces correct bank height around Wetland 4
A585FloodCompensationBasin.asc (Mitigation only)	Temporary flood compensation areas adjacent to Main Dyke
2d_zln_Compensation_Basin_Height_29.mif (Mitigation only)	Enforces 4.5mAOD embankment around basins

Roughness

3.2.5 Ordnance Survey MasterMap data, supplied in October 2016, was used to generate a new 2D roughness layer. Thirteen surface types were identified within the model domain and standard roughness values assigned accordingly.

3.2.6 The effect of buildings on flood depths and extents was assessed by increasing the Manning's n value assigned to the building polygon. The suitability of this approach was discussed with the EA and it was agreed that, as increased roughness is standard practice in fluvial modelling, it was acceptable (see post meeting 181018 note in Appendix F of the FRA (document reference TR010035/APP/5.2 – Rev 1)).

3.2.7 Additional roughness patches were added to cover the fields along the banks of the Main Dyke between Mains Lane and Garstang Road in order to reflect the undulating and overgrown nature of the ground, as identified on Google aerial mapping, but which was not accurately represented by the MasterMap data. A similar methodology was applied to the left and right banks of the Horsebridge Dyke immediately upstream of Tithebarn Street. In both locations, application of a slightly higher, and more representative roughness coefficient also helped to stabilise the model during larger flood events.

1D 2D Links

3.2.8 Links between the 1D domain and the 2D domain have been schematised using HX lines, digitised along channel bank tops. The 1D cross sections connect to two TUFLOW grid cells and supply a water level across the banks. In order to achieve model stability, Z point elevations have been added to the 2D domain which match the 1D cross section bank heights along the HX lines.

4 BASELINE TIDAL MODEL BUILD

4.1 Supplied River Wyre Model

4.1.1 In order to assess in more detail, the impact of the Scheme on tidal flood risk, a number of enhancements to the EA Wyre model were made, as described in Table 5. For stability reasons, the following structures were modelled as 2d_lfcsh:

- Minor crossing of the Main Dyke behind Kevin Avenue
- Proposed Scheme crossing of the Main Dyke
- A586 Garstang Road crossing of the Main Dyke

4.1.2 All other small bridges and culverts on the Main Dyke and Horsebridge Dyke were removed from the model. This approach was considered acceptable as the structures were small and conveyed only a minor proportion of flow when compared to the Wyre tidal flood flows. The Skippool Clough Culvert was also removed from the model in order to represent a 'flap shut' scenario. In a tidal flood event, the predominant direction of flow is up the Horsebridge Dyke and hence the flap would be closed. Given the small size of the culvert relative to the tidal flows, this approach was considered both appropriate and conservative.

4.1.3 Additional topographic data for the existing A585 between the Main Dyke and Horsebridge Dyke crossings was supplied by the design team and read into the tidal model as a 2d_z_TIN. This was done to ensure modelling of the correct overtopping regime, as this location is critical in controlling the progression of tidal flooding in land.

Model Extents

4.1.4 The supplied model had not enforced the A586 Garstang Road crossing of the Main Dyke and hence tidal flows propagating up the Main Dyke were unable to continue inland. This crossing was enforced in the enhanced tidal model. Upstream of this point, both Station Road and the railway culvert at Crossings Wood (west of Weeton Camp) were also enforced to remove barriers to flow propagation. On the Horsebridge Dyke, the railway crossing west of Berry's Lane and the culvert beneath Blackpool Old Road were opened for the same reasons.

Table 5: Tidal model enhancements

Model File	Description	Data Source
2d_fcsh_Model_Wyre_Channel_033	Defines Main Dyke channel Horsebridge Dyke channel	Minimum bed elevation from FMP 1D model channel cross sections
2d_srf_Model_Wyre_Channel_033	Storage Reduction Factor applied to Main Dyke and Horsebridge Dyke channels	Channel section widths from FMP 1D model

Model File	Description	Data Source
2d_lfcsh_Model_Wyre_BL_Structure_Patch_049_AC	A585 Crossing of Main Dyke. Note that file has been updated to remove 'Min' Shape Option as a bug fix for TUFLOW 2018-AC.	1D FMP Structure Details
2d_srf_Model_Wyre_Structure_Patch_040	Storage reduction factor for A585 crossing of Main Dyke.	1D FMP Structure Details
2d_lfcsh_Model_Wyre_MAIN02_0381_049_AC	Crossing of Main Dyke behind Kevin Avenue. Note that file has been updated to remove 'Min' Shape Option as a bug fix for TUFLOW 2018-AC.	1D FMP Structure Details
2d_lfcsh_Model_Wyre_Garstang_051_AC	A586 Garstang Road crossing of Main Dyke. Note that file has been updated to remove 'Min' Shape Option as a bug fix for TUFLOW 2018-AC.	LiDAR
1d_nwk_Model_Wyre_Culverts_047	Structures on the Main Dyke and Horsebridge Dyke	FMP 1D model
2d_zsh_tidal_defences_050	Tidal defences along Skippool Creek and Wyre Estuary	EA Asset Database, as modelled in linked 1D-2D model
2d_zsh_main_dyke_correction_038	Smooths out DTM on left bank of Main Dyke, behind Brockfield School	LiDAR
2d_zsh_DTM_Stability_004	Smooths out DTM on left bank of Main Dyke, downstream of Mains Lane	LiDAR
2d_zsh_Bridge_Patch_040	Bridge Decks which had been filtered from LiDAR data	FMP 1D model spill levels / LiDAR

Model File	Description	Data Source
2d_po_Model_Wyre_051	Plot Output lines to record flow in 2D channels	N/A
2d_mat_Model_Wyre_Stability_053	Roughness patches to improve model stability	Aerial Mapping / Engineering judgment
2d_mat_Model_Wyre_001	Base roughness	MasterMap
2d_fcsh_main_dyke_P_15 2d_fcsh_main_dyke_L_15	Field drains	LiDAR
2d_srf_main_dyke_15	Storage Reduction Factor for field drains	LiDAR
2d_fcsh_Model_Wyre_Garstang_051	Extends Main Dyke channel south of Garstang Road	LiDAR
2d_srf_Model_Wyre_Garstang_051	Extends Main Dyke channel south of Garstang Road	LiDAR
2d_bc_Model_Wyre_Culverts_047	Link between 2D channel and structures on the Main Dyke and Horsebridge Dyke	FMP Model / LiDAR

4.2 Tidal Model Boundaries

Present Day

4.2.1 The present-day tidal boundary conditions were left unchanged from the supplied model. The 0.5% AEP event was assessed as this event is used to define Flood Zone 3 when referring to tidal flooding.

Climate Change

4.2.2 The tidal boundary conditions for the climate change scenario in the supplied model were based on the 2009 UK Climate Impacts Programme (UKCP09) projections. In January 2019, the EA requested that climate change be considered in line with the work carried out as part of the 2018 UK Climate Impacts Programme (UKCP18), launched in November 2018.

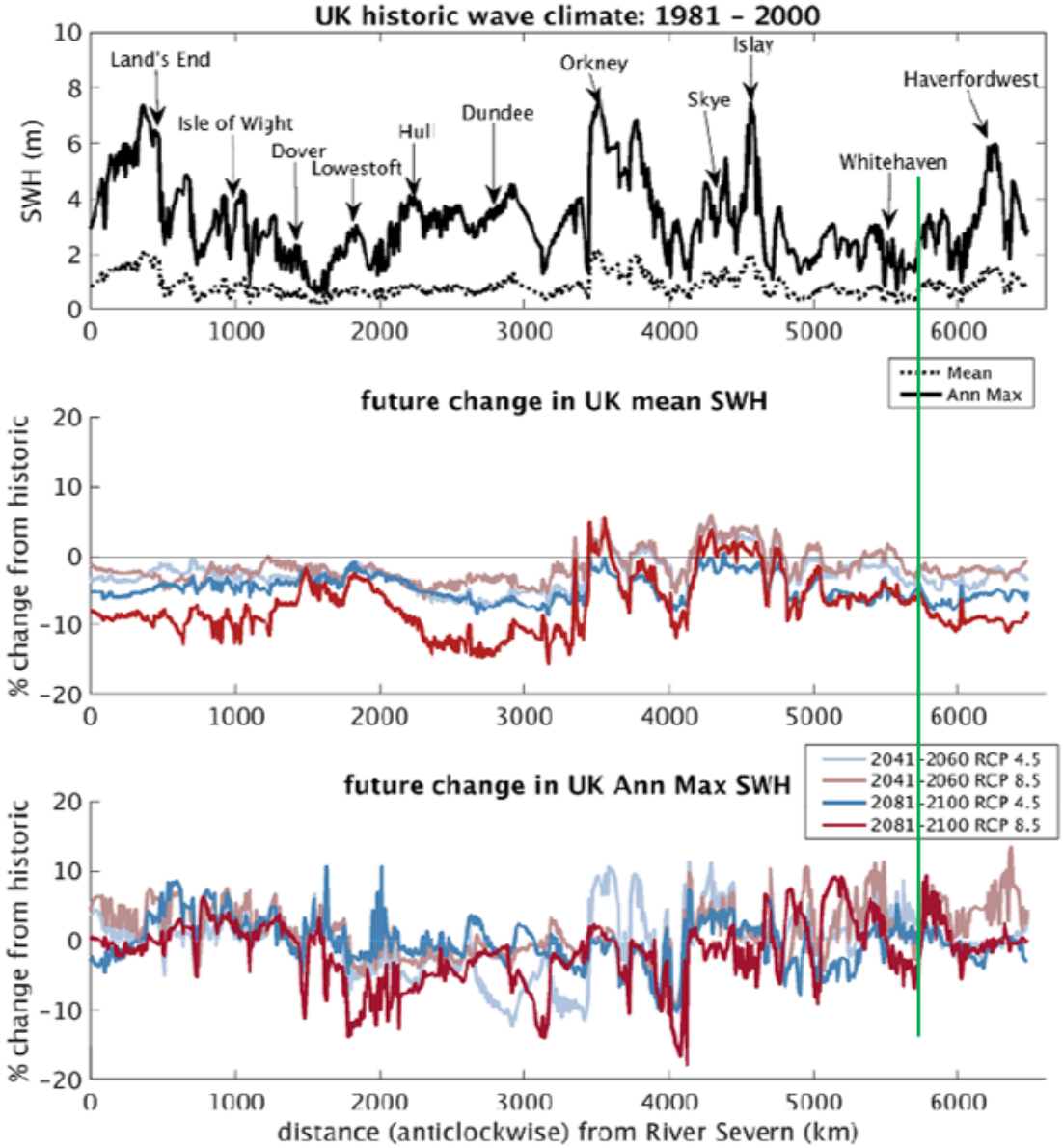
4.2.3 In the absence of published guidance, the EA confirmed that an uplift of 1.253m should be applied to the 0.5% AEP tidal curves in the Wyre Estuary. For reference, the supplied EA Wyre Estuary model (UKCP09) applied an increase of 0.69m on top of the present day 0.5% AEP tidal levels.

Wave Overtopping

4.2.4 Wave overtopping is a complex process controlled by the state of the sea (depth, wave properties) and the geometry of local flood defences and has the potential to reduce the effective Standard of Protection (SoP) of defences. High resolution wave simulations carried out as part of UKCP18 indicated that the changes in wave climate over the 21st century on exposed coasts will be dominated by the large-scale response to climate change. However, changes in more sheltered coastal regions are likely to remain dominated by local weather variability[6]. Overall, it was concluded that there is considerable uncertainty in future changes in wave regimes (Figure 11). Consequently, analysis of the Wyre Estuary model results was carried out to understand the likely impacts of wave overtopping on the Scheme (see below).

[6] *https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf*

Figure 11: UK historic wave climate (1981 – 2000), future change in UK mean Significant Wave Height, future change in UK annual maximum Significant Wave Height (source Met Office[6]). The green line shows the approximate location of the Scheme.



4.2.5 The defended scenario, inclusive of an allowance for wave overtopping, has been used to assess the tidal flood risk in the Wyre Estuary. The supplied EA Wyre Estuary model used the European Overtopping Manual (EurOtop) methodology to undertake a detailed analysis of the overtopping rates for each defence. Therefore, an analysis of existing results was carried out to determine the extent to which wave overtopping was influencing the tidal levels in the Wyre Estuary (over and above the increase resulting from the climate change increase in still water levels) to determine whether or not further wave overtopping analysis was required for the UKCP18 scenario. Figure 12 shows the location of the still water and wave overtopping boundaries in the vicinity of the Wyre Estuary.

Figure 12: Still water (purple) and wave overtopping (cyan) boundaries at the Wyre Estuary. Plot output locations shown by labelled purple circles (Contains Ordnance Survey data © Crown copyright and database right 2018).



4.2.6 Table 6 summarises the wave overtopping calculated for the defences in the vicinity of the Wyre Estuary.

Table 6: Wave overtopping calculated for the defences in the vicinity of the Wyre Estuary

Wave Overtopping Location	0.5% AEP	0.5% AEP UKCP09 Climate Change Allowance
Results_69	Wave overtopping	Wave overtopping
Results_70	No wave overtopping	No wave overtopping
Results_71	No wave overtopping	No wave overtopping
Results_72	No wave overtopping	Wave overtopping

4.2.7 This information confirms that there is a difference in the wave overtopping boundary conditions applied for the 0.5% AEP and the 0.5% AEP inclusive of the UKCP09 climate change allowance. Therefore, if this difference results in an increase in levels in the Wyre Estuary over and above the increase applied to the still water levels to

account for climate change, then further consideration of the impacts of wave overtopping may be required. In order to assess whether this is the case, results for plot output locations Model_Wyre_14 and Model_Wyre_15 (see Figure 12 for location) were analysed (Figure 13 and Figure 14 respectively).

Figure 13: Stage results at plot output location Model_Wyre_14. 0.5% AEP shown in green and 0.5% AEP plus UKCP09 climate change allowance shown in black.

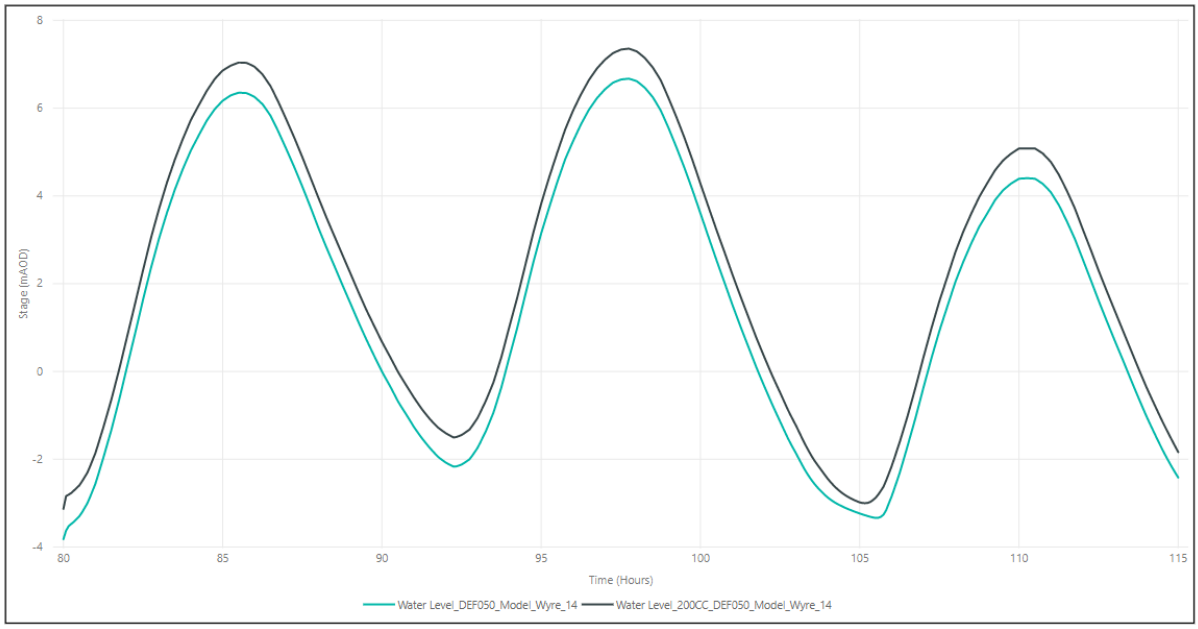
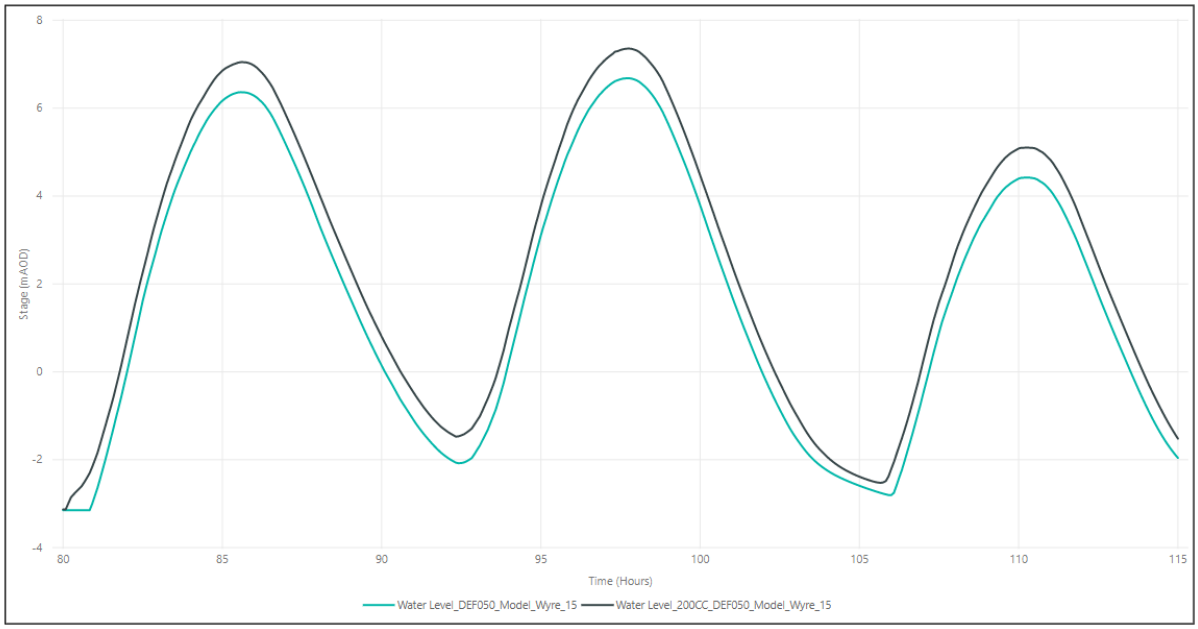


Figure 14: Stage results at plot output location Model_Wyre_15. 0.5% AEP shown in green and 0.5% AEP plus UKCP09 climate change allowance shown in black.



4.2.8 Figure 13 and Figure 14 confirm that the difference in stage at the peak of each tidal cycle is the same as the increase applied to the still water boundary for the UKCP09 climate change allowance i.e. there is no observable additional impact in the estuary, even though wave overtopping has been applied. Therefore, it is concluded that the impact of wave overtopping in the Wyre Estuary is negligible and hence it is

appropriate for the UKCP18 climate change scenario to apply the same wave overtopping boundary as the UKCP09 climate change scenario.

Summary of Tidal Boundary Conditions Assessed

4.2.9 Present day 0.5% AEP tidal boundary conditions (still water and wave overtopping) were maintained as per the supplied model.

4.2.10 The UKCP18 scenario was agreed with the EA and defined as follows:

- Application of a 1.253m increase the present day 0.5% AEP still water levels
- Maintained UKCP09 wave overtopping volumes

4.2.11 In addition, for all scenarios, a baseflow was applied to the Main Dyke in order to wet the Main Dyke to aid model stability.

5 OPTION MODELLING (FLUVIAL AND TIDAL MODELS)

5.1.1 The Scheme, as illustrated and described in the FRA (application document reference TR010035/APP/5.2 – Rev 1), has been assessed. The Scheme would impact both the Main Dyke floodplain and the existing A585 crossing of the Main Dyke at Skippool Bridge. Changes to both the 1D and 2D domains of the models were made to represent this. The following elements of the Scheme were schematised in the option flood models:

- Proposed Skippool Bridge Main Dyke crossing (1D domain)
- Updates to the Skippool Clough Culvert (1D Domain, fluvial model only (see Section 4.1)
- Proposed A585 embankment (2D domain)
- Proposed highway drainage wetland area (2D domain)
- Proposed temporary floodplain compensation areas (2D domain) (Section 7.1)
- Proposed dwarf wall along the eastbound carriageway east of Skippool Roundabout to maintain road crest levels in line with the existing A585

5.2 Proposed Skippool Bridge (1D Domain)

5.2.1 The proposals include a change from the existing two 1.8m diameter circular culverts to a 12.5m wide clear span bridge with a minimum soffit level of 5.0mAOD.

5.2.2 In the fluvial model, the proposals have been represented in 1D using a USBPR bridge unit. The channel cross sections immediately upstream and downstream of the bridge were updated to accommodate the new bridge and to ensure that conveyance through the widened structure was maximised. Overtopping onto the road has been modelled using FMP spill units set at the elevation of the bridge deck which are linked to TUFLOW HX boundaries. The levels along the Scheme are enforced via the application of a 2D surface model (Section 5.4).

5.2.3 In the tidal model, the Main Dyke crossing is modelled as a 2d_lfcsh; the pBlockage values and layer elevations have been set such that they represent the existing 1.8m diameter culvert, soffit level 3.24mAOD. The proposed crossing is modelled using a 2d_lfcsh with attributes set to represent a single rectangular culvert, 12.5m wide with a soffit level of 5.0mAOD.

5.3 Proposed Skippool Clough Culvert

5.3.1 The proposals comprise replacement of the existing 1.52m / 1.6m diameter flapped culvert with a 1.8m diameter flapped culvert. The invert levels at the inlet and outlet are 2.5mAOD and 1.5mAOD respectively, compared to 2.53mAOD and 1.78mAOD in the existing culvert. In the fluvial model, a 1D culvert unit has been used. As described in Section 4.1, the Skippool Clough culvert is not included in the tidal model.

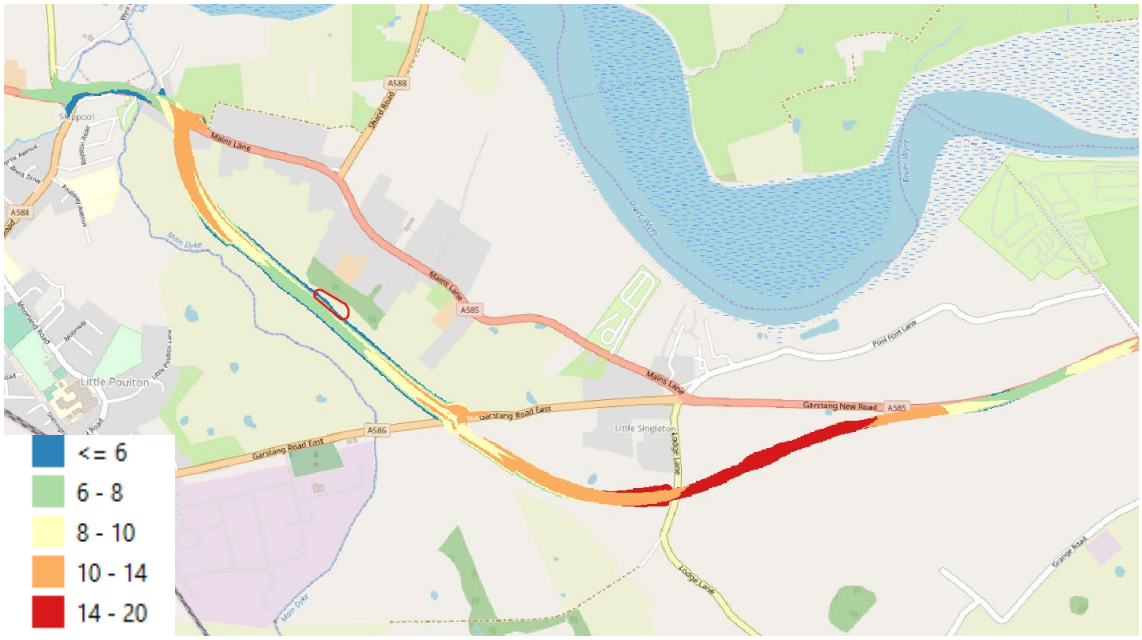
5.3.2 A technical memo was submitted to the EA in April 2019 outlining the design rationale for this structure, including how the potential impacts of scour and blockage have been addressed. This memo is included as an appendix to the EA Statement of Common Ground (document reference TR010035/APP/8/3).

5.4 Proposed A585 Embankment (2D Domain)

5.4.1 The ground model for the proposed embankment was supplied by the design team

and read directly into the tidal model as a 2d_z_TIN. This was key in determining the change in overtopping regime immediately east of Skippool roundabout. In the fluvial model, a surface model in ASCII format, as shown in Figure 15, was read into the model within the geometry control file. The fluvial flooding has limited interaction with the proposed embankment and therefore it is considered acceptable to use the ground model in ASCII format, whereas the level of interaction in the tidal model required significantly more detailed modelling.

Figure 15: Scheme alignment surface model elevations in mAOD (wetland area shown by red circle) (© OpenStreetMap contributors 2019)



5.4.2 Four new culverts have been added to the model to convey flood waters along the ditches described in Section 3.2. These culverts would be constructed of corrugated plastic and hence a Manning's n roughness coefficient of 0.025 has been applied. The same model file has been used to represent the culverts in the fluvial and tidal models.

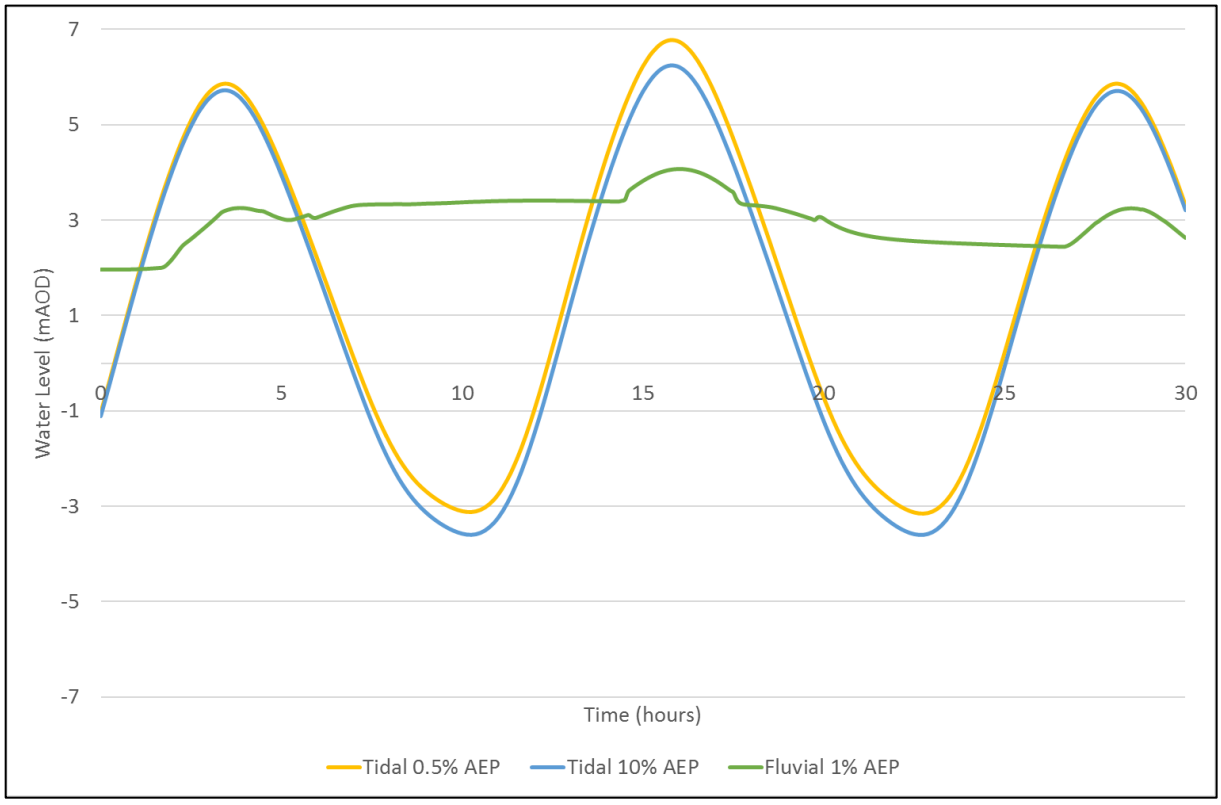
5.4.3 In addition, a wetland area (Figure **15**), included in the design to attenuate and treat discharges of highway runoff, has been enforced in the fluvial and tidal models using a TUFLOW generated TIN.

6 TIDE LOCKING

6.1.1 The EA requested that the impact of the tide locking of the outfalls on the Horsebridge Dyke and Main Dyke be assessed. Tide locking of the outfalls is predicted to occur when water levels in the Wyre rise above the water levels on the upstream side of these outfalls. The EA originally requested that this should be assessed by applying the design 10% AEP and 0.5% AEP tide levels at the downstream boundary. Given that these predicted water levels are in the order of 6.5mAOD, compared to the Mean High Water Springs (MHWS) level of around 3.5mAOD, significant model stability issues were encountered when applying these design levels.

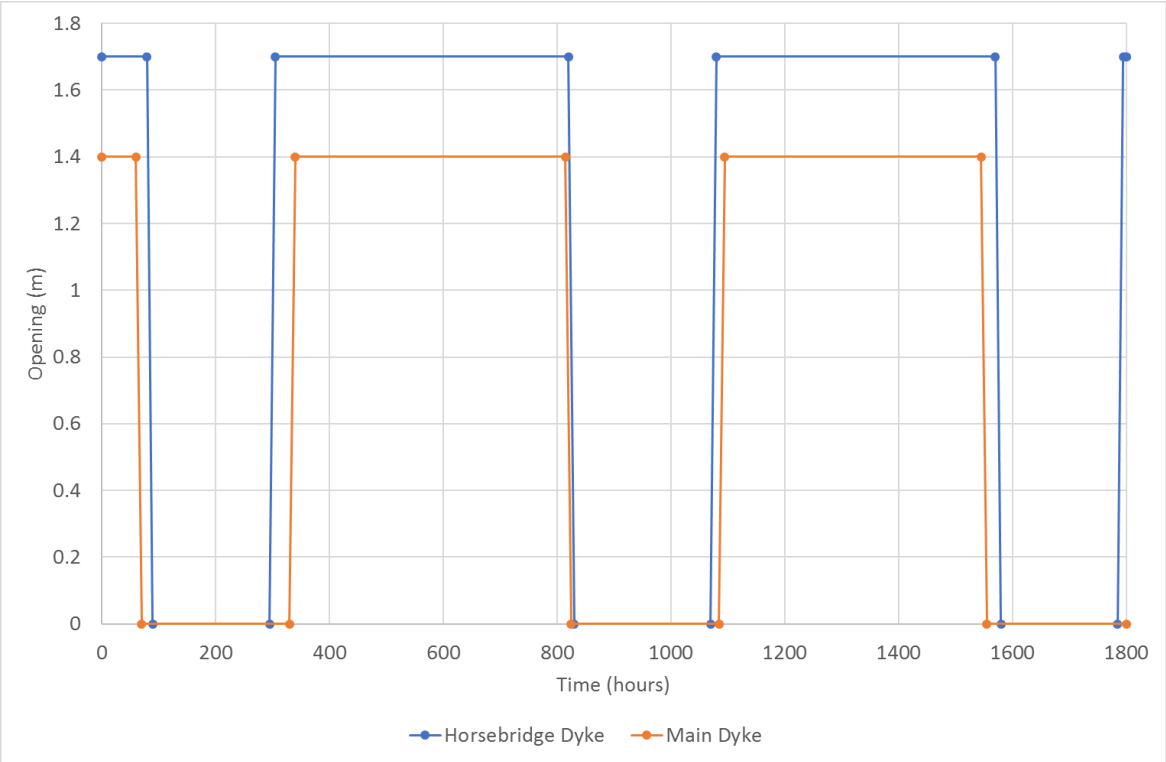
6.1.2 To model the impacts of this tide locking on upstream water levels in the Horsebridge Dyke and Main Dyke, the existing model structures (flapped outfalls) were replaced with sluice units controlled with time based rules. The rules were set to close the sluice at the times when the tide levels during the 10% AEP and 0.5% AEP events in the Wyre would be high enough to prevent the Horsebridge Dyke and Main Dyke discharging to the Wyre. The closure time was defined by comparing the predicted upstream water levels in the Horsebridge Dyke / Main Dyke with the predicted tidal levels in the Wyre. Due to the gradient of the tidal curve, a negligible difference was observed between the predicted closure time for the 10% AEP and the 0.5% AEP events (Figure 16).

Figure 16: Main Dyke tidal (downstream of flaps) and fluvial (upstream of flaps) levels



6.1.3 The rules in the sluice units were defined with a time base profile which forces the sluice to shut for the duration of the high tide, as shown in Figure 17. In each case, a 10 minute closure and opening time was applied for model stability.

Figure 17: Main Dyke and Horsebridge Dyke sluice opening profiles



6.1.4 In total, 22 tide locking model runs were carried out to assess the impacts on the baseline and with Scheme conditions for the suite of design events. Results are discussed in the FRA.

7 MITIGATION

7.1 Construction Phase

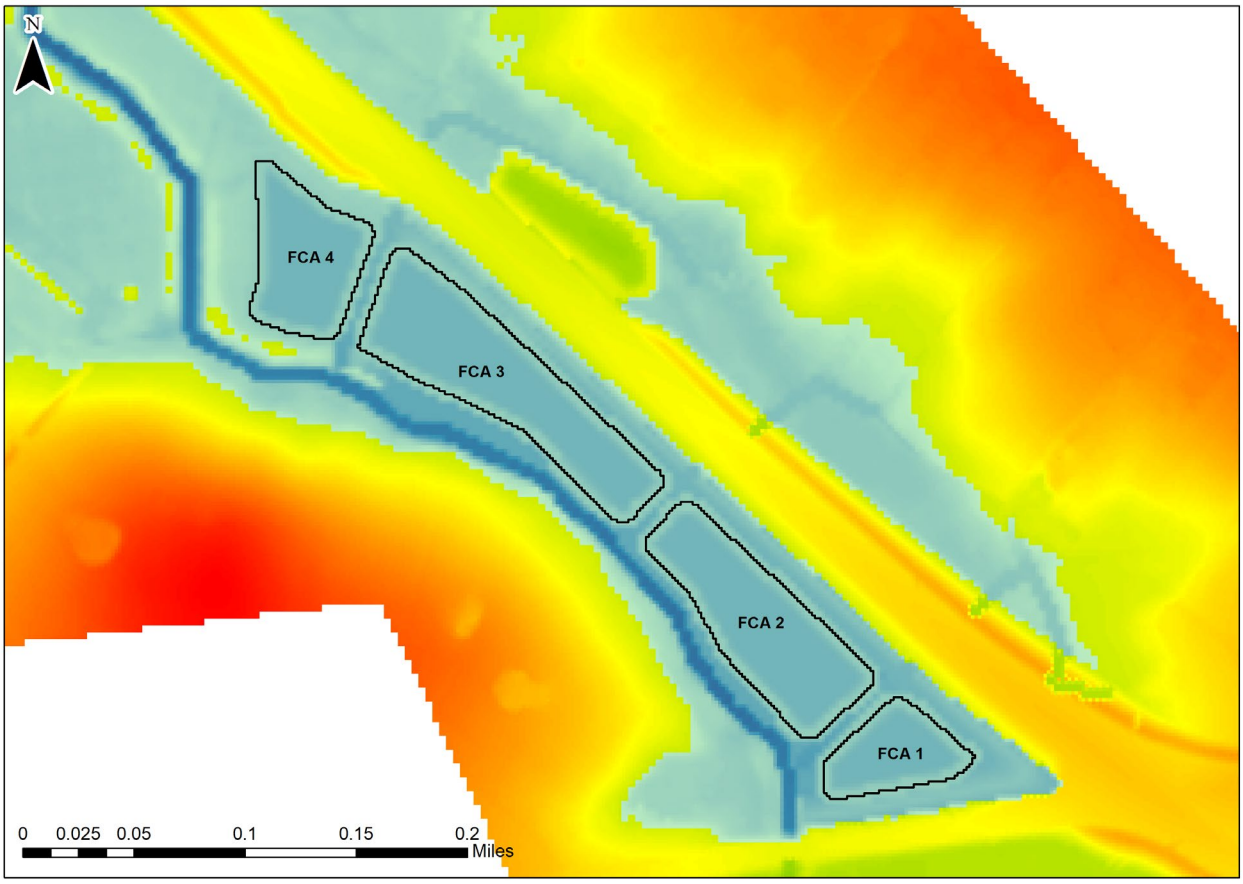
Construction Sequence

7.1.1 As described in the FRA (document reference TR010035/APP/5.2 – Rev 1), mitigation is required to ensure that increases in flood risk to third parties during construction are minimised for all events up to and including the 1% AEP plus 30% for climate change flood event.

Proposed Mitigation

7.1.2 An area of land on the right bank of the Main Dyke, immediately downstream of the A586, has been identified as having potential to accommodate temporary floodplain compensation areas (FCA) to offset the floodplain storage volumes removed by the road embankment footprint during its construction. Figure 18 shows the indicative locations.

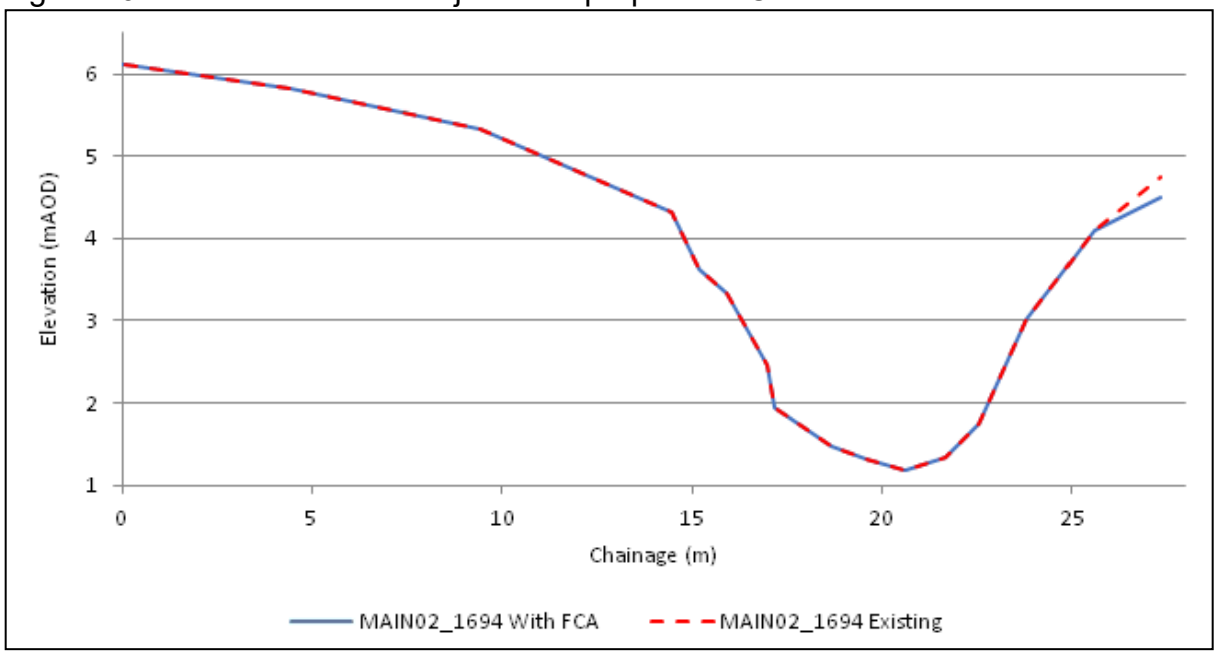
Figure 18 Location of proposed FCAs (Contains Ordnance Survey data © Crown copyright and database right 2017)



7.1.3 The FCA has been represented in the hydraulic model of the Main Dyke with base elevations of 3.5mAOD, surrounded by embankments with elevations of 4.5mAOD. These embankments have been modelled in FMP by amending the river cross sections, and in TUFLOW by applying a 2d Z line along the 1D (FMP) 2D (TUFLOW) model boundary. This schematisation allows water levels in the Main Dyke to rise to 4.5mAOD before spilling into the FCA. Dimensions and elevations of the FCA were

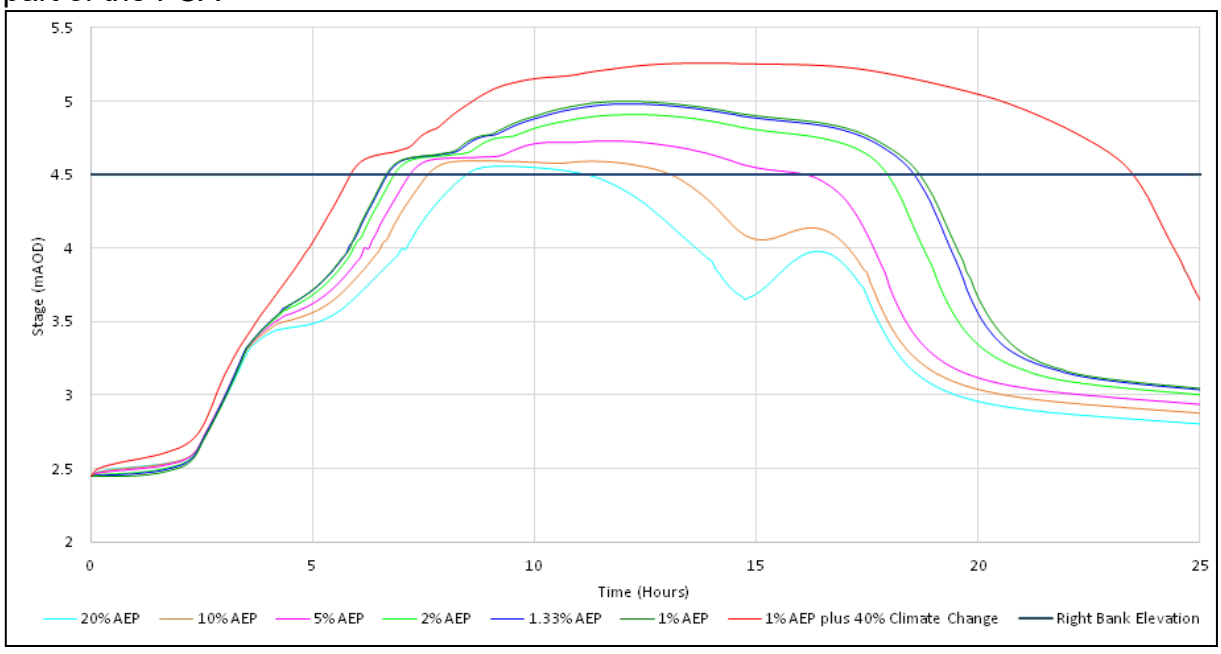
determined by the highway design team. An example of how the FMP cross sections were amended is shown in Figure 19.

Figure 19 FMP cross section adjacent to proposed FCA



7.1.4 The FCA stores flood water from the Main Dyke during the peak of a flood event. The duration for which flood levels are above the 4.5mAOD embankment height increases with increasing event magnitude (Figure 20) and it is during this time that the FCA will come into use.

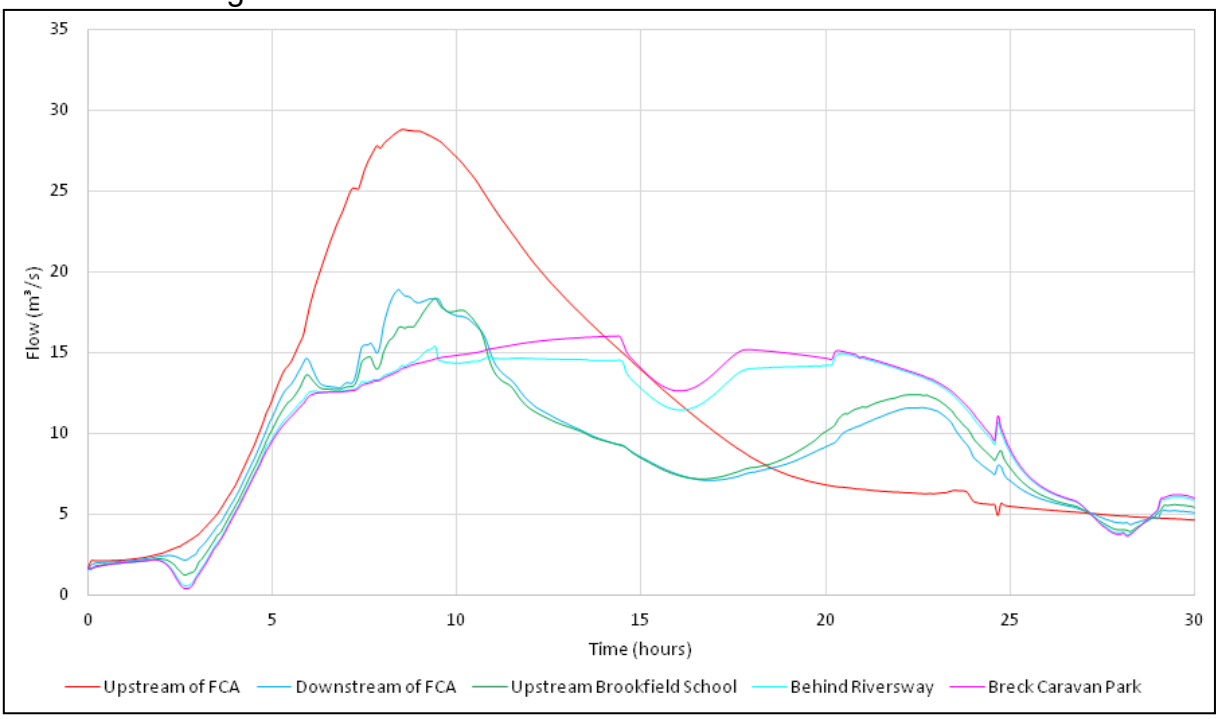
Figure 20: FMP stage hydrographs. Node MAIN02_1694 adjacent to the central part of the FCA



Impact of the FCAs on Flows in the Main Dyke

7.1.5 A series of flow hydrographs extracted from the model at cross sections along the Main Dyke during the 1% AEP event inclusive of a 30% allowance for climate change are shown in Figure 21. This demonstrates that during the peak of the flood event water flows into and is stored in the FCA. As a result, flows continuing downstream in the watercourse are lower. It should be noted that Figure 21 only shows flow hydrographs for the 1D FMP channel and not the combined channel and floodplain. As the flood hydrograph recedes, flows remain higher in the river cross sections downstream of the FCA compared to the cross section upstream. This is due to the influence of the tidal boundary; the highest tidal level occurs at 16 hours which restricts the outflow to the Wyre. This effect is observed at the cross section downstream of the FCA but at the cross section upstream of the FCA (some 700m further upstream on the Main Dyke), the tidal effect is no longer observed.

Figure 21 - Flow hydrographs along the Main Dyke, 1% AEP plus 30% allowance for climate change



FCA Drain Down Mechanism

7.1.6 In the 1% AEP event, the FCA begin to fill from 6.6 hours. The stage in the Main Dyke drops below 4.5mAOD at 18.6 hours although if the FCA needs to be fully drained, the level in the Main Dyke would need to fall below 3.5mAOD; this occurs at 20.3 hours.

7.1.7 In the 1% AEP plus climate change event, the FCA begins to fill from 5.9 hours. The stage in the Main Dyke drops below 4.5mAOD at 23.5 hours although if the FCA needs to be fully drained, the level in the Main Dyke would need to fall below 3.5mAOD; this occurs at 25.4 hours.

7.1.8 At the end of the model simulation, water remains in the proposed FCA because the current model schematisation does not include a pathway for water to drain back into

the Main Dyke once the peak of the flood event has passed. Whilst water remains within the FCA, the Standard of Protection (SoP) offered is reduced because the available storage is less.

7.1.9 Drain down mechanisms for FCAs may be by gravity, pumped, or by a combination of the two[7]. A spillway may also be required to enable the FCA to pass floods greater than those which it is designed to attenuate. A drain down mechanism has not been included in the current 1D 2D model due to the complexity of the schematisation and associated model stability issues.

7.1.10 In order to design the outfall and spillway structures, it is recommended that a 1D only FMP model is constructed of the Main Dyke channel and FCA using FMP Reservoir Units to model the FCA, Spill Units to model the embankments and Flapped Orifice Units to model the outfall to the Main Dyke. This additional modelling should be carried out during the detailed design phase. The data generated by this model would be used to inform a Flood Risk Activity Permit application for the temporary FCA, which would be prepared by the Contactor in consultation with the EA.

Reservoir Legislation

7.1.11 At present, the Reservoirs Act 1975, as amended by the Flood and Water Management Act 2010 regulates reservoirs in England capable of holding more than 25,000m³ of water above surrounding ground levels. Any such reservoirs are required to register with the EA and will be designated as either 'high risk' or 'not high risk'. High risk reservoirs are subject to inspection and supervision by qualified reservoir engineers.

7.1.12 The Flood and Water Management Act 2010 lowered the threshold for registration from 25,000m^3 to 10,000m^3; this has been enacted in Wales, Scotland and Northern Ireland but not yet in England. Therefore, due regard should be given to the likelihood that this change may be enacted in England in the future.

7.1.13 In line with the guidance above, a high level assessment of the approximate attenuation volumes for each part of the temporary FCA has been made, assuming a bankfull condition (i.e. water level at 4.5mAOD) with a base elevation of 3.5mAOD. Table 7 gives the approximate volumes that would likely be attenuated.

Table 7: Proposed FCA volumes

FCA	Volume (m³)
1	3,359
2	8,840
3	10,943*
4	5,646
TOTAL	28,789

[7] *Environment Agency Fluvial Design Guide*

7.1.14 None of the FCA areas are predicted to attenuate more than 25,000m³[8] individually, however it is noted that FCA3 is currently just above the possible future threshold of 10,000m³. This should be reviewed at detailed design stage.

7.1.15 Where a series of reservoirs are constructed along a valley or near to each other, there can be a risk that floodwater arising from a failure of one embankment enters the adjacent reservoir, potentially creating a cascade failure[9]. In the case of the proposed FCA the ground elevations in the vicinity are generally flat and should one of the embankments fail, it is considered likely that water would spread across the floodplain of the Main Dyke and into the watercourse, rather than into the adjacent FCA. At present, cascade reservoirs do not fall within the Reservoirs Act as amended for England. An All Reservoirs Panel Engineer should be consulted during the detailed design stage to provide confirmation that the FCA is constructed within the requirements of the Reservoir Act as amended for England at the time.

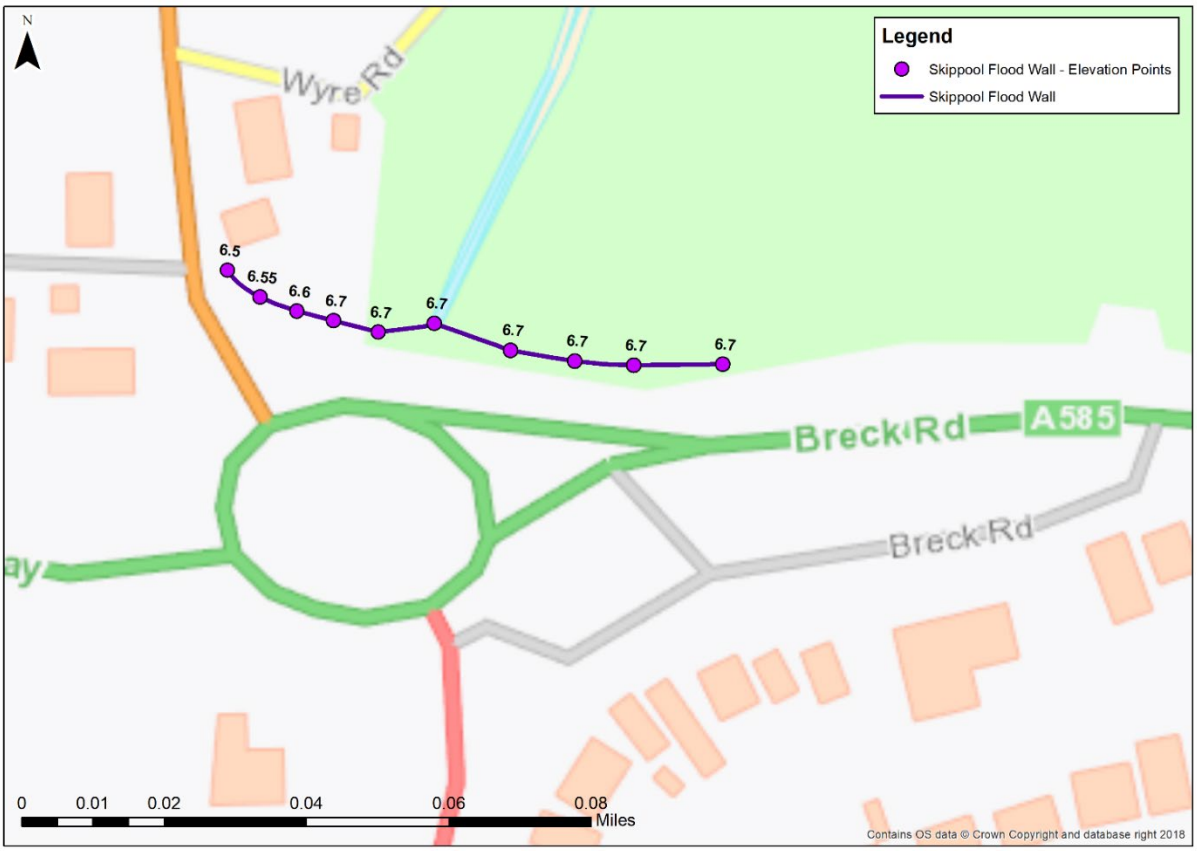
7.1.16 The FCA is included in both the fluvial and tidal models however it is within the fluvial model where they are critical due to the observed flood volumes and mechanisms.

7.2 Completed Scheme

7.2.1 The requirement for the Scheme to tie into existing road levels constrains the options available to raise and / or lower the road to mitigate for increased flood risk to and resulting from the Scheme. Therefore, as described in the FRA, a dwarf wall is proposed alongside the eastbound carriageway (north side of the road) in order to control the level of overtopping by tidal floodwaters as far as is practicable. Its position and proposed elevation is illustrated in Figure 22. The wall was included in the model as a 2d_zln.

[8] https://www.gov.uk/guidance/reservoirs-owner-and-operator-requirements
[9] *Environment Agency (2016) Reservoir Flood Mapping Specification*

Figure 22 – Skippool flood wall location and elevation (shown in purple) along the northern edge of Skippool Roundabout.

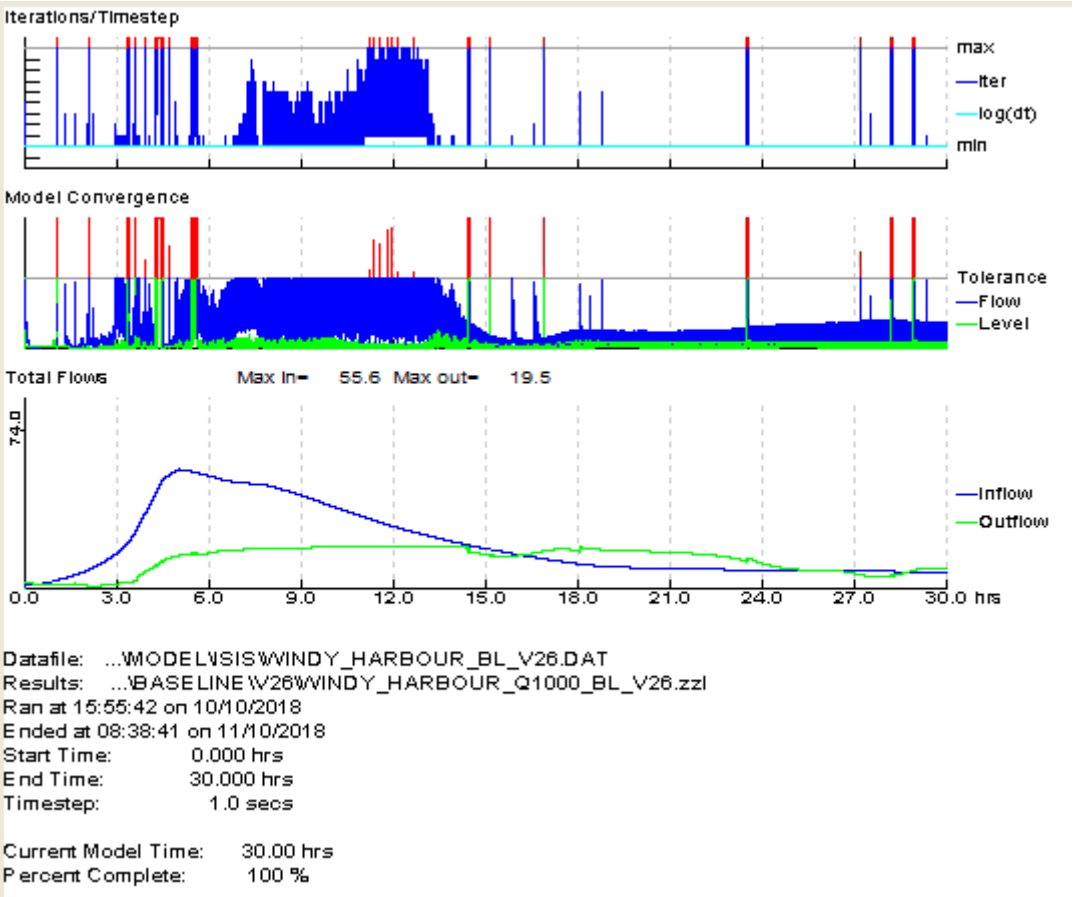


8 MODEL PROVING

8.1 FMP Convergence

8.1.1 The convergence plot for the 0.1% AEP baseline model run (Windy_harbour_Q1000_BL_V26), is shown in Figure 23. Review of the .zzd indicates that 80% of the poor convergence warnings occur at the A585 crossing over the Main Dyke (MAIN02_0230A and MAIN02_0230B). The stage plots for these nodes do not exhibit any oscillations and the poor convergence warnings are due to the rapid opening and closing of the flap gate between 3.5 and 5.5 hours as water levels are close to the soffit level of the flap.

Figure 23: FMP convergence plot, 0.1% AEP, baseline model

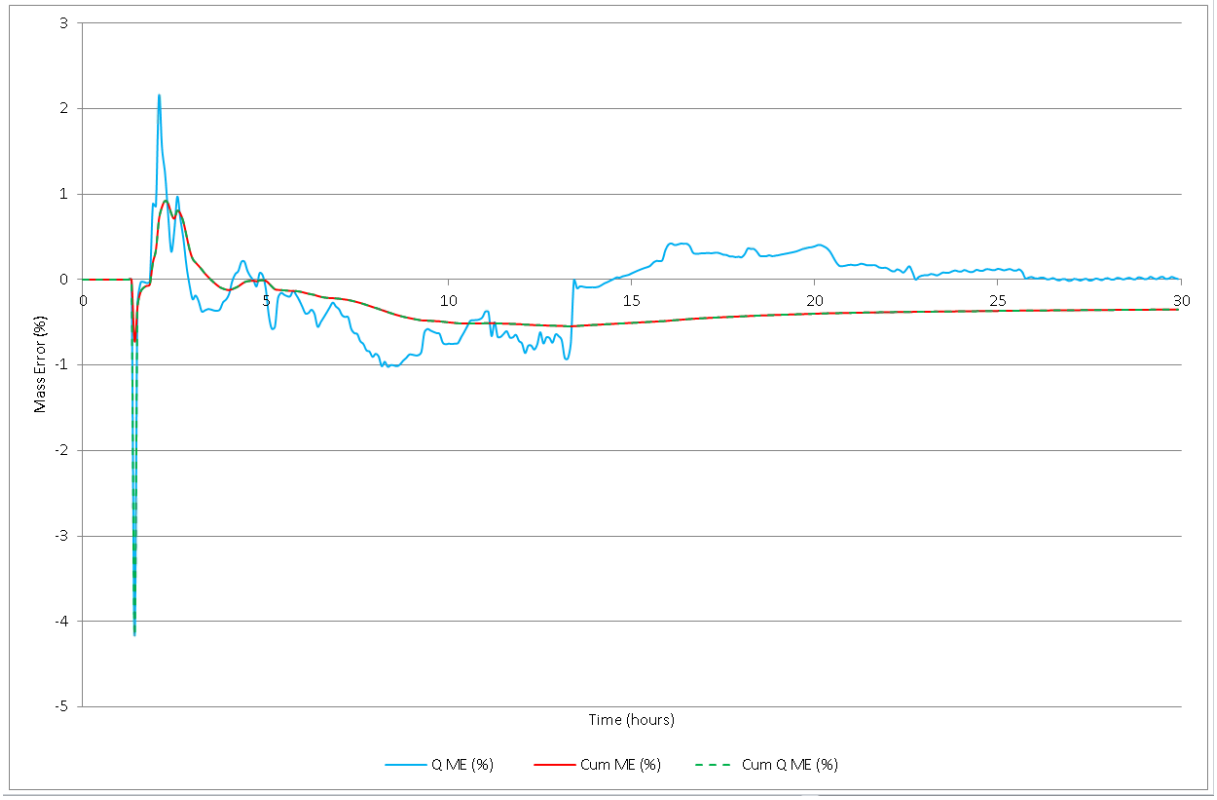


8.2 TUFLOW Mass Balance

Fluvial Model

8.2.1 The combined 1D-2D mass balance for the 0.1% AEP baseline fluvial model (Windy_harbour_Q1000_BL_V26) is shown in Figure 24. There is a spike (up to -4%) in the percentage mass error 1.5 hours into the simulation which settles down quickly. A review of the MB1 and MB2 outputs does not highlight any areas for concern. Given that the mass error settles down quickly, some 13 hours before the event peak, it is considered that the model is fit for purpose.

Figure 24: Percentage mass error, 0.1% AEP, baseline fluvial model



Tidal Model

The mass balance for the 0.5% AEP baseline model (Lancashire_Model_Wyre_T200_SCFC_DEF_053_MB) is shown in

Figure 25. The cumulative mass error values spike at -23%, 2.7 hours into the simulation. However, this settles to within the recommended +/-1% after 9 hours and remains generally stable for the rest of the simulation. A comparison of the 1D only, 2D only and combined 1D-2D cumulative mass error for the simulation was made (

8.2.2 Figure 26) which highlighted that the combined 1D-2D cumulative mass error was not equal to the sum of the 1D and 2D cumulative mass error. The Lancashire_Model_Wyre_T200_SCFC_DEF_053_TSMB1d2d.mif highlighted that the six tidal boundaries (HT) within the supplied model were oscillating (Figure 27). It was agreed with the EA that because these boundaries had not been changed from the supplied model, no further action was required.

Figure 25: Combined 1D-2D percentage mass error, 0.5% AEP, baseline tidal model

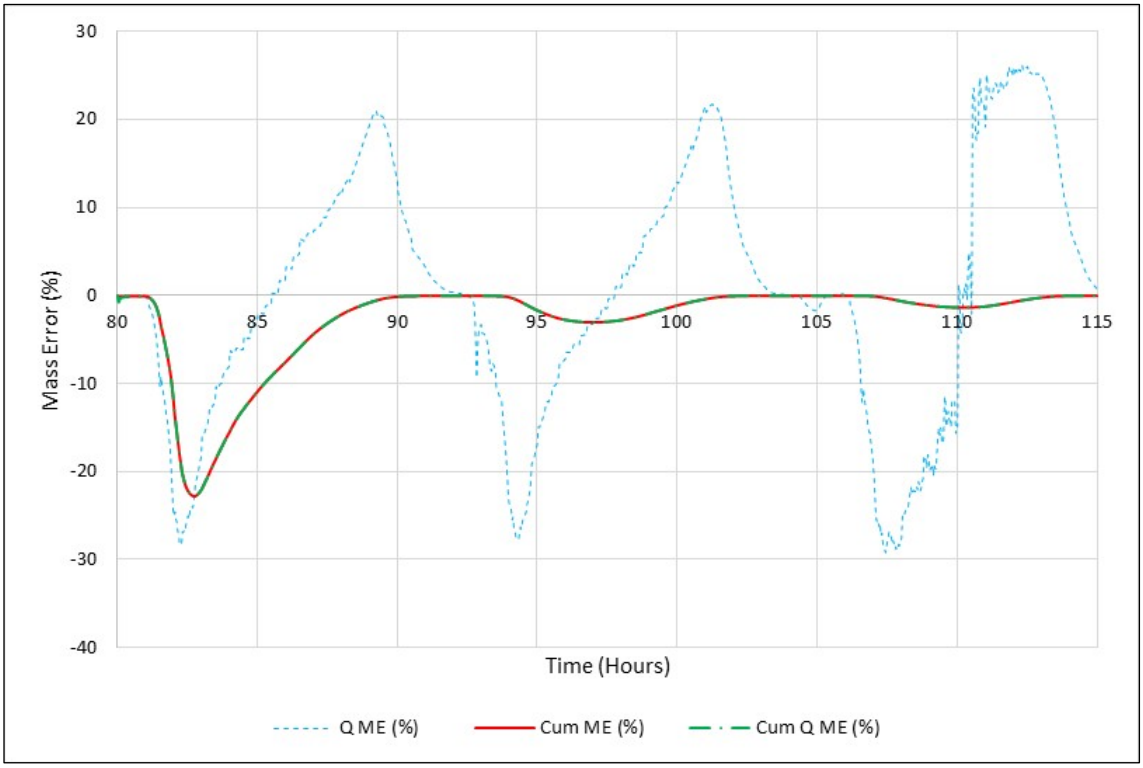


Figure 26: Cumulative mass error for 1D, 2D and combined 1D2D, 0.5% AEP, baseline tidal model

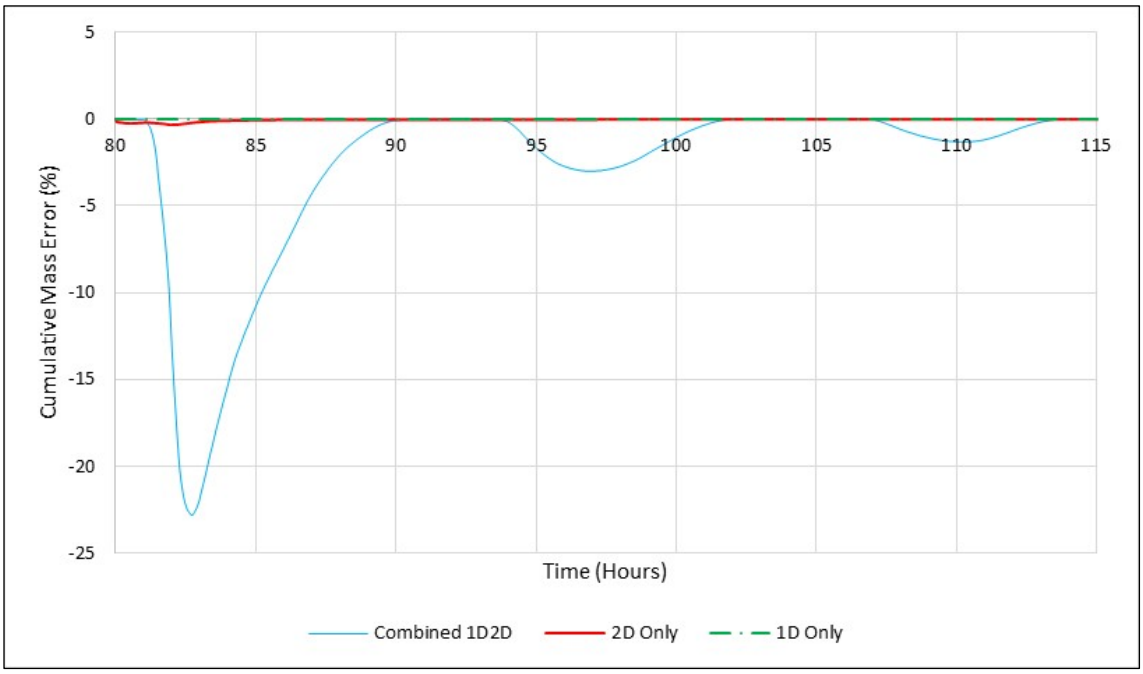
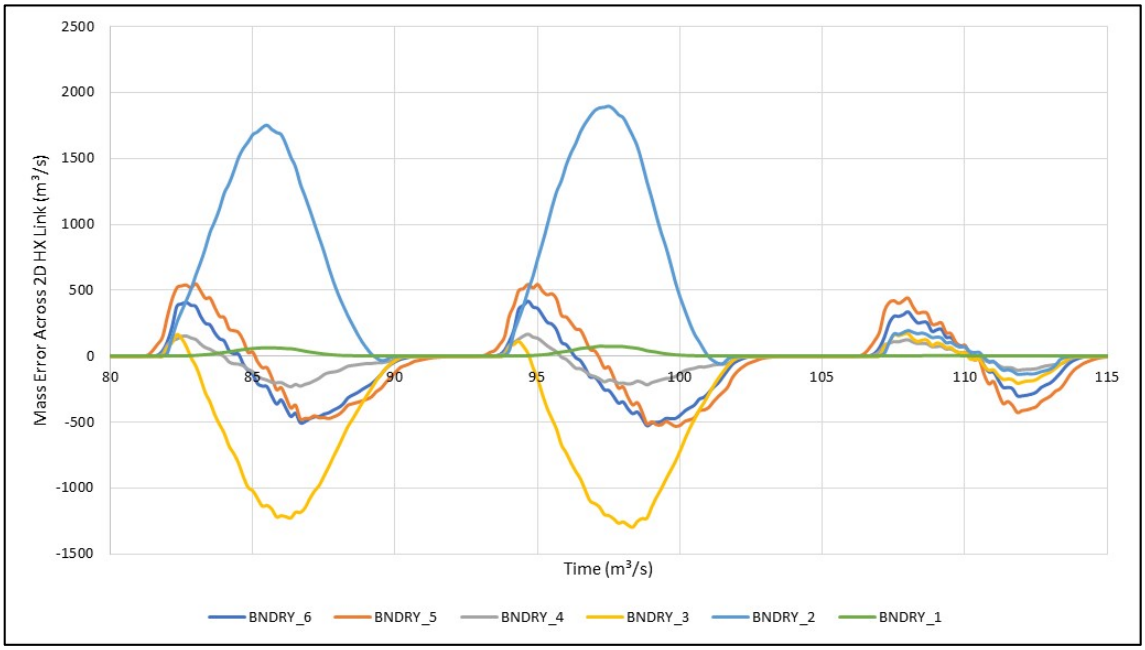


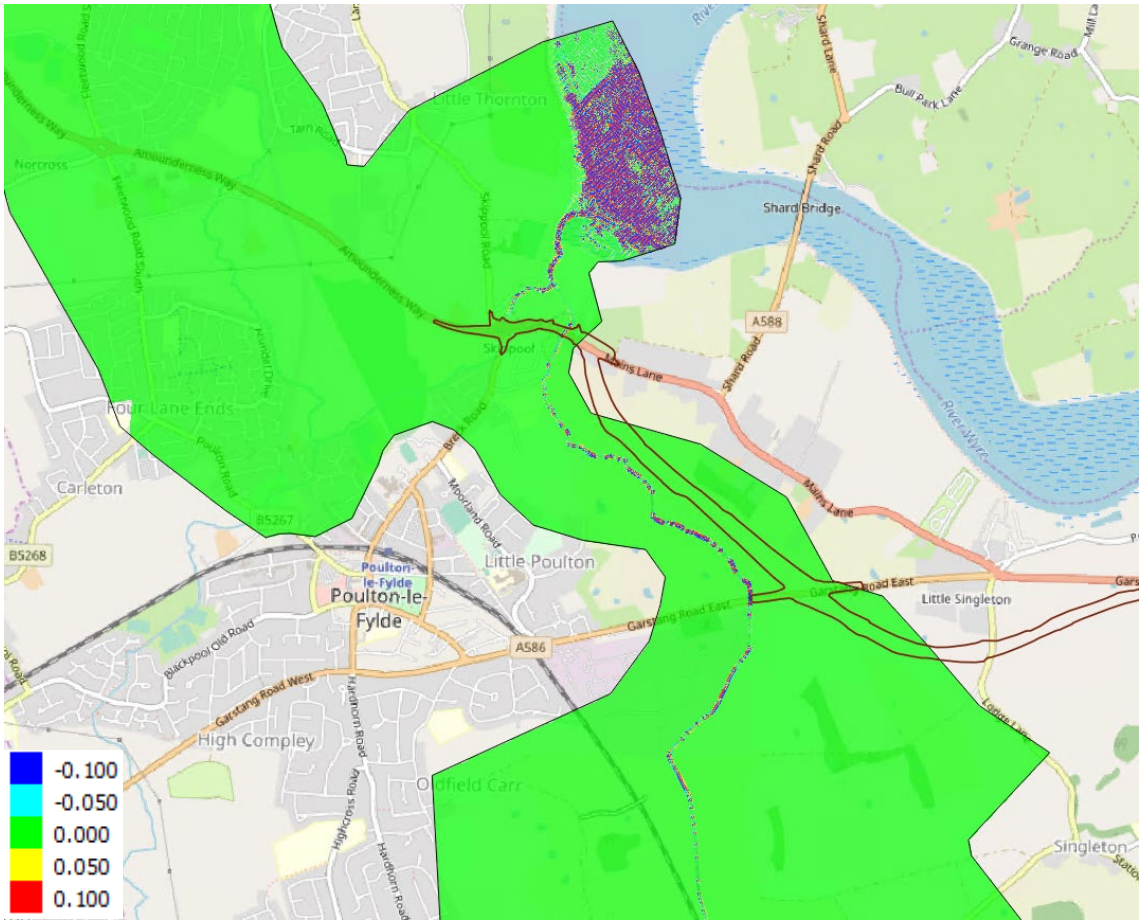
Figure 27 : Lancashire_Model_Wyre_T200_SCFC_DEF_053_TSMB1d2d



The Q ME oscillates with the tidal cycle and therefore further investigations were carried out into the impact of this on model results.

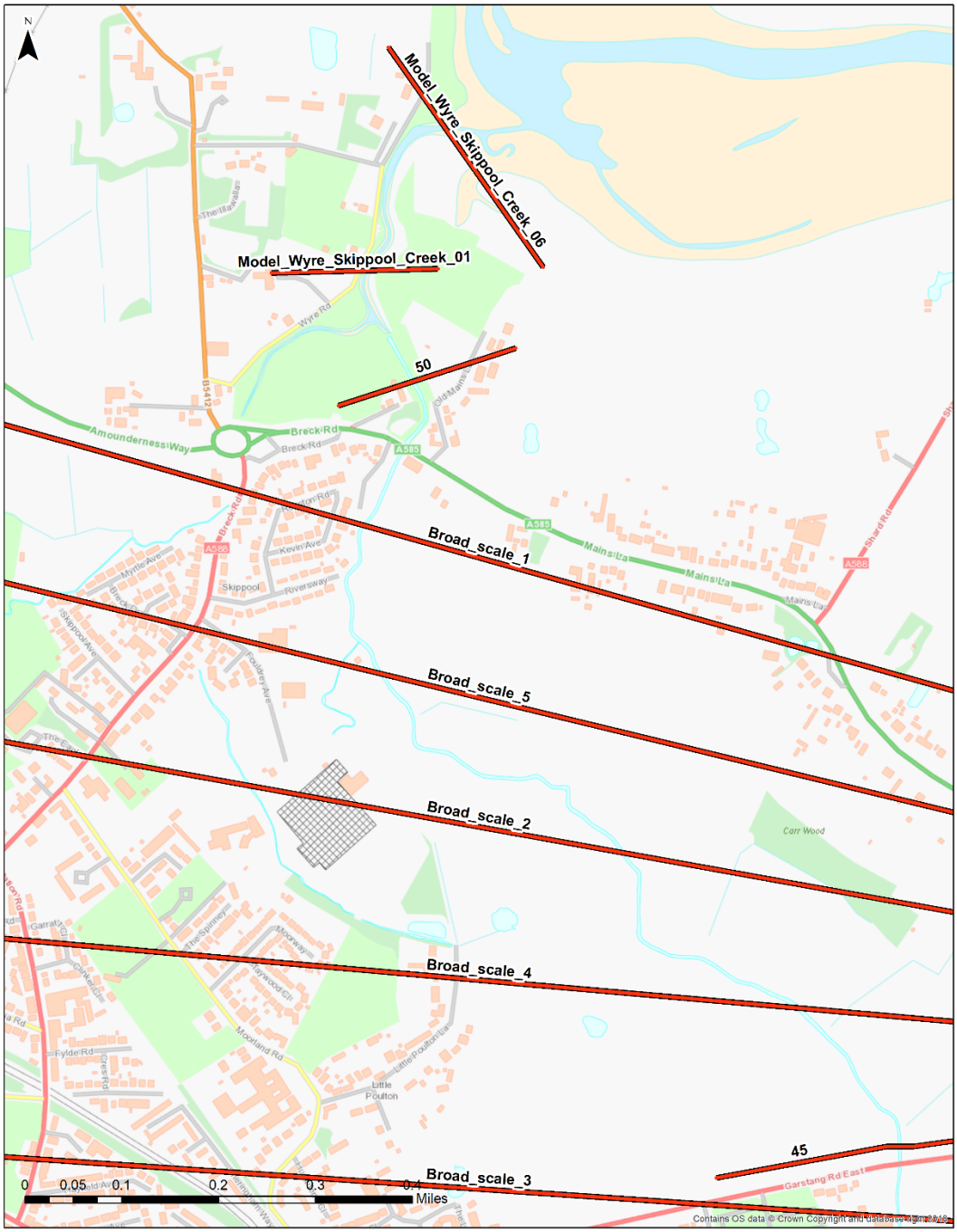
8.2.3 Figure 28 shows the MB2 grid output from the same simulation at 88 hours. It highlights areas of poor convergence along the Wyre itself, the Main Dyke and the downstream extent of the Horsebridge Dyke.

Figure 28 : Mass balance grid output, 0.5% AEP, baseline



8.2.4 To investigate this issue further, a selection of plot output (PO) lines (shown in Figure 30) were reviewed in order to provide further confidence in the model outputs.

Figure 29 : PO line locations



8.2.5 Figure 30 shows the stage outputs in locations highlighted by the mass balance grid output. Figure 31 and Figure 32 show results from PO lines distributed throughout the modelled area of interest to assess the overall stability and volume conservation. These confirm that results are acceptable.

Figure 30 : Stage results for PO lines through the Wyre Estuary and Main Dyke

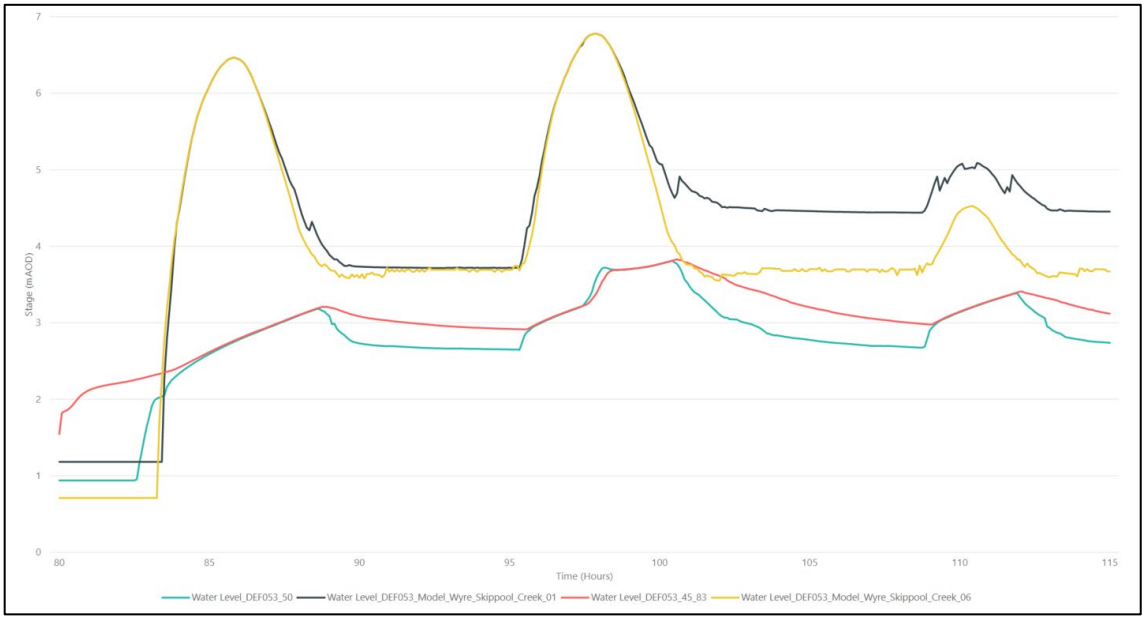


Figure 31 : Model wide stage results, 0.5% AEP, baseline

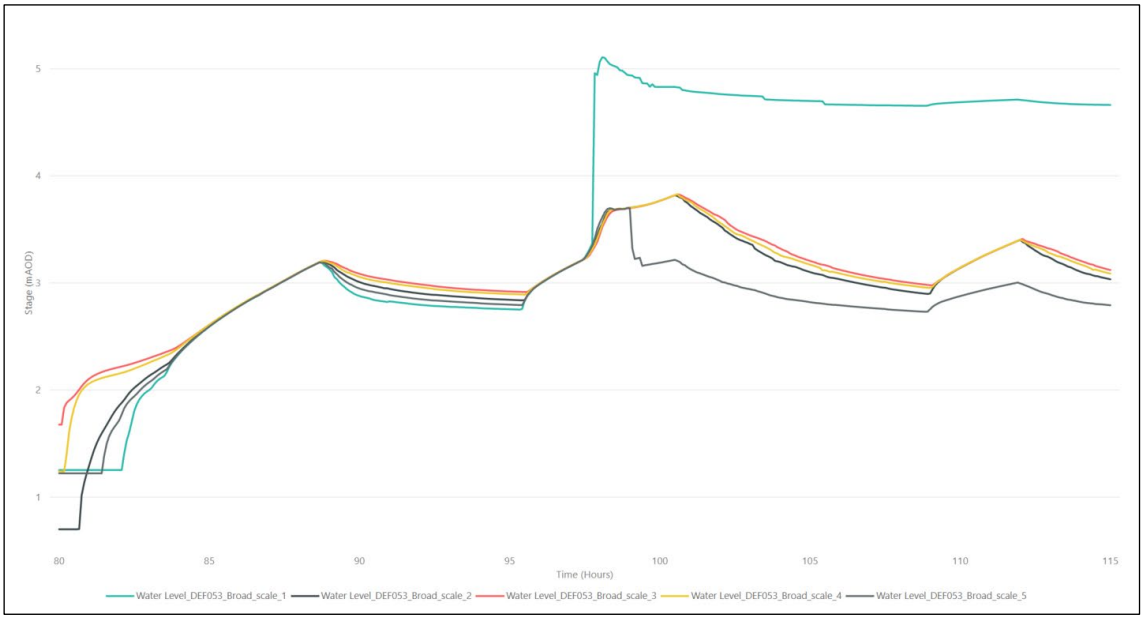
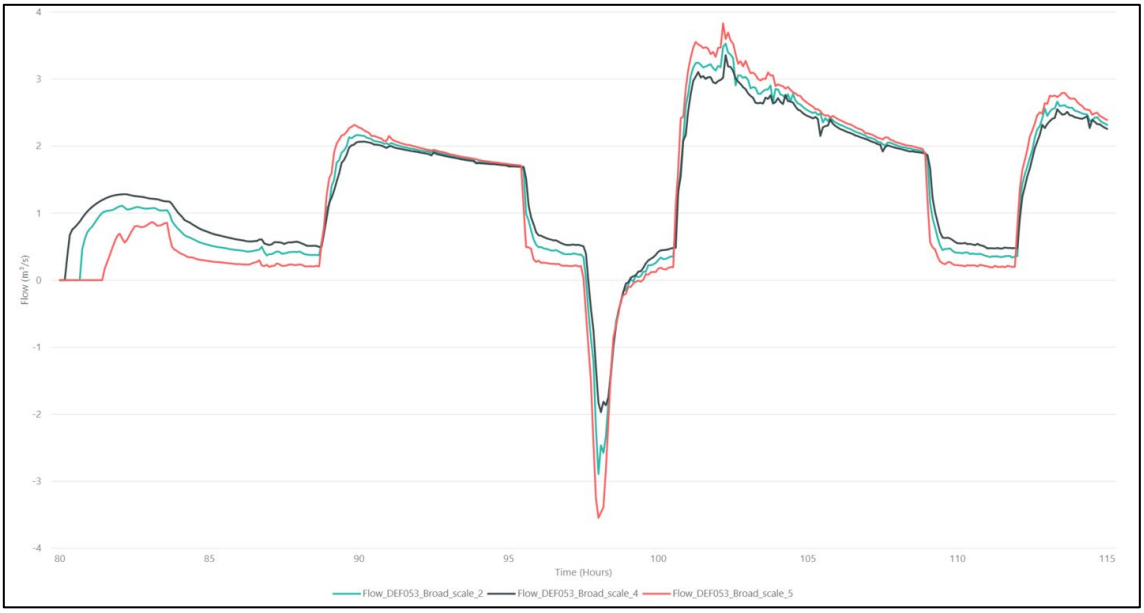


Figure 32 : Model wide flow results, 0.5% AEP, baseline



8.3 Fluvial Model: Errors, Warnings and Checks

FMP

8.3.1 The only warnings highlighted in the ZZD for the 0.1% AEP baseline run are related to different Manning's n values occurring within the same panel. The conveyance curves at highlighted locations have been reviewed and are smooth therefore it is not considered that the results are invalidated by these warnings.

TUFLOW

8.3.2 The TUFLOW warnings and checks for Windy_harbour_Q1000_BL_V26 have been reviewed and are discussed in Table 8**.**

Table 8: Review of TUFLOW warnings and checks for fluvial baseline 0.1% AEP model

Warning / Check	Response
CHECK 2078 - End of 3D HX breakline is dangling.	These locations have been reviewed and are acceptable
CHECK 2077 - Beginning of 3D line is dangling.	These locations have been reviewed and are acceptable
WARNING 1317 - WLL does not cross (2 point WLL only) or snap to 1D channel	Display issue only
WARNING 2073 - Object ignored. Only Points, Lines, Polylines & Region Centers used.	Outside model domain
CHECK 2099 - Ignored repeat application of boundary to 2D cell.	Correct boundary cell selected

8.1 Tidal Model: Errors, Warnings and Checks

8.1.1 The TUFLOW warnings and checks for Lancashire_Model_Wyre_T200_SCFC_DEF_053 and have been reviewed and are discussed in Table 9 and Table 10.

Table 9: Review of TUFLOW warnings and checks for tidal baseline 0.5% AEP model

Warning / Check	Response
CHECK 1284 - Connecting a 1D H boundary to 2D HX link.	Messages occur along the tidal boundary and confirm that the tidal boundary data in csv format has been linked to the correct location in the model domain.
CHECK 2077 - Beginning of 3D line is dangling.	Of the 10 warnings, four refer to features within the A585 domain and in all cases, the value applied is correct. The remaining six warnings refer to files supplied with the original EA model and are outside the A585 model domain.
CHECK 2078 - End of 3D line is dangling.	
CHECK 2370 - Ignoring coincident point found in Create TIN layer.	These occur where additional topographic data has been used to define the existing A585 DTM. Due to the nature of the dataset supplied, there are several overlapping points however a review of the DEM_Z check confirms that the correct geometry has been read in.
CHECK 2370 - Ignoring coincident point found in FC layer.	There are two overlapping data points in the 2d_fcsh layer used to define the Horsebridge Dyke approximately 1km upstream of the Scheme. The check files confirm that the correct values have been applied.
WARNING 2073 - Polyline object ignored. Only Regions, Lines, Polylines & Multiple Polylines used.	Occurs along the defence line east of Skippool Tidal Flaps. Levels applied are correct; no data supplied so LiDAR levels used where higher than the 6.6mAOD identified during site visit (see FRA for full details).
WARNING 2118 - Lowered SX ZC Zpt by XXm to 1D node bed level.	Correctly allocated in two locations where ESTRY culverts are connected to the 2D domain via SX boundaries.

Warning / Check	Response
WARNING 2991 - Negative V depth at [2416;0954]. Time = 97:04:55	Occurs on the River Wyre 6.5km downstream of the confluence with the Main Dyke. No impact on the results in the vicinity of the Scheme.

Table 10: Review of TUFLOW warnings and checks for tidal option 0.5% AEP model

Warning / Check	Response
CHECK 2370 - Ignoring coincident point found in Create TIN layer.	These occur where the point cloud data has been read in to define the proposed A585 DTM. Due to the nature of the dataset supplied, there are several overlapping points however a review of the DEM_Z check confirms that the correct geometry has been read in. There are a large number of warnings due to the length of the Scheme included in the TIN.
CHECK 2118 - Lowered SX ZC Zpt by XXm to 1D node bed level.	Occurs where the Z flag in the SX boundary linking the proposed culverts to the 2D domain has lowered the grid cell. All values are appropriate.
UKCP18 Model Run Only	
WARNING 2991 - Negative V depth at [2257;0679].	47 warnings. Located at the Household Waste Recycling Centre off Jameson Road approximately 5.5km north of the Scheme. Therefore not considered to impact on the conclusions of the FRA.
WARNING 2991 - Negative V depth at [xxxx;xxxx].	Seven additional locations reporting negative depth warnings. These are all remote from the Scheme and therefore not considered to impact on the conclusions of the FRA.

9 MODEL RESULTS

9.1.1 Model results for all scenarios and events, both fluvial and tidal, are discussed in detail in the FRA (document reference TR010035/APP/5.2 – Rev 1).

10 LIMITATIONS OF THE MODEL

10.1.1 The key limitations associated with the modelling carried out to inform this study are summarised below.

10.1.2 Missing survey data for the Main Dyke and Horsebridge Dyke meant that assumptions had to be made on the schematisation of the structures and the channel geometry without being able to carry out secondary checks. Consequently, the 1D elements of the models are based on the supplied EA 1D ISIS models.

10.1.3 Detailed survey data for the Wyre defences was not available. EA asset data, combined with LiDAR and site visit observations, have been used to ensure the most appropriate representation of these defences.

10.1.4 Survey data was not available for structures in the floodplain, notably culverts beneath the disused railway line running north from the Horsebridge Dyke to Amoundness Way. LiDAR data has been used to make a best estimate of the likely conveyance capacity of these structures.

10.1.5 Updated roughness values for the FMP channels were informed by photographs taken in 2002 supplied with the existing model report. These photographs were only available in areas where structures had been surveyed.

10.1.6 Model grid sizes of 4m and 5m were used for the fluvial and tidal models respectively. In creating averaged grids of these sizes, it is inherent that a level of accuracy is lost. Where appropriate, key structures and features have been enforced to ensure that their impact on flood extents and levels is captured.

10.1.7 The tidal model required that channels and some structures were modelled in 2D rather than 1D as in the fluvial model. This was necessary given the large volumes of water inundating the area during a 0.5% AEP tidal flood event. Removal of boundaries between 1D and 2D reduces the potential for instabilities. The most appropriate, best practice 2D approaches to modelling channels and structures have been used, informed by the same base data used in the 1D model. Although the tidal model results are not, and could not be, directly comparable with the fluvial model results the Scheme has been assessed against a directly compatible baseline, thus ensuring that the results are valid for this FRA.

10.1.8 There is inherent uncertainty in the derivation of all boundary data used in the modelling. However, given that the FRA presents a comparative assessment of the Scheme for each event, it is not considered that this uncertainty has a detrimental impact on the overall conclusions of the FRA. The modelling of a wide range of events enables a broad understanding of how the risk and impacts change with changing volumes and mechanisms of flooding.

11 ENVIRONMENT AGENCY CONSULTATION

11.1.1 Consultation with the EA has been undertaken throughout the duration of the project. Sections 11.2 to 11.3 summarise key reviews, meetings and decisions.

11.2 April 2017

11.2.1 The following documents were reviewed by the EA:

- Flood Risk Assessment (Ref: HE548643-ARC-GEN-A585-RP-EWE-2032-02), Arcadis, February 2017
- FRA Addendum: Memo - A585 Tide Locking (Ref: 5001-UA008849-UU41M-1.2), Arcadis, 16 March 2017

11.2.2 A response document (reference NO/2017/109668/02-L01) was provided. Table 11 lists the comments and the actions taken by Arcadis to address these.

Table 11: Comments and actions following the April 2017 EA consultation

EA Comment	Arcadis Response / Action
Section 8 in the FRA states that the scheme is at tidal flood risk in the vicinity of the Skippool junction and Windy Harbour junction and that because the road needs to tie into the existing network that this has to be acceptable. There is a failure to recognise that the scheme is at tidal flood risk where it is proposed along the length of Main Dyke (between Garstang Road and Mains Lane). It may be that the road will be sufficiently raised, however this should be discussed in the FRA.	Wyre model obtained and further work on tidal flood risk carried out (see Sections 4 and 5 of this annex and Sections 6.5, 7 and 9 of the FRA)
Section 6.1 in the FRA states that the scheme does not lie within the fluvial floodplain, which is incorrect. Figure 21 indicates that with the scheme in place it will not be at risk of flooding. This is acceptable provided that flood risk is not increased elsewhere. It is stated that the new road scheme will involve increasing the bridge capacity at Skippool Bridge and, as a result, the flood levels would be reduced upstream. Overall, this may be the case, however we would need to see your output files – depth grids – to be certain of this.	FRA updated to clarify that the Scheme is within the baseline fluvial floodplain but that by introducing the Scheme, the floodplain extents change and hence the Scheme is not at risk once constructed. Model results have been supplied to the EA and reviewed (see Sections 11.3 and 11.4 of this annex)

EA Comment	Arcadis Response / Action
We are pleased to see that you have modelled the effect that a tide lock could have on fluvial flows, the results of which are discussed in the FRA Addendum. Fluvial flooding with a tide locking scenario (with 10% AEP and 0.5% AEP tides) has been modelled, but it has not been mentioned that during the 10% AEP tide there is already some flooding without fluvial water and further flooding during the 0.5% AEP tidal event. In this scenario it is unclear why you have only applied the 30% fluvial flows for climate change, rather than 35% or 70%, as in the fluvial modelling, which is in accordance with new guidance. As with Figure 21 (mentioned above), Figure 6 indicates a reduction in flood extents with the scheme due to increased bridge capacity. We would need to see the depth grids for each scenario so we can check that flood risk is not increased at any location.	Purely tidal flooding is now considered separately within the FRA; the Wyre Estuary model has been used in this assessment. All design events including the plus 35% and plus 70% climate change scenarios have now been assessed. Model results have been supplied to the EA and reviewed (see Sections 11.3 and 11.4 of this annex)
If the scheme does offer a reduction in flood risk due to Skippool Bridge upsizing, then a Requirement on the Development Consent Order (DCO) will need to be imposed stating that this bridge must be upsized before any work within the floodplain is carried out.	Due to design constraints, the embankment within the floodplain must be completed before the Skippool Bridge crossing of the Main Dyke takes place. Subsequent discussions with the EA at a meeting on 30th April 2018 confirmed that any increases in flood risk during construction must be mitigated for. Events up to and including the 1% AEP plus 30% for climate change should be assessed. Information on the proposed mitigation strategy is included in Section 7 of this annex.

EA Comment	Arcadis Response / Action
If we find that the current scheme increases flood risk elsewhere, an alternative scheme will be required in order to develop within the floodplain along Main Dyke to ensure floodplain connectivity with the river, for example allowing floodwater to pass underneath the raised highway.	There are four ditches within the Main Dyke floodplain which are crossed by the Scheme. Connectivity will be maintained using culverts. These are included in the updated fluvial and tidal models.
Section 8 in the FRA states that a surface water drainage strategy would be implemented to ensure that there would be no increase in the surface water run-off from the scheme. Details of this will need to be provided to show where the additional surface water will be stored/discharged to, and that the additional run-off from the scheme does not increase the flood risk elsewhere.	A Drainage Design Development Report is included as Appendix E of the FRA (document reference TR010035/APP/5.2 – Rev 1).
As Main Dyke is designated a Main River, an Environmental Permit will be required for any outfalls, or any other works within 8 metres of the top of the bank/retaining wall of the watercourse, or 16 metres if it is a tidal Main River.	Further information has been submitted to clarify where the Scheme proposes working within these 8m and 16m zones. Consultation has been undertaken to discuss the projects approach to Environmental Permitting and it has been agreed that relevant consent applications will be prepared by the contractor, in consultation with the EA, during the detailed design stage of the Scheme.
Please note that the Lead Local Flood Authority, which is Lancashire County Council (LCC), is now the lead statutory consultee for major developments which have surface water flooding impacts, and we recommend that they are contacted. Further details can be found at: http://www.lancashire.gov.uk/council/planning/sustainabledrainage-systems.aspx	LCC in their capacity as the LLFA have been consulted about requirements in terms of Ordinary Watercourse Consents and management of surface water drainage from the Scheme. LCC have confirmed that in principle they have no concerns with the proposed works. As requested, draft Ordinary Watercourse Consents have been prepared for 7 structures on the basis of information currently available. One application has been submitted to the LLFA and was discussed at a meeting in January 2019. Formal comments are currently awaited.

EA Comment	Arcadis Response / Action
Depth grids should be provided to demonstrate that there will not be any increase in the flood risk to any of the properties located downstream of Skippool Bridge as a result of the scheme.	Model results have been supplied to the EA and reviewed (see Sections 11.3 and 11.4 of this annex)

11.3 June 2018

11.3.1 The hydraulic model files for the A585 fluvial model were reviewed by third party consultants working on behalf of the EA in June 2018. Table 12 lists the comments and the actions taken by Arcadis to address these.

Table 12: Comments and actions resulting from the June 2018 EA consultation

EA Comment	Arcadis Response / Action
This isn't the latest release of TUFLOW. Whilst not essential to update, it could have some impacts on the results. I would recommend some testing is done to see if the latest version makes a difference to the results.	The project started in 2015 and hence the version we started with has been maintained throughout the duration of the project. It should not be expected that changing versions would make a significant difference to the overall model results. The critical issue is to ensure that the baseline and 'with Scheme' models use the same versions of the software. It is not considered that this would change the overall conclusions of the study.
The following files are unavailable for the Q100+30 and Q100+70 baseline events: •1d_isis_nodes_horsebridge_dyke_11_tide_01.SHP •1d_isis_nodes_main_dyke_10_tide_01.SHP • Windy_harbour_BL_V22.tgc • Windy_harbour_BL_V22.tbc It looks like the wrong files have been referenced in the .tcf files for the .tgc and .tbc. They should be V23. V23 files have been supplied. I can't find the isis node files described above, but can see 1d_nwk files of the same name. Again has this been mis-referenced in the .tcf?	Requested files supplied. Model has since been updated to version 26 with corrected file references.

EA Comment	Arcadis Response / Action
Please can one (gxy) be supplied with future iterations of this model. Reviewing the model without one is particularly complex when it doesn't need to be.	GXY supplied.
In order to undertake a thorough review, survey information should be provided.	No new survey was commissioned for this study. The original ISIS models were supplied by the EA for use in the study. Survey drawings for the Main Dyke were also supplied by the EA however no survey of the Horsebridge Dyke could be located at the time of the request.
A gxy needs to be supplied, along with any survey information so that structures can be suitably assessed.	GXY supplied.
The model therefore is not representing the impact of the entire road embankment between Windy Harbour and Skippool. It will only provide information about the impacts between Skippool and Garstang Road. Is this the only area they were supposed to be showing the impacts of? If so then fine, but I would have expected the whole area to be modelled to show the impact of the entire road. Therefore the model needs to be extended to cover the area from Garstang Road to Windy Harbour.	The model extent was chosen for two reasons: 1. The proposed road turns away from the Main Dyke upstream of Garstang Road and crosses much higher ground which is outside the floodplain associated with the Main Dyke. Therefore, it was not considered that the road in this location would be at risk or, nor would impact on fluvial flood risk. 2. The existing EA model stopped just upstream of the Garstang Road. Given the issues discussed in point 1 it was not considered of sufficient benefit to procure additional survey to extend the model of the Main Dyke further upstream.

EA Comment	Arcadis Response / Action
The resolution of this LiDAR is ok. Is this the most up to date LiDAR available? Its 8yrs old. Does it include all the key features of the area? Has there been new development that wouldn't be accounted for?	The LiDAR used was downloaded at the start of the project in 2015. MasterMap data (updated in 2016) was used to define roughness and hence any buildings present at this time would be expected to be included within this data set. We agree that any ground raising as part of any new development may not therefore be picked up. However, most of the Main Dyke floodplain is either undeveloped farmland or existing residential development with limited scope for any infill development. Therefore, we do not consider that the LiDAR used is inappropriate for the scope of this assessment.
No evidence of additional site topographic data being used. Explanation to be given in supporting documentation around what has been used to determine the 2D topography.	The detailed crest elevations of the Scheme embankment have a negligible impact on fluvial flooding once the embankment is placed in the floodplain. Given that the whole length of the Scheme as it crosses the Main Dyke floodplain is considerably above peak water levels for the 1% AEP plus 70% for climate change event, the extent to which the embankment is above this has no impact on model results. Therefore, site specific topographic data was not considered necessary in addition to full LiDAR coverage. During a tidal flood event, the elevation of the A585 embankment pre and post Scheme is critical in controlling flooding inland. Therefore, site specific topographic data was read into the model as a TIN. Post Scheme levels were supplied by the design team.

EA Comment	Arcadis Response / Action
Increased roughness only for buildings has been implemented. Stubby buildings approach is recommended for an FRA but not considered essential. No explanation of choice of method given in the reporting supplied. Use of method should be justified.	Using Manning's 'n' to define building structures is standard practice for fluvial modelling, unlike surface water modelling, where best practice is to raise the building footprint. We consider that the use of increased roughness to represent buildings is appropriate for this study.
Defences and embankments all appear to be correctly represented. No obviously spurious defence heights. Without the survey data or AIMS data the actual crest heights couldn't be checked. Should crest heights need to be checked explicitly then the surveyed information needs to be supplied by which to check against.	The EA supplied defence data used as part of their Wyre Estuary tidal modelling. We do not have any additional survey information.
The model domain needs to be extended to cover the full extent of the proposed scheme so that its impacts can be tested.	See comments above.

EA Comment	Arcadis Response / Action
A tidal boundary condition has been applied. This is applied as an HT boundary. Although described in the reporting document, that 3 different tide curves have been created, it doesn't appear to use them. Only one tidal curve file can be found in the BC folder which is called 'tMHWS'. I would expect this file to change for the climate change runs. Other boundaries applied seem to be appropriate and in line with that described in the reporting. Only a brief explanation is given as to how the MHWS boundary has been created and this has been done for a 2016 level but we're now in 2018. This is therefore out of date. Provide an explanation of what downstream boundary has been used for the climate change runs.	We generated the tide curves for two purposes: 1. MHWS for use as a downstream boundary condition directly in the FMP TUFLOW model. 2. The 10% AEP and the 0.5% AEP event curves were used in the tide locking assessment we carried out at the request of the EA. We used this information to assess at what time, and for how long, the tidal flaps would be closed. We were unable to read the boundaries for the 10% AEP and 0.5% AEP events directly into the FMP TUFLOW model as the significantly high water levels caused the model to crash. An assessment of the tidal flood risk using the more extreme 0.5% AEP event has been carried out separately using the EA's Wyre Estuary tidal model. Further discussion on the tidal boundaries are included in Sections 4.2 and 6 of this annex.
The model domain needs to be significantly increased to the east to ensure the full scheme is modelled.	See comments above.
It would be useful for the .tmf file to not only give a code, but also a description field. Reviewing of the manning's n values used was very tedious and time consuming as I had to map between the GIS and the .tmf file to see what each code was representing and therefore if the manning's n value was appropriate. This would have been a far quicker check if the description field had been included in the .tmf file. Please consider updating this for any future model submission for this FRA or any other.	This does not impact on validity of the model results or FRA conclusions.

EA Comment	Arcadis Response / Action
The materials file doesn't cover the full northern extent of the code layer. Whilst there may not be too much/if any flooding occurring here, you should ensure that the materials layer and code layer tie up.	We agree that this would usually be best practice. However, for the purposes of this study, this is significantly away from the area of interest / zone of impact and hence will not impact on the final conclusions of the FRA.
Culverts on some of the minor drains near Greenways Nursery and around Little Singleton, have been included in a 1d nwk layer. Represented as polylines and then a 2d-bc file associated with CN and SX connections. Details all contained in the 1d nwk layer is appropriate with suitable entry and exit losses applied. Invert levels have been applied (all are around the 3.7 to 4m levels) and the change in u/s to d/s looks appropriate.Culvert width has been set to 1.5m. However, no survey of these structures has been provided to be able to check that they have been modelled correctly.Undefended runs haven't been undertaken so no need to remove the defences/structures. If specific checks over these culverts are needing to be made then the survey data needs to be supplied.	The 1.5m diameter culverts are only present in the 'with Scheme' model. They represent the way in which connectivity of the existing drains will be maintained through the Scheme embankment. Therefore, there is no survey data associated with them.
Mass balance is within tolerable limits for all scenarios within the 2D domain. Model convergence in the 1D isn't good and in some simulations the convergence is very poor. Convergence in the 1D domain needs to be improved. Unnecessary fluctuations in the model convergence plots.	Discussion on this is included in Section 8 of this annex.
Numerous checks and warnings in every scenario run within both the 1D and 2D domains. The model either needs to be improved to remove the checks/warnings (which seems possible due to the nature of the errors) or they need to be adequately explained/justified in reporting documents.	Discussion on these messages is included in Section 8 of this annex.

EA Comment	Arcadis Response / Action
No calibration runs have been completed but it is unknown if there is suitable data to carry out any calibration and/or verification. No further checks completed on this section. If calibration data is available, then the model should be calibrated and verified.	A request to the EA was made for calibration data in July 2016 – no data was available.
No sensitivity testing has been provided. It is going to be tested and reported separately. The sensitivity analysis will need to be reviewed prior to scheme approval. It is unclear in the reporting what sensitivity will be undertaken but should include at least two of the typical tests described on the left in this table.	We have assessed the sensitivity to the downstream boundary condition by looking at a tide locked scenario. We have also looked at sensitivity to change in flows by assessing three climate change scenarios.
It would be good for a separate modelling report to be supplied which could detail the model set up, structures modelled and chosen not to model, changes to defaults, errors and warnings etc This would greatly aid the review.	Detailed modelling information has been removed from the FRA and included within this Modelling Annex as Appendix B to the FRA report.

11.4 August 2018

11.4.1 The FRA report for the Scheme was submitted to the EA for review in May 2018. Comments on this were provided by the EA on 22nd August 2018. Table 13 summarises these comments and the responses to them.

Table 13: Comments and actions resulting from the August 2018 EA consultation

EA Comment	Arcadis Response / Action
There is no Non Technical Summary (NTS)	NTS included within the revised FRA (document reference TR010035/APP 5.2 - Rev 1).
Section 2.4.1 - flood history: The wording suggests the EA failed in their obligations to provide information.	Now Section 3.4.1. Reworded within the revised FRA.
Section 5 - Assessment methodology is too technical.	New modelling annex to the FRA created.

EA Comment	Arcadis Response / Action
Section 5.2 - Use of 2015 LiDAR may not account for development and key features occurring within the catchment after this time.	Addressed in Section 3.2 of the Modelling Annex. Approach agreed with the EA October 2018.
Roughness and buildings – 'Stubby' buildings can and should be used for fluvial and coastal modelling studies.	Roughness and buildings are now covered in the Modelling Annex. This issue was raised in the model review comments supplied by the EA in July 2018. The comment stated: *'Increased roughness only for buildings has been implemented. Stubby buildings approach is recommended for an FRA but not considered essential. No explanation of choice of method given in the reporting supplied. Use of method should be justified'*. This comment suggests that the approach taken in the A585 model is acceptable but that an explanation for the approach used should be provided. These discussions are provided in this Modelling Annex. Furthermore, sensitivity testing on the approach used to model buildings has been carried out for similar studies (at the request of the EA) and has shown minimal impacts on the overall conclusions drawn from the model results. In addition, use of increased roughness as a method for modelling buildings has been accepted by other EA regions. Adopted approach agreed by the EA as acceptable in October 2018
Model Extent - provide satisfactory comments as to why the model extent was selected	Addressed in Section 3.1 of the Modelling Annex. Adopted approach agreed by the EA as acceptable in October 2018
Tidal Boundary is two years out of date; the impact maybe little or none but confirmation is required.	Addressed in Section 3.1 of the modelling annex. Adopted approach agreed by the EA as acceptable in October 2018

EA Comment	Arcadis Response / Action
Mass Balance - convergence plots not explained in the FRA report	Addressed in Section 8 of the Modelling Annex.
Errors and Warnings 1D and 2D 1D - include all relevant info for completeness 2D - explain in the FRA reporting	Addressed in Section 8 of the Modelling Annex.
Table 10 - conclusions drawn are not clear	This section has been updated within the revised FRA.
Construction phase flood mitigation proposals could form part of the DCO	These commitments are set out in the Outline Construction Environment Management Plan that has been prepared (document reference TR010035/APP/7.2) and the Record of Environmental Actions and Commitments (REAC) (document reference TR010035/APP/7.3), which form part of the DCO application.
Pool Foot Creek - clarify the paragraph 'resultant small flows, it is not anticipated that the Scheme will be at risk of fluvial flooding from this watercourse, which crosses the watercourse some 1.8m above the level of the surrounding floodplain'	Now Section 7.6. This has been updated within the revised FRA to clarify the risk of flooding from this source.
Limitations of the model - text is too generic/cover all	Further detail provided in Section 10 of this Modelling Annex.
Protection of 3rd parties - tidal flood risk is not well enough described and it is not clear where and how tidal risk is increased	Now Section 9.1; this has been updated within the revised FRA.
Protection of the Scheme - tidal risks are concerning; Clarify what parts of the scheme are at risk of flooding and what can and cannot be resolved through mitigation as part of the design. Explain why betterment can't be provided.	Further work has been carried out to assess and mitigate for increases in tidal flood risk to and as a result of the Scheme. This is described in Section 7.2 of this Modelling Annex. A betterment is now achieved in some locations.

EA Comment	Arcadis Response / Action
Temporary defences; more info is required if temp defences are a serious consideration.	Following further consideration, provision of temporary defences is not considered a likely option, therefore reference to these has been removed from the revised FRA.
Compensation storage - Develop further the proposals for compensation storage.	Further discussion on the temporary compensation proposals is included within Section 7 of this Modelling Annex.
Appendix D - maps are truncated and do not show the eastern section of the scheme nr Windy Harbour junction.	This section of the Scheme is at risk of tidal flooding only; we have not modelled this area but the JBA Wyre Estuary model shows that there is no risk to the Scheme at this location (Table 8 of the revised FRA). A note has been added to Appendix D of the FRA (document reference TR010035/APP/5.2 – Rev 1) to clarify.
The minimum proposed soffit level of the A585 crossing over the Main Dyke is 5.020 metres above Ordnance Datum (mAOD). You advised us that this is above all the design events you have tested. This includes 1% Annual Exceedance Probability (AEP) plus 30% climate change and 35% climate change and the 0.1% AEP scenario). You have not tested the 1% AEP plus 70% for climate change which has a peak stage of 5.201mAOD.	We have tested the 1% AEP plus 70% event and hence we can confirm that the peak water level for this event is above the proposed soffit level of the new Skippool Bridge. Agreement was reached with the EA (October 2018) that this was acceptable.
Any potential impacts would need to modelled in detail and mitigation measures to manage any over land flow for the upper end estimate would need to be accommodated for as part of the overall design. The FRA must demonstrate that there will be no increase in flooding as a result of the changes, and ideally an overall benefit. In Flood Zone 3a 'essential infrastructure' should be designed and constructed to remain operational and safe in times of flood.	We have modelled the potential impacts in detail and report in the FRA that the 'with Scheme' model does result in a betterment against the existing situation for the 1% AEP plus 70% fluvial event. Approach agreed with the EA October 2018.

11.1 October 2018

11.1.1 A meeting was held with the EA in October 2018 to discuss the issues and comments listed in Table 13. A number of these issues were closed out as shown. Further work has since been carried out to address the outstanding comments.

11.2 December 2018

11.2.1 Comments on the proposed temporary floodplain compensation scheme were received via email; comments and responses are summarised in Table 14.

Table 14: Comments and actions resulting from the December 2018 EA consultation

EA Comment	Arcadis Response / Action
At present, it would appear that the FCA is simply an engineered depression on the right-hand bank of Main Dyke that would come into play when the bank top level of 4.5m AOD is overtopped. It is not clear how far away from the river the FCA is or the indicative direction of flow paths that would start to fill the FCA.	Further detail is now included in Section 7 of this Modelling Annex.
As previously discussed, there is no information on anticipated the volumes of water being stored and what the anticipated duration would be.	Further detail is now included in Section 7 of this Modelling Annex.
The design and modelling described in the memo is not well advanced as the current model schematisation does not include a pathway for water to drain back into the Main Dyke once the peak of the flood event has passed, as discussed in our meeting (on 18 October 2018). The proposal would, it appears, include a flapped outfall rather than a hydraulically connected spillway.	Further detail is now included in Section 7 of this Modelling Annex.
We also have some concerns that the current proposal could potentially fall under the Reservoir Act 1975. If this was the case the implications are likely to be significantly onerous as the developer would have to appoint a reservoirs engineer to oversee the construction of the FCA and comply with the requirements.	Further detail is now included in Section 7 of this Modelling Annex.

11.3 January 2019

11.3.1 Relevant Representations (RR) were made by the EA in January 2019. Comments and responses to the flood risk elements of the RR are summarised in Table 15.

Table 15: Comments and responses; EA Relevant Representations (January 2019)

EA Comment	Arcadis Response / Action
There are aspects relating to the assessment and mitigation of flood risk impacts that will require further consideration and remain of concern to us. If these concerns are overcome, we consider it is likely to be necessary to include a specific requirement within the DCO to ensure that the final agreed flood mitigation measures will be implemented.	Discussions with the EA are on-going with regard to flood mitigation measures to reach a position of agreement.
The compensatory storage area has only been modelled at present and as yet, to the best of our knowledge has not been developed into detailed design. We will need to see detailed design proposals that we could agree will function as intended and that would allow us to permit the works under the Environmental Permitting Regulations.	The Scheme is not currently at detailed design stage and a contractor is not presently engaged. A recommendation has been added to the revised FRA to ensure that detailed design proposals for the compensation areas are agreed with the EA by the Contractor during the next stage of the project. Key design commitments to safeguard EA interests have also been added to the outline CEMP and to the REAC, updated at Deadline 2.
Clarification on the proposed replacement Horsebridge Dyke culvert needs to be provided and design of any replacement agreed with us.	Further detail on the Skippool Clough (Horsebridge Dyke) culvert is included in Section 5.3 of this Modelling Annex. In addition, a separate technical memo has been prepared and submitted to the EA (April 2019).
We have not been given the opportunity to review the 'enhancements' to the tidal model, but we are aware that Highways England's consultant is currently working on this.	The tidal model was sent to the EA in February 2019. Further detail on the tidal model review process is contained in Sections 11.5, 11.6 and 11.7.

EA Comment	Arcadis Response / Action
We consider that climate change allowances should be revisited to ensure that a suitable and up to date evidence base is used in determining whether the development will be safe for its lifetime and to inform detailed design of the project. The following issues will need to be addressed: The allowances need updating to reflect UK Climate Projections 18 (UKCP18), which has recently been published. The H++ scenario should be considered and assessed given the safety critical aspects of the scheme. In relation to the above, the lifetime of the development should be clearly stated.	A 0.5% AEP event inclusive of a climate change allowance based on UKCP18 projections has been run. Results from this are reported in the revised FRA. Text regarding the potential lifetime of the development has been added to the FRA.
Flood risk activity permits will be required for several permanent structures within 8 metres of the main rivers, Horsebridge Dyke and Skippool Creek (Main Dyke): the replacement Horsebridge Dyke culvert, replacement Skippool Bridge and surface water outfalls. Permits will also be required for any other flood risk activities which meet the above criteria for any temporary works or structures during construction.	Flood risk activity permits for all relevant temporary (construction stage) activities and for permanent works would be prepared in consultation with the EA by the Contractor during the detailed design stage of the Scheme. The Scheme is currently at the preliminary design stage and there is currently no contractor on board. The Applicant has outlined to the Environment Agency at a meeting on the 1 April 2019 that they are not seeking to disapply any permits required for the Scheme. The Applicant is also in discussions with the EA to agree a Statement of Common Ground which will deal with the process and timescales for securing the permits.

11.4 February 2019

11.4.1 Supplementary to the RR, additional comments were received in February 2019. Comments and responses to these are summarised in Table 16.

Table 16: Comments and responses; EA Supplementary Comments to Relevant Representations (February 2019)

EA Comment	Arcadis Response / Action
The lifetime of the development should be clearly stated.	Information added to the FRA.
It is suggested that additional mitigation can and should be provided to allow the tidal control structure to discharge more efficiently and negate these flood level increases.	Item proposed for discussion at a further meeting in February / March 2019. See Section 11.6 for outcomes.
We have been advised that mitigation cannot be designed into the Scheme at this location and reliance will be placed on flood warning and evacuation. An appropriate flood warning and evacuation plan should be developed in discussion with the emergency services and included and submitted as part of the DCO.	Draft Flood Warning and Emergency plan submitted to the EA in May 2019. Plan to be submitted as part of the DCO application.
Insufficient information on the impacts of haul roads on flood risk is provided. Insufficient information on the location, specification and usage of site compounds has been provided. Site compounds within 8m of the top of the Main Dyke would not be permitted, compounds in the floodplain will likely need a FRAP. One compound is shown as in the floodplain of the Main Dyke, the operator will need to consider layout, levels, storage and fencing type.	New figures included in FRA which shows the locations of haul roads and site compounds relative to flood risk and distances from the Main Dyke. Additional recommendations regarding specifications of haul roads and compounds added to the FRA and outline Construction Environmental Management Plan (CEMP).
Information is provided on the increases in baseline tidal flood depth during the 0.5% plus CC AEP event, resulting in property damages. It is not clear from this information provided as to the level of assessment undertaken.	Further detail added to the Modelling Annex and FRA.

EA Comment	Arcadis Response / Action
The Engineering Section Drawings are difficult to read and don't identify our areas of interest in terms of main rivers etc. Detailed sections should be developed to inform pre-app discussions regarding Environmental Permits.	Additional section drawings provided to the EA (February 2019).
Provide clarification on intended amendments and/or modifications to any existing structures in, over under or within 8m of the top of bank of the main river, defence or asset or 16m if tidal (including any proposed drainage outfall structures).	GIS drawing files submitted to the EA (April 2019) illustrating the locations of works within 8m and 16m of the top of bank of main rivers and EA assets.

11.5 March 2019

11.5.1 The enhanced tidal model was submitted for review and comments from the EA were received on 20th March 2019. Comments and responses to these are summarised in Table 17.

Table 17: Comments and responses; EA Tidal Model Review (March 2019)

EA Comment	Arcadis Response / Action
In TidalResultsMemo_050.pdf Table 1 the total properties experiencing detriment is totalled incorrectly, it should read 50 not 24, if you tally improvements of <1cm you should also count the detriments or<1cm.	Table 1 is now Table 9 in the revised FRA. Property counts have been reported as requested.
Additional topographic data for the existing A585 between the Main Dyke and Horsebridge Dyke crossings was supplied by the design team. And used to create 2d_ztin_Topo_Existing_Surface.MIF No survey data was supplied to check this Z TIN is built correctly, model READS in zpt correctly.	The point cloud survey data was supplied to the EA on 29/03/19. The DEM_Z confirms that the road embankment has been defined in the model.

EA Comment	Arcadis Response / Action
Garstang Road levels DEM_Z and DTM match up but DEM Z has not picked up Infrastructure levels from 2d_zln file which presumably was from survey in the JBA model? The reviewer cannot confirm this was from survey.	The zln check file confirms that the supplied JBA files have been read in. The RIDGE command is used in the TGC (retained from supplied model) and hence the Zpt is only changed if the ZLN elevation is higher.
Railway cutting has not been put into DEM_Z on Horsebridge Dyke at 334574 439870. All other railway crossings have been burnt into the DEM	Railway cutting is enforced onto the DTM in the revised tidal model.
Wetland area has no connections into it. Should it be connected to the road network in the model?	The wetland area is designed to attenuate road run off. The detailed function of this is discussed in the drainage design development report (appended to the FRA). The road and the drainage pond are outside the extents of flooding in all modelled tidal flood events. It is not considered that the omission of any connections between the road and the wetland area will materially alter the conclusions of the FRA.
Constant baseflow for Horsebridge Dyke 0.4mAOD but bed level is set to minimum of 2.47mAOD. No wet cells shown on depth grid outputs from this boundary. How is baseflow functioning	2d_bc_Model_Wyre_040 is a QT boundary and hence applies a baseflow of 0.4m³/s not a stage. This was added during model development for stability reasons and is now obsolete. This has been removed from the revised model.

EA Comment	Arcadis Response / Action
Wyre Model extent is large enough however the culvert beneath Garstang Road has not been modelled, effectively ending the model here. The depth grid on the upstream extent of the main Dyke backs up against the high DTM levels of Garstang Road. This will cause backing up downstream, also does not allow assessment of baseline Vs. Scheme risk south of Garstang Road. The road scheme turns east onto higher ground here so the scheme will not be affected but it is the impact on other land uses that cannot be assessed	The model ended here in line with the fluvial model. The revised model has now been extended west of the railway line at Staining Lodge Golf Course to quantify changes upstream of Garstang Road.
Stability patches used, values and locations are acceptable when compared with Chow 1959. Stability patch code 4 (mannings 0.07) are odd in shape and overlap polygons in the same file.	Stability patches were applied during model development and related to areas where stability issues were encountered. Patches have been streamlined in the revised model.
For the baseline model the 1d_nwk_Model_Wyre_Culverts_047 has no survey to compare these features with. They are being read into the model correctly.	We do not have survey data for R_C_01. Data for the tidal flaps (MAIN02_TFBu) was supplied by the EA for use in this study.
The 2d_lfcsh_Model_Wyre_MAIN02_0381_049_AC_polyline represents the small bridge behind Kevin Avenue. No survey data is supplied to assess the dimensions and blockage of this structure.	We were not supplied with survey data. Indicative dimensions were taken from the EA fluvial model of the Main Dyke.

EA Comment	Arcadis Response / Action
The 2d_lfcsh_Model_Wyre_BL_Structure_Patch_049_AC_polyline represents the culvert beneath Mains Lane, this is marked as flood Gate on OS mapping but no details are provided of this being treated as shut (like Skippool Clough) are provided. No survey data is supplied to assess the dimensions and blockage of this structure. However, the lfcsh provides 5.04m2 of conveyance which equates to the existing pipe dimensions as stated in the report. This one file is used (in the .tgc) for both DEF and OPT models, the OPT should have different parameters to read in the new rectangular 12.5m opening beneath the road.	There are wooden gates which are now obsolete due to the new Skippool tidal flaps downstream. Therefore, these have been modelled as open based on discussions held with the EA at the time. Confirmed with the EA that the attributes for the lfcsh are different for the baseline and Option models.
How have the 4 new plastic culverts that connect the ditches beneath the proposed road included in the model OPT runs?	ESTRY culverts have been used to model the proposed culverts beneath the embankment. These are connected using 2d_bc SX boundaries allowing them to pass water. File supplied to the EA 29/3/19.
1d_nwk_embankment_culverts_bund_15 specifies 1.5m diameter culverts connected with SX and CN lines. ACTION Report section 5.4.2 states Mannings 0.01 is used but model file uses 0.025. Further action to clarify and amend.	FRA report should state 0.025 as they are currently proposed as corrugated polypipe. FRA report amended.
Why has a channel Storage Reduction Factor for the Dykes been applied and how was the threshold set at 0.32?	The SRF value is based on the average channel dimensions of the Dykes as taken from the 1D FMP model. The SRF factor has been applied to the two cell width lowered by the 2d_fcsh. Enforcing the channel into the 2D was done to ensure a clear pathway for any flows coming up the Main Dyke / Horsebridge Dyke, rather than to accurately map the flood levels. This is an enhancement to the supplied model which did not enforce any channels onto the base DTM.

EA Comment	Arcadis Response / Action
On field drains how has the percentage blockage of 60% and Storage Reduction Factor of 0.4 been selected? Whilst this will represent a precautionary situation it has not been documented sufficiently.	As above, the field drain dimensions were estimated from LiDAR and a pBlockage / SRF applied to the cells.
As reported, the cumulative mass error values spike at -23%, 2.7 hours into the simulation however this settles to within the recommended +/-1% after 9 hours and remains generally stable for the remainder of the simulation. However, MB1D MB2D show values all within 1%. See https://www.tuflow.com/forum/index.php?/topic/1061-mass-balance-combined-vs-1d2d-nan/ 'If the combined CME does not add up to the sum of the 1D and 2D CME, then this means there is an issue with the 1D/2D linking.'	The TSMB1d2d output for the HX boundaries confirms that these are inherent within the supplied JBA model and hence no change has been made as part of this study. The other 1D-2D boundaries added to the model as part of the FRA are for the Skippool tidal flaps and the proposed culverts. CSV results indicate that these structures are passing flow correctly.
17 additional errors/warnings in the DEF 200 UKCP18 run are not explained. More crucially no descriptions of error/warnings for the OPT runs are given. There are negative depth warnings at Breck Road in the DEF and OPT runs	Some additional negative depth warnings noted. Full commentary is provided in Section 8 of this Modelling Annex.
It is assumed that the lack of calibration of the original Wyre model was accepted previously by the EA. No additional calibration runs have been completed but it is unknown if there is suitable data to carry out any calibration and/or verification. No further checks completed on this section.	No calibration data is available.
Sensitivity testing was carried out for the original Wyre Model, it is assumed that this was accepted by the EA. No additional sensitivity testing has been provided. No further checks completed on this section	It is our understanding that the model was accepted by the EA. We have considered sensitivity to increased flows due to climate change in the Wyre Estuary.

11.6 1st April 2019

11.6.1 A meeting was held with the EA on 1st April 2019. Comments and responses to these are summarised in Table 18.

Table 18: Comments and responses; EA Meeting 1st April 2019

Issue	Arcadis Response / Action
Detailed design information for the floodplain compensation storage cannot be provided as the project is not yet in the detailed design phase. EA need assurance that the FCA would able to be consented.	CEMP, REAC and FRA updated to add commitments regarding: maintaining EA access to Main Rivers, ensuring bank stability, maintaining levels / avoiding sudden dips in ground and bank levels. The contractor would be bound by these commitments. Information from a Supervising Reservoirs Engineer has been added to the FRA.
Discussion was held regarding the comment raised previously regarding additional mitigation to allow the tidal control structure to discharge more efficiently and negate any flood level increases.	The Scheme has no influence on the current operation of the tidal gates. Whilst a small increase in baseline water levels are predicted with the Scheme in place, these are in channel increases, with no detriment to baseline flood risk (and significant benefits further upstream). It was also noted that the gates are not mechanised but controlled by water level conditions. The EA confirmed that no real practical interventions had been suggested. Therefore text has been added to the FRA to confirm that the flaps are in EA ownership and that they will continue to maintain these. The Scheme will have no impact on any current maintenance and operation regimes.

Issue	Arcadis Response / Action
The EA highlighted that the key concerns around the replacement of the Skippool Clough Culvert are managing the potential for scour/erosion, risk of blockage (particularly given the angle between the culvert inlet and upstream channel), and ensuring that the design is resilient to the tidal flow conditions at the downstream end. Information on the decision-making process behind the design decisions that have been taken to date is required. Maintenance responsibilities for the various elements of the asset should be clarified. (Note: the downstream tidal outfall/headwall is in private ownership but maintained by the EA, this needs to be resolved). Design must ensure that EA access is maintained.	Technical note on the Skippool Clough Culvert provided to the EA in April 2019. Culvert invert levels specified in Section 5.3 of this Modelling Annex.
The EA highlighted that UKCP18 uplift proposed by Arcadis is potentially underestimated. Although no published guidance is available, the EA agreed to confirm a project specific allowance.	Tidal model re-run with EA UKCP18 allowance.
Further details are required where haul roads and site compounds have potential to interact with floodplains and Main Rivers.	Additional information added to Section 7.5 of the revised FRA. Commitments added to the outline CEMP and REAC regarding set back distances, boundary fencing types etc.

Issue	Arcadis Response / Action
EA requested further detail / clarity on the plans submitted to show the proposed works which are situated close to EA assets to assist in future permitting.	GIS shape files submitted to EA: Scheme red line boundary 8m and 16m buffer zones (measured from the top of bank of the Main Dyke, Horsebridge Dyke and River Wyre) Drainage outfall/headwall locations and drainage ponds Temporary floodplain compensation areas Main Dyke crossing Skippool Clough replacement culvert alignment, plus inlet/outlet structures Dwarf walls

11.7 3rd April 2019

11.7.1 Comments on the draft Modelling Annex, Tidal Results Memo and UKCP18 Memo submitted by Arcadis were received from EA on 3rd April 2019. Comments and responses to these are summarised in Table 19.

Table 19: Comments and responses; EA correspondence 3rd April 2019

EA Comment	Arcadis Response / Action
We acknowledge the guidance, both external and indeed internal on UKCP18, is at the moment very limited. However, we felt that the proposal put forward in your UKCP18 memo, for the application of a 0.85m increase to the present day 0.5% AEP still water levels (that had been applied to 2100), was an underestimation of UKCP18 Sea Level Rise, presented in the flood risk assessment (FRA). Sea level rise from 2016 to 2120 is 1.253m. This should be applied to all boundary condition points 1222, 1226, 1228, 1230 and 1236	An allowance of 1.253m has been applied to the revised tidal model.
Tidal results memo needs revising when the updated UKCP18 recommendations have been modelled and impacts assessed.	The tidal model results are now included in the revised FRA.

EA Comment	Arcadis Response / Action
Page 17. 4.2 Tidal Model Boundaries 4.2.2- 4.2.6 These sections discuss climate change scenarios and methodology for still water levels. Section 4.2.6 concludes with sentence stating that 'EA have been consulted on this approach'. We have provided a written response to the Acadis UKCP18 memo. More recently we have confirmed the 0.85m is an underestimation	All references to climate change have been updated to include the UKCP18 scenario as set out by the EA.
Page 22 4.2.13 talks about: • Application of a 0.85m increase the present day 0.5% AEP still water levels • Maintained UKCP09 wave overtopping volumes	All references to climate change have been updated to include the UKCP18 scenario as set out by the EA.
Page 27 7.1.4 Proposed mitigation Flood Compensation Areas (FCA's) Discussions around FCA's are ongoing	Additional details have been added to the revised FRA and the Modelling Annex.
Page 32 7.2 Completed Scheme This section talks about measures required to mitigate for the slight lowering in elevation of the Scheme, and that a dwarf wall is proposed alongside the eastbound carriageway (north side of the road). Its position and proposed elevation is illustrated in Figure 22. Providing caveats give us confidence that the proposals can be controlled through DCO, then we will be satisfied	Commitments added to the REAC and outline CEMP
We have concerns that a number of documents will now be out of date and will need to be updated in a holistic manner as part of current work	All EA comments have been addressed and are reflected in the updated FRA (document reference TR010035/APP/5.2 – Rev 1).

APPENDIX C – FEH CALCULATION RECORD

Page Left Intentionally Blank

Flood estimation calculation record

Introduction

This document is a supporting document to the Environment Agency's flood estimation guidelines. It provides a record of the calculations and decisions made during flood estimation. It will often be complemented by more general hydrological information given in a project report. The information given here should enable the work to be reproduced in the future. This version of the record is for studies where flood estimates are needed at multiple locations.

Contents

		Page
1	METHOD STATEMENT	3
2	LOCATIONS WHERE FLOOD ESTIMATES REQUIRED	7
3	STATISTICAL METHOD	9
4	REVITALISED FLOOD HYDROGRAPH (REFH) METHOD	13
5	DISCUSSION AND SUMMARY OF RESULTS	14
6	ANNEX - SUPPORTING INFORMATION	16

Approval

	Signature	Name and qualifications	For Environment Agency staff: Competence level (see below)
Calculations prepared by:	[redacted]	[redacted] Hydrologist MESci	Level 1
Calculations checked by:		[redacted] Senior Hydrologist BSc, MSc, MCIWEM, CWEM	Level 3
Calculations approved by:		[redacted] Senior Hydrologist BSc, MSc, MCIWEM, CWEM	Level 3

Environment Agency competence levels are covered in Section 2.1 of the flood estimation guidelines:

- Level 1 – Hydrologist with minimum approved experience in flood estimation
- Level 2 – Senior Hydrologist
- Level 3 – Senior Hydrologist with extensive experience of flood estimation

ABBREVIATIONS

AM	Annual Maximum
AREA	Catchment area (km^2)
BFI	Base Flow Index
BFIHOST	Base Flow Index derived using the HOST soil classification
CFMP	Catchment Flood Management Plan
CPRE	Council for the Protection of Rural England
FARL	FEH index of flood attenuation due to reservoirs and lakes
FEH	Flood Estimation Handbook
FSR	Flood Studies Report
HOST	Hydrology of Soil Types
NRFA	National River Flow Archive
POT	Peaks Over a Threshold
QMED	Median Annual Flood (with return period 2 years)
ReFH	Revitalised Flood Hydrograph method
SAAR	Standard Average Annual Rainfall (mm)
SPR	Standard percentage runoff
SPRHOST	Standard percentage runoff derived using the HOST soil classification
Tp(0)	Time to peak of the instantaneous unit hydrograph
URBAN	Flood Studies Report index of fractional urban extent
URBEXT1990	FEH index of fractional urban extent
URBEXT2000	Revised index of urban extent, measured differently from URBEXT1990
WINFAP-FEH	Windows Frequency Analysis Package – used for FEH statistical method

1 Method statement

1.1 Overview of requirements for flood estimates

Item	Comments
Give an overview which includes: • Purpose of study • Approx. no. of flood estimates required • Peak flows or hydrographs? • Range of return periods and locations • Approx. time available	Arcadis Consulting Ltd. (Arcadis) have been commissioned by Highways England to undertake a hydrological assessment of the catchment of the Main Dyke and its main tributary the Horsebridge Dyke, to inform a Flood Risk Assessment for the proposed A585 Windy Harbour to Skippool Road Improvement Scheme, in Lancashire. Design flood hydrographs have been produced for the 2 year, 100 year, 100 year plus 30%, 35% and 70% Climate Change (CC) and 1000 year events. These flows will be routed through a hydraulic model of the watercourses to define baseline flood conditions and to represent the scheme, quantifying any impacts and identifying any mitigation measures required. These watercourses were last modelled by the Environment Agency in 2003 and both the EA hydrology and hydraulic model have been reviewed and updated using current best practice methodologies and available data.

1.2 Overview of catchment

Item	Comments
Brief description of catchment, or reference to section in accompanying report	The study catchment and Flow Estimation Points (FEPs) have been schematised in Figure 1 (Annex 1). A total of 5 FEPs have been defined, to include 1 check point downstream of the confluence of the main channel of the Horsebridge Dyke and a small tributary at National Grid Reference (NGR) 334651, 440077. The FEP *'Add'* a small area of the Horsebridge Dyke catchment that is not represented on the FEH web service. Horsebridge Dyke flows to the Skippool Creek, a 587m length of Environment Agency (EA) Main River which drains into the River Wyre. The dyke itself consists of 5.16km of EA Main River and a non-Main River section of some 2.74km (downstream grid ref SD33703760, upstream SD33163619 at Stanley Park Lake). Approximately 300m of the Main River section is tidally affected, terminating near the Amounderness Way/Breck Road/Mains Lane road traffic roundabout. Main Dyke, also known as the Hillylaid Pool, also drains into the Wyre via the Skippool Creek. It drains an area from Marton Mere in Blackpool to its outfall at Skippool, a channel length of 10.62km which is all defined as Main River (downstream grid ref SD35724074, upstream SD33243536). Further information is provided in the A585 Skippool to Windy Harbour Flood Risk Assessment (Arcadis, 2016).

1.3 Source of flood peak data

Was the HiFlows UK dataset used? If so, which version? If not, why not? Record any changes made	Yes – Version 3.3.4 – August, 2014

1.4 Gauging stations (flow or level)

(at the sites of flood estimates or nearby at potential donor sites)

Water-course	Station name	Gauging authority number	NRFA number (used in FEH)	Grid reference	Catch-ment area (km^2)	Type (rated / ultrasonic / level…)	Start and end of flow record
New Mill Brook	New Mill Brook @ Hollowforth Hall	-	72817	SD503364	31.9	Velocity Area	01/1972 to Date

1.5 Data available at each flow gauging station

Station name	Start and end of data in HiFlows-UK	Update for this study?	Suitable for QMED?	Suitable for pooling?	Data quality check needed?	Other comments on station and flow data quality – e.g. information from HiFlows-UK, trends in flood peaks, outliers.
New Brook Mill @ Hollowforth Hall	01/1972 to Date	-	Yes – gauged to around QMED	No – too much uncertainty once flows are out of bank.	-	The weir was primarily constructed as a low flow gauge and drowns out at a relatively low level. Large flows spill onto the right bank floodplain. Rating developed from gaugings, with modelled top-end to allow for bypassing / out of bank flow.
Give link/reference to any further data quality checks carried out			N/A			

1.6 Rating equations

Station name	Type of rating e.g. theoretical, empirical; degree of extrapolation	Rating review needed?	Reasons – e.g. availability of recent flow gaugings, amount of scatter in the rating.
N/A	-	-	-
Give link/reference to any rating reviews carried out		N/A	

1.7 Other data available and how it has been obtained

Type of data	Data relevant to this study?	Data available ?	Source of data and licence reference if from EA	Date obtained	Details
Check flow gaugings (if planned to review ratings)	N/A	-	-	-	-
Historic flood data – give link to historic review if carried out.	Yes	Yes	Public consultation event	19/09/16	Anecdotal evidence of flooding from local residents gathered during a public consultation event. See Annex 4 for detail.
			EA Ref: CL5227HR	December 2015	Product 4 data pack including historical flood extent maps.

Flow data for events	Yes	No	-	-	-
Rainfall data for events	Yes	No	-	-	-
Potential evaporation data	N/A	-	-	-	-
Results from previous studies	Yes	Yes	Atkins (2003) Hydrologic Report River Wyre Catchment Flood Risk Mapping Investigation Persimmon Homes/Jones Homes (2015) Garstang Road East Flood Risk Assessment	 November 2015	This report informs the River Wyre Catchment Flood Risk Mapping Investigation and reports on the hydrology of the Horsebridge and Main Dykes. FRA in support of a residential development scheme located in the lower catchment of the Main Dyke, presenting hydraulic modelling results and flood mapping.
Other data or information (e.g. groundwater, tides)	N/A	-	-	-	-
			-	-	-

1.8 Initial choice of approach

Is FEH appropriate? (it may not be for very small, heavily urbanised or complex catchments) If not, describe other methods to be used.	Flood Estimation Handbook (FEH) Statistical and rainfall runoff (ReFH) methods are considered appropriate. However, the catchments draining to FEP2, FEP3, FEP CheckA and FEP Add, are heavily urbanised (URBEXT1990>0.125). Application of the standard ReFH method is therefore not recommended on these catchments and the urban extension to the method has been applied to generate comparative suites of design flow estimates.
Outline the conceptual model, addressing questions such as: • Where are the main sites of interest? • What is likely to cause flooding at those locations? (peak flows, flood volumes, combinations of peaks, groundwater, snowmelt, tides…) • Might those locations flood from runoff generated on part of the catchment only, e.g. downstream of a reservoir? • Is there a need to consider temporary debris dams that could collapse?	The main site of interest is the lower catchment of the Main/Horsebridge Dyke in the vicinity of the existing A585 road crossing. Situated within the low-lying tidal reaches of the River Wyre catchment, both watercourses drain by gravity, have limited gradients and are subject to tide locking in their lower reaches. Urban land use, which in particular dominates in the Horsebridge Dyke catchment also has an influence on the flood response.
Any unusual catchment features to take into account? e.g. • highly permeable – avoid ReFH if BFIHOST>0.65, consider permeable catchment adjustment for statistical method if SPRHOST<20% • highly urbanised – avoid standard ReFH if URBEXT1990>0.125; consider FEH Statistical	The watercourses are not pumped, are not defined as highly permeable and are not subject to major reservoir influence. However, the catchments are subject to tide locking and the watercourses are constrained by the surrounding urban developments of Flyde and Thornton.

or other alternatives; consider method that can account for differing sewer and topographic catchments • pumped watercourse – consider lowland catchment version of rainfall-runoff method • major reservoir influence (FARL<0.90) – consider flood routing • extensive floodplain storage – consider choice of method carefully	
Initial choice of method(s) and reasons Will the catchment be split into subcatchments? If so, how?	Neither of the subject watercourses are gauged for level or flow therefore flood estimation relies on catchment descriptor based equations and models. The initial choice is the FEH Statistical method, with comparative estimates generated from the ReFH method (urban extension as applicable to FEP2, FEP3, CheckA and FEP Add). The catchments of the subject watercourses have been split to reflect the hydraulic model schematisation and to generate inflows into the model at the required locations. Flow from the lumped catchment to FEP1 has been scaled to account for the proportional area of the catchment draining to the upstream model boundary along the Main Dyke, where an inflow input is required in the hydraulic model. The remainder of the total flow for the catchment will be input into the model as a lateral inflow between the upstream (US) and downstream (DS) model extents. For FEP3 (Horsebridge Dyke), the flow for the lumped catchment will be also apportioned according to the area draining to the US model extent and the DS boundary of the watercourse. Further details of the apportioning methodology is provided in Appendix Annex 3. Check A is a check point flow and does not represent an inflow to the hydraulic model.
Software to be used (with version numbers)	FEH Web Service WINFAP-FEH v3.0.003[1] / ReFH spreadsheet / ReFH Flood Modeller Pro

[1] WINFAP-FEH v3 © Wallingford HydroSolutions Limited and NERC (CEH) 2009.

2 Locations where flood estimates required

The table below lists the locations of subject sites. The site codes listed below are used in all subsequent tables to save space.

2.1 Summary of subject sites

Site code	Watercourse	Site	Easting	Northing	AREA on FEH CD-ROM (km^2)	Revised AREA if altered
FEP1	Main Dyke	Main Dyke between Main Dyke Bridge at Garstang Road and The Wyre Way	335714	440746	28.28	-
FEP2	Unnamed stream	Small tributary of the Horsebridge Dyke	334619	440096	0.94	-
FEP3	Horsebridge Dyke	Horsebridge Dyke between Garstang Road West and Croft House	334646	440063	9.54	-
CheckA	Confluence of the Unnamed stream and Horsebridge Dyke	-	334662	440090	10.48	-
Add		Direct catchment of the Horsebridge Dyke downstream of its confluence with the Main Dyke near Little Thornton.	355690	440780	-	1.66
Reasons for choosing above locations		These subject sites have been defined to represent inflows to the hydraulic model. N.B. Check flow FEPs do not represent inflows to the hydraulic model.				

2.2 Important catchment descriptors at each subject site (incorporating any changes made)

Site code	FARL	PROPWET	BFIHOST	DPLBAR (km)	DPSBAR (m/km)	SAAR (mm)	SPRHOST	URBEXT*	FPEXT
FEP1	0.97	0.41	0.45	6.24	16.80	924	39.10	0.1460	0.2478
FEP2	1.00	0.52	0.55	1.63	10.50	921	30.57	0.2256	0.3830
FEP3	0.97	0.41	0.35	4.53	16.80	907	40.63	0.3697	0.2166
CheckA	0.968	0.41	0.36	4.31	16.20	908	39.74	0.3449	0.2318
Add	1.00	0.42	0.42	4.97	8.50	910	33.20	0.2628	0.2329
**URBEXT2000 values updated to 2016*									

2.3 Checking catchment descriptors

Record how catchment boundary was checked and describe any changes (refer to maps if needed)	Catchment boundaries were checked using OS contour and LiDAR data and no changes to the FEH web service boundaries were required. However, the direct catchment represented by the 'Add' FEP, is not included on the FEH web service and the boundary of this catchment was therefore defined using OS contour and LiDAR data.

<table>
<tr>
<td>Record how other catchment descriptors (especially soils) were checked and describe any changes. Include before/after table if necessary.</td>
<td>FEH descriptors describing catchment soils and geology (SPRHOST and BFIHOST) were checked with reference to Sheet 3 of the Soil Survey of England and Wales 1:250k Map.

Catchment descriptors were checked for the catchments draining to FEP1, FEP2, FEP3 and Check A and estimated for the FEP ‘Add’ using the methods outlined in the table below:

<table>
<tr><th>Descriptor</th><th>Method</th></tr>
<tr><td>SAAR</td><td>Value adopted as average of neighbouring adjacent FEH catchments</td></tr>
<tr><td>FARL</td><td>Visual checks on reservoirs and proportions on OS maps.
Equation 4.1 of FEH Vol 5</td></tr>
<tr><td>SPRHOST</td><td>Calculated following the method set out in the Institute of Hydrology Report No. 126</td></tr>
<tr><td>BFIHOST</td><td>As for SPRHOST</td></tr>
<tr><td>PROPWET</td><td>Value adopted as average of neighbouring adjacent catchments</td></tr>
<tr><td>DPSBAR</td><td>Calculated from LiDAR data</td></tr>
<tr><td>DPLBAR</td><td>Calculated using equation 7.1 FEH Vol 5*</td></tr>
<tr><td>URBEXT1990</td><td>Derived from URBAN50K in accordance with the methodology presented in the R&D Technical Report FD1919 (EA/DEFRA 2006)</td></tr>
<tr><td>URBEXT2000</td><td>As for URBEXT1990</td></tr>
</table>
*with sensibility checks undertaken using GIS</td>
</tr>
<tr><td>Source of URBEXT</td><td>URBEXT1990 (ReFH)/URBEXT2000 (FEH Statistical)</td></tr>
<tr><td>Method for updating of URBEXT</td><td>CPRE formula from FEH Volume 4</td></tr>
</table>

3 Statistical method

3.1 Search for donor sites for QMED (if applicable)

Comment on potential donor sites Mention: • Number of potential donor sites available • Distances from subject site • Similarity in terms of AREA, BFIHOST, FARL and other catchment descriptors • Quality of flood peak data Include a map if necessary. Note that donor catchments should usually be rural.	Donor sites were investigated for each of the subject catchments. A search radius of 35km was adopted (based on centroid distance) and one potential donor station was found: **72817 New Mill Brook @ Hollowforth Hall** – WINFAP highlights that this station is closest to the subject catchments, with a centroid distance of 18.91km. FEH guidelines stipulate that donor stations should, in most cases, be rural (even if the subject catchment is urbanised). The candidate donor catchment is rural (URBEXT2000 – 0.021) and is similar in terms of area and soil conditions (permeability) to the subject catchments and is within 20km by centroid distance. This station was therefore selected as a donor to inform flow estimation at FEP1, FEP3 and Check A. Owing to the small catchment size of FEP2 (0.94km^2) and FEP Add (1.66km^2), it is considered that the use of this donor station is not appropriate.

3.2 Donor sites chosen and QMED adjustment factors

NRFA no.	Reasons for choosing or rejecting	Method (AM or POT)	Adjust-ment for climatic variation?	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjust-ment ratio (A/B)
72817	See Section 3.1	AM	-	20.91	18.56	1.13
Which version of the urban adjustment was used for QMED at donor sites, and why? Note: The guidelines recommend great caution in urban adjustment of QMED on catchments that are also highly permeable (BFIHOST>0.8).				Kjeldsen (2010)		

3.3 Overview of estimation of QMED at each subject site

Site code	Method	Initial estimate of QMED rural (m^3/s)	Data transfer						Final estimate of QMED* (m^3/s)
			NRFA numbers for donor sites used (see 3.3)	Distance between centroids d_{ij} (km)	Power term, a	Moderated QMED adjustment factor, (A/B)[a]	If more than one donor		
							Weight	Weighted average adjustment factor	
FEP1	DT	9.14	72817	18.91	0.32	1.04	-	-	11.23
FEP2	CD	0.41	-	-	-	-	-	-	0.57

Site code	Method	Initial estimate of QMED rural (m^3/s)	Data transfer						Final estimate of QMED* (m^3/s)
			NRFA numbers for donor sites used (see 3.3)	Distance between centroids d_{ij} (km)	Power term, a	Moderated QMED adjustment factor, $(A/B)^a$	If more than one donor: Weight	If more than one donor: Weighted average adjustment factor	
FEP3	DT	4.35	72817	21.73	0.30	1.04	-	-	6.15
CheckA	DT	4.63	72817	21.61	0.30	1.04	-	-	6.55
Add	CD	0.95	-	-	-	-	-	-	1.26
*Urban adjusted to 2016									
Are the values of QMED consistent, for example at successive points along the watercourse and at confluences?			Yes, QMED is consistent, increasing at the check flows downstream of confluences.						
Which version of the urban adjustment was used for QMED, and why?			Kjeldsen (2010)						

Notes

Methods: AM – Annual maxima; POT – Peaks over threshold; DT – Data transfer; CD – Catchment descriptors alone.

When QMED is estimated from POT data, it should also be adjusted for climatic variation. Details should be added.

When QMED is estimated from catchment descriptors, the revised 2008 equation from Science Report SC050050**Error! Bookmark not defined.** should be used. If the original FEH equation has been used, say so and give the reason why.

The guidelines recommend great caution in urban adjustment of QMED on catchments that are also highly permeable (BFIHOST>0.8). The adjustment method used in WINFAP-FEH v3.0.003 is likely to overestimate adjustment factors for such catchments. In this case the only reliable flood estimates are likely to be derived from local flow data.

The data transfer procedure is from Science Report SC050050. The QMED adjustment factor A/B for each donor site is given in Table 3.3. This is moderated using the power term, a, which is a function of the distance between the centroids of the subject catchment and the donor catchment. The final estimate of QMED is $(A/B)^a$ times the initial estimate from catchment descriptors.

If more than one donor has been used, use multiple rows for the site and give the weights used in the averaging. Record the weighted average adjustment factor in the penultimate column.

3.4 Derivation of pooling groups

The composition of the pooling groups is given in the Annex 2. All subject sites have used the same pooling group, based on that formed for FEP3, as it was determined there was no significant difference in the default pooling group compositions. The table below summarises the changes made to the default pooling group composition.

Name of group	Site code from whose descriptors group was derived	Subject site treated as gauged? (enhanced single site analysis)	Changes made to default pooling group, with reasons Note also any sites that were investigated but retained in the group.	Weighted average L-moments, L-CV and L-skew, (before urban adjustment)

Name of group	Site code from whose descriptors group was derived	Subject site treated as gauged? (enhanced single site analysis)	Changes made to default pooling group, with reasons Note also any sites that were investigated but retained in the group.	Weighted average L-moments, L-CV and L-skew, (before urban adjustment)
Pool1	FEP3	P	The default pooling group has 17 stations and 520 station years of data. A review of WINFAP-FEH highlights that the default pooling group is heterogenous (H2=3.9776) and a review of the pooling group is desirable. The following stations were removed from the pooling group: **49006 Camel @ Camelford** –short record of data. **47022 [redacted] @ Newnham Park** –rapid response of catchment to storm events and significant china clay mining in the catchment which has altered the local hydrology. **44008 South Winterbourne @ Winterbourne Steepleton** –significant bypassing at this station. **72014 Condor @ Galgate** – station subject to drowning. **28033 Dove @ Hollinsclough** –difficulty in gauging at higher flows, potential underestimation of high flows at this station. The following stations were added to the pooling group: **48004 Warleggan @Trengoffe** **206006 Annalong @ Recorder** **27010 Hodge Beck @ Bransdale Weir** The modified pooling group has 15 stations and 515 station years of data. WINFAP-FEH suggests that the pooling group remains heterogeneous (H2=2.1694) and a review is still desirable. However, it is considered that no further modifications would be made to the pooling group.	L-SKEW:0.195 L-CV: 0.23
Notes Pooling groups were derived using the revised procedures from Science Report SC050050 (2008). The weighted average L-moments, before urban adjustment, can be found at the bottom of the Pooling-group details window in WINFAP-FEH.				

3.5 Derivation of flood growth curves at subject sites

Site code	Method (SS, P, ESS, J)	If P, ESS or J, name of pooling group (3.4)	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Parameters of distribution* (location, scale and shape)	Growth factor for 100-year return period**
FEP3	P	-	GL – WINFAP recommended	Urban Adjustment – Kjedlsen, 2010	Location: 1.00 Scale:0.233 Shape: -0.195	2.13
FEP1	P	-	GL – WINFAP recommended	Urban Adjustment – Kjedlsen, 2010	-	2.10

Site code	Method (SS, P, ESS, J)	If P, ESS or J, name of pooling group (3.4)	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Parameters of distribution* (location, scale and shape)	Growth factor for 100-year return period**
FEP2	P	-	GL – WINFAP recommended		-	2.78
Check A	P	-	GL – WINFAP recommended	Urban Adjustment – Kjedlsen, 2010	-	2.13
Add	P	-	GL – WINFAP recommended	Urban Adjustment – Kjedlsen, 2010		2.13

*Rural Parameters of distribution for FEP3 only as urban adjustment not made in WINFAP

**100 year growth factor following urban adjustment

Notes

Methods: SS – Single site; P – Pooled; ESS – Enhanced single site; J – Joint analysis

A pooling group (or ESS analysis) derived at one gauge can be applied to estimate growth curves at a number of ungauged sites. Each site may have a different urban adjustment, and therefore different growth curve parameters.

Urban adjustments to growth curves should use the version 3 option in WINFAP-FEH: Kjeldsen (2010).

Growth curves were derived using the revised procedures from Science Report SC050050 (2008).

3.6 Flood estimates from the statistical method

Site code	Flood peak (m^3/s) for the following return periods (in years)					
	2yr	100yr	100yr +CC (30%)	100yr +CC (35%)	100yr +CC (70%)	1000yr
FEP1	11.23	23.60	30.68	31.86	40.12	28.20
FEP2	0.57	1.59	2.07	2.15	2.70	2.84
FEP3	6.15	13.09	17.02	17.67	22.25	19.79
Check A	6.55	13.95	18.14	18.83	23.72	21.10
Add	1.26	2.68	3.48	3.62	4.56	4.05

4 Revitalised flood hydrograph (ReFH) method

Note: [1]The Urban Extension to the ReFH method has been applied to the below FEPs in line with best practice guidelines (EA, 2015).

4.1 Parameters for ReFH model

Note: If parameters are estimated from catchment descriptors, they are easily reproducible so it is not essential to enter them in the table.

Site code	Method: OPT: Optimisation BR: Baseflow recession fitting CD: Catchment descriptors DT: Data transfer (give details)	Tp (hours) Time to peak	C_{max} (mm) Maximum storage capacity	BL (hours) Baseflow lag	BR Baseflow recharge
FEP1	CD	4.02	346.13	30.45	1.15
FEP2[1]	CD	0.39	395.60	-	1.55
FEP3[1]	CD	0.84	272.62	-	0.88
CheckA[1]	CD	0.94	282.97	-	0.91
Add[1]	CD	2.19	322.30	-	1.08
Brief description of any flood event analysis carried out (further details should be given below or in a project report)		N/A			

4.2 Design events for ReFH method

Site code	Urban or rural	Season of design event (summer or winter)	Storm duration (hours)	Storm area for ARF (if not catchment area)
FEP1	Rural	Winter	7.5	-
FEP2	Urban	Summer	7.5	-
FEP3	Urban	Summer	7.5	-
Check A	Urban	Summer	7.5	-
Add	Urban	Summer	7.5	-
Are the storm durations likely to be changed in the next stage of the study, e.g. by optimisation within a hydraulic model?			No – a uniform storm duration has been modelled, representative of the recommended duration for the lumped catchments of the Main and Horsebridge dykes.	

4.3 Flood estimates from the ReFH method

Site code	Flood peak (m^3/s) for the following return periods (in years)					
	2	100	100+30% CC	100+35% CC	100+70% CC	1000
FEP1	9.89	23.41	30.43	31.60	39.80	39.55
FEP2	0.95	2.50	3.25	3.38	4.25	4.30
FEP3	6.61	24.79	32.23	33.47	42.14	42.32
Check A	9.18	24.05	31.27	32.47	40.89	41.01
Add	1.03	2.70	3.51	3.65	4.59	4.79

5 Discussion and summary of results

5.1 Comparison of results from different methods

This table compares peak flows from various methods with those from the FEH Statistical method at example sites for two key return periods. Blank cells indicate that results for a site were not calculated using that method.

Site code	Ratio of peak flow to FEH Statistical peak					
	Return period 2 years			Return period 100 years		
	ReFH			ReFH		
FEP1	0.88			0.99		
FEP2	1.67			1.57		
FEP3	1.07			1.89		
Add	0.82			1.01		

5.2 Final choice of method

Choice of method and reasons – include reference to type of study, nature of catchment and type of data available.	Study catchments are not gauged for flow and whilst a donor was identified to inform the FEH Statistical method, this donor was located fairly distantly from the subject catchments, therefore its influence was reduced by the distance weighting factor. Uncertainty in the estimated flows is therefore relatively high. As indicated in Table 5.1 comparative flows from the FEH Statistical and ReFH methods compare closely at FEP1 and Add, which are both more rural catchments, where the 'standard' ReFH model is applicable. The degree of urbanisation in catchments draining to FEPs 2 and 3 triggers application of the urban extension to the ReFH method, which in these catchments has produced higher flow estimates than the FEH Statistical method. Given the uncertainty, it is recommended that flows from the FEH Statistical method are adopted for FEP1 and ReFH flows adopted for the remaining FEPs.

5.3 Checks

What is the 100-year growth factor? Is this realistic? (The guidance suggests a typical range of 2.1 to 4.0)	100 year growth factors range from 2.1 (FEH Stat at FEP1) to 2.6 (ReFH urban extension at FEPs 2 and Add) to 3.7 at FEP 3 and are within the typical range.
If 1000-year flows have been derived, what is the range of ratios for 1000-year flow over 100-year flow?	Ratios range from 1.2 (FEH Stat at FEP1) to 1.7 (ReFH urban extension at FEPs 2 and 3).
What range of specific runoffs (l/s/ha) do the results equate to? Are there any inconsistencies?	Specific runoff rates at the 100 year return period range from 8.3l/s/ha (FEP1) to approximately 26l/s/ha at FEPs 2 and 3, which represent the most urban sub-catchments.
How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred.	Flow estimates have been compared with the flows that were routed through the EA Wyre Catchment Flood Risk Mapping Investigation model (2003). As illustrated in the table below the contemporary flow estimates are higher than the 2003 flows, with the exception of a slightly lower flow at the 100yr on the Main Dyke. This comparison has been presented to the EA and confirmation has been received that the flow estimates from this current study are acceptable for use in informing the A585 Flood Risk Assessment (see Annex 6.5)

Location	2 yr Flow Arcadis	2 yr Flow EA 2003	100 yr Flow Arcadis	100 yr Flow EA 2003
Main Dyke	11.23	10.09	23.7	24.6

	downstream				
	Horsebridge Dyke downstream	6.55	3.66	13.95	10.20

5.4 Final Results

Site code	Flood peak (m^3/s) for the following return periods (in years)								
	2	100	100+30% CC	100+35% CC	100+70% CC	1000			
FEP1	11.23	23.60	30.68	31.86	40.12	28.20			
FEP2	0.95	2.50	3.25	3.38	4.25	4.30			
FEP3	6.61	24.79	32.23	33.47	42.14	42.32			
Add	1.03	2.70	3.51	3.65	4.59	4.79			

If flood hydrographs are needed for the next stage of the study, where are they provided? (e.g. give filename of spreadsheet, name of ISIS model, or reference to table below)	

6 Annex - supporting information

6.1 Catchment Delineation

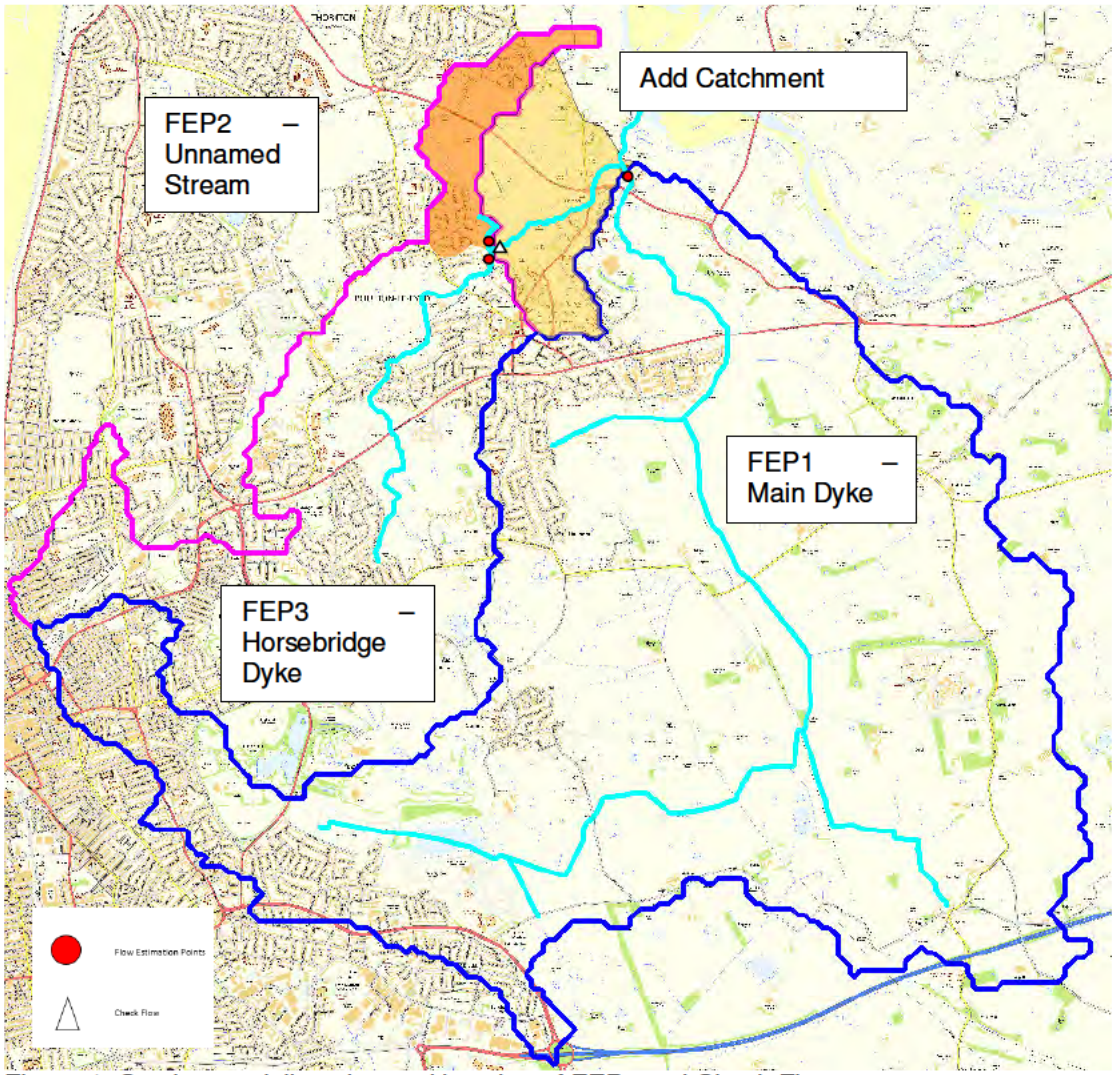


Figure 1: Catchment delineation and location of FEPs and Check Flow

6.2 Pooling Group Composition

DEFAUT POOLING GROUP

Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
27073 (Brompton Beck @ Snainton Ings)	0.592	32	0.813	0.197	0.022	0.386
20002 (West Peffer Burn @ Luffness)	1.892	41	3.299	0.292	0.015	1.774
203046 (Rathmore Burn @ Rathmore Bridge)	2.038	30	10.934	0.136	0.091	1.47
72014 (Conder @ Galgate)	2.221	45	17.703	0.193	0.059	0.274

26802 (Gypsey Race @ Kirby Grindalythe)	2.236	13	0.109	0.261	0.199	0.492
27051 (Crimple @ Burn Bridge)	2.297	40	4.539	0.222	0.149	0.344
73015 (Keer @ High Keer Weir)	2.306	21	12.239	0.156	0.001	0.693
25019 (Leven @ Easby)	2.312	34	5.538	0.347	0.394	0.818
49003 (de Lank @ de Lank)	2.351	46	13.559	0.232	0.241	0.426
47022 (Tory Brook @ Newnham Park)	2.37	19	7.331	0.257	0.071	0.47
45816 (Haddeo @ Upton)	2.416	19	3.456	0.324	0.434	0.708
41020 (Bevern Stream @ Clappers Bridge)	2.424	43	13.49	0.214	0.208	0.906
25003 (Trout Beck @ Moor House)	2.443	39	15.164	0.176	0.291	1.156
28033 (Dove @ Hollinsclough)	2.48	33	4.666	0.266	0.415	0.72
49006 (Camel @ Camelford)	2.485	6	8.832	0.11	-0.293	2.624
25011 (Langdon Beck @ Langdon)	2.502	26	15.878	0.241	0.326	1.929
44008 (South Winterbourne @ Winterbourne Steepleton)	2.505	33	0.42	0.395	0.332	1.81
Total		520				
Weighted means				0.237	0.188	

FINAL POOLING GROUP

Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
27073 (Brompton Beck @ Snainton Ings)	0.592	32	0.813	0.197	-0.022	1.239
20002 (West Peffer Burn @ Luffness)	1.892	41	3.299	0.292	0.015	2.252
203046 (Rathmore Burn @ Rathmore Bridge)	2.038	30	10.934	0.136	0.091	1.105
26802 (Gypsey Race @ Kirby Grindalythe)	2.236	13	0.109	0.261	0.199	0.273
27051 (Crimple @ Burn Bridge)	2.297	40	4.539	0.222	0.149	0.83
73015 (Keer @ High Keer Weir)	2.306	21	12.239	0.156	0.001	0.796
25019 (Leven @ Easby)	2.312	34	5.538	0.347	0.394	1.443
49003 (de Lank @ de Lank)	2.351	46	13.559	0.232	0.241	0.524
45816 (Haddeo @ Upton)	2.416	19	3.456	0.324	0.434	1.152
41020 (Bevern Stream @ Clappers Bridge)	2.424	43	13.49	0.214	0.208	0.458
25003 (Trout Beck @ Moor House)	2.443	39	15.164	0.176	0.291	1.142
25011 (Langdon Beck @ Langdon)	2.502	26	15.878	0.241	0.326	1.704
27010 (Hodge Beck @ Bransdale Weir)	2.519	41	9.42	0.224	0.293	0.323
206006 (Annalong @ Recorder)	2.532	48	15.33	0.189	0.052	1.347
48004 (Warleggan @ Trengoffe)	2.603	43	9.799	0.268	0.287	0.412

Total	516		
Weighted means		0.23	0.195

6.3 Additional supporting information – Apportioning of Flows

Flow from the lumped catchment to FEP1 has been scaled to account for the proportional area of the catchment draining to the US model boundary along the Main Dyke, where an inflow input is required in the hydraulic model.

The remainder of the total flow for the catchment will be put into the model as a lateral inflow between the upstream (US) and downstream (DS) model extents for this watercourse.

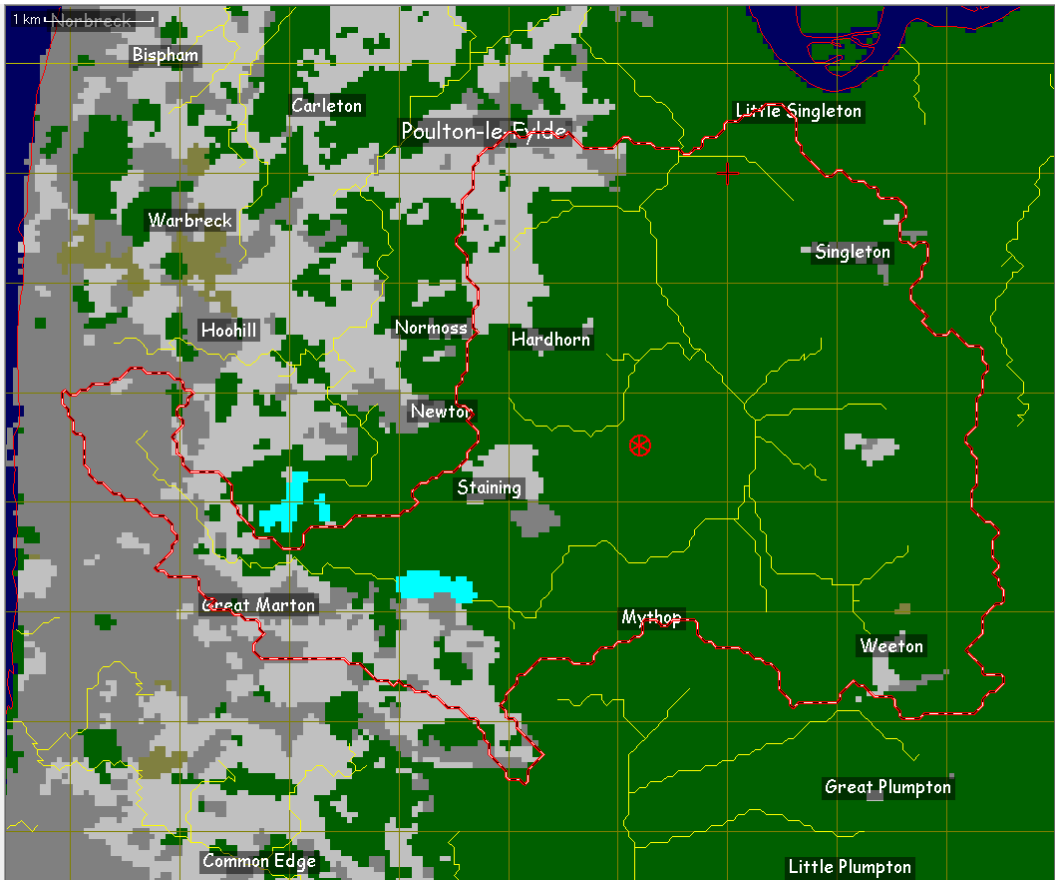


Image 1 – FEH CD-ROM Catchment draining to the US model extent of the Main Dyke. The catchment area totals 26.43km^2. As a proportion of the total catchment to the DS extent of the watercourse, this is equal to 95%.

Therefore, the modelled inflows are as follows for the Main Dyke:

FEP1	**FEH Statistical Flows (m^3/s)**	
Return Period (Years)	***US inflow***	***Lateral***
2	10.67	0.56
100	22.42	1.18
100+30% CC	29.15	1.53

100+35% CC	30.27	1.59
100+70% CC	38.11	2.01
1000	26.79	1.41

For FEP3 (Horsebridge Dyke), the flow for the lumped catchment has also been apportioned according to the area draining to the US model extent and the DS boundary of the watercourse.

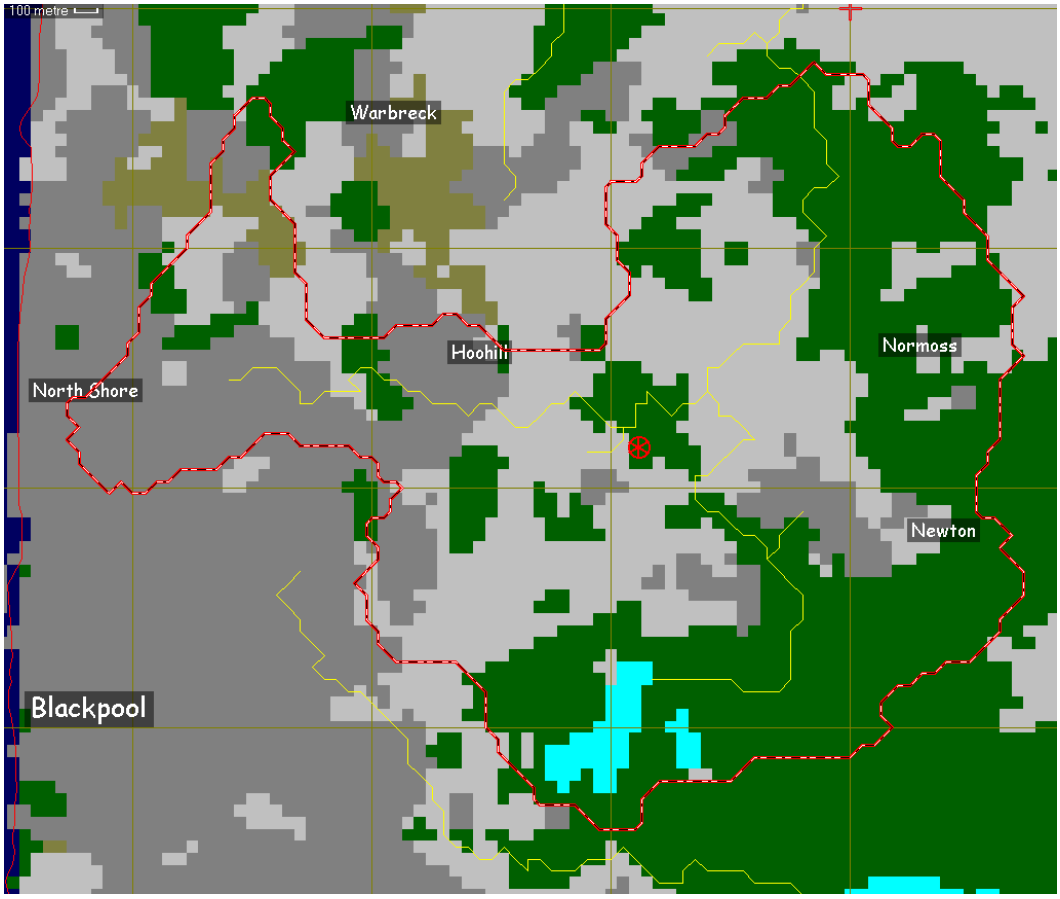


Image 2 - FEH CD-ROM Catchment draining o the US model extent of the Horsebridge Dyke. The catchment area totals 6.79km^2. As a proportion of the total catchment to the DS extent of the watercourse, this is equal to approximately 70%.

6.4 Additional supporting information – Anecdotal Flooding Information

Anecdotal Flooding Information from Public Consultation: A number of people referred to flooding along the Main Dyke being severe and extending quite far south. Apparently this has improved a lot since the tidal gates were installed but they believe that a lack of maintenance of the Dyke in certain stretches is a problem. The Dyke is very narrow and overgrown south of Little Singleton but widens out further south.

6.5 Environment Agency Correspondence

From: [redacted]
Sent: 12 January 2017 11:40

To: [redacted]
Subject: RE: A585 modelling study

Hello Lisa

The revised flows will be acceptable for the Flood Risk Assessment without the need for a detailed EA review. As you point out the increased flows for climate change will provide a much more conservative flood estimation.

With regards
Ian

From: [redacted]
Sent: 11 January 2017 14:44
To: [redacted]
Cc: [redacted]
Subject: A585 modelling study

Hello Ian

I am working with Claire Gibson on the A585 scheme and one of the actions that was agreed during one of your calls was for us to check our new design flow hydrology against the hydrology in the existing EA models of the Main and Horsebridge Dykes. Please see below a summary comparison table.

Flow Estimation Location	2 year flow - Arcadis	2 year flow – EA 2003	100 year flow - Arcadis	100 year flow –EA 2003
Main Dyke at DS limit	11.23	10.09	23.7	24.6
Horsebridge Dyke at DS limit	6.55	3.66	13.95	10.2

In the main our new flows are higher than the EA 2003 model flows, with the exception of a slightly lower flow at the 100yr on the Main Dyke. However, the scenario we are modelling is the 100 year plus climate change event, incorporating a +30% factor for CC (so arriving at a more conservative flow).

I light of these findings I was hoping you could agree that our design hydrology is acceptable without detailed EA review.

Kind Regards

Lisa

[redacted] | Principal Hydrologist | [redacted]
Arcadis | Arcadis House Cymru, Fortran Road, St Mellons Business Park, Cardiff | CF3 0EY | Wales
T. 02920 926742 | M. + 07947 221117
www.arcadis.com



Be green, leave it on the screen.

APPENDIX D – MAPPED FLOOD EXTENTS AND IMPACTS

Page Left Intentionally Blank

A585 Skippool to Windy Harbour Improvement Scheme

TR010035

5.2 Appendix D: Hydraulic Model Results

APFP Regulation 5(2)(e)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Volume 5

May 2019

Page left intentionally blank

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning
(Applications: Prescribed Forms and
Procedure) Regulations 2009

A585 Skippool to Windy Harbour Improvement Scheme

Development Consent Order 201[ ]

HYDRAULIC MODEL RESULTS

Regulation Number:	Regulation 5(2)(e)
Planning Inspectorate Scheme Reference	TR010035
Application Document Reference	TR010035/APP/5.2
Author:	A585 Skippool to Windy Harbour Improvement Scheme Project Team, Highways England

Version	Date	Status of Version
Rev 0	April 2019	DCO Submission
Rev 1	May 2019	Deadline 2 Submission

Page left intentionally blank

TABLE OF FIGURES

Figure D 1 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 50% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017) 1
Figure D 2 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 20% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017) 2
Figure D 3 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 10% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017) 3
Figure D 4 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 5% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017) 4
Figure D 5 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 2% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017) 5
Figure D 6 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 1.33% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017) 6
Figure D 7 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 1% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017) 7
Figure D 8 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 1% AEP (+30% Climate Change) flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 8
Figure D 9 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 1% AEP (+35% Climate Change) flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 9
Figure D 10 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 1% AEP (+70% Climate Change) flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 10
Figure D 11 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 0.1% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017) 11
Figure D 12 - Maximum flood depth difference [Scheme – Baseline] for the 50% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017) 12
Figure D 13 - Maximum flood depth difference [Scheme - Baseline] for the 20% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017) 13
Figure D 14 - Maximum flood depth difference [Scheme - Baseline] for the 10% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017) 14
Figure D 15 - Maximum flood depth difference [Scheme - Baseline] for the 5% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017) 15
Figure D 16 - Maximum flood depth difference [Scheme - Baseline] for the 2% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017) 16
Figure D 17 - Maximum flood depth difference [Scheme - Baseline] for the 1.33% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017) 17

Figure D 18 - Maximum flood depth difference [Scheme - Baseline] for the 1% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017) 18
Figure D 19 - Maximum flood depth difference [Scheme - Baseline] for the 1% AEP (+30% Climate Change) flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017) 19
Figure D 20 - Maximum flood depth difference [Scheme - Baseline] for the 1% AEP (+35% Climate Change) flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017) 20
Figure D 21 - Maximum flood depth difference [Scheme - Baseline] for the 1% AEP (+70% Climate Change) flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017) 21
Figure D 22 - Maximum flood depth difference [Scheme - Baseline] for the 0.1% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017) 22
Figure D 23 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 50% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017) 23
Figure D 24 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 20% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017) 24
Figure D 25 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 10% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017) 25
Figure D 26 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 5% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017) 26
Figure D 27 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 2% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017) 27
Figure D 28 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 1.33% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017) 28
Figure D 29 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 1% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017) 29
Figure D 30 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 1% AEP (+30% Climate Change) flood event.

Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017) 30
Figure D 31 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 50% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 31
Figure D 32 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 20% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 32
Figure D 33 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 10% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 33
Figure D 34 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 5% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 34
Figure D 35 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 2% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 35
Figure D 36 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 1.33% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017) 36
Figure D 37 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 1% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 37
Figure D 38 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 1% AEP (+30% Climate Change) flood event (Contains Ordnance Survey data © Crown copyright and database right 2017) 38
Figure D 39 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 1% AEP (+35% Climate Change) flood event (Contains Ordnance Survey data © Crown copyright and database right 2017) 39
Figure D 40 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 1% AEP (+70% Climate Change) flood event (Contains Ordnance Survey data © Crown copyright and database right 2017) 40
Figure D 41 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 0.1% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 41
Figure D 42 - TUFLOW Model Output Zone used for Tidal Model runs. The model calculates solutions for all cells within the model domain which extends north west towards Thornton, Cleveleys and Fleetwood. However, results grids are only written out for the area in the model output zone giving rise to the straight edges observed around the perimeter of the flood extent. The output zone has been used to limit run times, and reduce file sizes by only writing results for the study area. (Contains Ordnance Survey data © Crown copyright and database right 2017) 42
Figure D 43 - Maximum flood extents [Tidal Baseline and 'With Scheme' (Option)] for the 0.5% AEP Tidal flood event (Contains Ordnance Survey data © Crown copyright and database right 2017) 43
Figure D 44 - Maximum flood extents [Tidal Baseline and 'With Scheme' (Option)] for the 0.5% AEP Tidal + UKCP18 Climate Change (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 44
Figure D 45 - Maximum flood depth difference [Tidal Baseline and 'With Scheme' (Option)] for the 0.5% AEP Tidal flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 45
Figure D 46 - Maximum flood depth difference [Tidal Baseline and 'With Scheme' (Option)] for the 0.5% AEP Tidal + UKCP18 Climate Change Sensitivity Test (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 46

Figure D 47 - Maximum flood depth difference [Baseline and 'with Mitigation'] for the 1% AEP + 30% Climate Change flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)..... 47
Figure D 48 - A map showing the extent of the area considered for property level flood level analysis. MasterMap building polygons for all properties within the area shown to experience a change in flood risk were extracted from within this area (Contains Ordnance Survey data © Crown copyright and database right 2018). 48

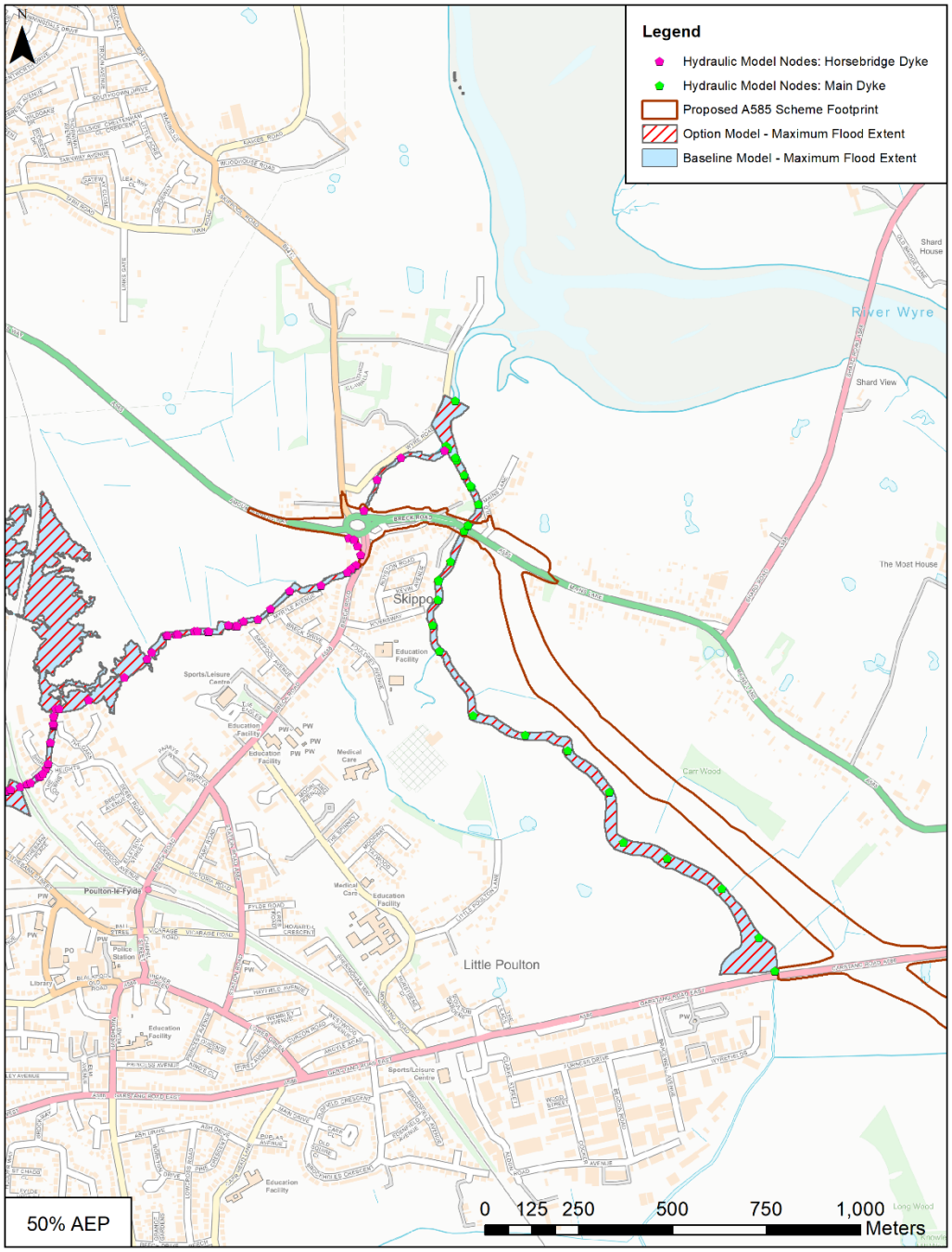


Figure D 1 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 50% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

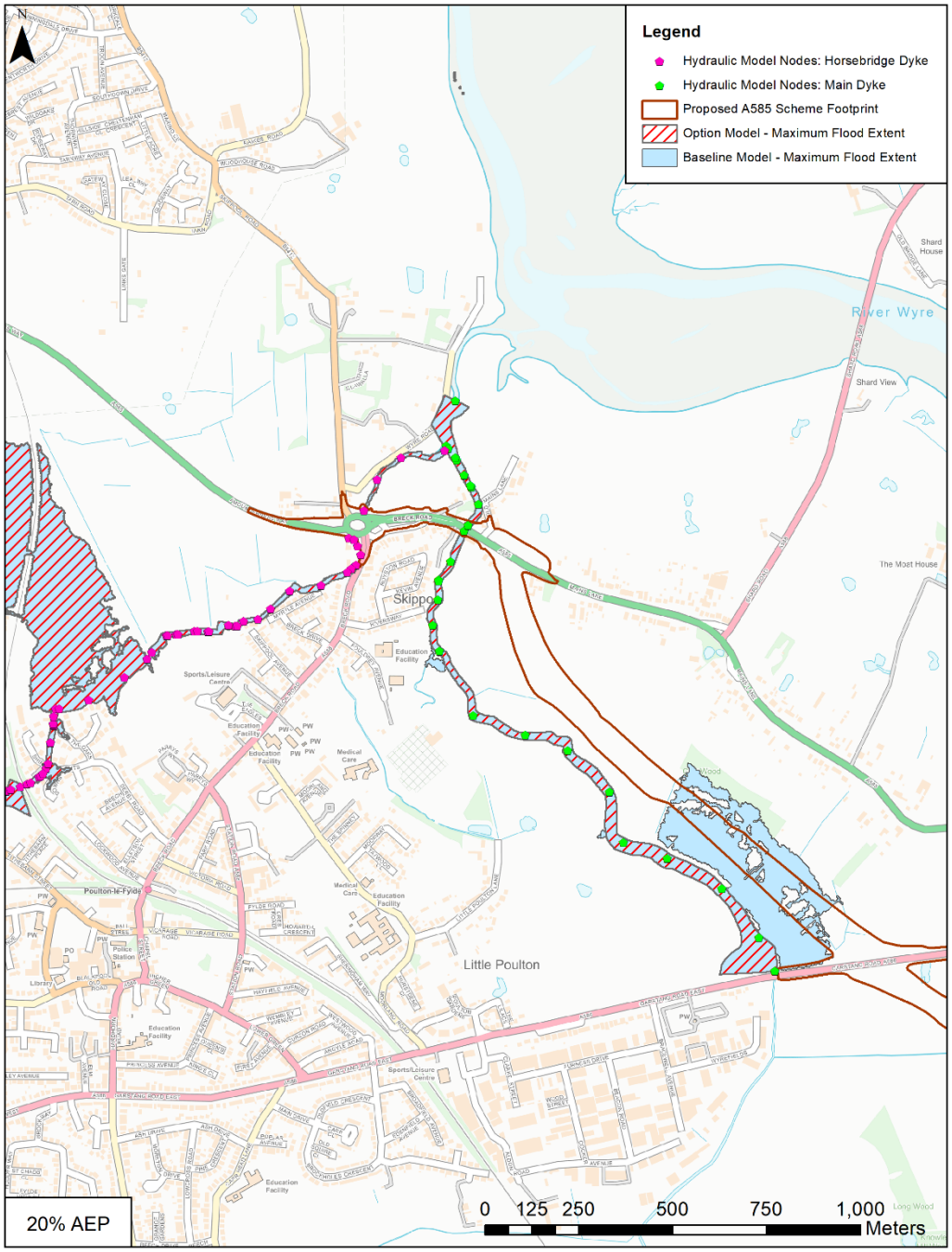


Figure D 2 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 20% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

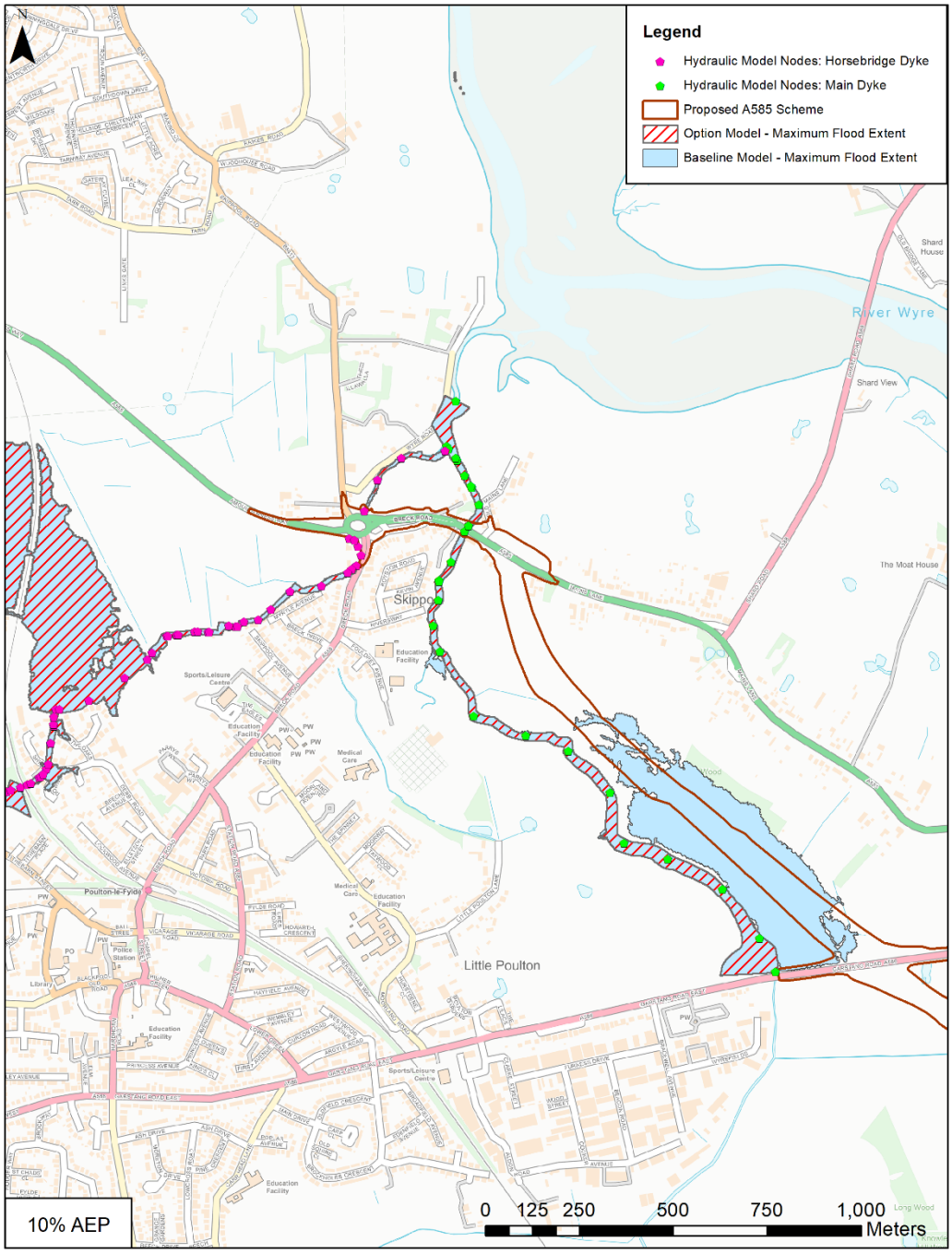


Figure D 3 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 10% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

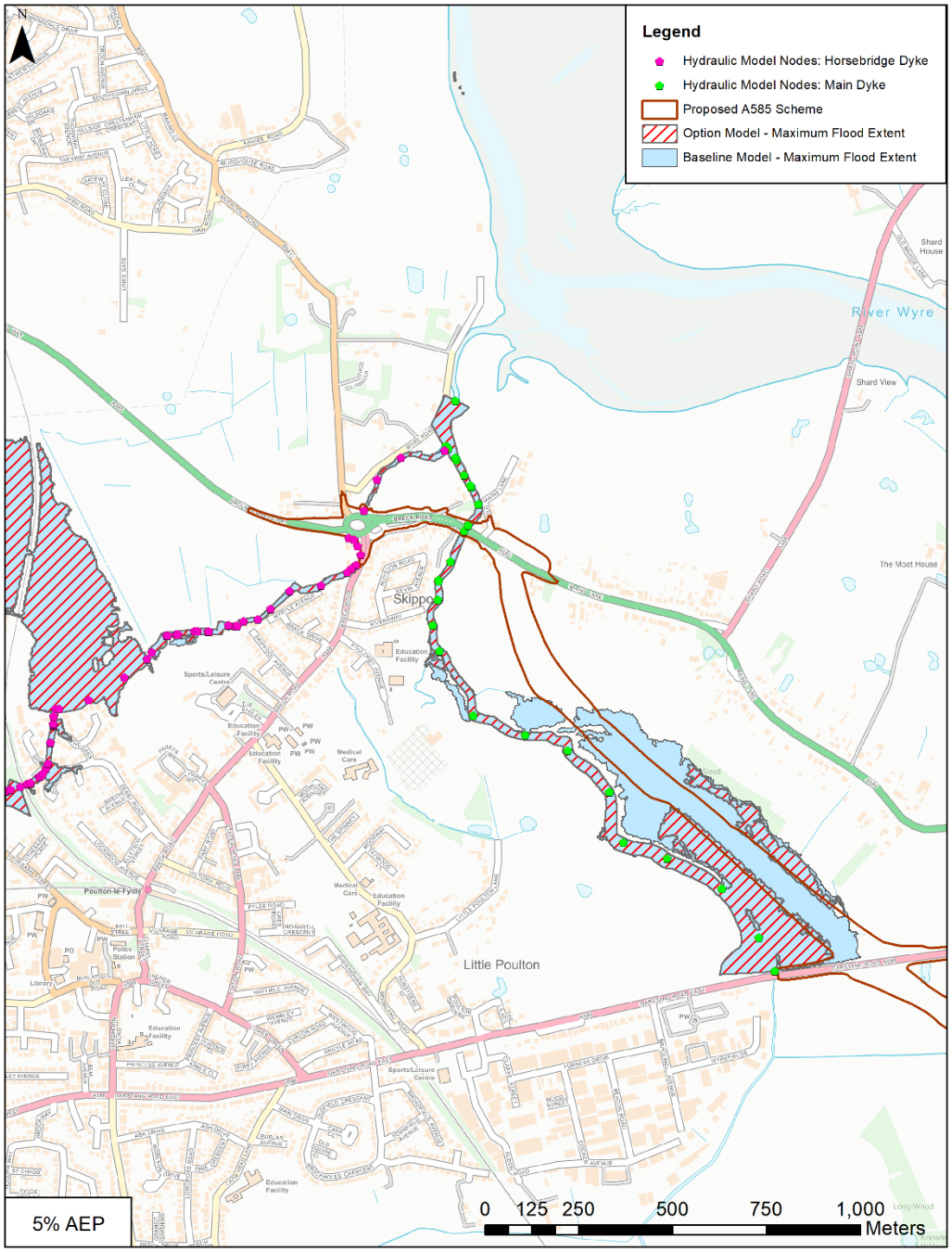


Figure D 4 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 5% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

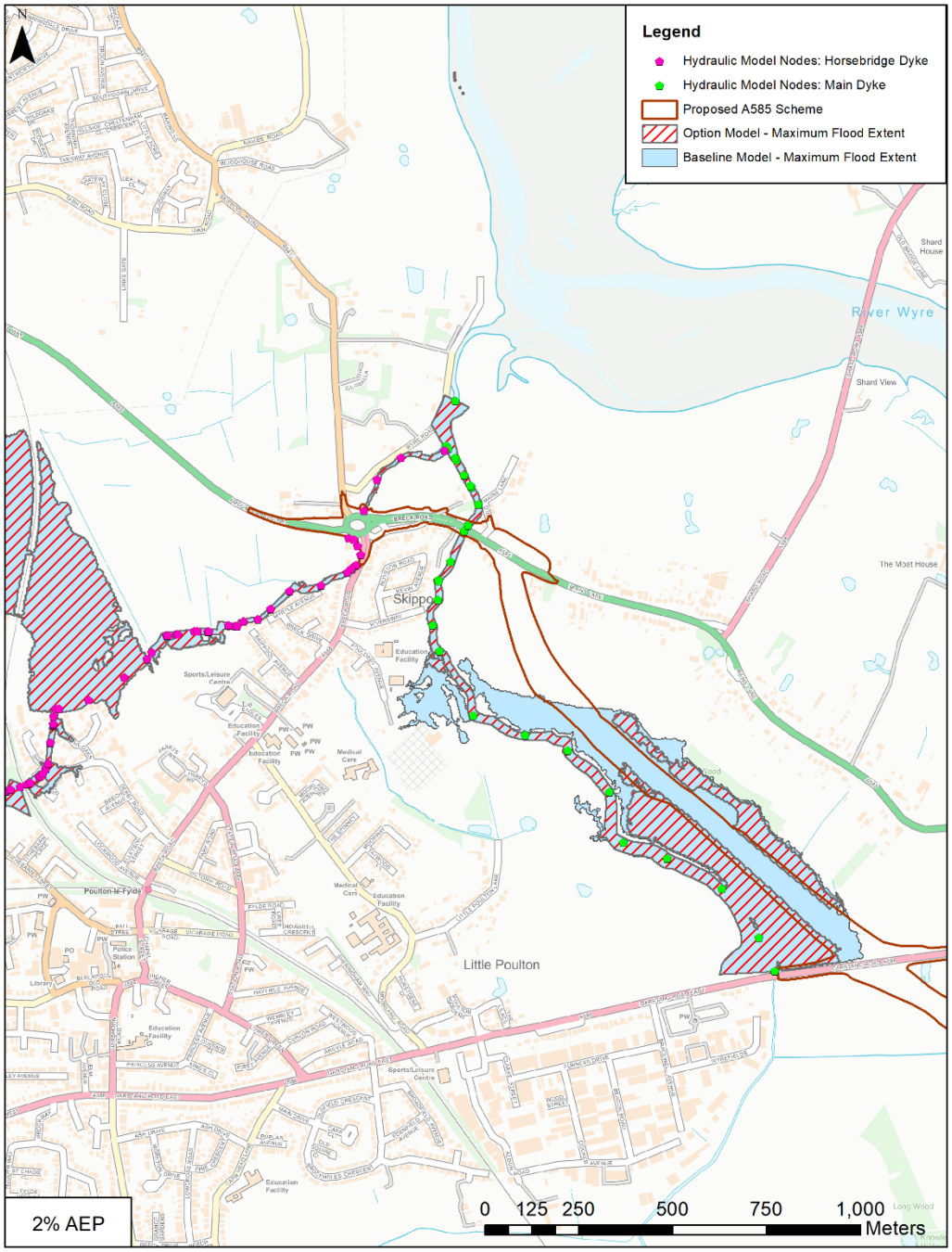


Figure D 5 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 2% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

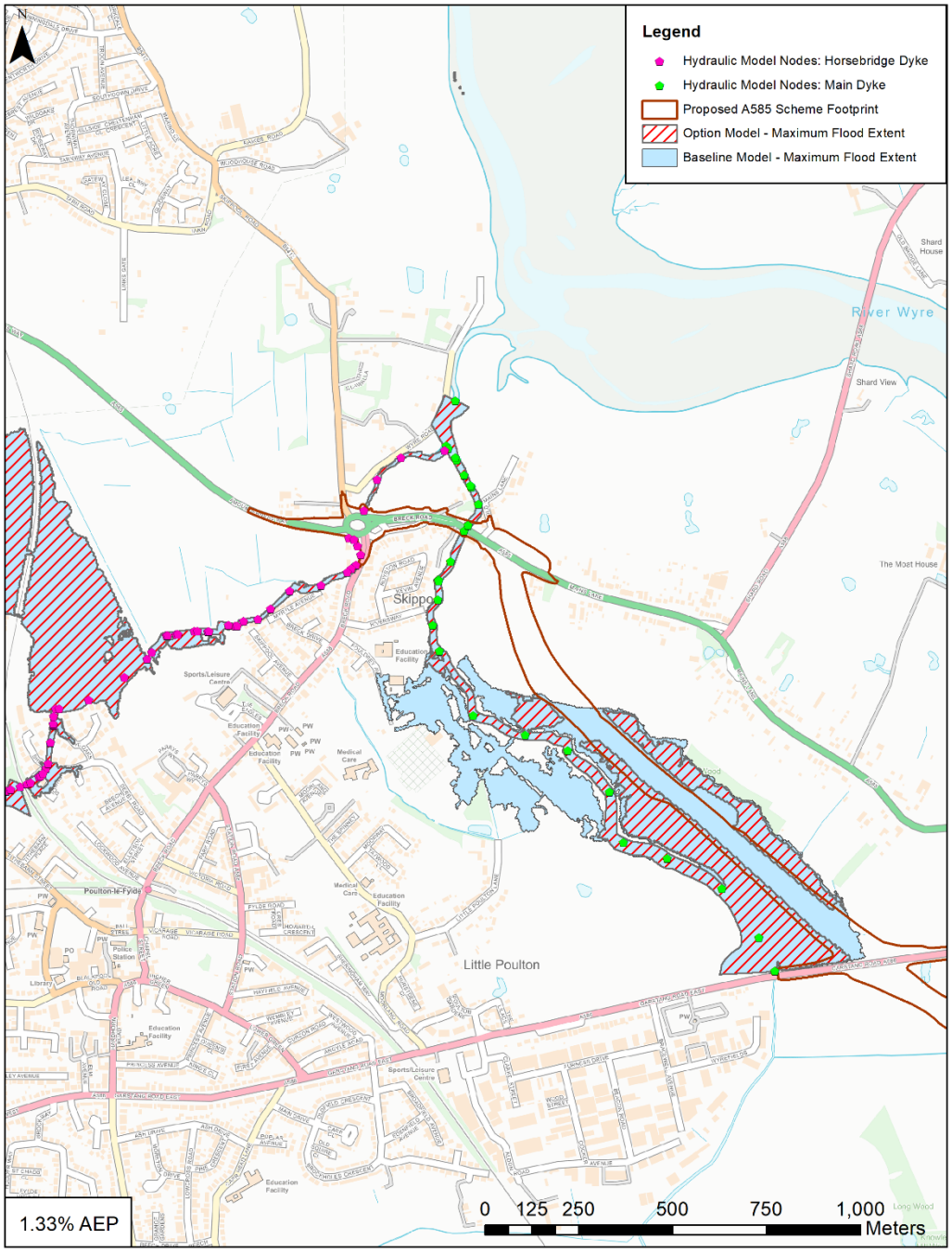


Figure D 6 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 1.33% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

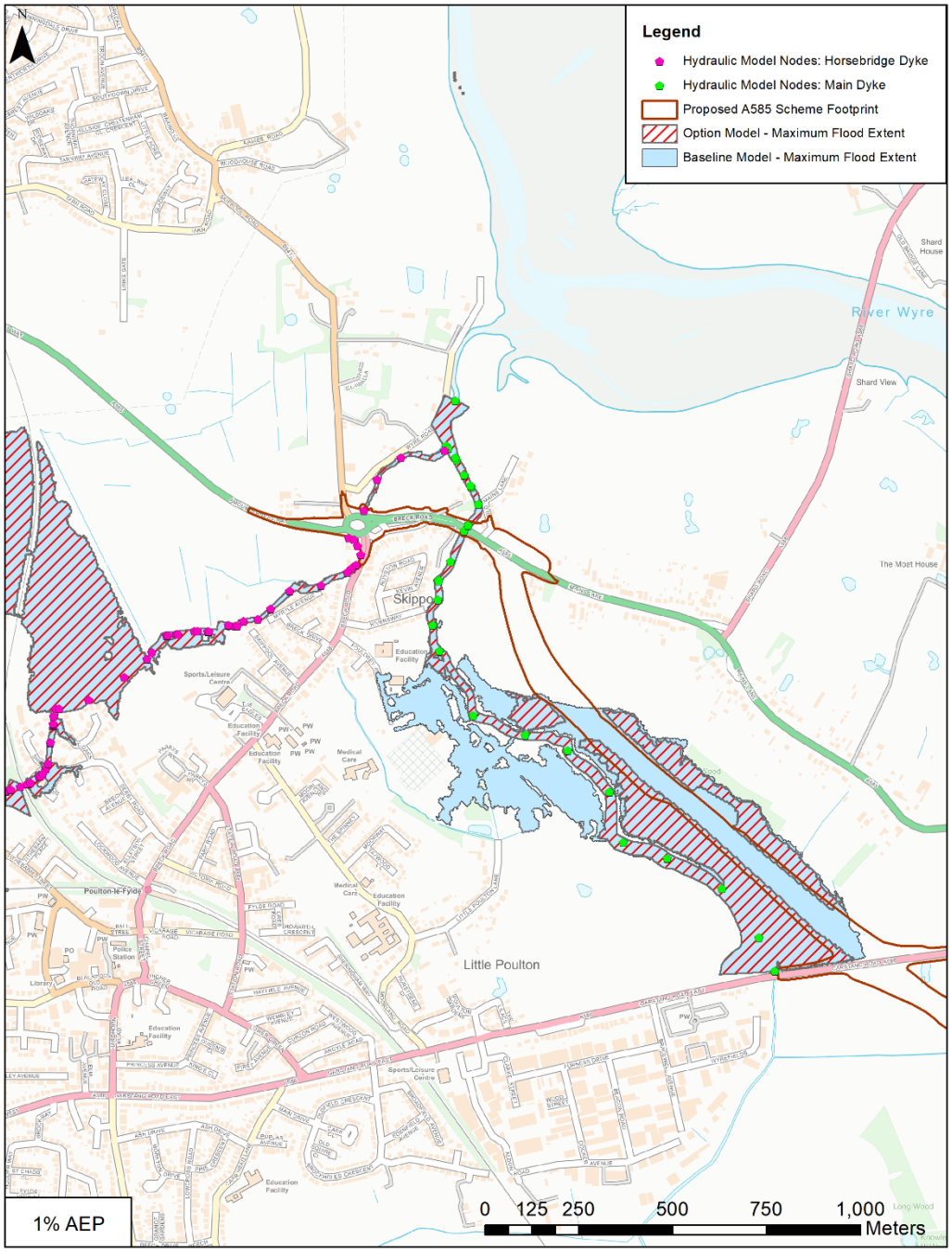


Figure D 7 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 1% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

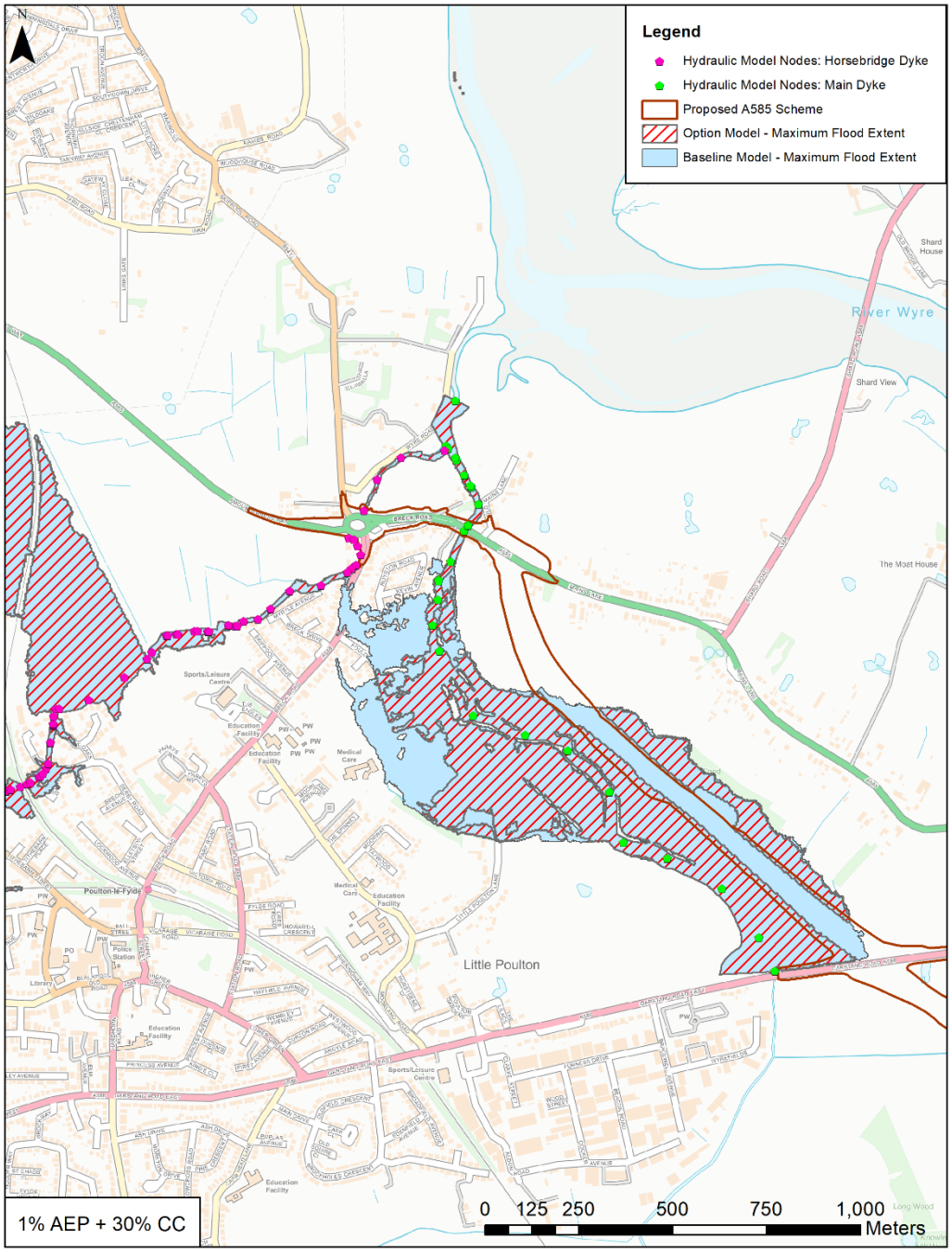


Figure D 8 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 1% AEP (+30% Climate Change) flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

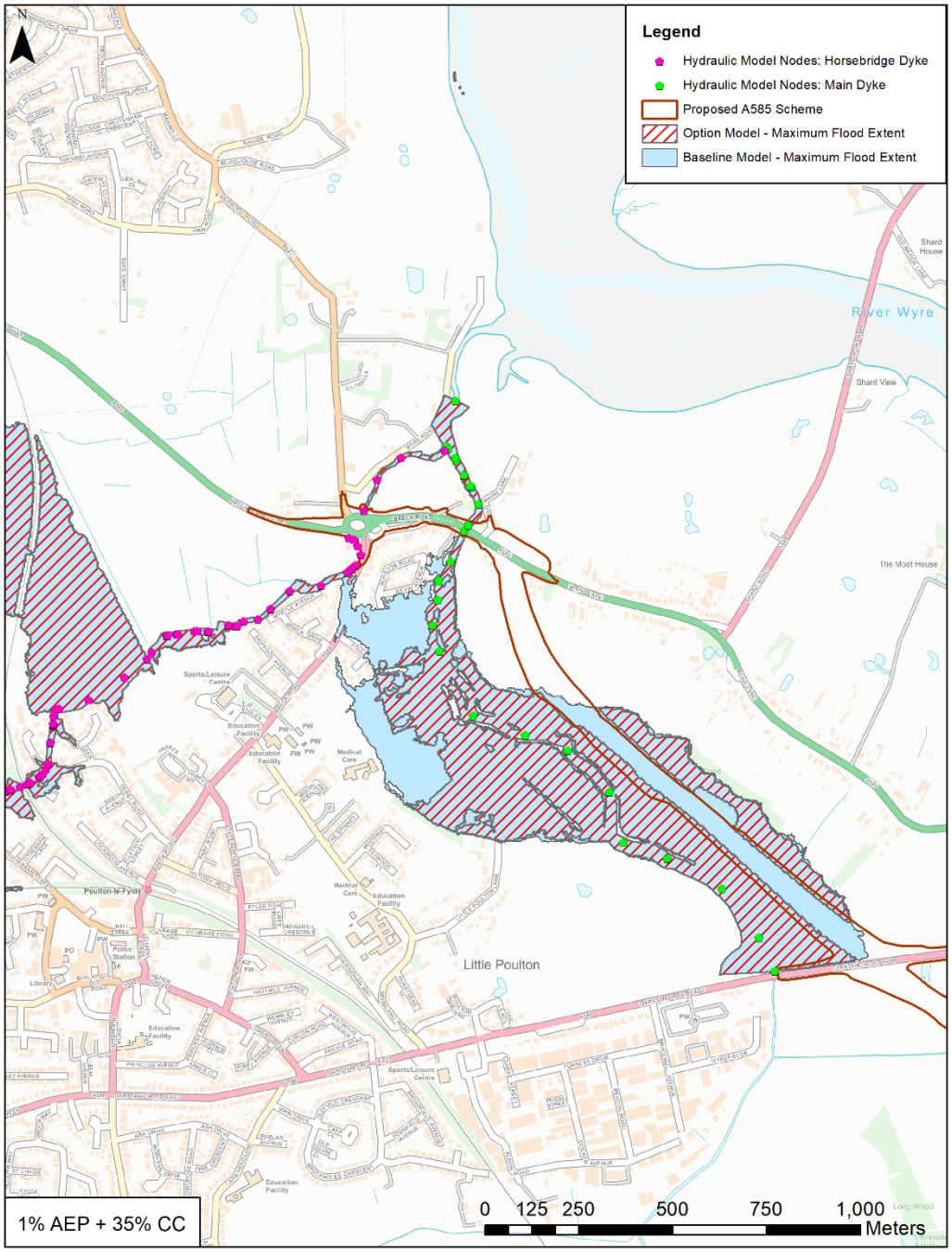


Figure D 9 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 1% AEP (+35% Climate Change) flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

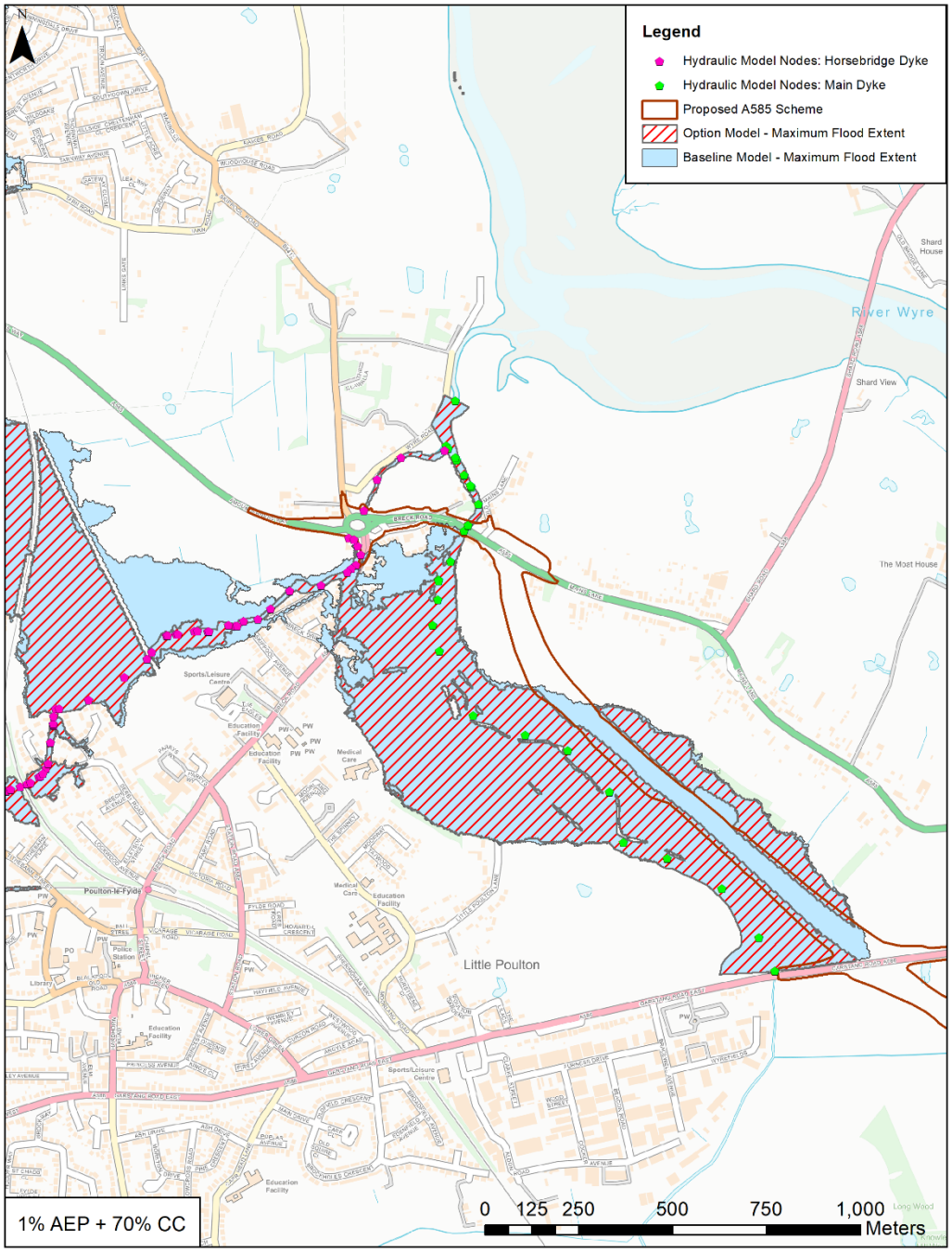


Figure D 10 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 1% AEP (+70% Climate Change) flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

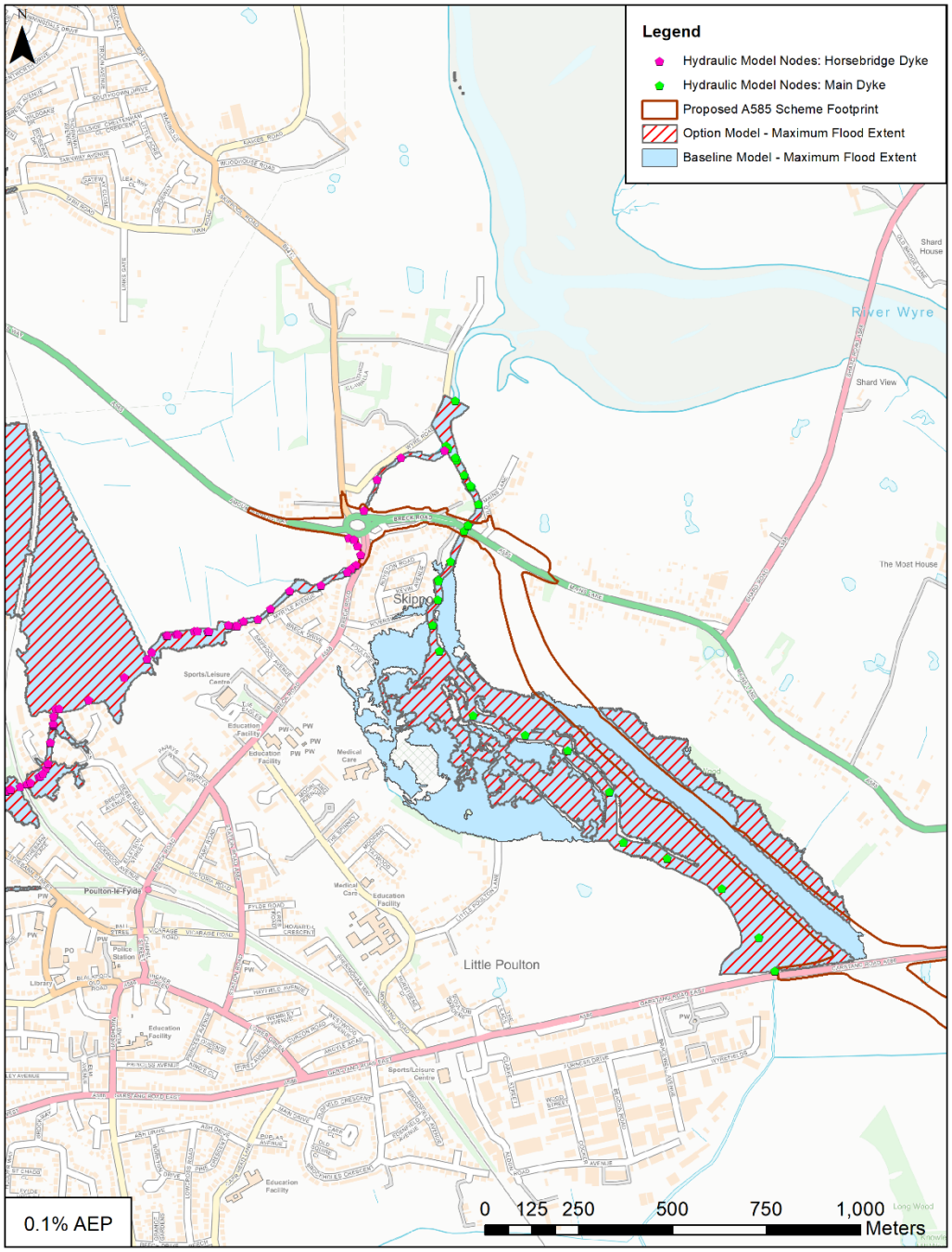


Figure D 11 - Maximum flood extents [Baseline and 'With Scheme' (Option)] for the 0.1% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

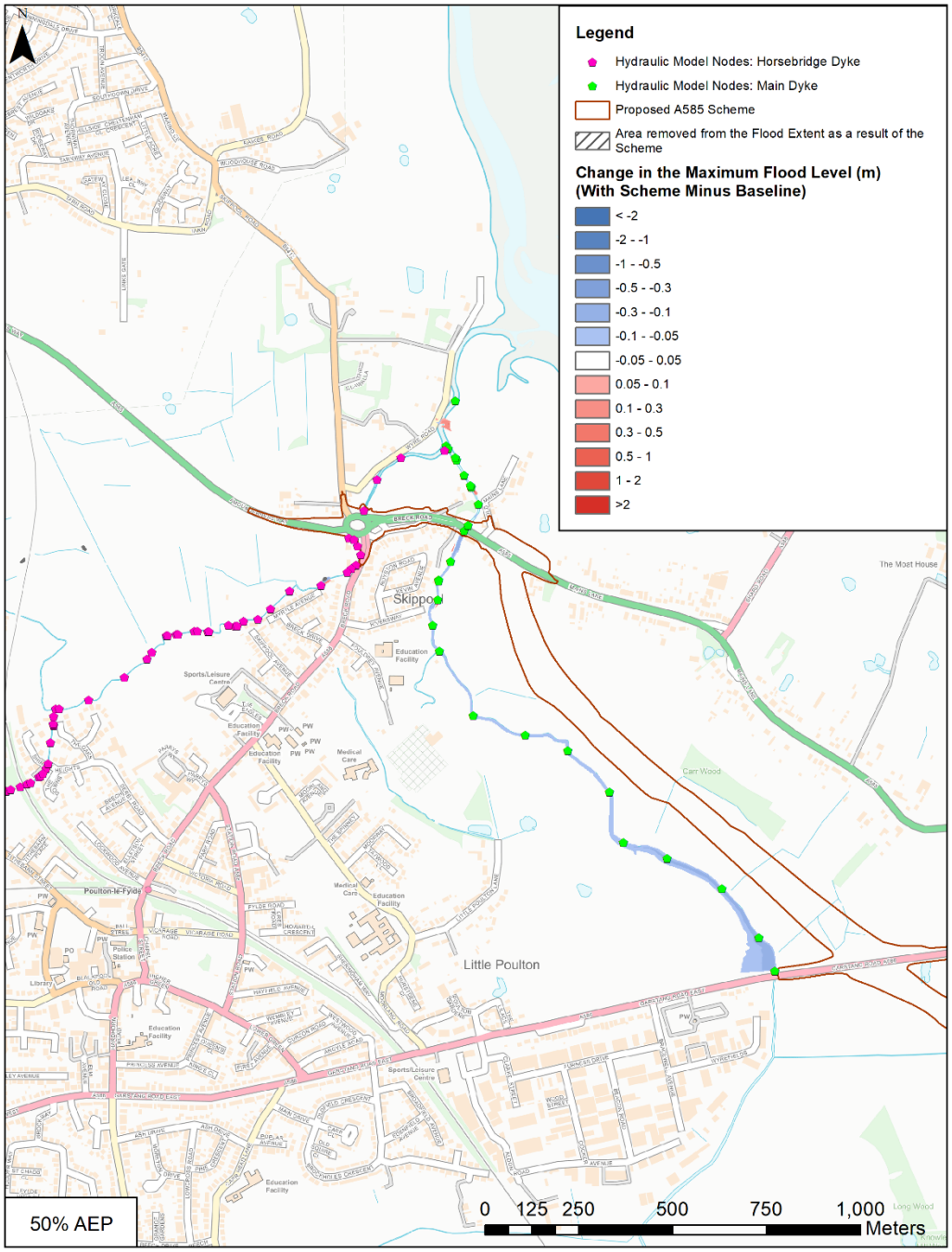


Figure D 12 - Maximum flood depth difference [Scheme – Baseline] for the 50% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017)

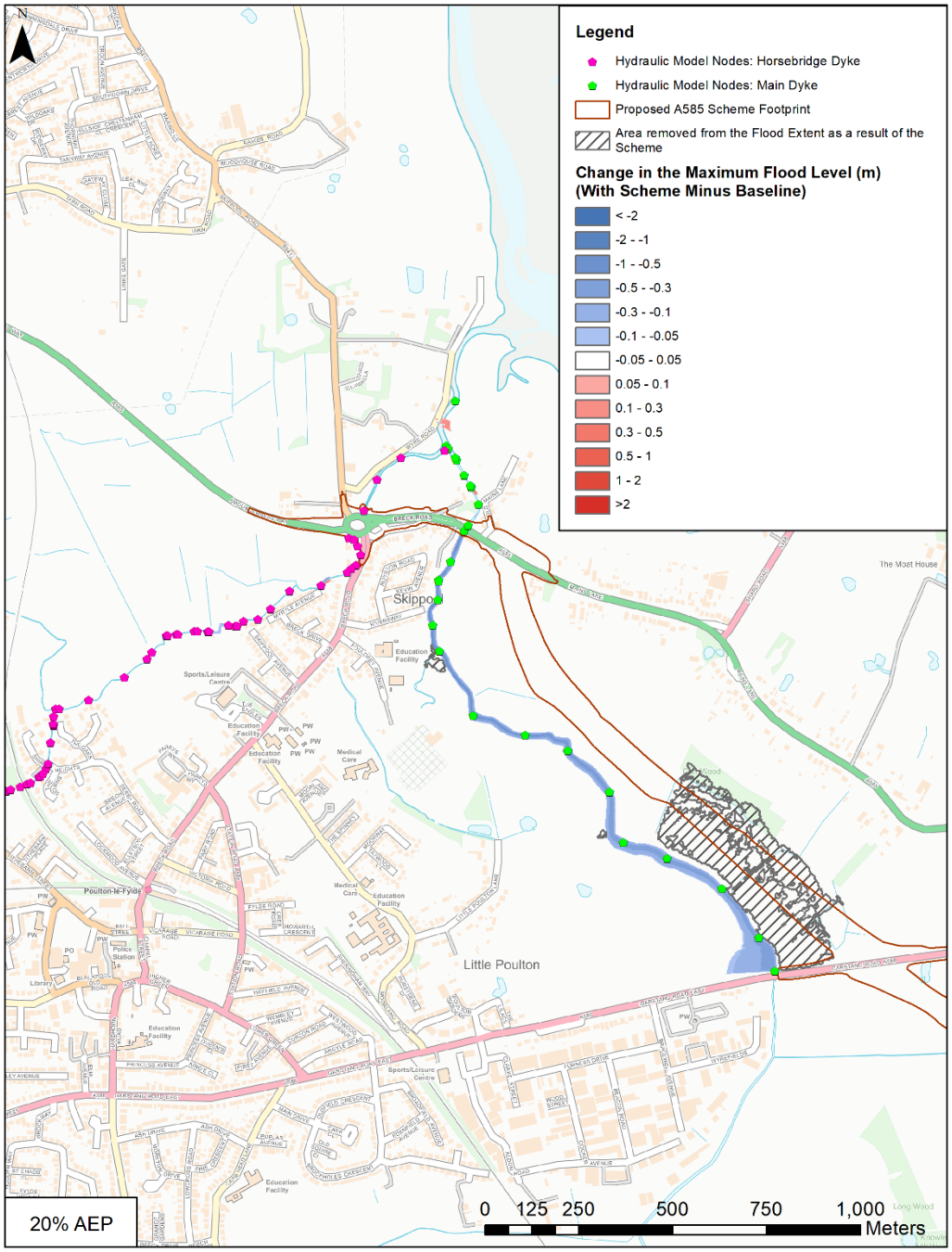


Figure D 13 - Maximum flood depth difference [Scheme - Baseline] for the 20% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017)

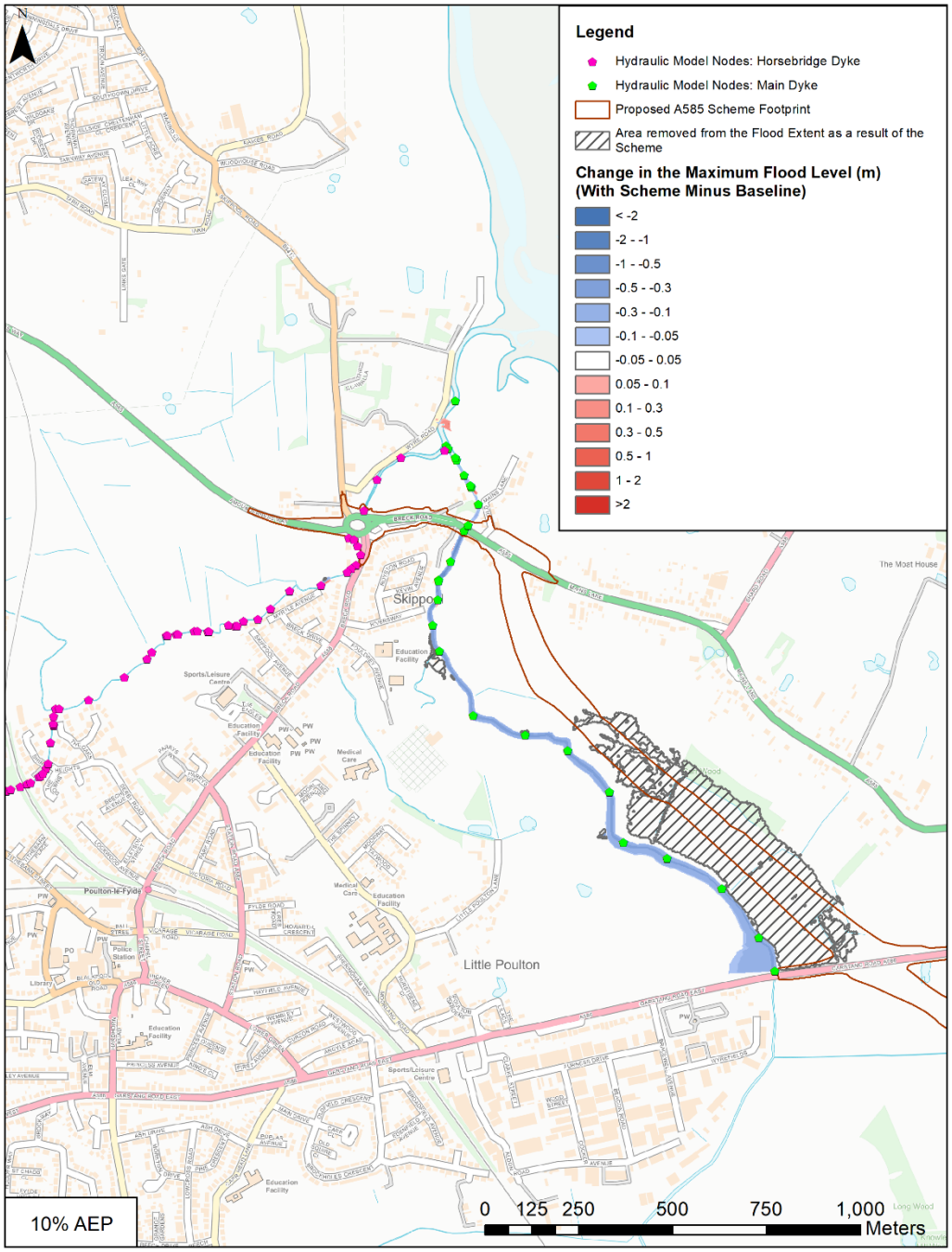


Figure D 14 - Maximum flood depth difference [Scheme - Baseline] for the 10% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017)

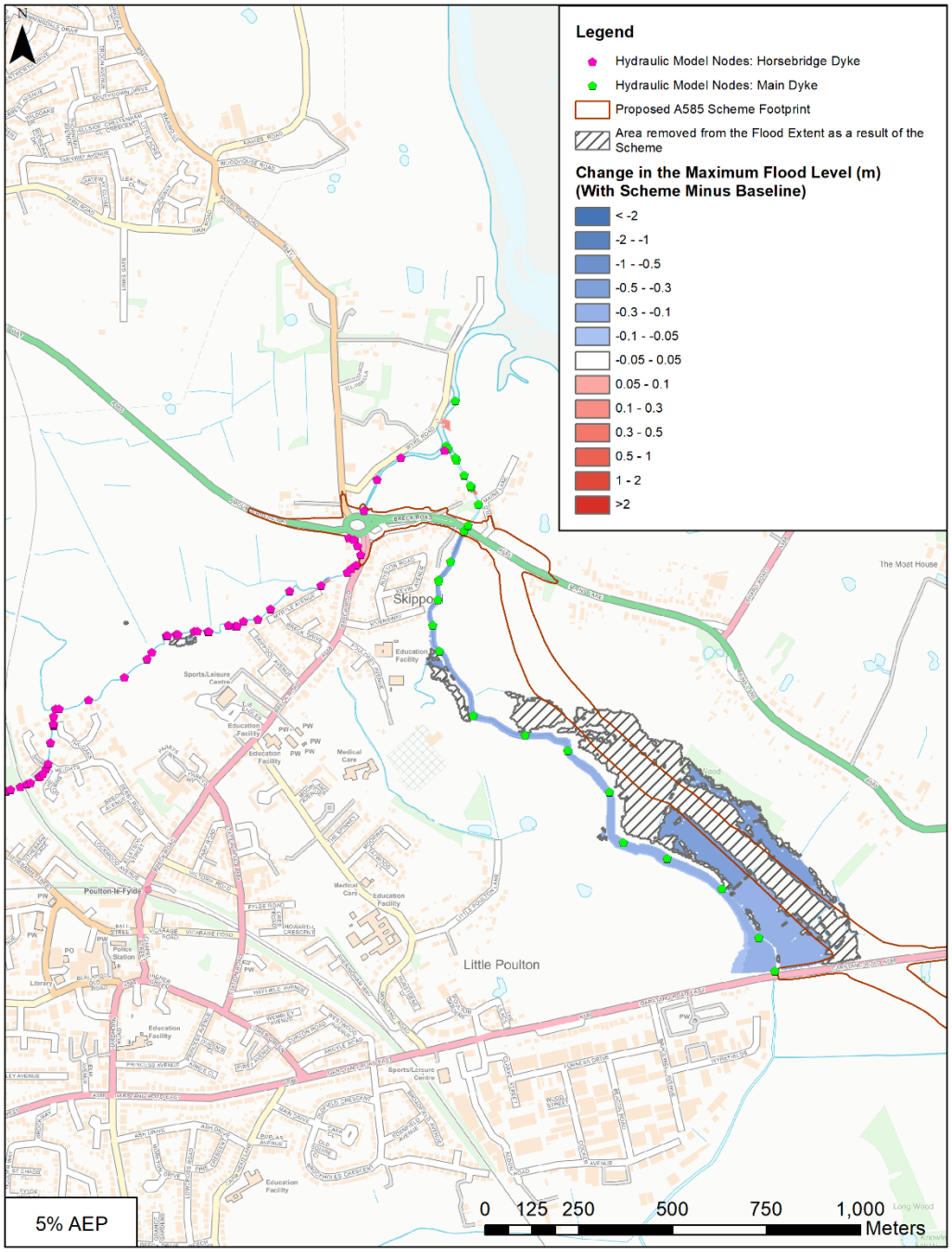


Figure D 15 - Maximum flood depth difference [Scheme - Baseline] for the 5% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017)

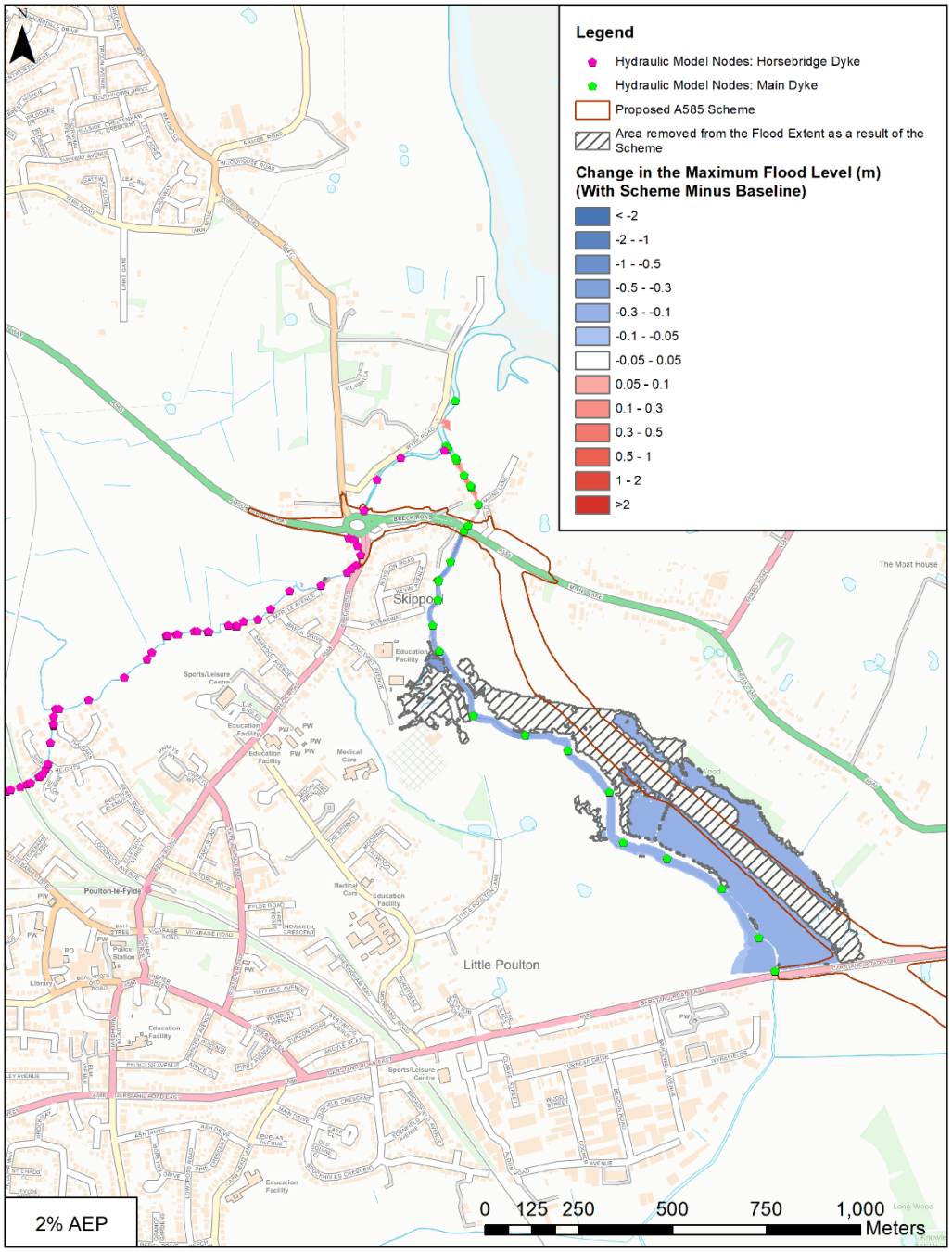


Figure D 16 - Maximum flood depth difference [Scheme - Baseline] for the 2% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017)

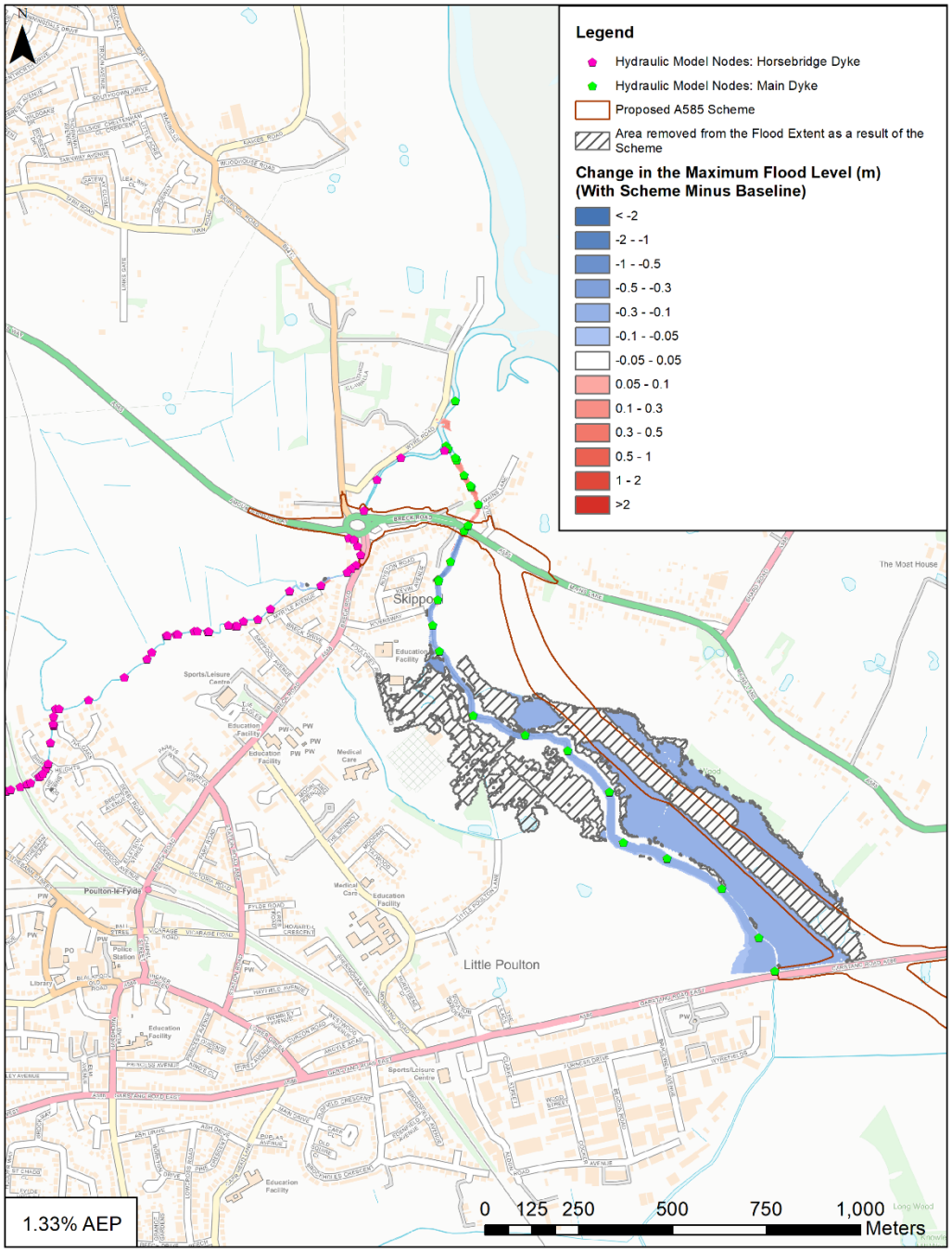


Figure D 17 - Maximum flood depth difference [Scheme - Baseline] for the 1.33% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017)

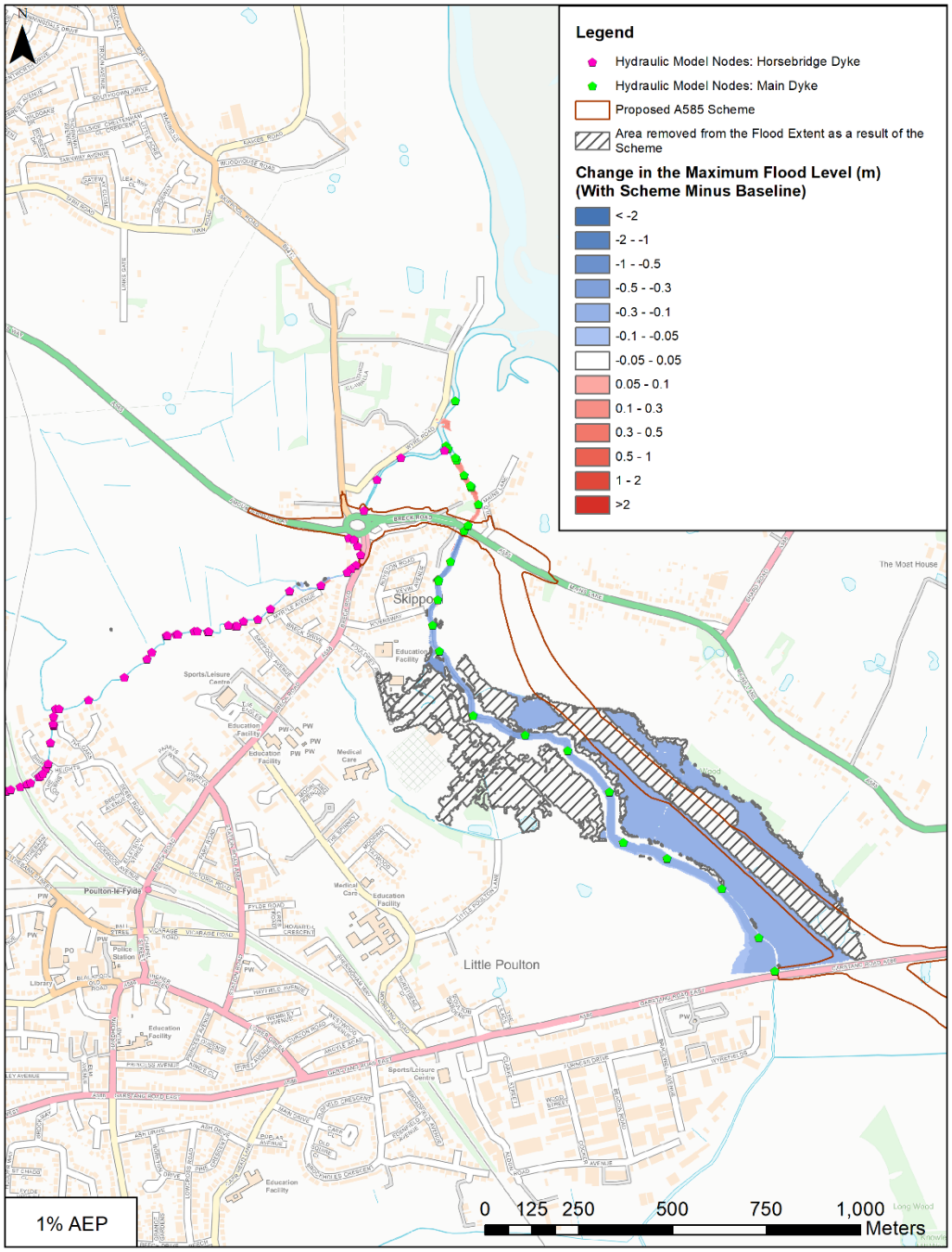


Figure D 18 - Maximum flood depth difference [Scheme - Baseline] for the 1% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017)

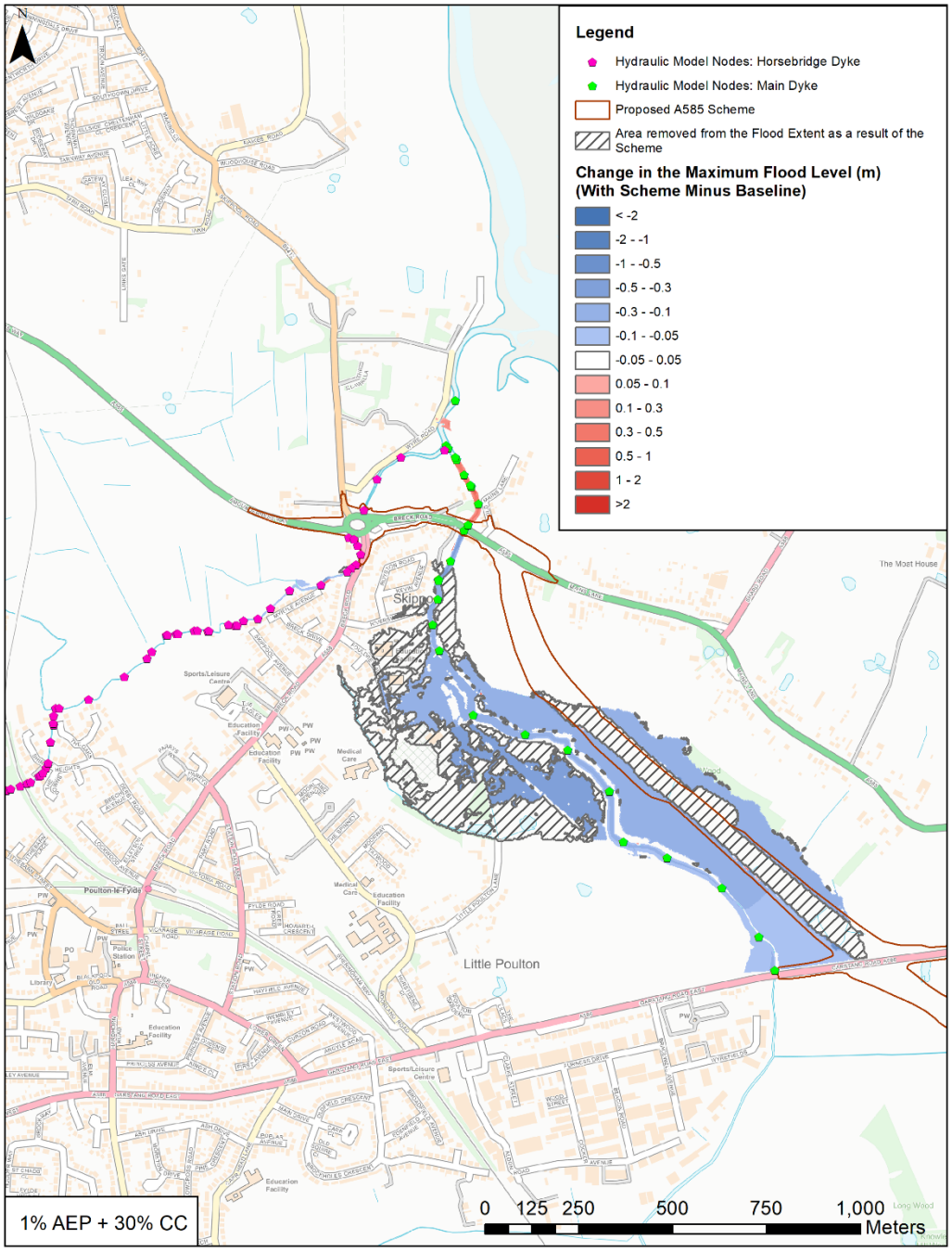


Figure D 19 - Maximum flood depth difference [Scheme - Baseline] for the 1% AEP (+30% Climate Change) flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017)

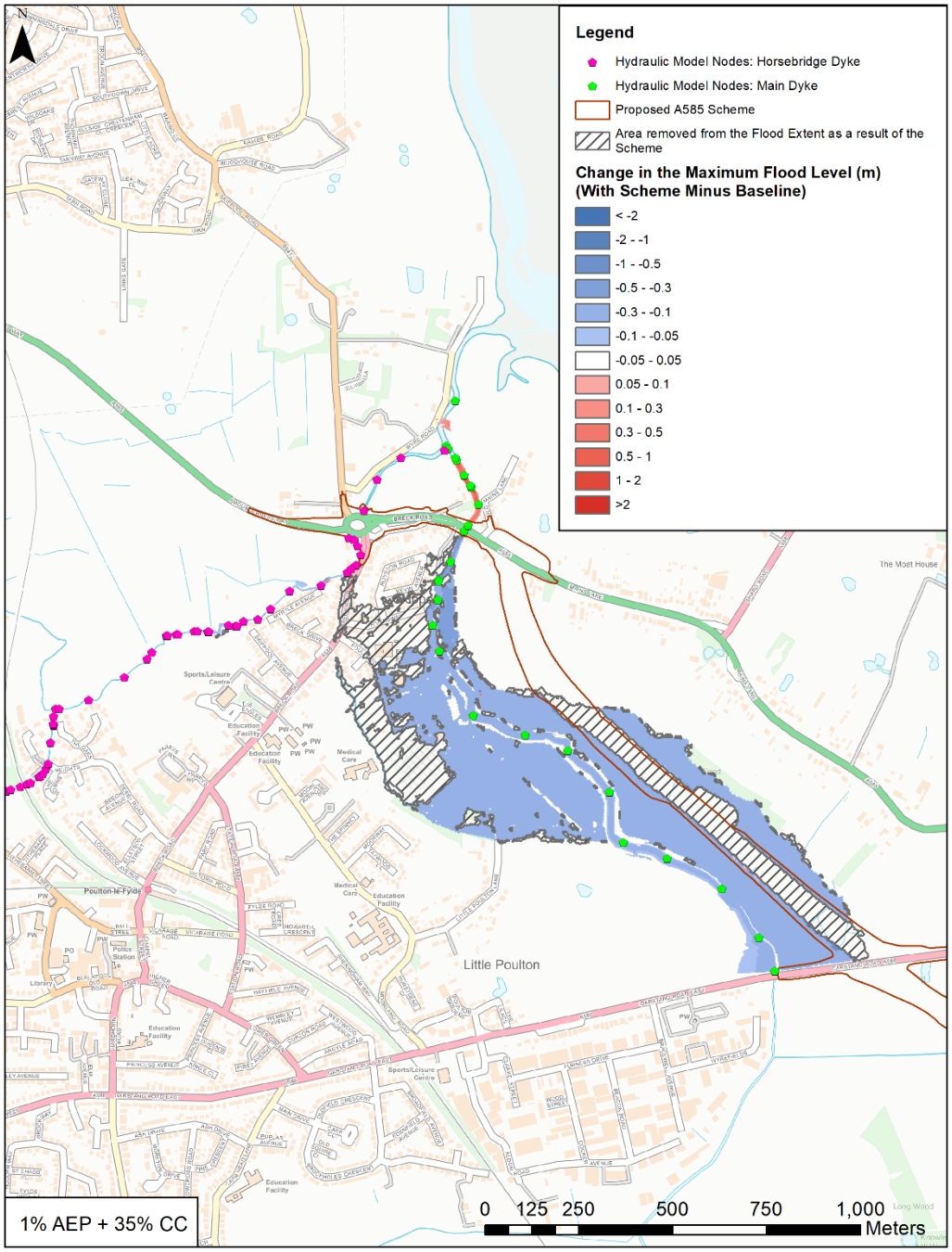


Figure D 20 - Maximum flood depth difference [Scheme - Baseline] for the 1% AEP (+35% Climate Change) flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017)

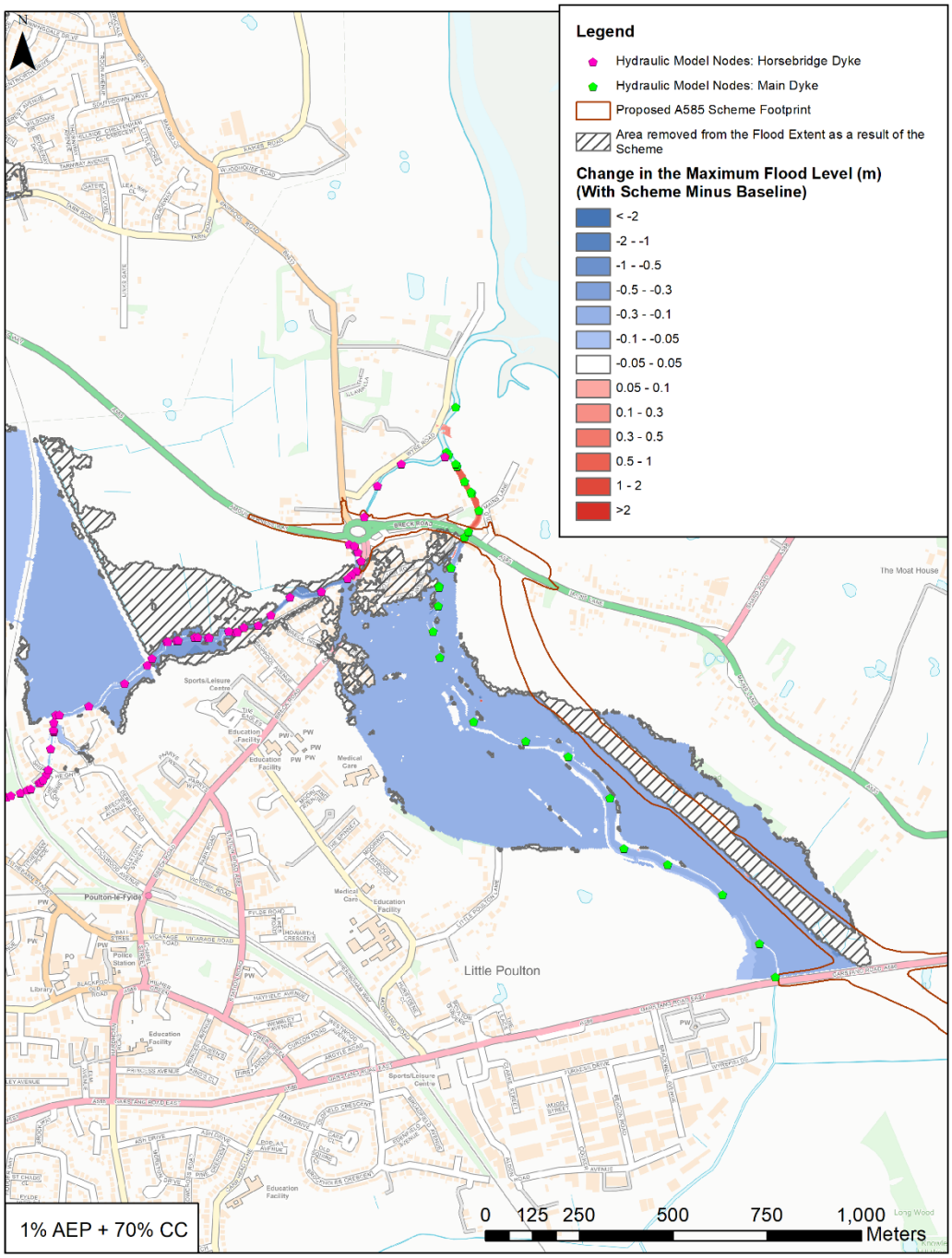


Figure D 21 - Maximum flood depth difference [Scheme - Baseline] for the 1% AEP (+70% Climate Change) flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017)

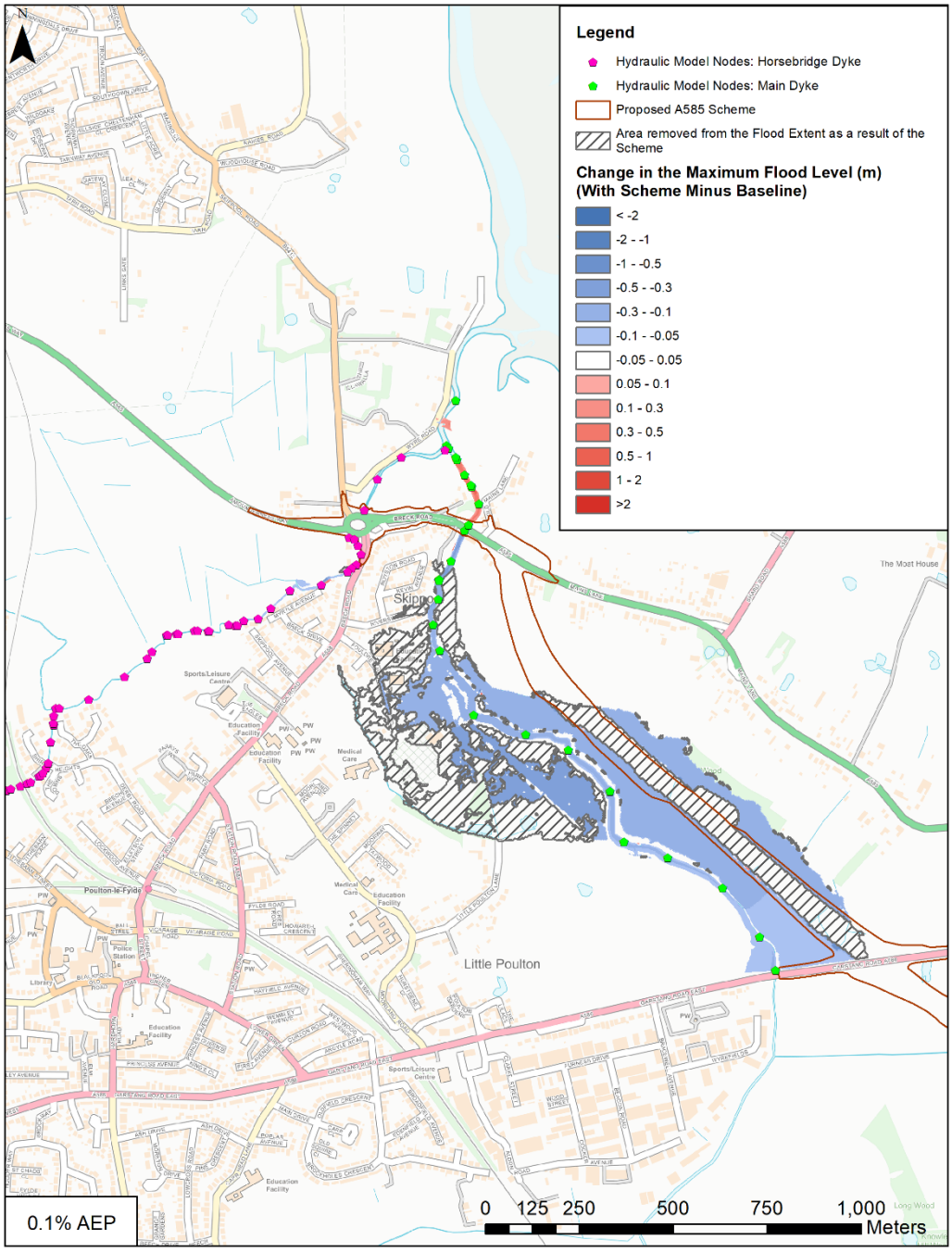


Figure D 22 - Maximum flood depth difference [Scheme - Baseline] for the 0.1% AEP flood event. Includes area removed from the flood extent as a result of the Scheme (Contains Ordnance Survey data © Crown copyright and database right 2017)

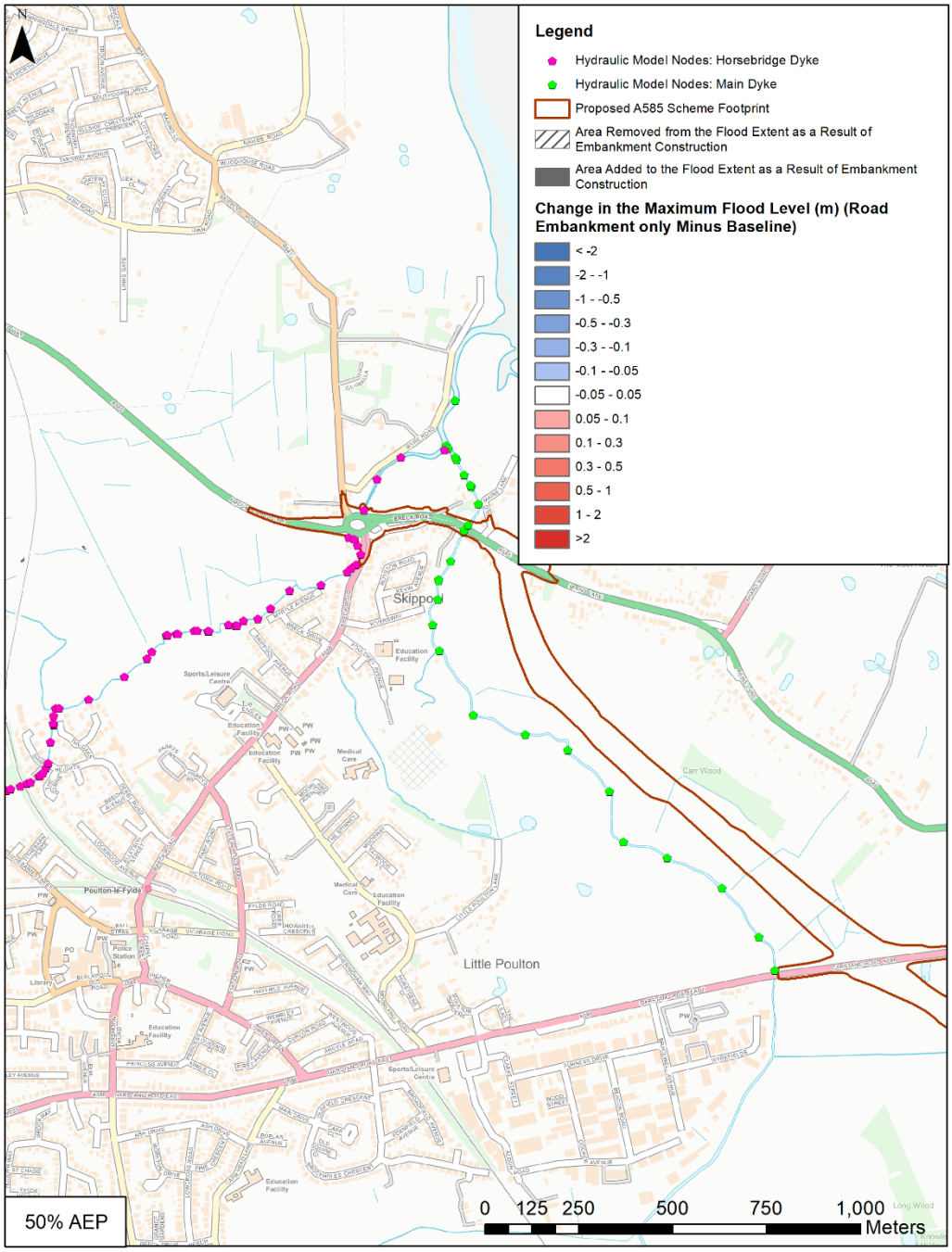


Figure D 23 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 50% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017)

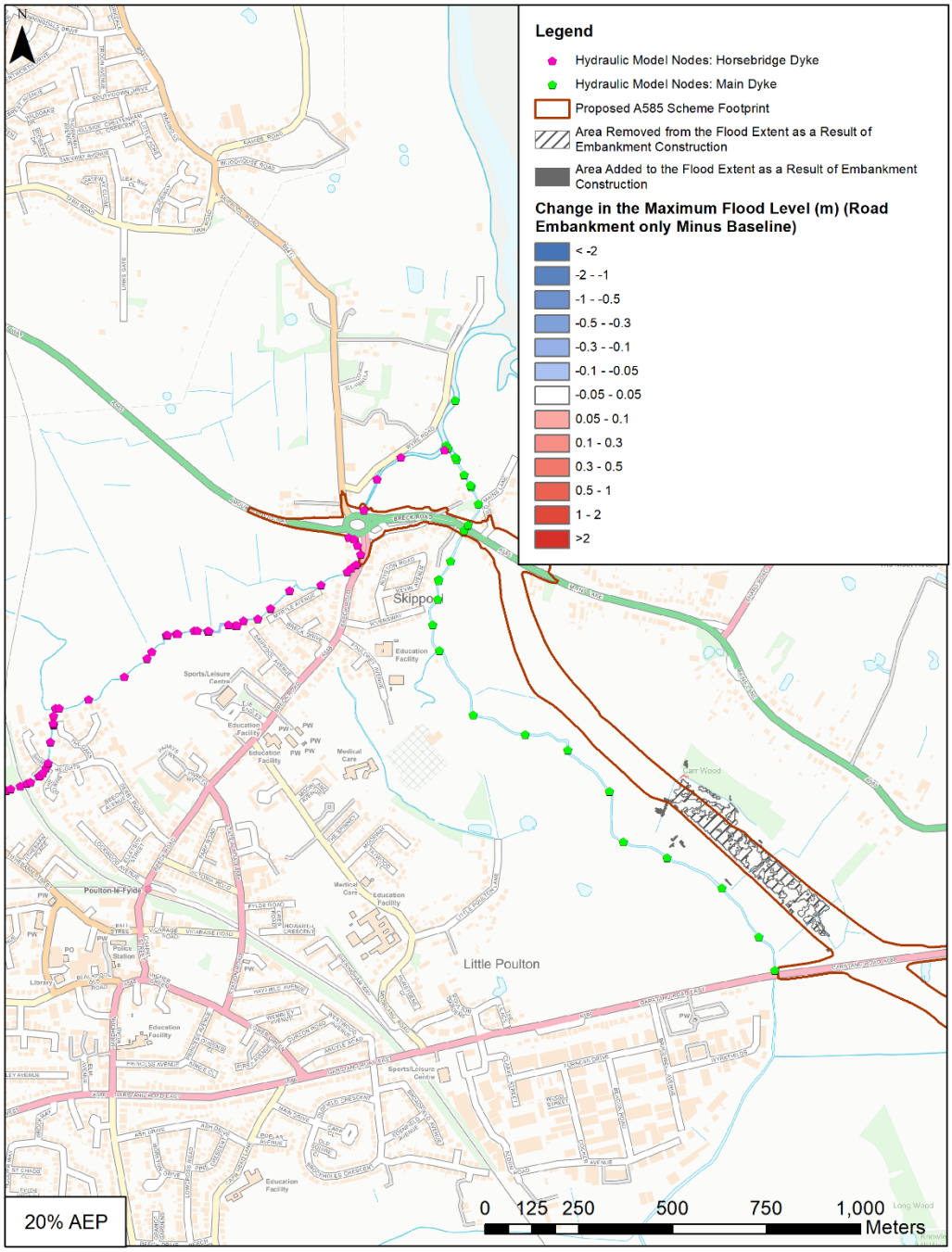


Figure D 24 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 20% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017)

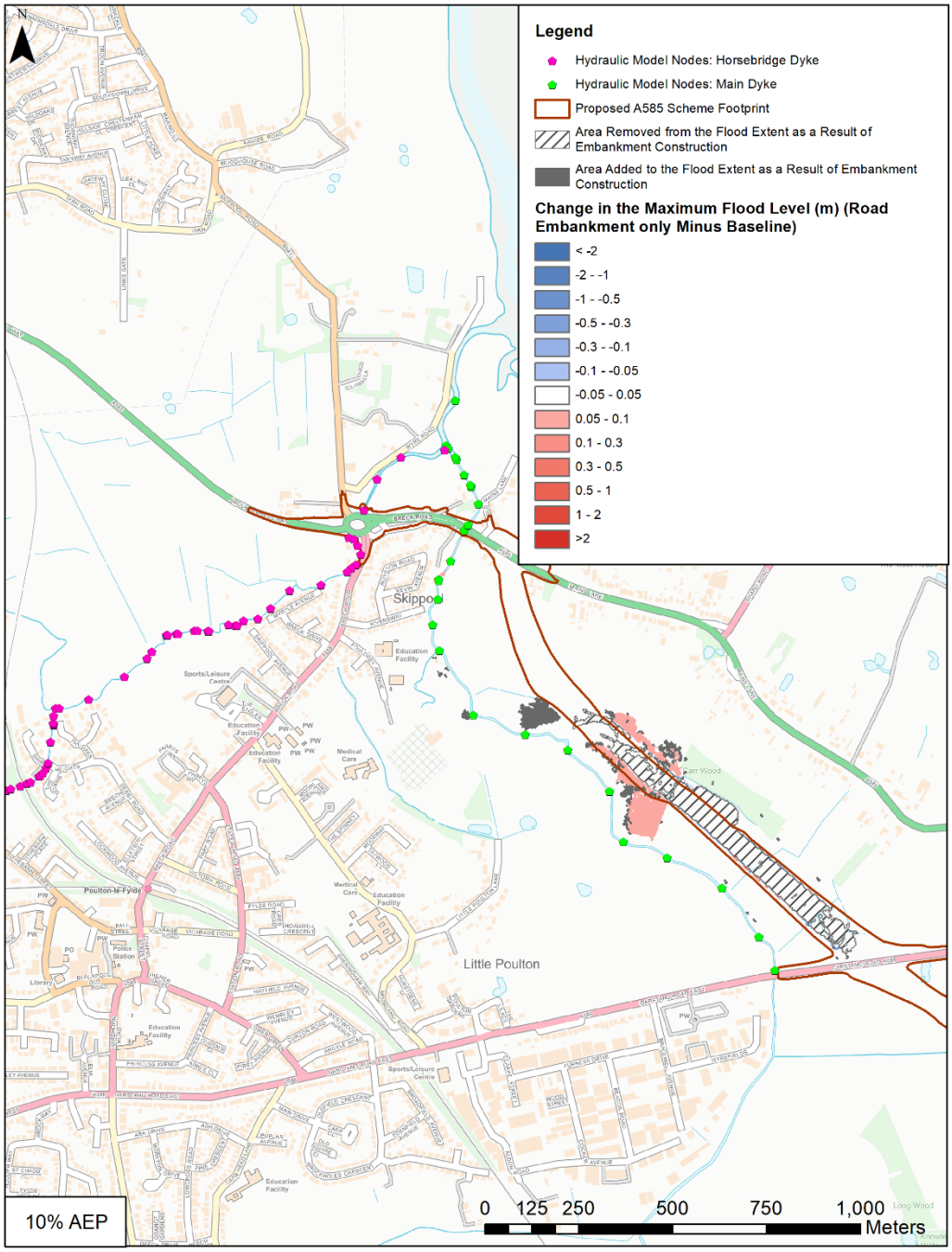


Figure D 25 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 10% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017)

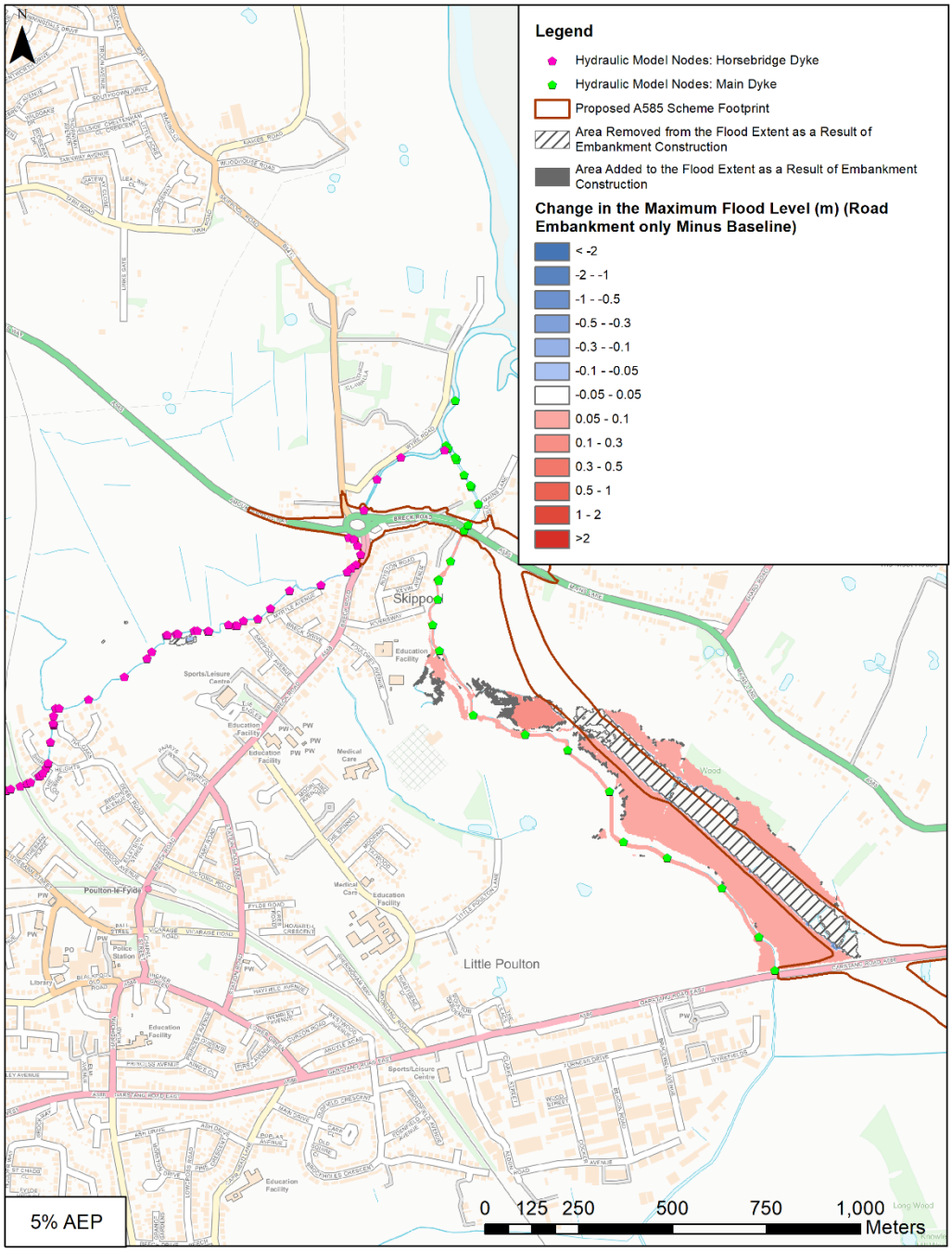


Figure D 26 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 5% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017)

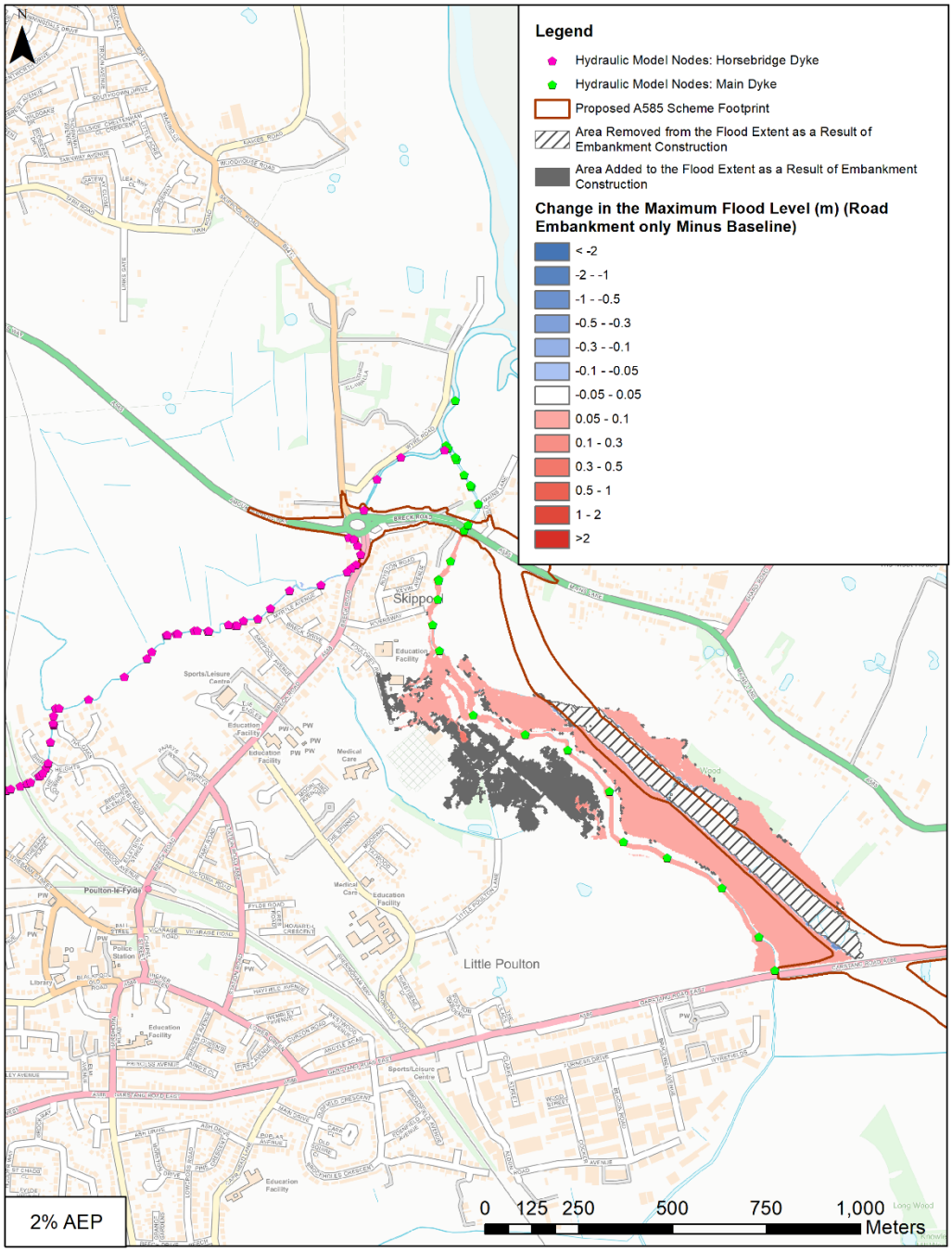


Figure D 27 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 2% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017)

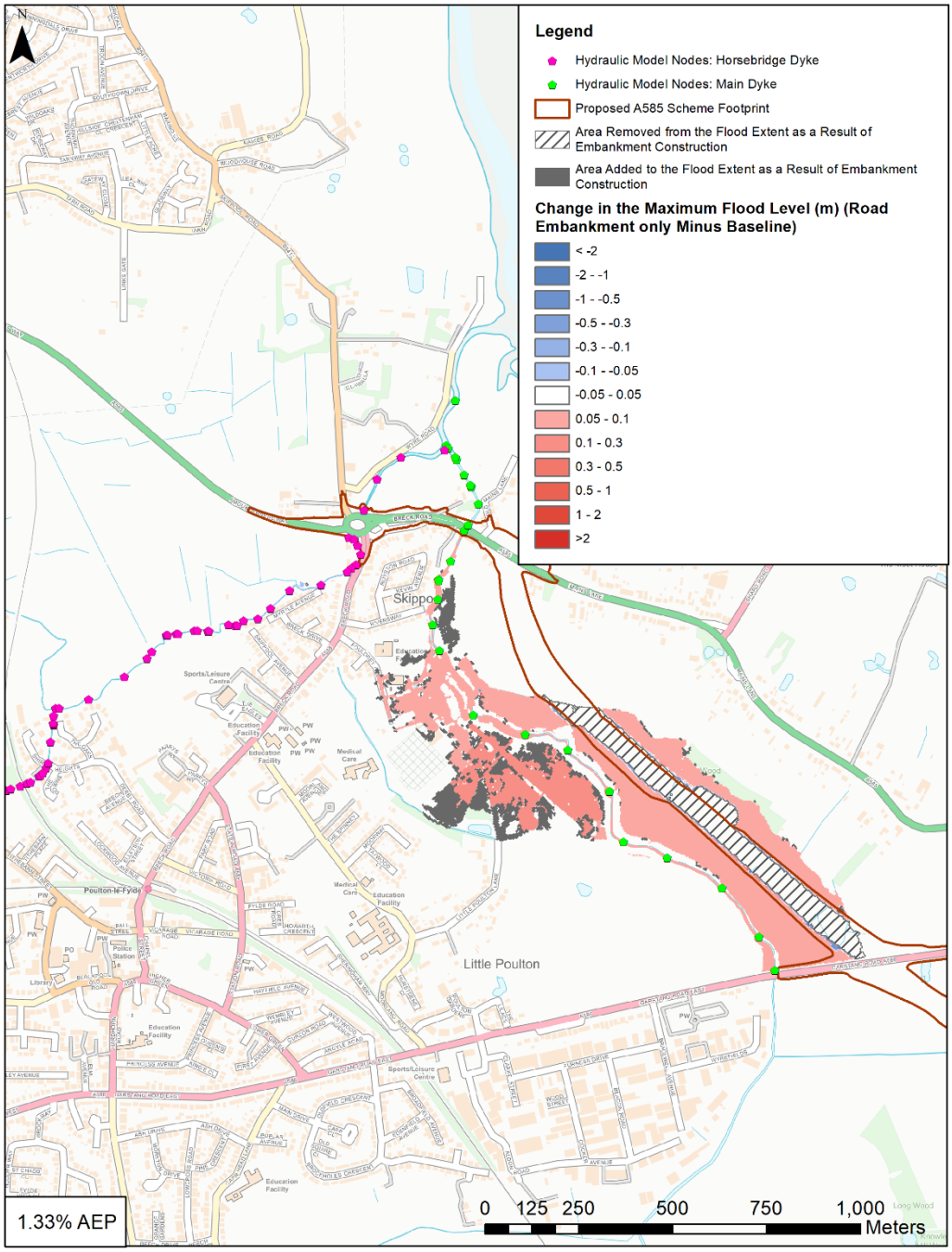


Figure D 28 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 1.33% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017)

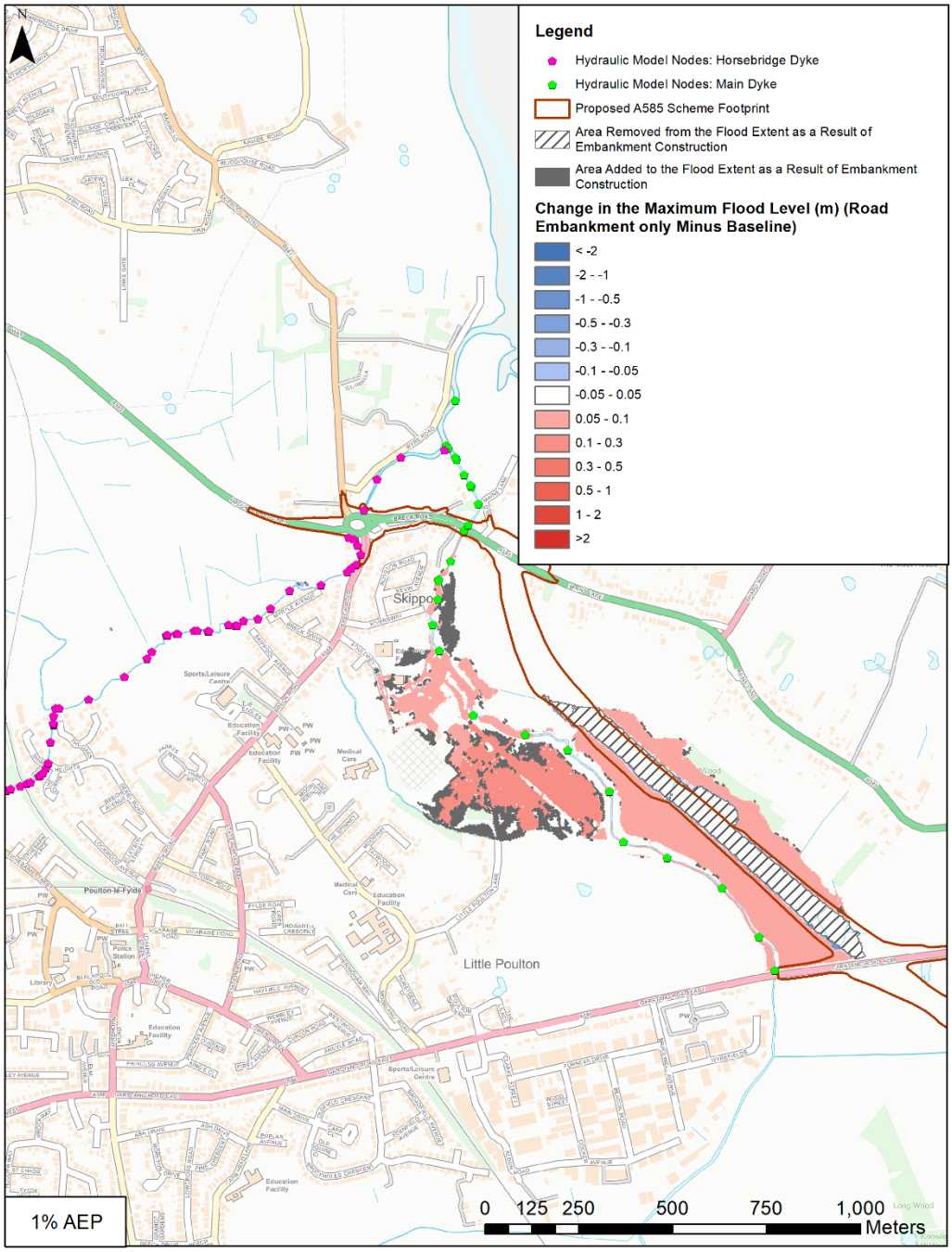


Figure D 29 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 1% AEP flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017)

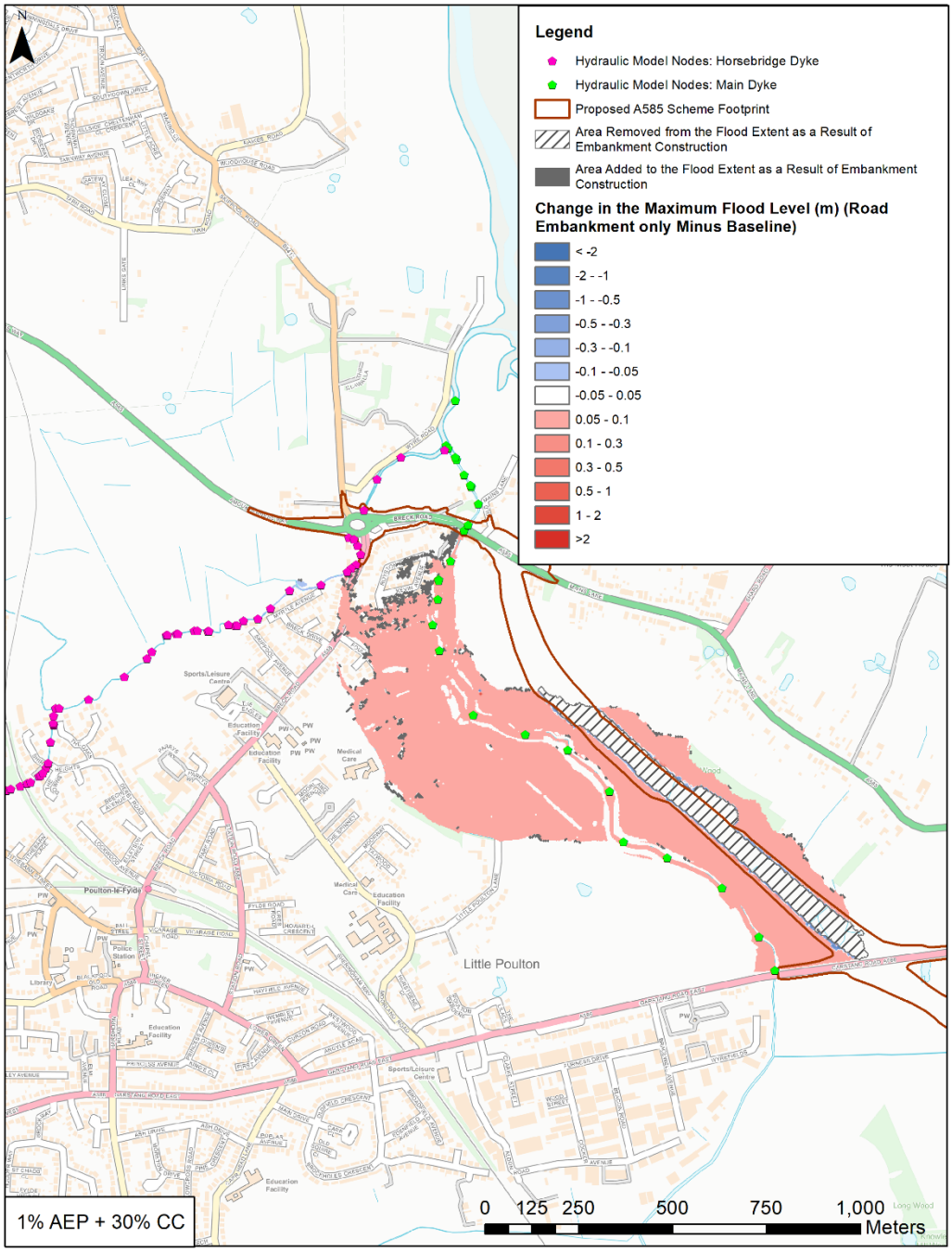


Figure D 30 - Maximum flood depth difference [Scheme with embankment only and no widening of the A585 Main Dyke crossing - Baseline] for the 1% AEP (+30% Climate Change) flood event. Includes areas removed from and added to the flood extent as a result of embankment construction. (Contains Ordnance Survey data © Crown copyright and database right 2017)

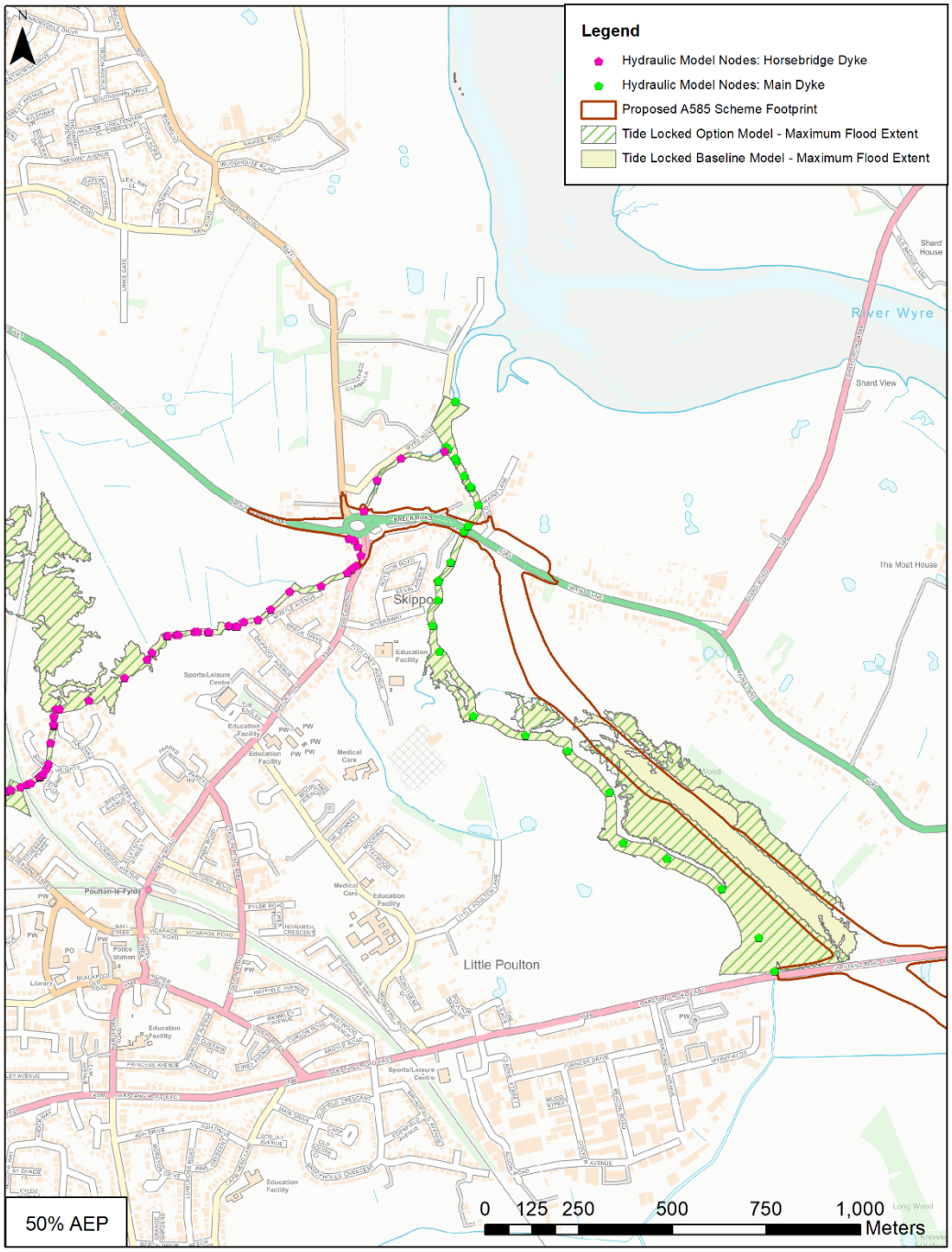


Figure D 31 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 50% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

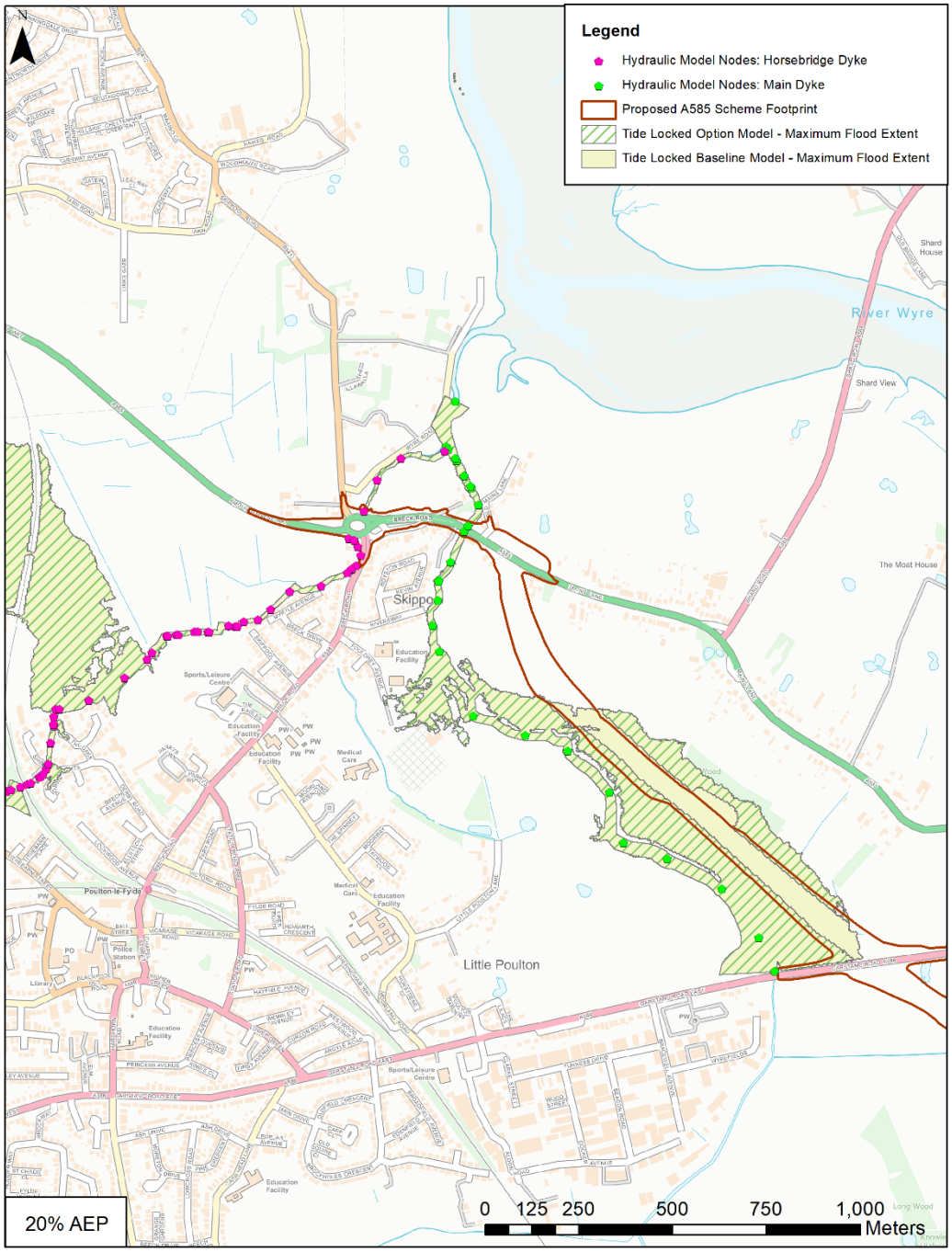


Figure D 32 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 20% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

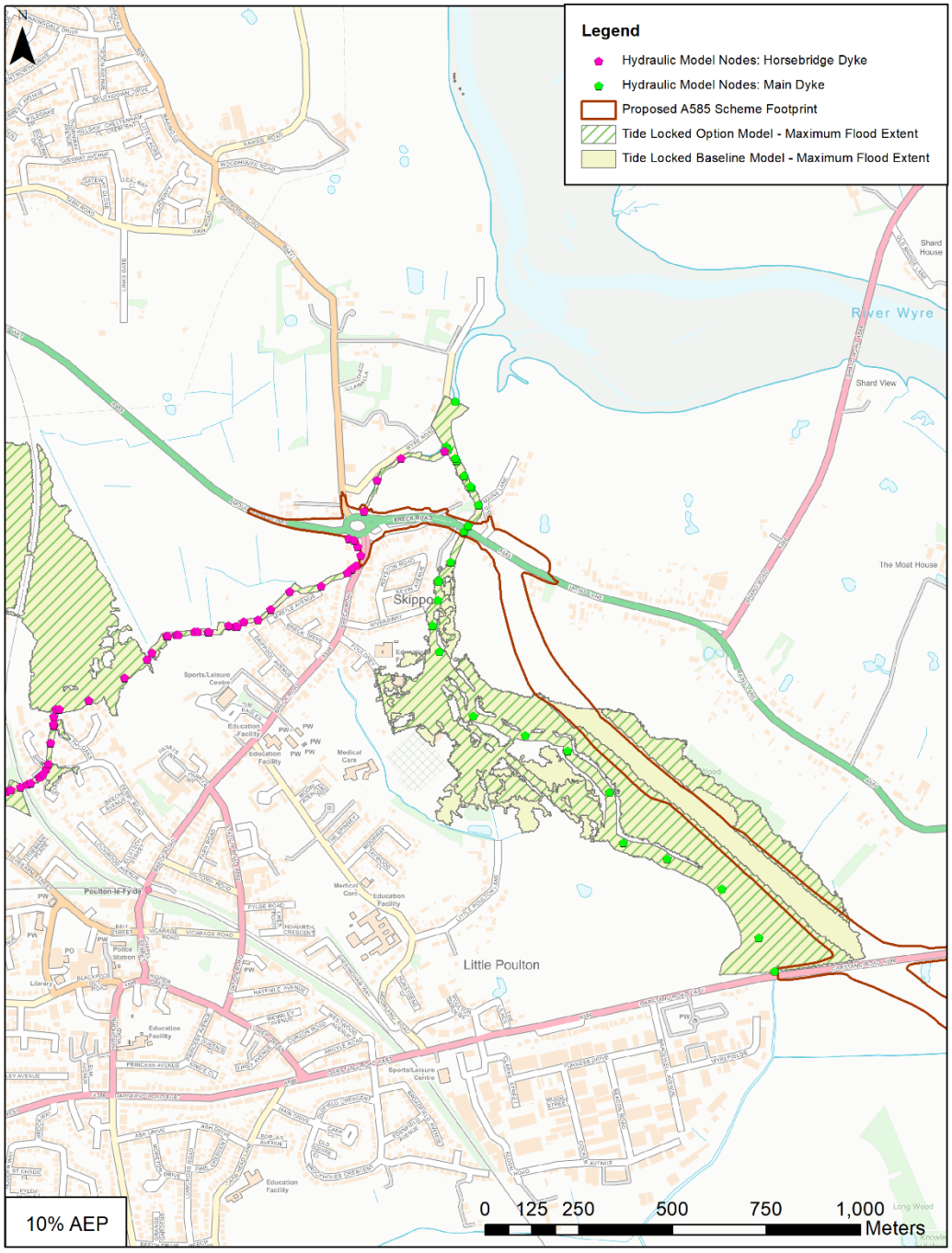


Figure D 33 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 10% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

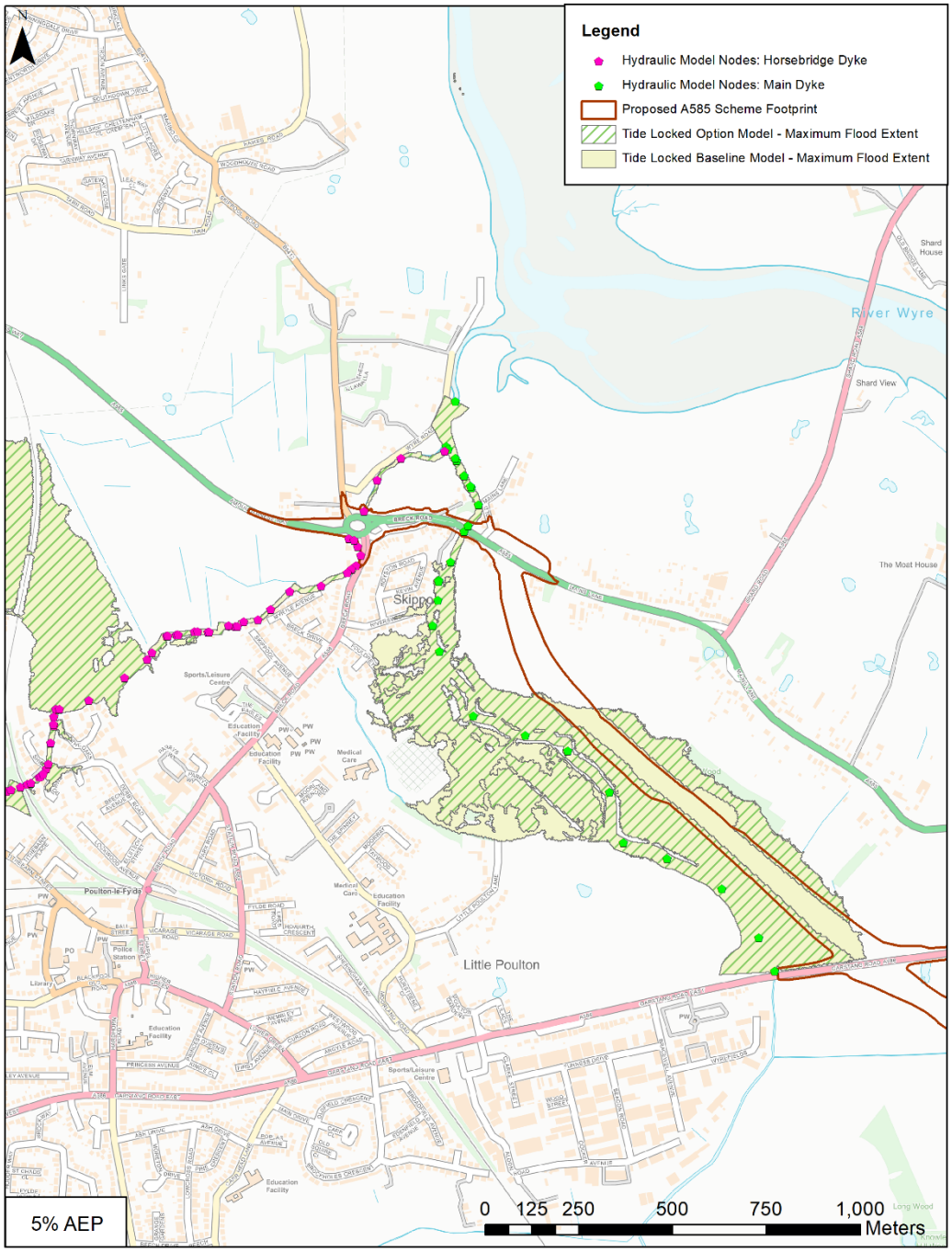


Figure D 34 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 5% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

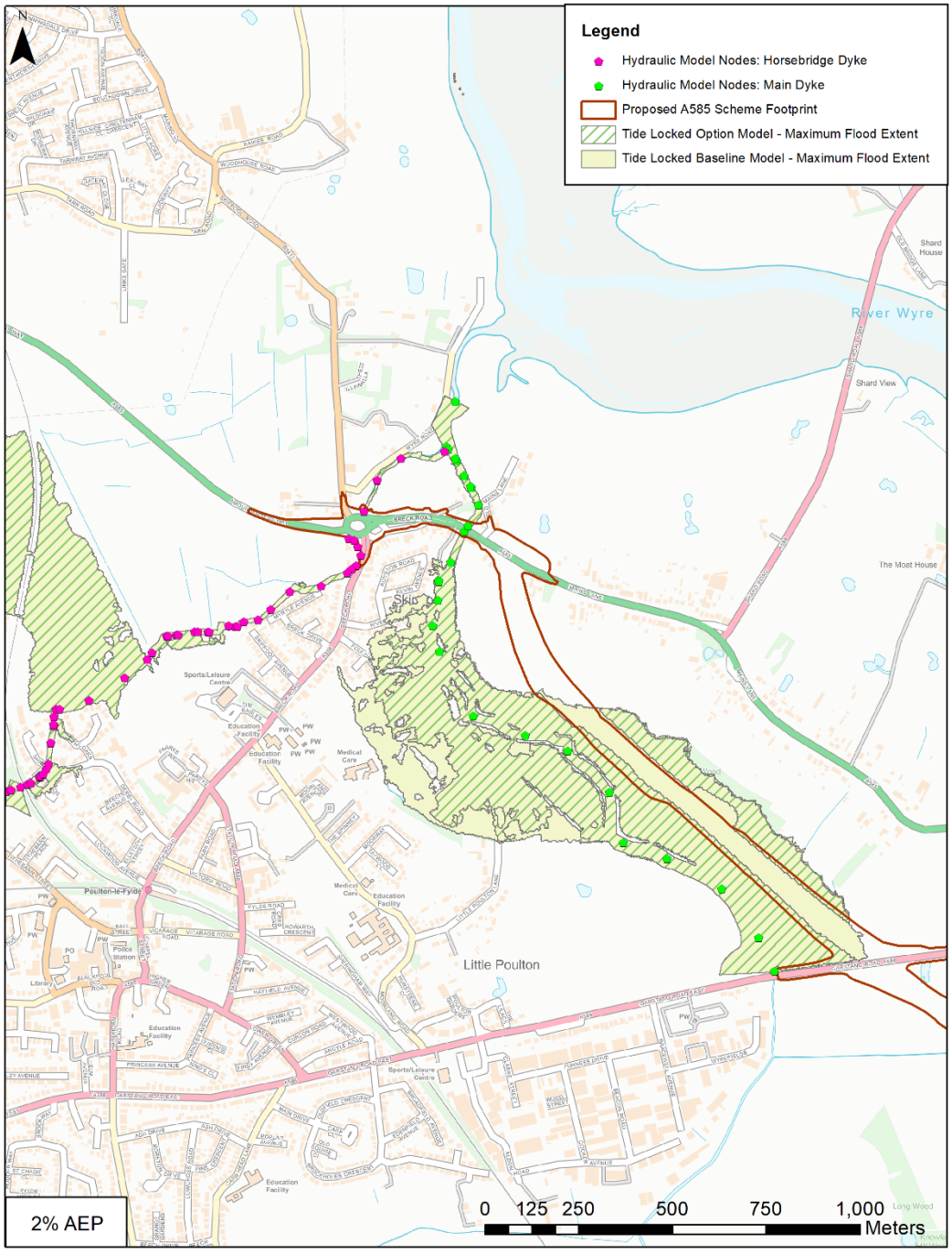


Figure D 35 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 2% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

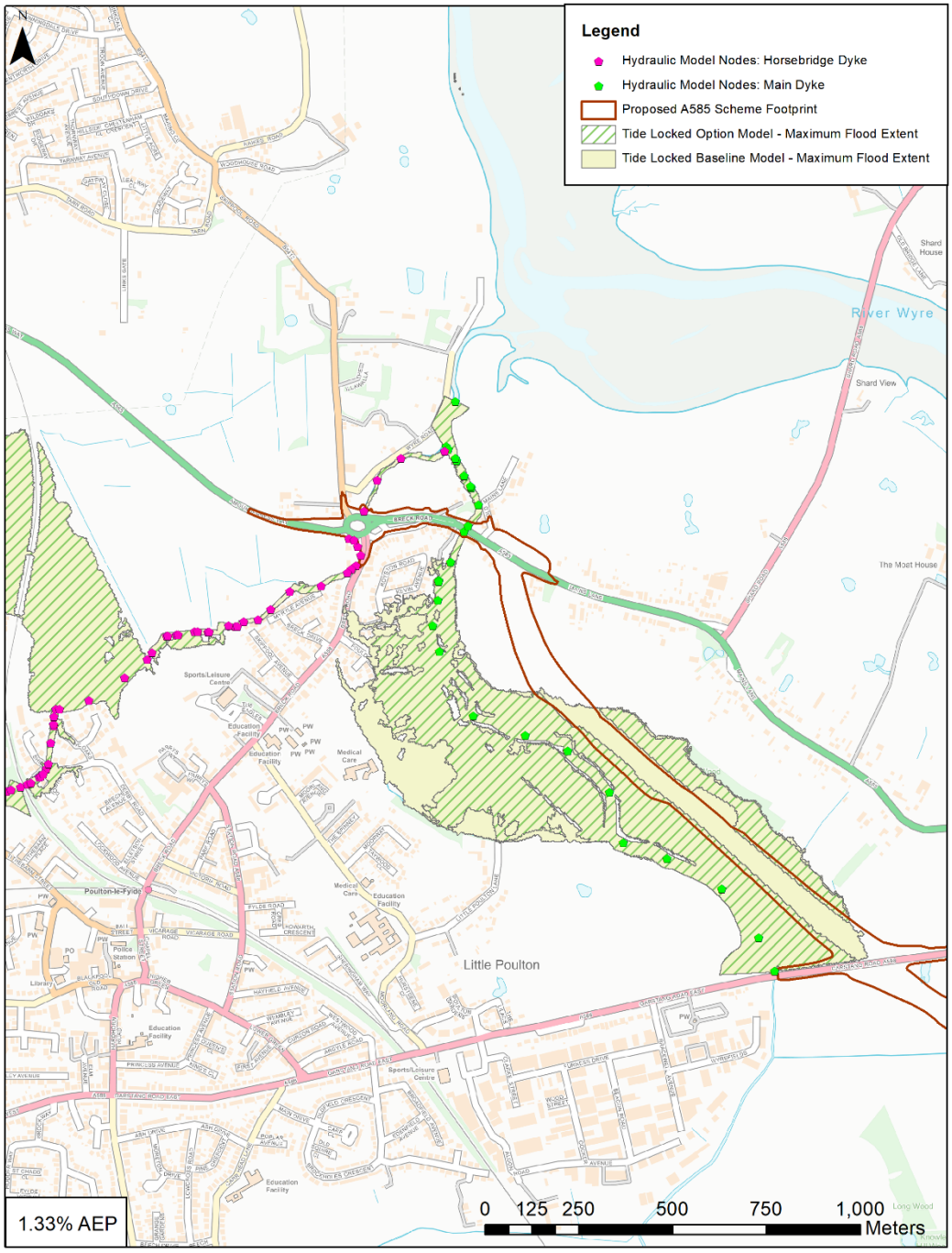


Figure D 36 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 1.33% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

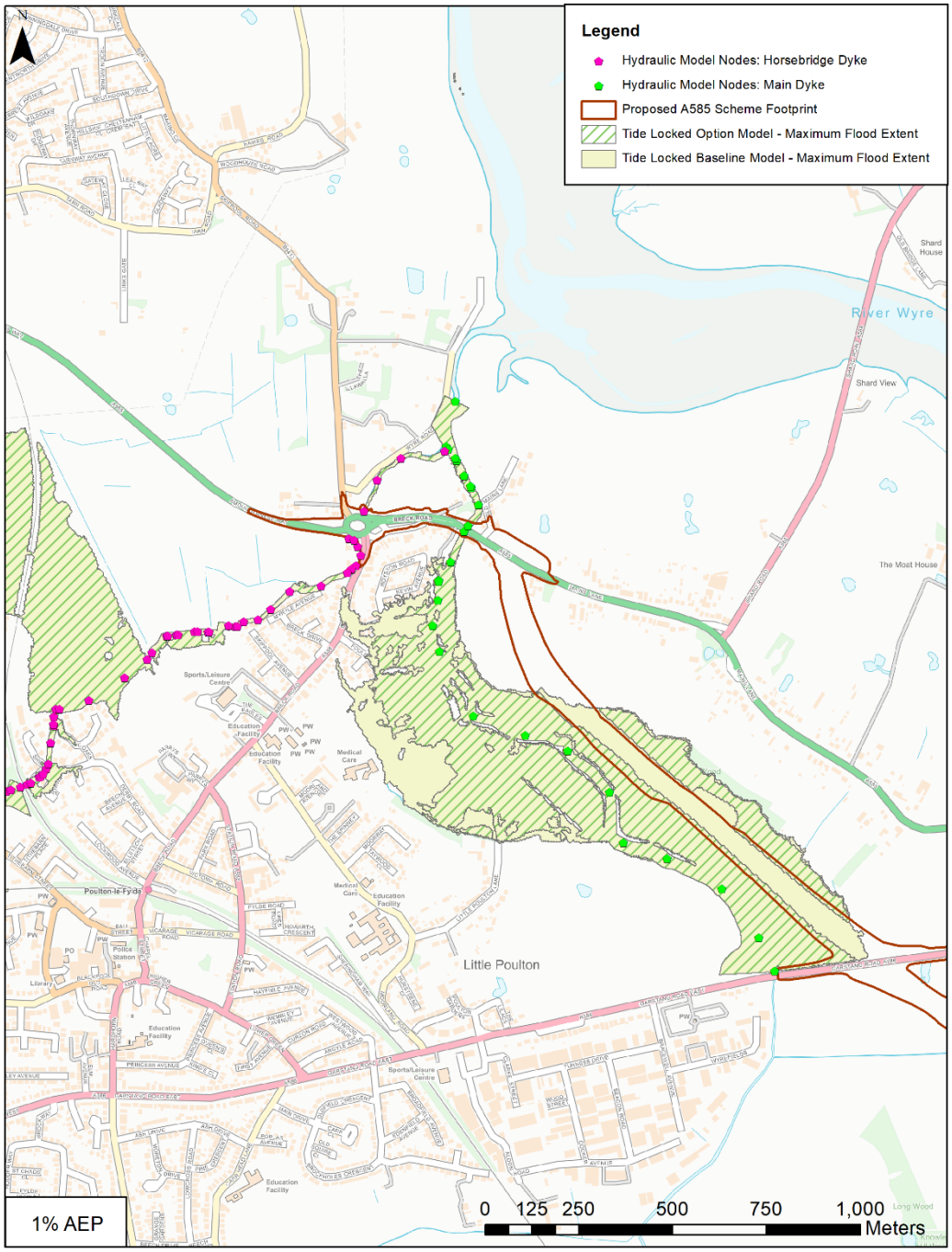


Figure D 37 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 1% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

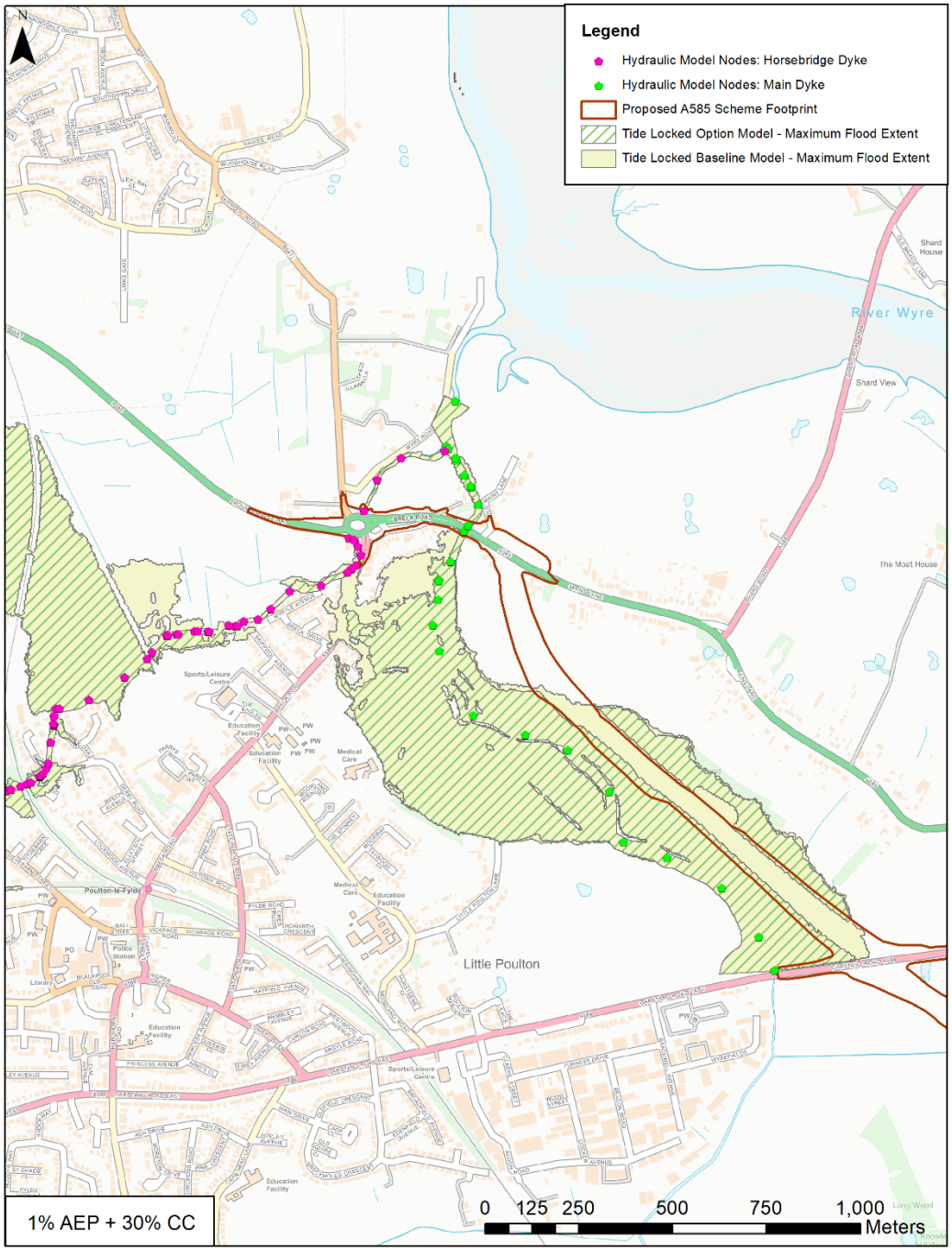


Figure D 38 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 1% AEP (+30% Climate Change) flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

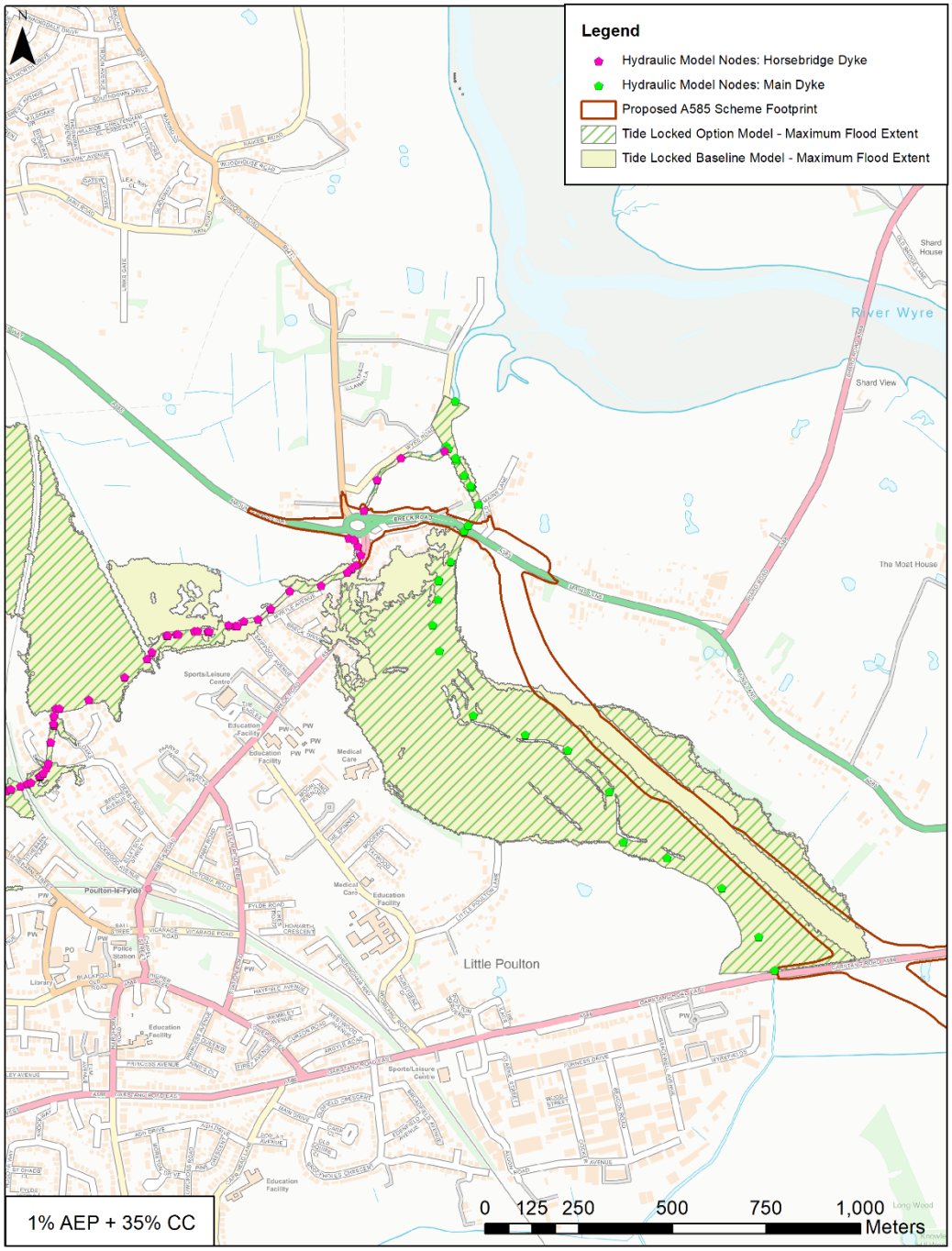


Figure D 39 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 1% AEP (+35% Climate Change) flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

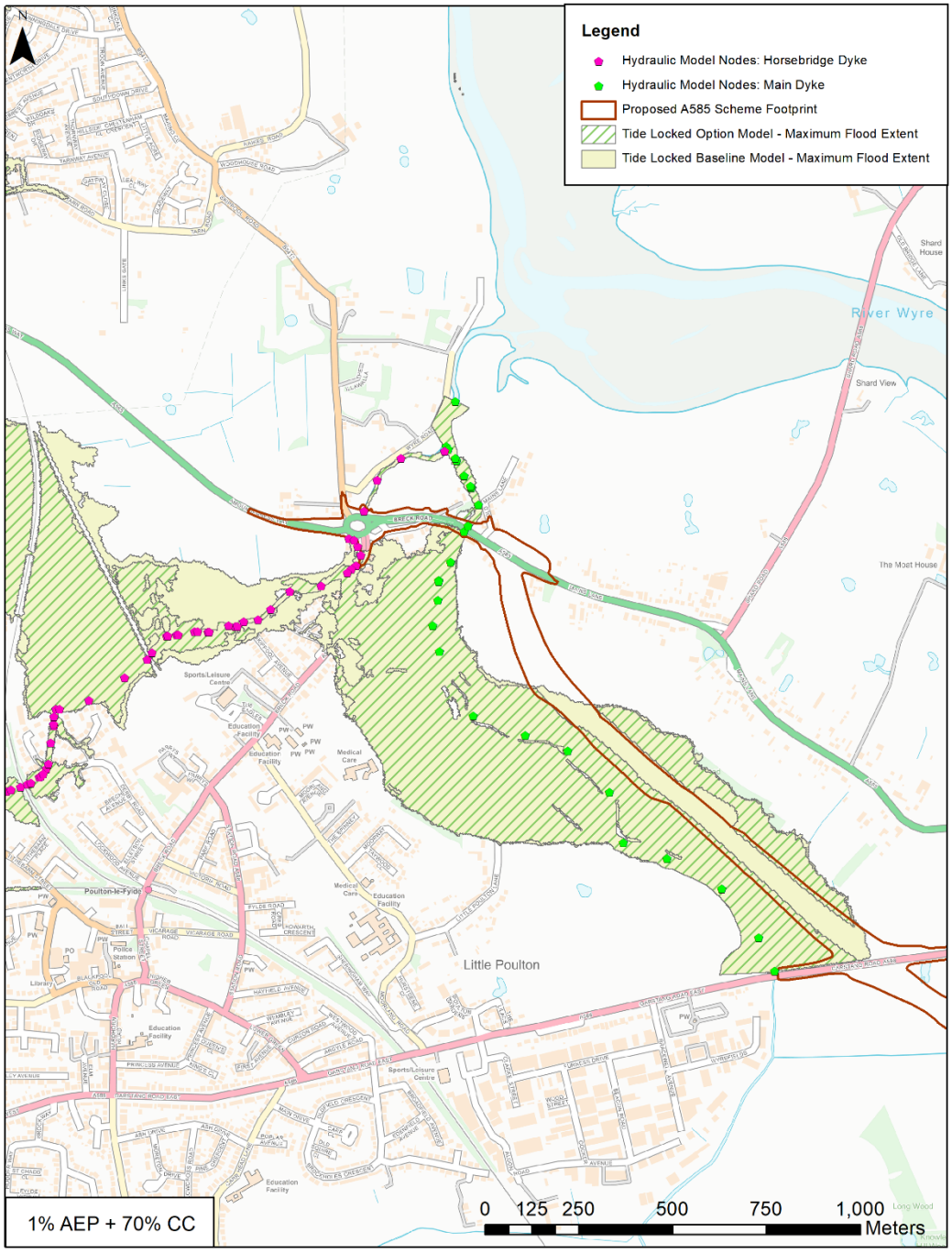


Figure D 40 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 1% AEP (+70% Climate Change) flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

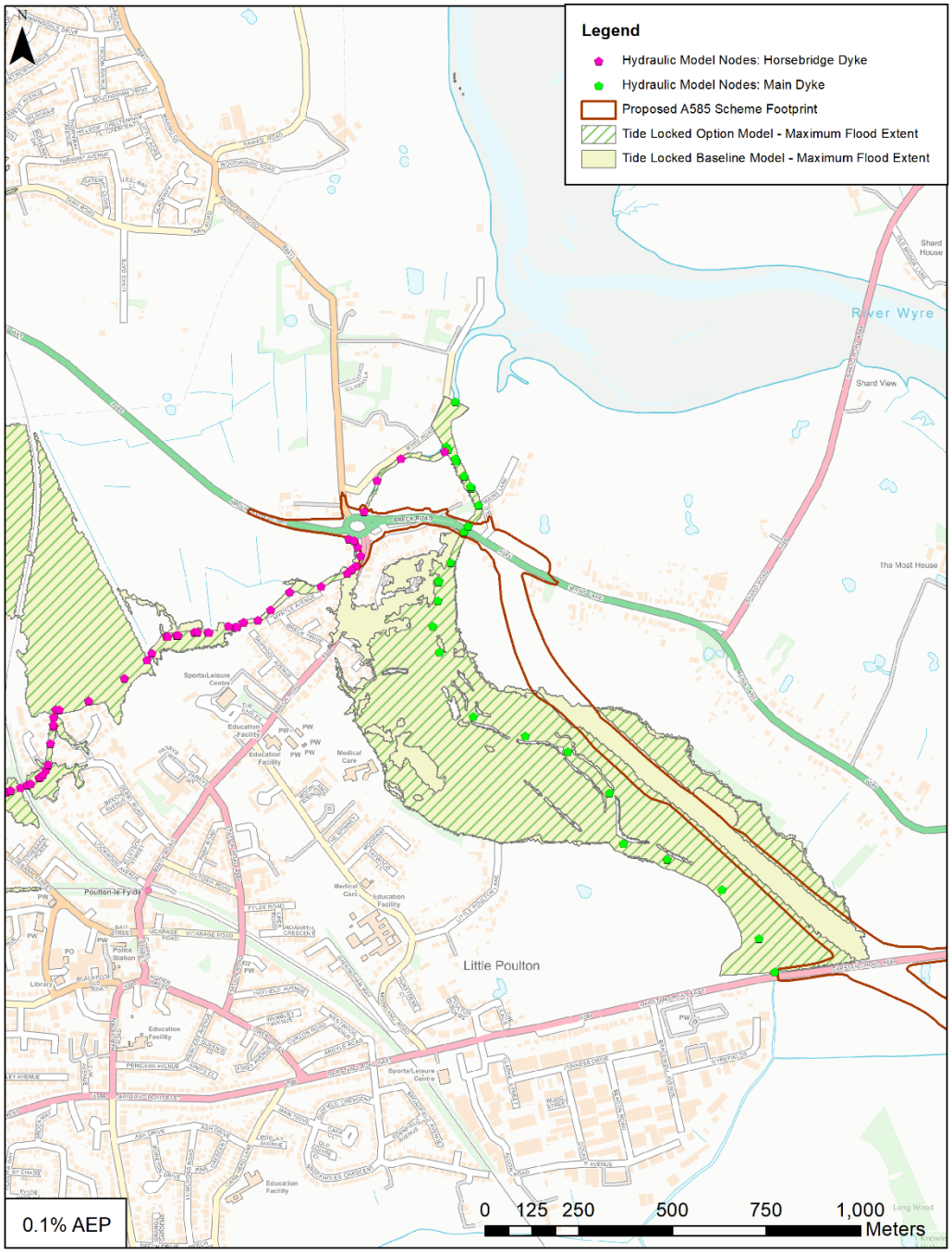


Figure D 41 - Maximum flood extents [Tide Locked Baseline and 'With Scheme' (Option)] for the 0.1% AEP flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

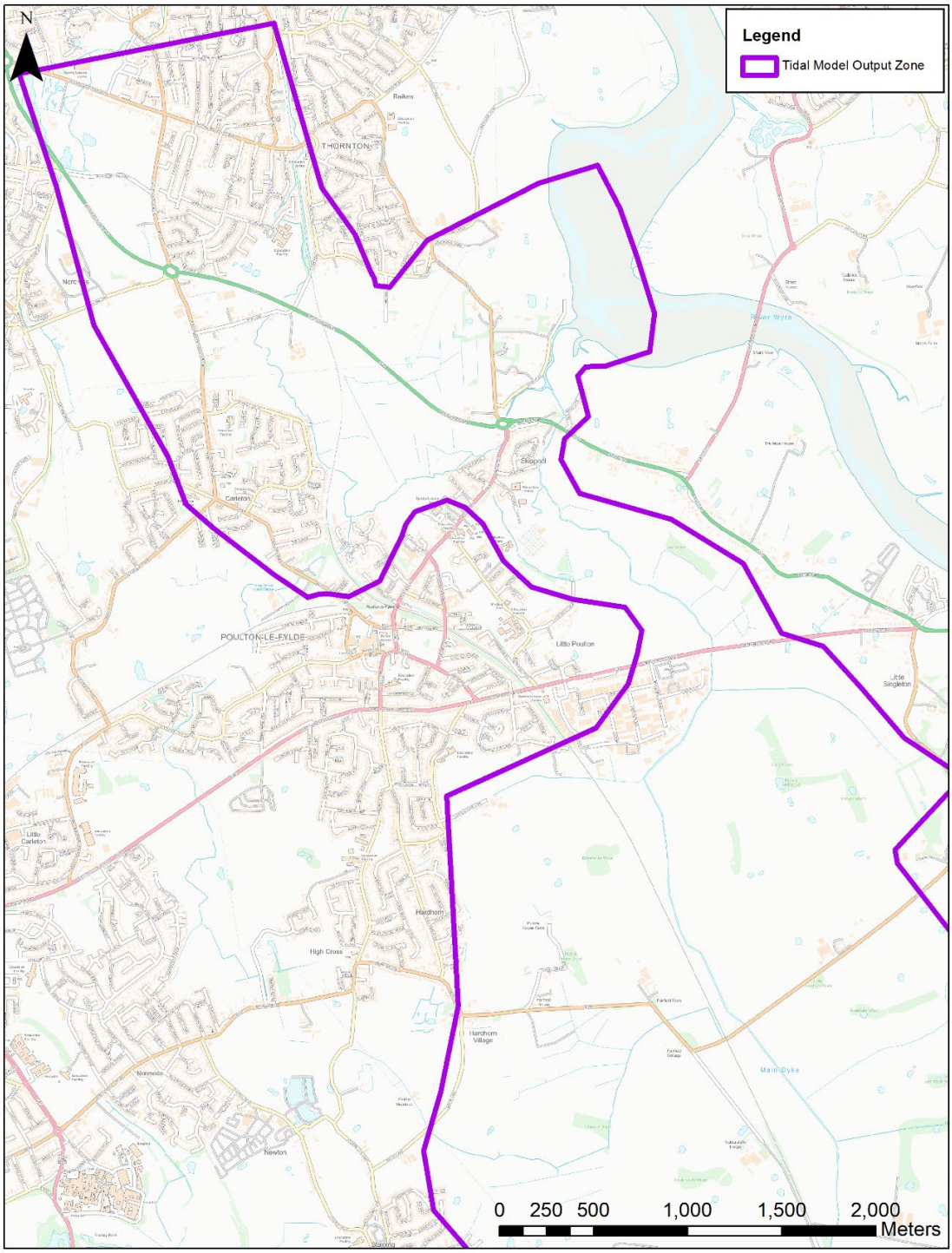


Figure D 42 - TUFLOW Model Output Zone used for Tidal Model runs. The model calculates solutions for all cells within the model domain which extends north west towards Thornton, Cleveleys and Fleetwood. However, results grids are only written out for the area in the model output zone giving rise to the straight edges observed around the perimeter of the flood extent. The output zone has been used to limit run times and reduce file sizes by only writing results for the study area. (Contains Ordnance Survey data © Crown copyright and database right 2017)

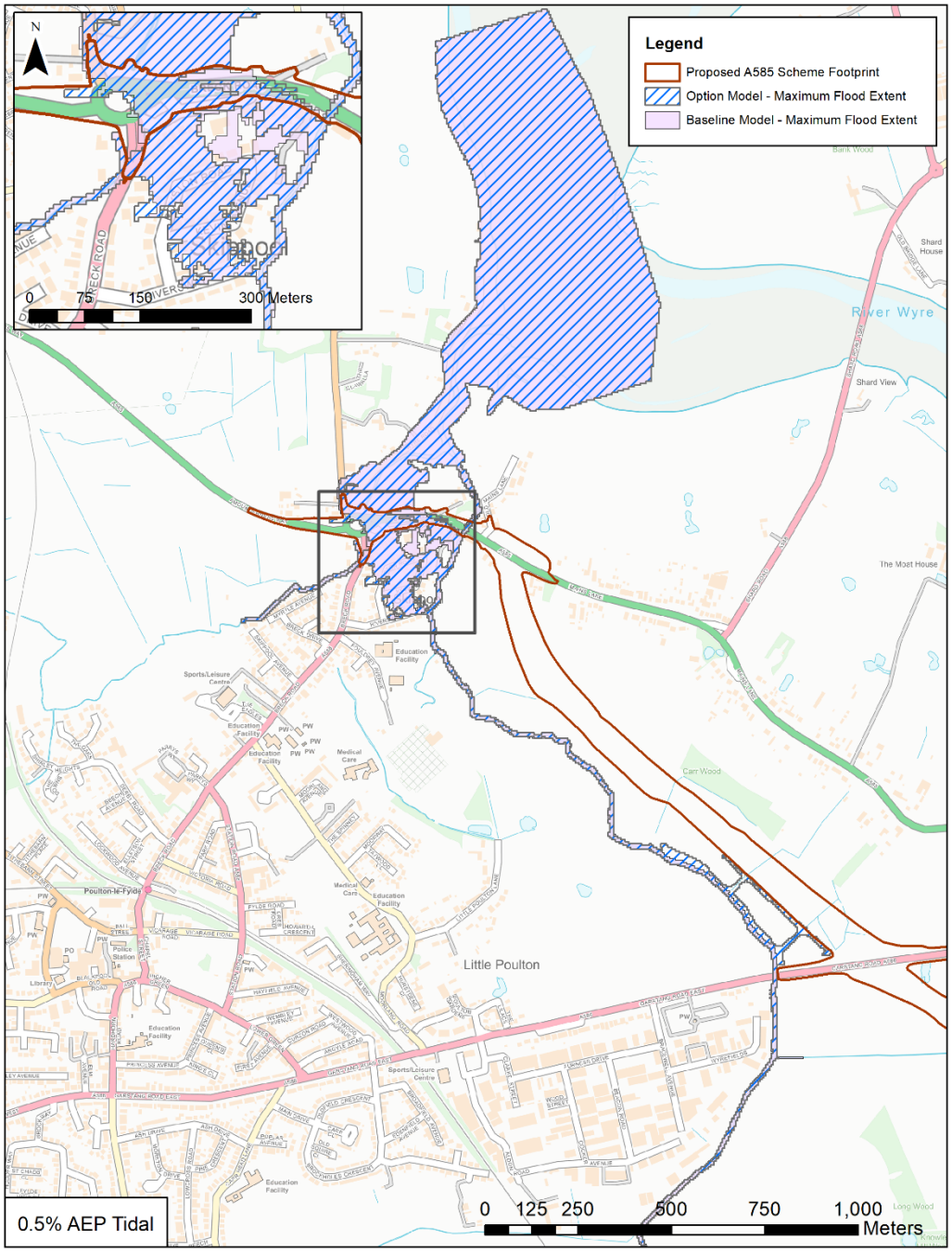


Figure D 43 - Maximum flood extents [Tidal Baseline and 'With Scheme' (Option)] for the 0.5% AEP Tidal flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

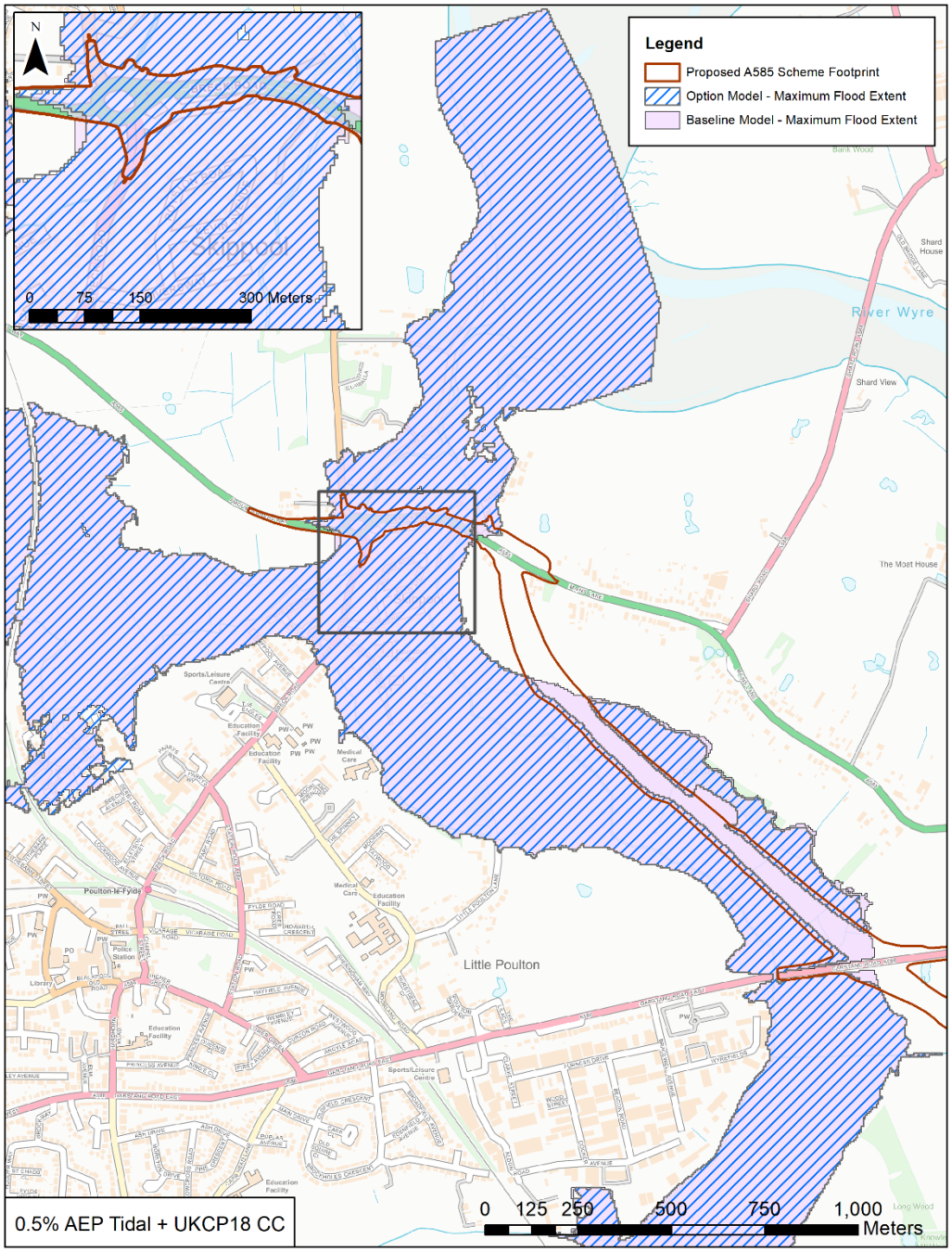


Figure D 44 - Maximum flood extents [Tidal Baseline and 'With Scheme' (Option)] for the 0.5% AEP Tidal + UKCP18 Climate Change (Contains Ordnance Survey data © Crown copyright and database right 2017)

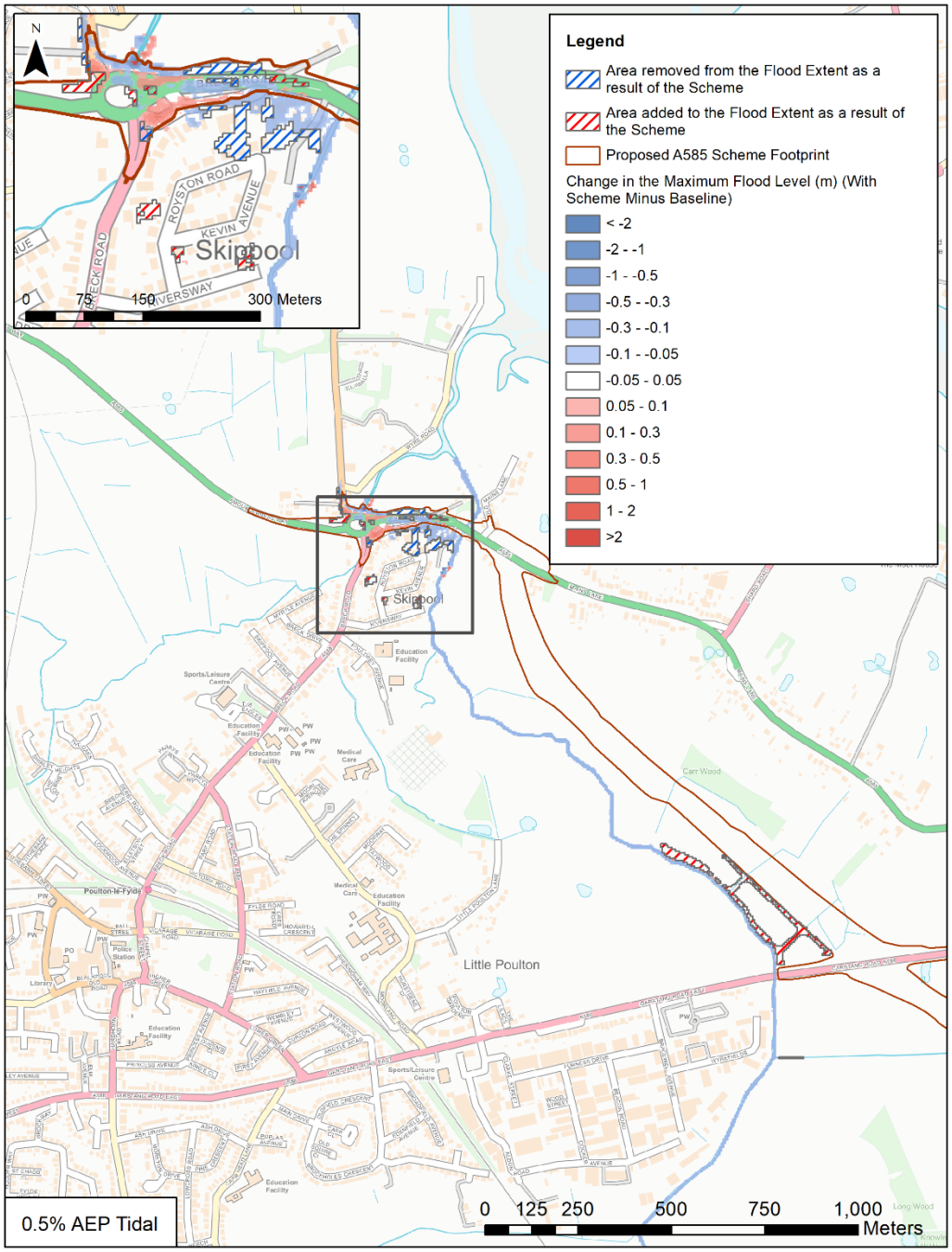


Figure D 45 - Maximum flood depth difference [Tidal Baseline and 'With Scheme' (Option)] for the 0.5% AEP Tidal flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)

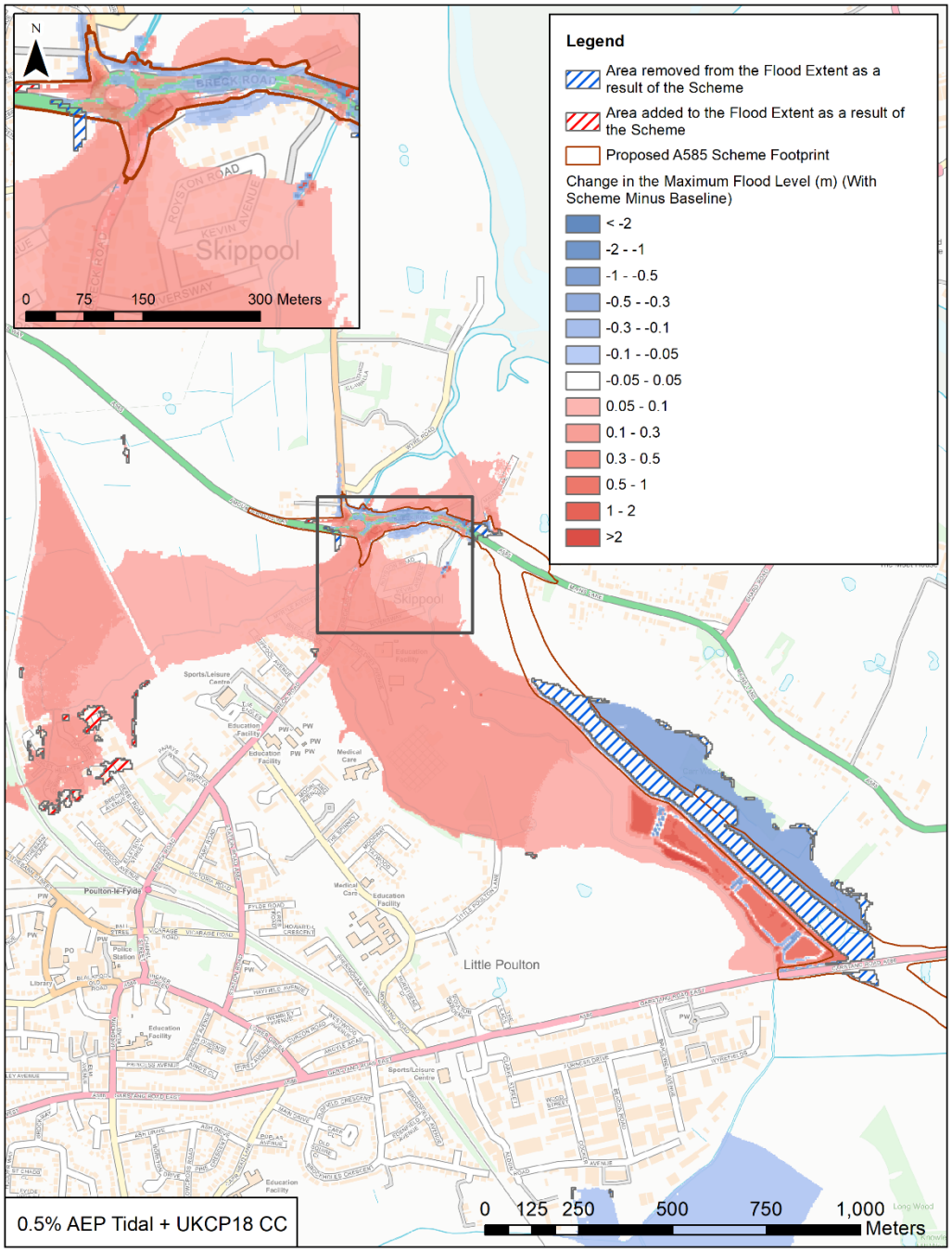


Figure D 46 - Maximum flood depth difference [Tidal Baseline and 'With Scheme' (Option)] for the 0.5% AEP Tidal + UKCP18 Climate Change Sensitivity Test (Contains Ordnance Survey data © Crown copyright and database right 2017)

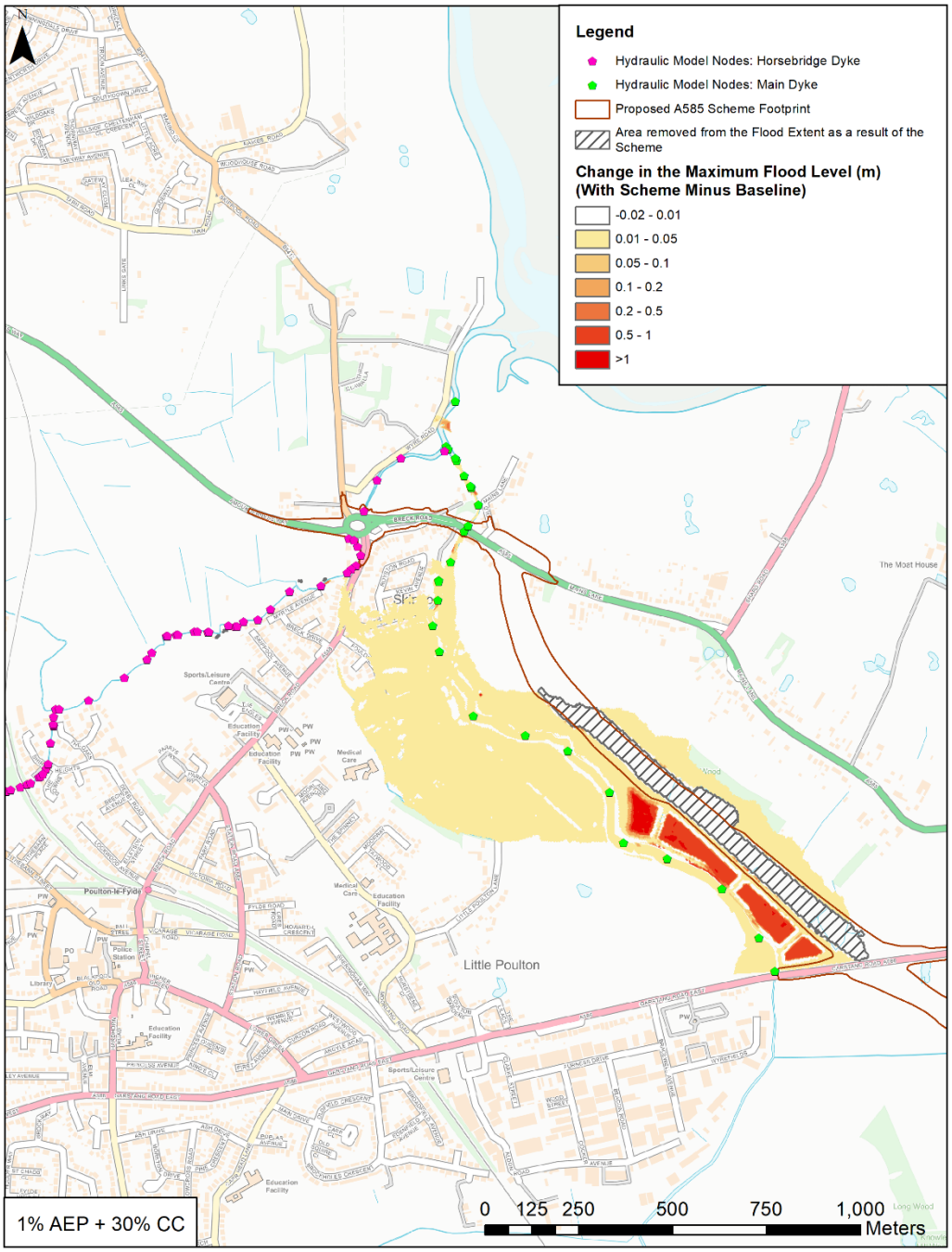


Figure D 47 - Maximum flood depth difference [Baseline and 'with Mitigation'] for the 1% AEP + 30% Climate Change flood event (Contains Ordnance Survey data © Crown copyright and database right 2017)1

[1] *In this case, a change of +/- 1cm has been used to colour the difference grid to aid clarity of understanding*

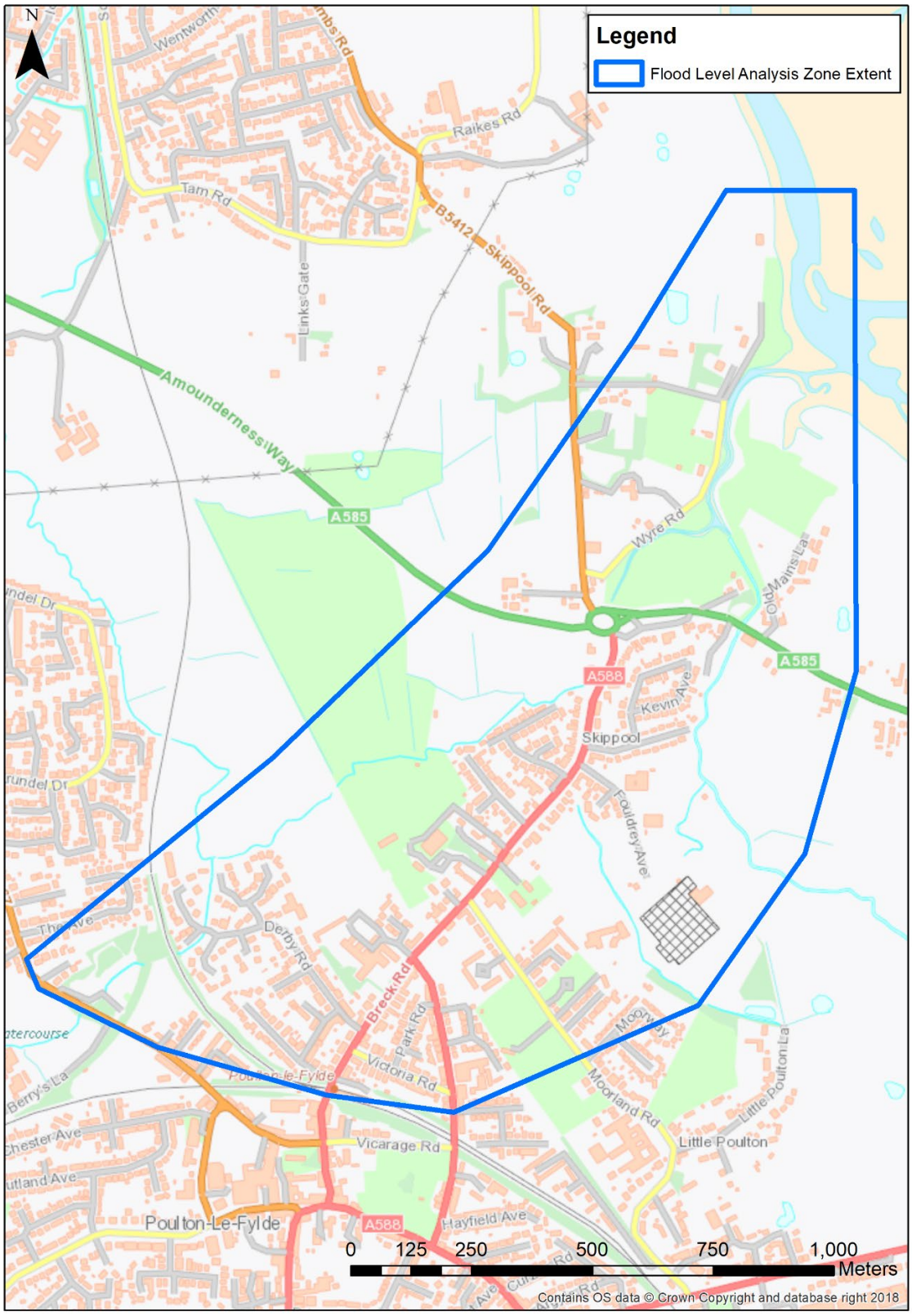


Figure D 48 - A map showing the extent of the area considered for property level flood level analysis. MasterMap building polygons for all properties within the area shown to experience a change in flood risk were extracted from within this area (Contains Ordnance Survey data © Crown copyright and database right 2018).

APPENDIX E – DRAINAGE DESIGN DEVELOPMENT REPORT

Page Left Intentionally Blank

A585 Windy Harbour to Skippool

Drainage Design Development Report

HE548643-ARC-HDG-A585-RP-D-3198

02 AUGUST 2018

Registered office Bridge House, 1 Walnut Tree Close, Guildford GU1 4LZ
Highways England Company Limited registered in England and Wales number 09346363

DOCUMENT CONTROL

Document Title	Drainage Design Development Report
Author	Alan [redacted]
Owner	Nick [redacted]
Distribution	David [redacted], Quentin [redacted], Santi [redacted]
Document Status	First Issue – For Comment

REVISION HISTORY

Version	Date	Description	Author
1.0	02/08/2018	First Issue	Alan [redacted]

REVIEWER LIST

Name	Role

APPROVALS

Name	Signature	Title	Date of Issue	Version

© The original format of this document is copyright to Highways England.

This report dated 02 AUGUST 2018 has been prepared for Highways England (the "Client") in accordance with the terms and conditions of appointment dated 16 March 2016 (the "Appointment") between the client and Arcadis Consulting (UK) Limited ("Arcadis") for the purposes specified in the Appointment. For the avoidance of doubt, no other person(s) may use or rely upon this report or its contents, and Arcadis accepts no responsibility for any such use or reliance thereon by any other third party.

TABLE OF CONTENTS

1 INTRODUCTION 1
1.2 Background 1
2 EXISTING DRAINAGE 3
2.1 Existing available drainage data 3
2.2 Existing drainage condition data 3
2.3 Existing drainage systems 3
2.4 Existing topography 3
2.5 Existing waterbodies 4
2.6 Existing flood risk assessment data 5
2.7 Aquifers and groundwater 6
2.8 Geology 8
2.9 Existing drainage catchments and discharge points 9
2.10 Condition of the existing drainage assets (stage 2 data) 11
2.11 Existing drainage design life 11
2.12 Flood hotspot summary 11
2.13 Priority outfall summary 15
2.14 Priority culvert summary 16
3 PROPOSED HIGHWAY DRAINAGE 18
3.1 The legal framework – flood risk 18
3.2 The legal framework – water quality 18
3.3 Design standards 19
3.4 Design principles 19
3.5 Climate change 19
3.6 Water quality 20
3.7 Pollution control 20
3.8 Consultations undertaken to inform the design 20
3.9 Agreed design principles 22
3.10 Strategy for retaining the existing drainage 22
3.11 Pre-earthworks drainage strategy 22
3.12 Works within the floodplain 23
3.13 Proposed drainage catchments 23
3.14 Proposed drainage strategy – Catchments 1, 2 and 3 23
3.15 Proposed drainage strategy – Catchments 4, 5, 6 and 7 25
3.16 Proposed drainage strategy – Catchment 8 27
3.17 Proposed drainage strategy – Catchment 9 28
3.18 Proposed drainage strategy – Catchment 10 29
3.19 Proposed discharge rates 29
3.20 Defects and remediation 30
3.21 Off network access and future maintenance 30
3.22 Risk (Health and safety) 31
3.23 Buildability 31

3.24 Departures from standard 31
Appendix A – Existing CCTV asset and condition data 32
Appendix B – Existing drainage asset and condition survey plans (Gap analysis plans) 33
Appendix C – Existing drainage catchment and waterbodies plans 34
Appendix D – Existing drainage and site clearance plans 35
Appendix E – Priority outfall register extract 36
Appendix F – Correspondence 37
Appendix G – Proposed drainage catchment plan and proposed drainage plans 38
Appendix H – Water quality assessments 39
Appendix I – Accidental spillage containment assessments 40
Appendix J – Technical note (TN22) – Drainage CCTV asset and condition survey review 41
Appendix K – Maintenance operations 42

LIST OF FIGURES

Figure 1-1: Scheme Study Area 1
Figure 1-2: The Scheme 2
Figure 2-1: Scheme area topography 4
Figure 2-2: Existing Watercourses and Overland Flow Catchments 5
Figure 2-3: EA Flood Zone and Main River Mapping (not to scale) 6
Figure 2-4: EA Source Protection Zone Mapping (not to scale) 7
Figure 2-5: EA Groundwater Vulnerability Mapping (not to scale) 7
Figure 2-6: EA Source Protection Zone Mapping (not to scale) 8
Figure 2-7: Drift geology 9
Figure 2-8: HADDMS Recorded Flood Incidents between Skippool Junction and Shard Road Junction 11
Figure 2-9: HADDMS Recorded Flood Incidents between Shard Road and Garstang Road East 12
Figure 2-10: HADDMS Recorded Flood Incidents between Garstang Road and the approach to Windy Harbour Junction (not to scale) 14
Figure 2-11: HADDMS Recorded Flood Incidents between Windy Harbour Junction and Fleetwood Road 15
Figure 2-12: HADDMS Priority outfalls overall status between Skippool Junction and Skippool 16
Figure 2-13: HADDMS Priority outfalls overall status between Garstang New Road and Windy Harbour Junction (not to scale) 16
Figure 2-14: HADDMS Priority culvert overall status between Garstang New Road and Windy Harbour Junction (not to scale) 17
Figure 2-15: HADDMS Priority culvert overall status register extract 17
Figure 3-1: Table 5 extract from technical guidance note to NPPF (DCLG – 2012) 20
Figure 3-2: Table 2 extract from flood risk assessment: climate change guidance 20

LIST OF TABLES

Table 2-1: Existing Drainage Catchments and Discharge points 10
Table 2-2: Existing Drainage Catchment Areas and Discharge Rates 10
Table 2-3:Flood Event Incident Records 12
Table 2-4: Flood Event Incident Records 13
Table 2-5: Flood Event Incident Records 14
Table 2-6: Flood Event Incident Records 15
Table 3-1: Stage 3 Design consultation 21
Table 3-2: Culverts Location and Size Information 23
Table 3-3: Proposed catchment discharge rates 29
Table 3-4: 1 in 5-year proposed discharge rates and % difference from existing 29

1 INTRODUCTION

1.1.1 This Drainage Design Development Report superseded Technical Note 17 which provided guidance on the design principles required at the preliminary design Stage 3.

1.1.2 This Drainage design development report is intended to be a live document detailing relevant background information, mandatory requirements, DMRB design standards, correspondence to date and points of contact to be used for future detailed design.

1.2 Background

1.2.1 Highways England has been investigating options to alleviate a major bottle neck along the A585 between the Windy Harbour junction and the Skippool junction near Poulton-le-Fylde. As a result of the options work Highways England published the Preferred Route Announcement on 24 October 2017 indicating that an offline 'southern' bypass solution between the two junctions was the preferred solution (hereafter referred to as the 'Scheme').

1.2.2 The A585 (T) is a single carriageway trunk road, which provides the only viable access from the motorway network (M55 at Junction 3) into Fleetwood and its urban areas. As a result, it suffers from extreme congestion. The Government's Autumn Statement in 2014 identified the need for an Improvement Scheme along the A585 between Windy Harbour and Skippool to ameliorate the impact of traffic on the route between the two villages and to remove a major bottleneck.

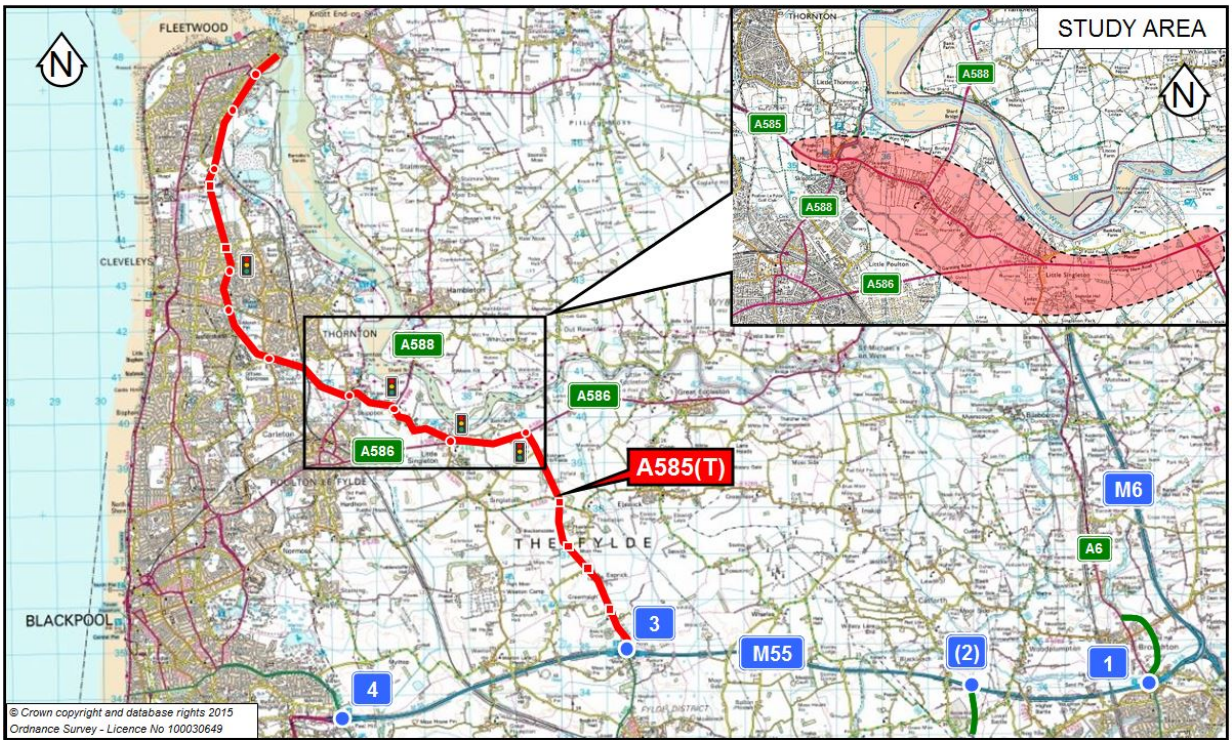


Figure 1-1: Scheme Study Area

1.2.3 The Scheme would follow a route to the south of the ribbon development between Skippool and Little Singleton. It is 4.86km in length, would bypass two of the most significant junction constraints and provide dual-carriageway capacity. Figure 1-1shows the geographic location of the Scheme and the surrounding road network. **Figure 1-2** presents the Scheme.

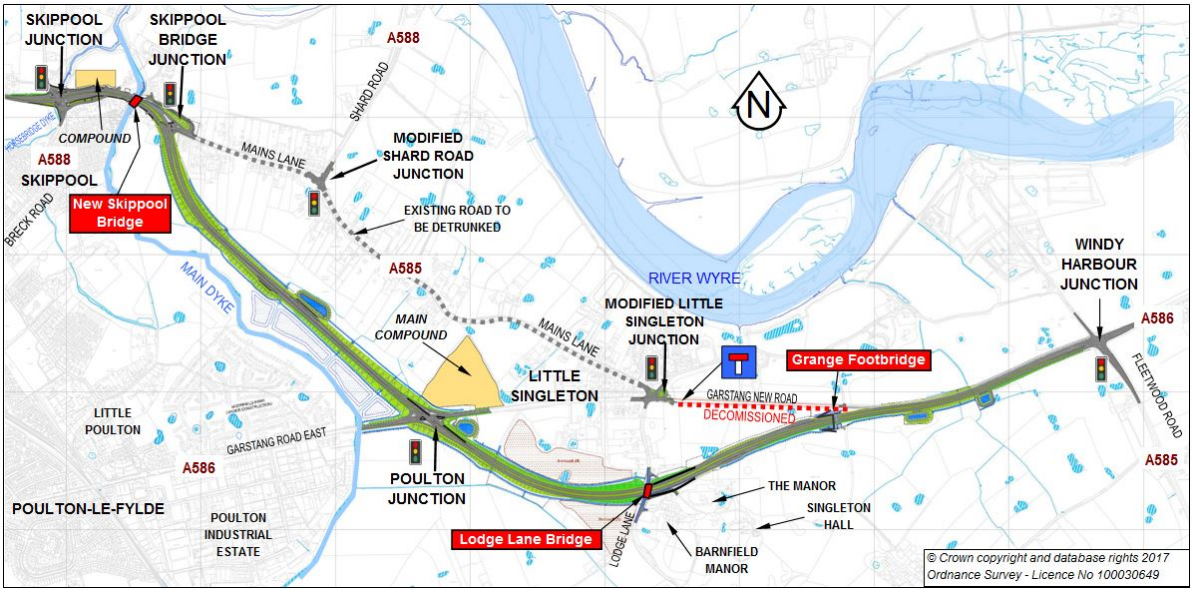


Figure 1-2: The Scheme

1.2.4 Main roads affected by the Scheme are:

- A585 Amounderness Way – the southern end of the single carriageway largely rural trunk road including the Skippool Roundabout junction with A588 Breck Road and B5412 Skippool Road;
- A585 Mains Lane – single carriageway trunk road from Skippool to Little Singleton (Five Lane Ends junction). There are 131 houses, 7 businesses and 2 caravan parks fronting Mains Lane and Breck Road between Skippool roundabout and Little Singleton Junction, there are also 2 set of traffic signals;
- A585 Garstang New Road – rural single carriageway trunk road from Five Lane Ends junction leading to recently upgraded traffic signal controlled Windy Harbour Junction;
- A586 Garstang Road East – Local Road Network (LRN) operated by Lancashire County Council (LCC);
- A588 Shard Road across Wyre estuary – Local Road Network (LRN) operated by LCC;
- B5260 Lodge Lane – cross country road running southwards from Five Lanes End junction that is used as a north-south rat-run to areas such as the employment areas south of the M55 such as Warton and Wesham/Kirkham – operated by LCC.

1.2.5 The landscape surrounding the Scheme is generally low lying and coastal characterised by arable fields, pasture, drainage ditches and small to medium sized blocks of mixed woodland. The Wyre Way regional trail runs east from the edge of the Wyre Estuary Country Park along the southern bank of the Wyre Estuary as far as Little Singleton. Further to this, there is publicly accessible land at The Wyre Estuary Country Park which is located north of Skippool. There is a greater density of residential properties surrounding the western half of the Scheme with farmland becoming more prevalent to the east. To the south of Little Singleton and east of the B5260 there is an area of non-designated parkland (Singleton Park). There are eight Noise Important Areas along Breck Road, Mains Lane and Fleetwood Road within the vicinity of the Scheme.

1.2.6 Environmental constraints within the locality of the Scheme include the Morecambe Bay and Duddon Estuary Special Protection Area (SPA), Ramsar, Site of Special Scientific Interest (SSSI) and recommended Marine Conservation Zone (rMCZ) approximately 500m to the north of the Scheme. There are also three Biological Heritage Site (BHS) designations associated with the Wyre Estuary (important at a local level). The Main Dyke watercourse lies to the west of the Scheme and there are areas of low lying floodplain and some areas of flood zone 3 associated with Main Dyke and the Wyre Estuary covering the Scheme footprint. Heritage features include the Conservation Areas at Poulton-le-Fylde and Singleton as well as isolated Grade II Listed Buildings.

2 EXISTING DRAINAGE

2.1 Existing available drainage data

2.1.1 Existing as-built records and drainage data for the existing A585 trunk road has been obtained from Highways England Drainage Data Management System (HADDMS).

2.1.2 As-built drainage data has also been received from Enterprise Mouchel (Area 13) for the newly constructed Windy Harbour Junction (Drawing number: 780003/501z & 502z).

2.1.3 No data has been received from Lancashire County Council (LCC) for the local drainage networks which connect to the existing A585 trunk road. LCC stated during a walk over survey on the 30/11/2017 that no formal data is available.

2.1.4 This information has been used to determine the existing drainage collector, carrier systems and outfalls serving the existing A585 within the study area.

2.1.5 From a desk top gap analysis study of the available data, additional asset survey will be required to fill the gaps in the missing asset data.

2.2 Existing drainage condition data

2.2.1 A review of the existing drainage assets condition data on HADDMS has confirmed that there is limited data available detailing its condition.

2.2.2 The only condition survey data available is between Skippool Junction and Skippool Bridge and the data shows that the existing network currently has 6no. category 4 defects (holes / broken pipes) and 1no. category 5 defects (collapsed drain). There are also 17no. location where the survey had to be abandoned due to the level of debris, water level and loss of vision. Refer to Appendix A for existing CCTV data.

2.2.3 Consequently, to fill in the asset and condition data gaps a drainage gap analysis set of plans has been created (Refer to Appendix B, drawing numbers HE548643-ARC-HDG-A585-DR-D-3301 To 3312) along with an CCTV asset and condition survey specification. These documents were issued to Highways England in 2017 to procure a CCTV asset and condition survey to allow us to fill in the gaps and verify our assumptions.

2.3 Existing drainage systems

2.3.1 The existing highways drainage on the A585 route within the study area is predominantly by trapped gulley's or kerb off-let gullies connecting to carrier drains, with intermediate chambers, that discharge into field ditches or watercourses. In general, there are no specific measures to treat highway discharges but some of the outfalls are provided with flap valves to prevent backflow of water from the larger watercourses affected by tidal conditions from the River Wyre Estuary.

2.3.2 The exception to the above is the drainage network provided for the recently upgraded Windy Harbour Junction that uses combined kerb-drains that discharge to an oversized pipe that has been provided with a penstock valve and vortex flow control device at the outfall from this catchment.

2.3.3 19no. existing drainage catchment have been identified. These catchments are located at the tie-ins locations of the new offline bypass and along the parts of the existing A585 which will be de-trunked following the completion of the new offline bypass.

2.4 Existing topography

2.4.1 The study area is situated in the coastal plain between the Irish Sea and the River Wyre. The topography of the area comprises a low lying gently undulating terrain. The terrain is dominated by a north-west to south-east running ridge that lies to the South of the River Wyre. This rises from around 13m AOD at Skippool to 24m AOD at Little Singleton. While the top of the ridge is rounded, the side slopes of the ridge fall, typically, at about 1 in 20.

2.4.2 West of the ridge the Skippool–Lytham Channel containing Main Dyke runs in a generally south to north direction and is some 300m to 500m wide. The elevation of the channel is around 4.5m AOD. South of Garstang Road East the main ridge is cut into by a small re-entrant valley approximately 1km long running in a south easterly direction containing a drainage ditch but extends eastwards for a total distance of about 1.6km as a dry valley between Little Singleton and Singleton village.

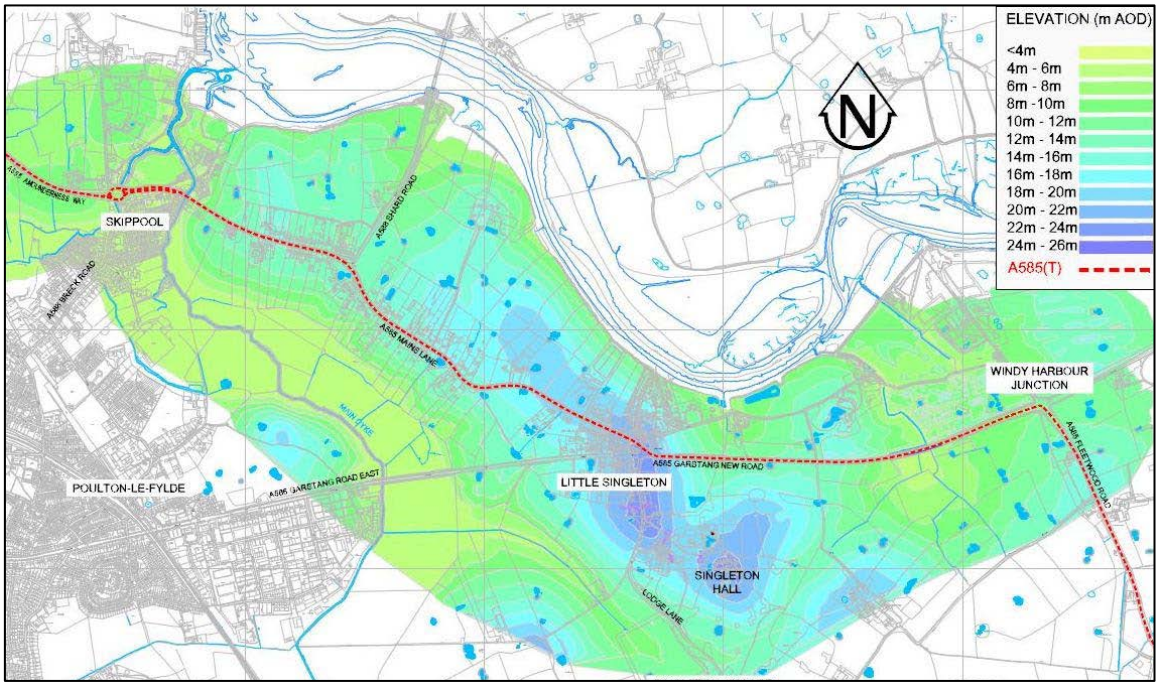


Figure 2-1: Scheme area topography

2.4.3 The existing A585 at Skippool Junction Roundabout is at approximately 6.5m (AOD) and falls (travelling eastbound) over about 0.5km on a very shallow gradient to the location of the Skippool Bridge over Main Dyke. From Skippool Bridge, the A585 (Mains Lane) follows the ridge rising gently to an elevation of 23.6m AOD at Little Singleton. From this high point at Little Singleton in an eastbound direction, the topography drops initially with a 6% gradient, before flattening out and dropping again with a gradient of 3% reaching a low point of about 6.4m AOD approximately 500m west of Windy Harbour Junction. From here, the topography rises to the Windy Harbour Junction at 10.5m AOD with gradients of up to 2.5%.

2.5 Existing waterbodies

2.5.1 There are 4 no. primary watercourses and 5no. minor watercourse / field ditches that have been identified within the scheme area. The Main Rivers listed below are managed by the Environment Agency. The primary watercourses being:

- River Wyre (Main River) – not directly affected by the Scheme
- Horsebridge Dyke (Main River)
- Main Dyke (Main River)
- Un-named watercourse known as Pool Foot Creek

2.5.2 At the western end of the scheme, Horsebridge Dyke falls in a generally north-easterly direction passing under Skippool Roundabout through Skippool Clough Culvert to discharge into the River Wyre Estuary. The culvert is 1.6m diameter of concrete and extended corrugated steel construction and has a 1.6m diameter flap valve at its northern end to prevent tidal flooding. In the event of tidal flooding the flap valve would be shut, and Horsebridge Dyke would be unable to discharge. The Environment Agency manages this flap valve.

2.5.3 The bypass route runs along the Main Dyke valley. Main Dyke is an artificial watercourse constructed between 18th -19th century for the purposes of agricultural drainage and falls in a northerly direction to connect with Horsebridge Dyke before discharging into the Wyre Estuary at Skippool Creek. The watercourse is protected from tidal flooding by a tidal gate about 200m north of the A585 road. The form

of the tidal gate is a pair of flap valves enhanced by lowering gates to be operated in extreme tidal events. This provides protection against tidal flooding to a level of about 6.5m AOD. In the event of tidal flooding the flap valves would be closed, and Main Dyke would be unable to discharge. The Environment Agency manages this flood gate.

2.5.4 Main Dyke has several field ditches that discharge into it along its length as can be seen in Figure 2-2.

2.5.5 At the eastern end of the scheme the only watercourse crosses the bypass route about 0.5km west of Windy Harbour Junction. We have called this watercourse Pool Foot Creek. The watercourse is protected by a flood gate at its discharge into the Wyre Estuary. The level of protection provided by these gates is approximately 6.5mAOD. It is not known who owns/manages this flood gate.

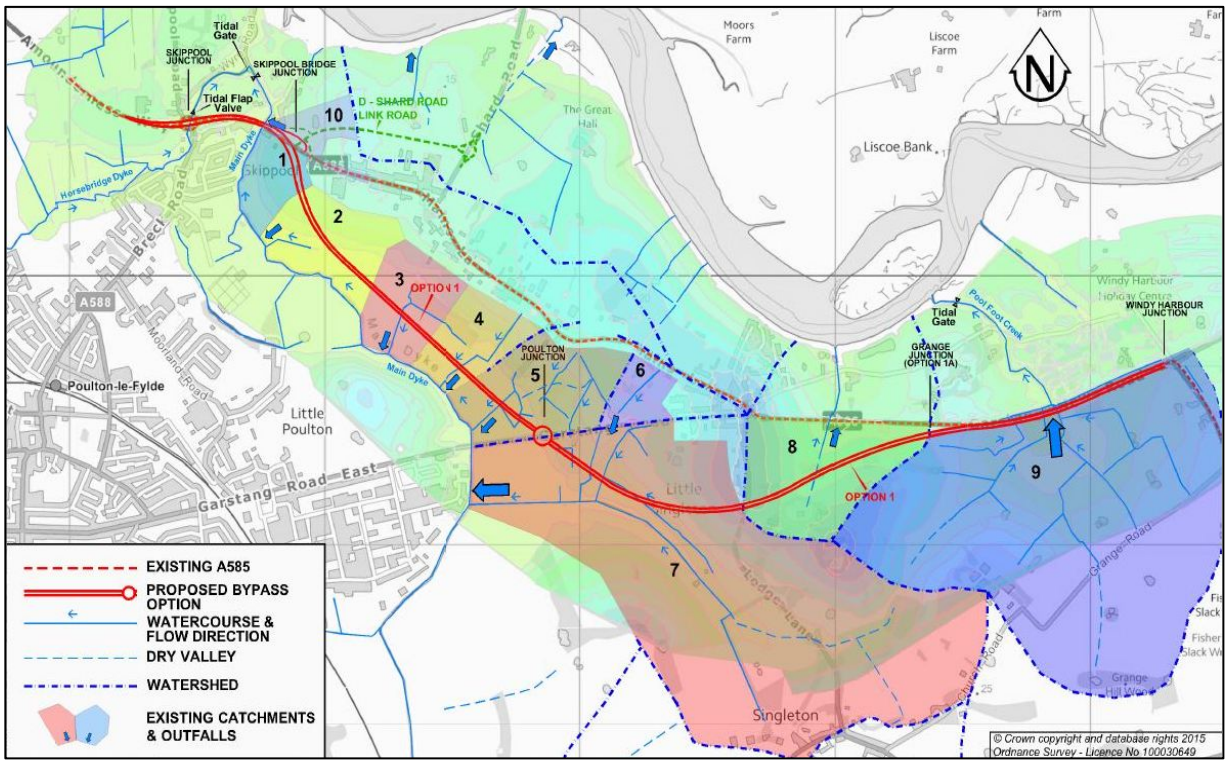


Figure 2-2: Existing Watercourses and Overland Flow Catchments

2.5.6 Apart from watercourses, other waterbodies such as ponds and lakes are also present within the area of interest. Many of the waterbodies are small ponds which are isolated within the adjacent rural areas and can be seen on the Existing drainage and site clearance catchment plan in Appendix C.

2.6 Existing flood risk assessment data

2.6.1 The EA, via their website, provide floodplain mapping data for the UK. The floodplain is the area that would naturally be affected by flooding if a river rises above its banks, or high tides and stormy seas cause flooding in coastal areas.

2.6.2 The floodplain mapping shows two different kinds of flooding for the river and the sea and are described as:

- Zone 3 (dark blue) – Shows the area that could be affected by flooding either from rivers or the sea, if there were no flood defences. This area could be flooded:
  - I. from the sea by a flood that has a 0.5 per cent (1 in 200 years) or greater chance of happening each year; or
  - II. from a river by a flood that has a 1 per cent (1 in 100 years) or greater chance of happening each year.
- Zone 2 (light blue) - shows the additional extent of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1 per cent (1 in 1000 year) chance of occurring each year.

2.6.3 Where there is no blue shading, flooding from rivers and/or the sea is very unlikely. There is less than a 0.1 per cent (1 in 1000 years) chance of flooding occurring each year. These areas are described as Flood Zone 1.

2.6.4 There are 3no. primary watercourses within the scheme area, which are classified as Statutory Main River as discussed in section 2.5.1

2.6.5 From the EA's flood plain mapping the proposed offline bypass is at risk from 1 in 100-year river flood event and the 1 in 200-year tidal event (flood zone 3), as shown in **Figure 2-3**. The current fluvial flooding is associated with the river being tide locked and the restriction imposed by the existing Skippool Bridge.

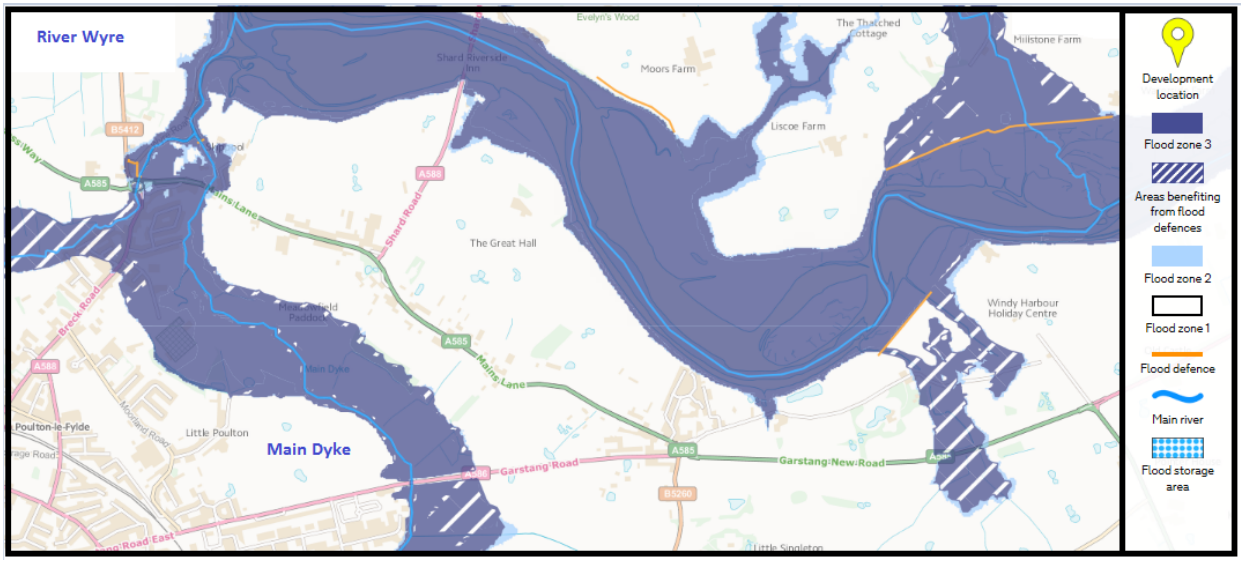


Figure 2-3: EA Flood Zone and Main River Mapping (not to scale)

2.6.6 A Flood Risk Assessment report (HE548643-ARC-GEN-A585-RP-EWE-2032) identifies that parts of the bypass route are within flood risk zones 1, 2 and 3 particularly affecting the sections:

- At Skippool Junction
- Between the proposed Skippool Bridge junction and Poulton junction
- Immediately south-west of Poulton Junction; and
- At Pool Foot Creek west of Windy Harbour Junction.

2.6.7 However, it should be noted that the effect of the scheme on these flood zones needs to be reviewed following completion of the Flood Risk Assessment (still to be agreed with the Environment Agency).

2.7 Aquifers and groundwater

2.7.1 The EA provides groundwater mapping data for the UK. Groundwater supplies a third of the drinking water in England and Wales. The EA has a duty to monitor and protect the quality of groundwater and to conserve its use for water resources as set out in their Policy and Practice for the Protection of Groundwater (1998). As a result, the EA have defined Source Protection Zones (SPZs) for 2000 groundwater sources (wells, boreholes and springs) used for the supply of public drinking water.

2.7.2 The shape and size of a zone depends on the condition of the ground, how the groundwater is removed, and other environmental factors.

2.7.3 The maps show three main zones:

- Inner zone (Zone 1) - Defined as the 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres
- Outer zone (Zone 2) - Defined by a 400-day travel time from a point below the water table. This zone has a minimum radius of 250 or 500 metres around the source, depending on the size of the abstraction; and
- Total Catchment (Zone 3) - Defined as the total recharge area around a source.

2.7.4 An overview of the scheme area shown in **Figure 2-4** below indicates that there are no Inner, Outer or Total Catchment (Zone 1, 2 or 3) source protection zones within the existing A585 truck road corridor.

2.7.5 No discussion regarding groundwater abstraction licenses for public, industrial and agricultural water supplies point has been held with the EA due to the distance the scheme is away from the source protection zones.

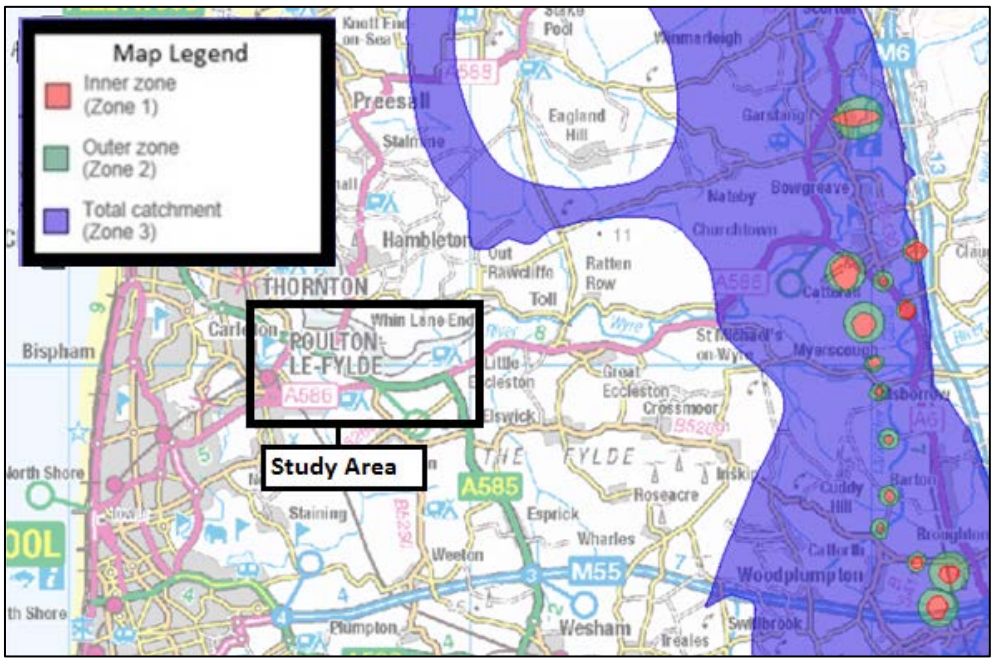


Figure 2-4: EA Source Protection Zone Mapping (not to scale)

2.7.6 A review of the Groundwater Vulnerability Mapping has also been undertaken to examine the EA's assessment of the likelihood of a pollutant discharged at ground level reaching groundwater within superficial and bedrock aquifers. The status of the aquifer shown in **Figure 2-5**is an indication of the importance of the groundwater for drinking water supply.

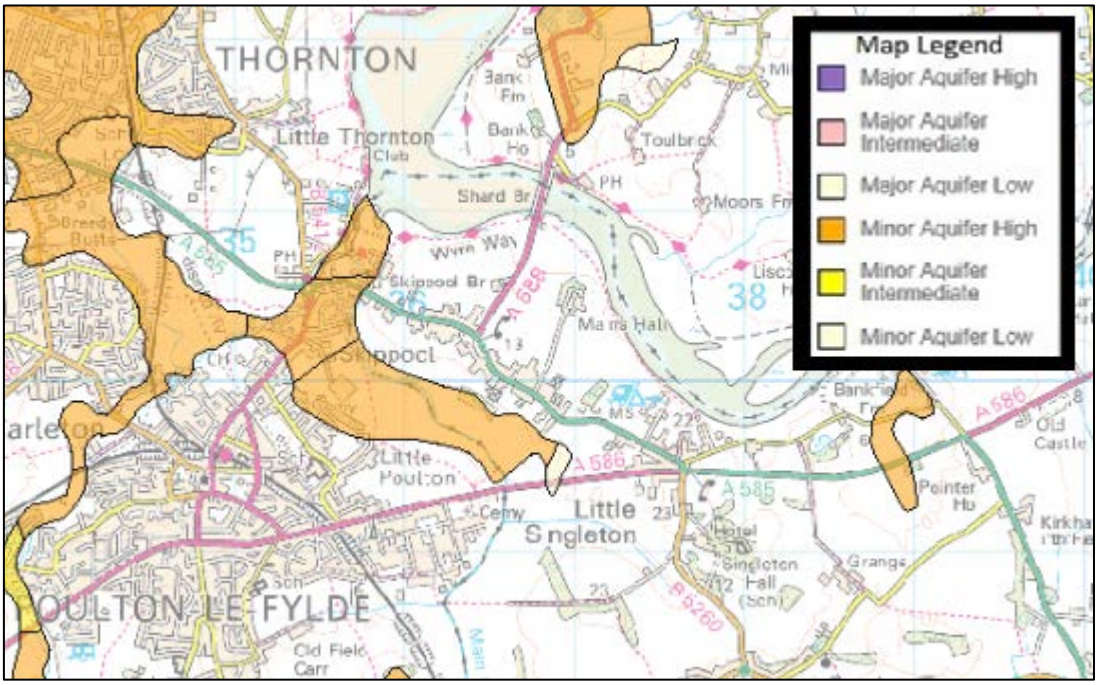


Figure 2-5: EA Groundwater Vulnerability Mapping (not to scale)

2.7.7 Part of the proposed offline bypass is located above a Minor Aquifer which has a vulnerability status of high. The remainder of the scheme located outside of an aquifer.

2.7.8 The groundwater level within the Minor Aquifer is unknown and the existing drainage information suggests that the existing A585 drainage discharges to watercourses and not to ground.

2.7.9 The Groundwater Flooding Susceptibility Mapping (**Figure 2-6**) shows that there is a limited potential for surface water flooding caused by groundwater along the existing A585. As would be expected, groundwater could potential cause flooding at the ground surface close to watercourse locations.

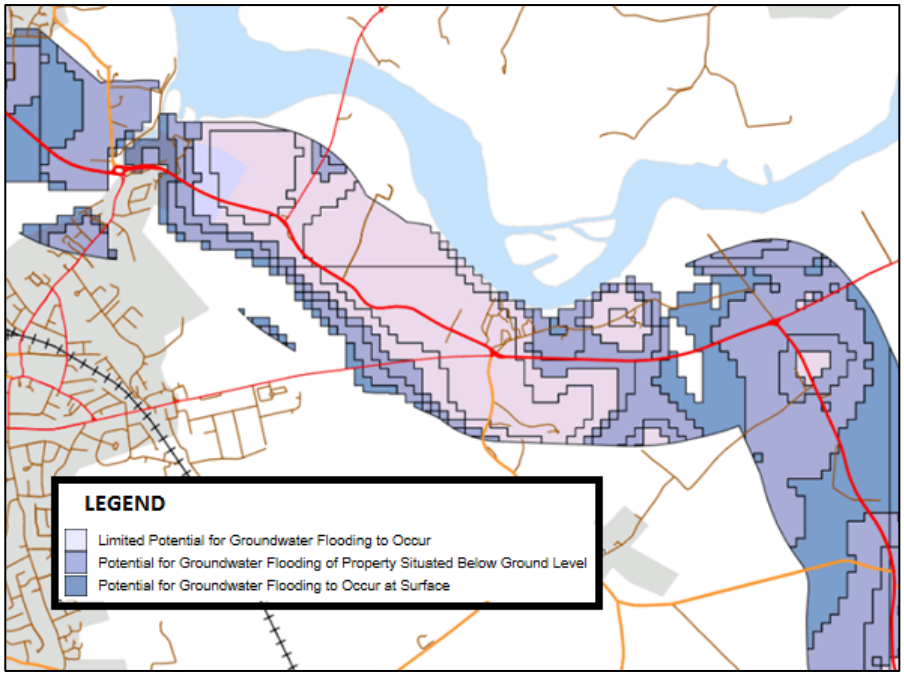


Figure 2-6: EA Source Protection Zone Mapping (not to scale)

2.7.10 The Stage 2 ground investigation data is limited, and as a result, further ground investigation works have been undertaken at Stage 3 to inform the preliminary design.

2.8 Geology

2.8.1 A review of the geology in the scheme area has identified that the bypass crosses agricultural land that is classified as Grade 2 in the Agricultural Land Classification system. The geology underlying the options comprises glacial till and tidal flat deposits (predominantly clay and silt) underlain by mudstone bedrock. These soils and rocks tend to have a low permeability that leads to the restriction of movement of contamination.

2.8.2 An overview of the drift geology can be seen in **Figure 2-7**:

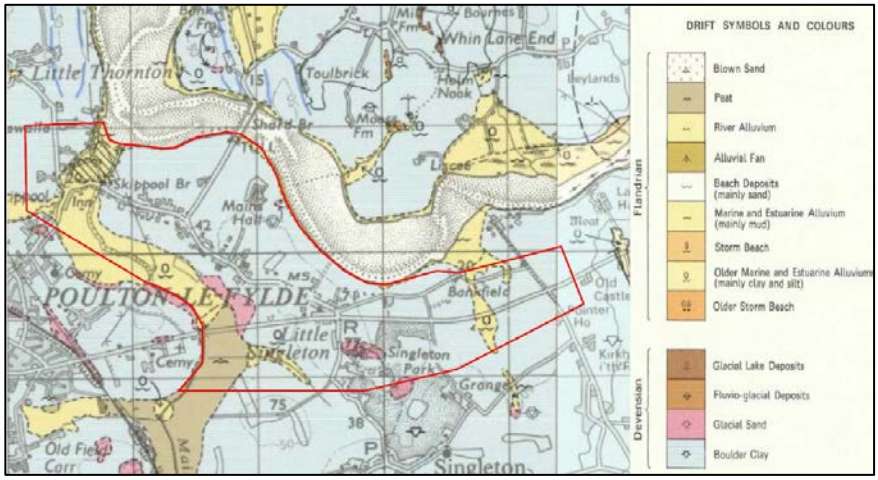


Figure 2-7: Drift geology

2.8.3 Along the route of the proposed bypass, the ground conditions vary and, in summary – working from west to east, are:

- Amounderness Way west of Skippool Junction – artificial embankment on generally glacial till
- Skippool Junction to Main Dyke – River alluvium with soft marshy areas
- Bypass on embankment from Skippool Bridge Junction to Poulton Junction – along the interface between Glacial Till and River Alluvium comprising very soft ground
- Poulton Junction – interface between River Alluvium, Peat and Glacial sands and gravels
- East of Poulton Junction to Lodge Lane – bypass on embankment and then deep cutting mainly on Glacial Till
- East of Lodge Lane to Garstang New Road deep cutting through Glacial Till but also passing through a possible cap of glacial sands and gravels; and
- Garstang New Road to Windy Harbour Junction – Glacial Till but crossing an incursion of river alluvium about 0.5km west of Windy Harbour Junction.

2.9 Existing drainage catchments and discharge points

2.9.1 The desk top study of the as-built records, HADMMS and CCTV asset surveys have indicated a total of 19no. primary drainage catchments within the scheme limits.

2.9.2 The existing drainage catchments and their discharge points are shown on the Existing Drainage Catchments and Waterbodies plans provided in Appendix C

2.9.3 Table 2-1 lists the existing road drainage catchments and their discharge points:

Catchment ID	Location Description	Approximate Road Length (m)	Receiving Watercourse
1	Amounderness way to Skippool Junction	485	Horsebridge Dyke/ Skippool Creek
2	B5412 Skippool Road	60	Horsebridge Dyke/ Skippool Creek
3	A585 Break Road to Skippool Bridge	260	Main Dyke
4	Skippool Bridge to A585 Mains Lane	415	Main Dyke
5	A585 Mains Lane to A585 Shard Road	325	Unknown
6	A585 Shard Road	575	Unknown
7	A585 Shard Road to A585 Mains Lane	545	Unknown

Catchment ID	Location Description	Approximate Road Length (m)	Receiving Watercourse
8	A585 Mains Lane	400	Unknown
9	A585 Garstang New Road	710	Land ditch to River Wyre
10	A585 Garstang New Road	490	Land ditch to River Wyre
11	A585 Garstang New Road	780	Land ditch to River Wyre
12	A586 Garstang New Road East	530	Land ditch to Main Dyke
13	A586 Garstang New Road East	590	Main Dyke
14	B2560 Lodge Lane	210	Unknown
15	Pool Foot lane	80	Unknown
16	A4585 Shard Road	610	Land ditch to River Wyre
17	Old Mains Lane	38	Unknown
18	Skippool Junction	150	Horsebridge Dyke/ Skippool Creek
19	Skippool Junction	80	Horsebridge Dyke/ Skippool Creek

Table 2-1: Existing Drainage Catchments and Discharge points

2.9.4 A hydraulic modelling assessment of the existing drainage networks has been undertaken in Micro Drainage to determine existing discharge rates and the results are tabulated in Table 2-2. This assessment is based on the existing data available and will need to be updated and reviewed following receipt of the outstanding asset and condition survey data.

Catchment ID	Drainage Network Catchment Area (impermeable Catchment)	Calculated Existing Flow Rates in litres per second (1 in x year storm return period)		
(…)	(ha)	1 in 1 year	1 in 5 year	1 in 100 year
1	0.753	61.3	91.1	132.7
2	0.126	10.8	17.3	30.8
3	0.418	29.9	50.4	77.3
4	0.706	42.9	60.2	82.5
5	0.383	26.1	35.5	52.4
6	0.605	27.3	54.4	107.2
7	0.507	31.5	40	50.7
8	0.446	41.9	60.6	100.6
9	0.836	69.9	109	168.5
10	0.438	33	48.8	69.1
11	2.073	112.9	184.9	306.8
12	0.578	49.2	70.3	96.1
13	0.526	29.6	43.5	66.5
14	0.158	10.8	13.9	20.2
15	0.115	11.6	19.2	27.4
16	0.513	30.7	43.5	79.9
17	0.044	4.4	7.4	17.5
18	0.100	10.8	18	27.7
19	0.207	15.3	23.7	34.5

Table 2-2: Existing Drainage Catchment Areas and Discharge Rates

2.9.5 The existing highway drainage on the A585 route within the study area is predominantly by trapped gulley's or kerb off let gulley's connecting to carrier drains, with intermediate chambers, that discharge into field ditches or watercourses. In general, there are no specific measures to treat highway the larger discharges but some of the outfalls are provided with flap valves to prevent backflow of water from the larger watercourses.

2.9.6 The only exception to the above is the drainage network provided for the recently upgraded Windy Harbour Junction that uses combined kerb-drains that discharge to an oversized pipe that has been provided with a penstock valve and vortex flow control device at the outfall from this catchment.

2.9.7 The existing drainage networks are shown on the “Existing Drainage and Site Clearance” plans provided in Appendix D.

2.9.8 Highways England Operations Directorate Department did state that there could be existing surface water drains from the proposed de-trunked A585 that could cross the proposed offline bypass and they should be traced and the pipes protected and / or diverted to ensure their outfalls are maintained.

2.10 Condition of the existing drainage assets (stage 2 data)

2.10.1 A review of the available Stage 2 CCTV asset and condition data has been undertaken to confirm the condition of the existing drainage assets.

2.10.2 The review identified that CCTV asset and condition data is only available for the section of existing carriageway between Skippool Junction and Skippool Bridge and the available survey data is provided in Appendix A.

2.10.3 A review of this data has shown that there is current 1no. category 5 defect (collapsed pipe) and 6no. category 4 defects and 17no. “Survey abandoned” due to collapse, debris or loss of vision.

2.10.4 Further CCTV asset and condition data will be required to complete the stage 3 design, as discussed further in section 3.10.

2.11 Existing drainage design life

2.11.1 Limited as-built data is available and as a result the time of construction is difficult to confirm. However, the road wasn’t original constructed to DMRB standards and it’s difficult to confirm its residual life and has been subject to changes in the 1960’s and 1970’s before the road became a Trunk Road.

2.11.2 The DRMB states that the drainage assets have a design life of 60 years.

2.12 Flood hotspot summary

2.12.1 HADDMS has been reviewed for existing flooding incidents and “hotspots” along the existing A585 and at the tie-in location for the new offline bypass. 26 no. flood incidents between 2005 and 2015 have been identified with the scheme limits which include the existing A585 which will be de-trunked.

2.12.2 Extracts of maps identifying flood hotspot locations are given in Figure 2-8 to Figure 2-11 and a summary of details from HADDMS are provided in Tables Table 2-3 to Table 2-6.

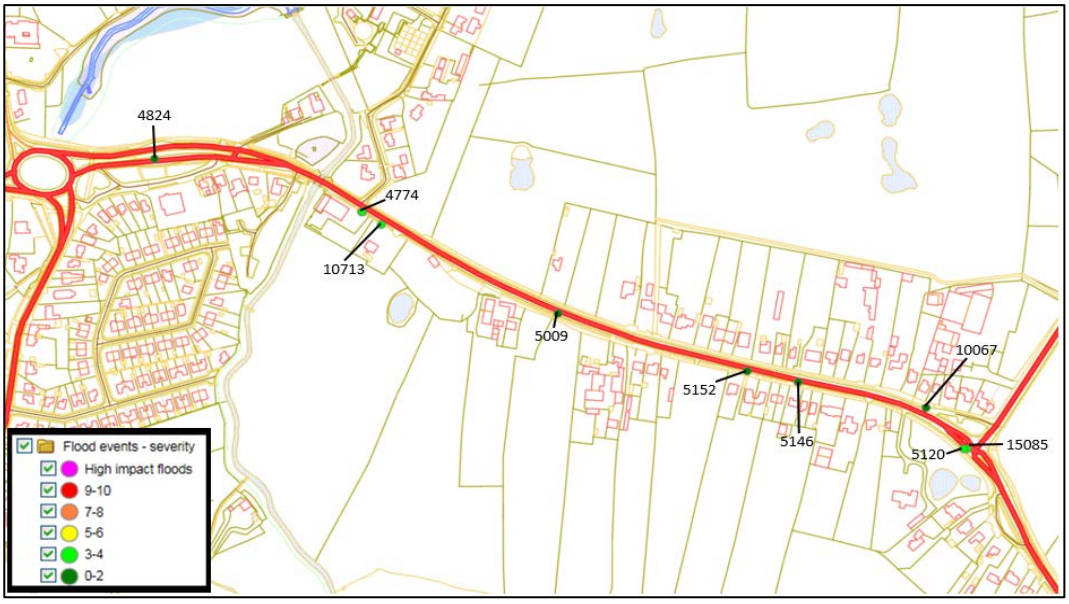


Figure 2-8: HADDMS Recorded Flood Incidents between Skippool Junction and Shard Road Junction (not to scale)

2.12.3 There are 9no. recorded flooding incidents between Skippool Junction and Shard Road as shown in Figure 2-8 and detailed in Table 2-3.

Flood ID	Date/Time Reported	Location (MP)		Description	Severity
		OS Easting	OS Northing		
4824	03/04/2006 14:54	335582	335582	Report of water on carriageway A585 Skip Pool - A585 Skip Pool by the ESSO garage	0.77
4774	21/10/2005 09:39	335798	440524	Report of 3 Blocked Gullies causing carriageway to flood - A585 Mains Lane adjacent to Shard Lane traffic signals Bet House No 137 and 139	2.94
10713	05/10/2012 15:45	335818	440510	water has been running off fields adjacent to carriageway. gullies unable to cope with volume of water following sustained period of heavy rainfall	2.52
5009	21/08/2008 05:43	336002	440413	Report of flooding - Between Singleton lights & Skippool roundabout	0.84
5152	06/01/2010 12:43	336199	440350	Blocked Drain - Outside 150 Mains Lane	0.76
5146	07/12/2009 14:59	336252	440338	Blocked drain causing flooding - Outside 150 Mains Lane	0.67
10067	11/05/2012 12:25	336385	440310	flooding	0.25
5120	08/10/2009 16:36	336424	440265	Blocked gullies - Shard Bridge Road	2.94
15085	28/03/2015 08:44	336428	440265	Flooding on carriageway due to partially blocked gullies and heavy rainfall.	3.53

Table 2-3:Flood Event Incident Records

2.12.4 The 9no. recorded incidents can be attributed to blocked gullies and pipe work and are all low risk.

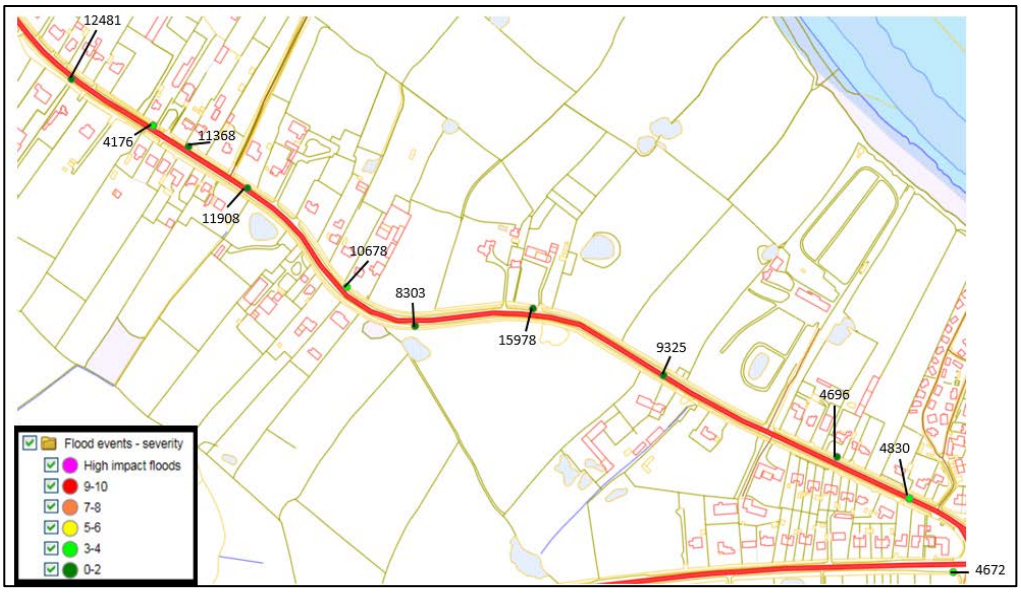


Figure 2-9: HADDMS Recorded Flood Incidents between Shard Road and Garstang Road East (not to scale)

2.12.5 There are 10no. recorded flooding incidents between Shard Road and Garstang Road as shown in Figure 2-9and detailed in Table 2-4.

Flood ID	Date/Time Reported	Location (MP)		Description	Severity
		OS Easting	OS Northing		
12481	09/09/2013 11:00	336591	440036	Small amount of flooding over the carriageway	0.67
4176	08/01/2007 12:21	336688	439982	Reporting further problems with blocked gully - Outside 60 Mains Lane, Little Singleton	3.53
11368	18/12/2012 13:46	336730	439958	Have come across flooding outside 84 Mains Lane. Flooding is across the footway and both carriageways and requires jetting.	0.25
11908	15/02/2013 11:55	336800	439910	water flowing from drain cover in footway. drain is part of c 'way drainage system. water flows at low pressure across footpath into c 'way channel	0.76
10678	01/09/2012 13:55	336918	439796	A585 - Approximately 15 metres of eastbound carriageway affected.	3.78
8303	11/08/2011 05:30	336999	439751	Flooding caused by numerous blocked gullies and exceptionally heavy rainfall	0.76
15978	18/11/2015 13:15	337139	439771	Received a call from a member of the public who reports flooding onto her property from the Mains Lane causing her electric gates to become faulty. Contacted Tony Peet who will attend.	1.12
9325	16/12/2011 11:52	337294	439694	Member of public reported flooding on his driveway due to a blocked drain on the footpath. Mains Lane, A585.	0.84
4696	22/10/2004 17:57	337500	439600	Callers Drive is flooded Due to water running down from the Carriageway - A585 outside Above Address	0.84
4830	23/05/2006 10:06	337586	439552	Report of a blocked gully A585 - A585 Mains Lane	2.94

Table 2-4: Flood Event Incident Records

2.12.6 The 10no. recorded incidents can be attributed to blocked gullies and pipe work and are all low risk.



Figure 2-10: HADDMS Recorded Flood Incidents between Garstang Road and the approach to Windy Harbour Junction (not to scale)

2.12.7 There are 2no. recorded flooding incidents between Garstang Road and the approach to Windy Harbour Junction as shown in Figure 2-10 and detailed in Table 2-5.

Flood ID	Date/Time Reported	Location (MP)		Description	Severity
		OS Easting	OS Northing		
4836	23/06/2006 11:27	337683	439469	Report of a Blocked Drain on the roundabout at River Wyre Hotel - A585 at roundabout at River Wyre Hotel opposite to Lamp column T369	2.94
4808	03/01/2006 08:02	337695	439463	Report of a blocked road drain on the Trunk Road A 585 at Little Singleton Poulton-le Fylde - A585 at Little Singleton Poulton-le Fylde	2.94

Table 2-5: Flood Event Incident Records

2.12.8 The 2no. recorded incidents can be attributed to blocked pipe work and are both low risks.

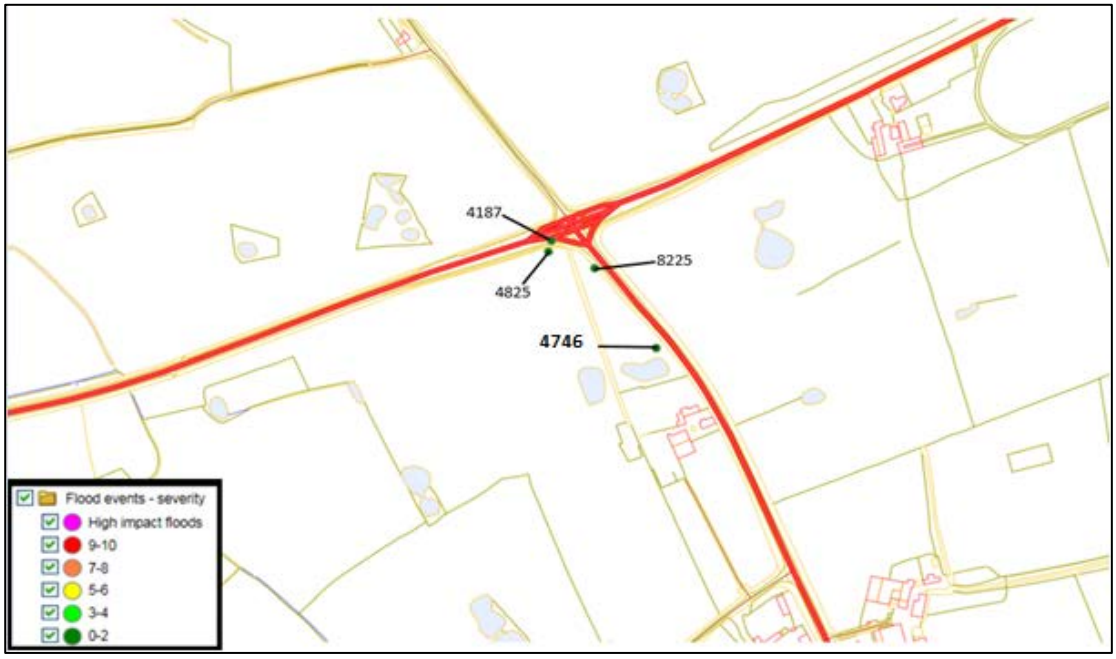


Figure 2-11: HADDMS Recorded Flood Incidents between Windy Harbour Junction and Fleetwood Road (not to scale)

2.12.9 There are 10no. recorded flooding incidents between the approach to Windy Harbour Junction and Fleetwood Road as shown in Figure 2-11 and detailed in Table 2-6.

Flood ID	Date/Time Reported	Location (MP)		Description	Severity
		OS Easting	OS Northing		
4825	13/04/2006 09:21	339300	439650	4 blocked gullies - A585 Mains Lane Jct Shard Rd	0.67
4187	11/11/2008 11:28	339303	439662	Blocked gullies overflowing - Mains Lane, Poulton-Le-Fylde	0.88
8255	04/08/2011 13:35	339348	439632	standing water in kerbside channel into live lane due to heavy rainfall. gullies clear	0.25
4746	20/04/2005 10:37	339412	439545	Caller is Reporting Blocked Drain looks like Bricks in it and is flooding his Yard - A585 Outside Callers Address Poulton le Fylde	0.84

Table 2-6: Flood Event Incident Records

2.12.10 The 4no. recorded incidents can be attributed to blocked gullies and pipe work and are all low risk.

2.13 Priority outfall summary

2.13.1 In 2000 Highways England investigated potentially polluting outfalls across its entire strategic road network. The outfalls were classified A to D according to their perceived risk, “A” being “Very High” and “D” being “Low” risk. Those outfalls classified as ‘A’ (very high risk) were labelled ‘Priority Outfalls’. A total of 10 no. outfalls location are recorded on the HADMMS as shown in Figure 2-12and Figure 2-13.

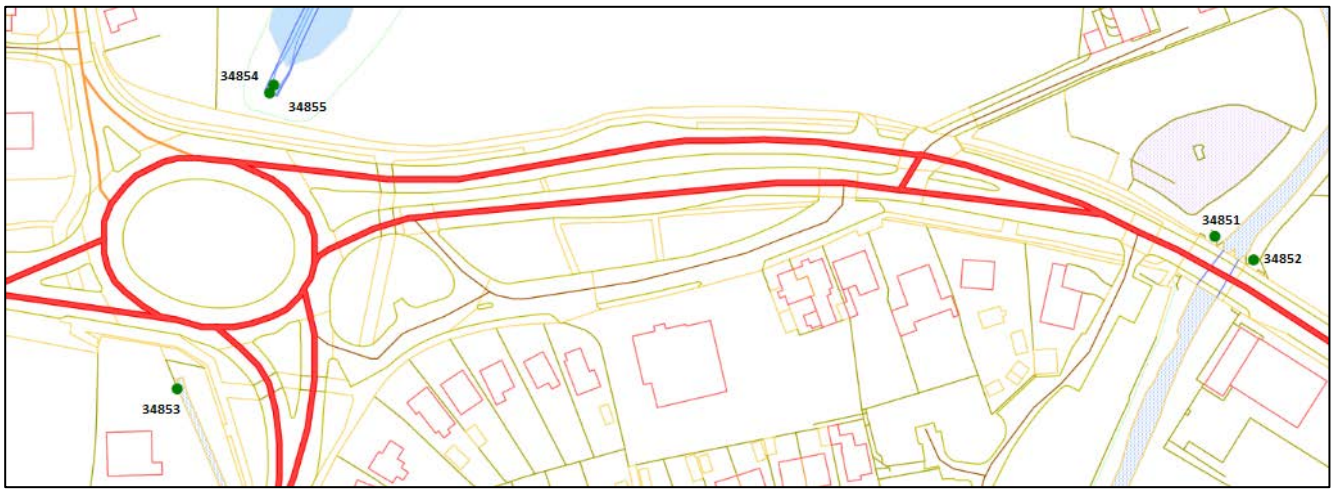


Figure 2-12: HADDMS Priority outfalls overall status between Skippool Junction and Skippool (not to scale)

2.13.2 5 no. outfalls have been identified between Skippool Junction and Skippool Bridge, all of which have an outfall overall status of “D” (low risk) and do not form part of the Priority Outfall Programme.

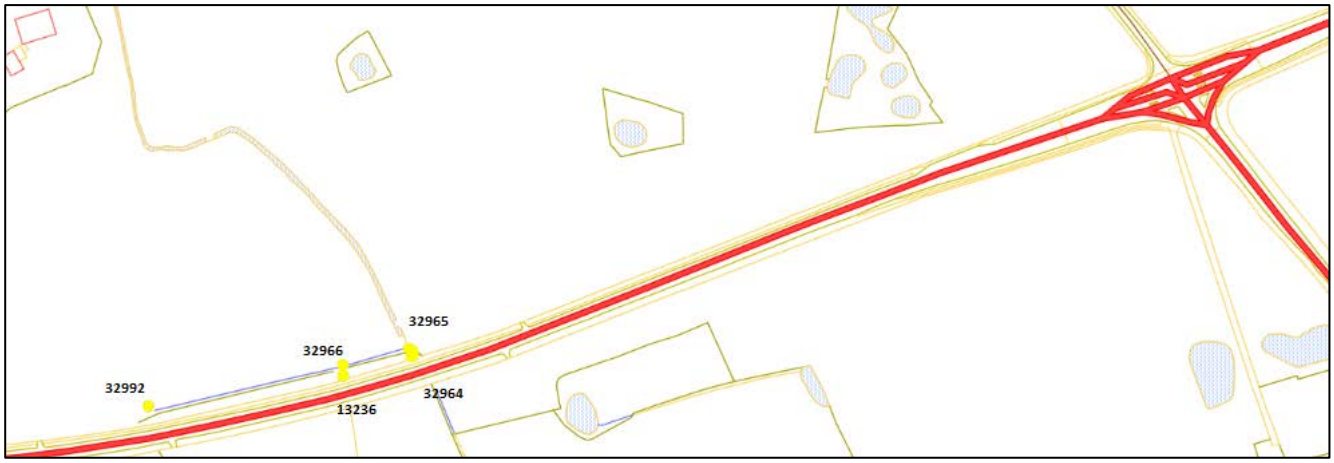


Figure 2-13: HADDMS Priority outfalls overall status between Garstang New Road and Windy Harbour Junction (not to scale)

2.13.3 5 no. outfalls have been identified between Garstang Road and Windy Harbour Junction, all of which have an outfall overall status of “C” (moderate risk) and do not form part of the Priority Outfall Programme.

2.13.4 An extract from the outfall register for each outfall can be found in Appendix E.

2.14 Priority culvert summary

2.14.1 Highways England also have a priority culverts register which identifies culverts under the road network that are undersized and could lead to flooding incidents during heavy rain. The culverts were classified A to D according to their perceived risk, “A” being “Very High” and “D” being “Low” risk.

2.14.2 One culvert has been identified with the scheme study area as shown in Figure 2-14 and it has been classified as low risk (classification D) as shown in Figure 2-15.



Figure 2-14: HADDMS Priority culvert overall status between Garstang New Road and Windy Harbour Junction (not to scale)

2.14.3 The register states that the culvert has no history of flooding and has a status “D” (low risk).

Culvert Register

Culvert Register ID	7584
HD43 asset ref	SD3839_8147a.1
Baseline category	D (Low)
Number of flood events	0-1
Flood severity	No history of flooding
Max impact	None
Verification status	Desk Study complete - no field study required
Action status	Not required
Overall risk status	X (Risk Addressed)
Proposed solution	Not required
Actual solution	Not required
Last updated	29/07/2011

Figure 2-15: HADDMS Priority culvert overall status register extract

2.14.4 The existing Skippool Clough Culvert is not classified as a drainage culvert on HADDMS but is recorded as a culvert in SMIS due to its internal diameter.

3 PROPOSED HIGHWAY DRAINAGE

3.1 The legal framework – flood risk

3.1.1 In England and Wales, the Environment Agency (EA) has a general supervisory role over all matters relating to land drainage and flood defence. Under the Land Drainage Act, there are two primary types of watercourse defined:

- Statutory Main River; and
- Ordinary Watercourses.

3.1.2 For 'Statutory Main River', the Environment Agency has powers under the Land Drainage Act and Water Recourses Act for flood defence purposes. For 'Ordinary Watercourses' the Local Authority has powers under the Land Drainage Act 1991 and local Land Drainage Byelaws to make riparian landowners manage watercourses appropriately. The relevant local authority is Lancashire County Council.

3.1.3 Highways England acting on behalf of the Secretary of State for Transport has the powers, under Section 100 of the Highways Act to discharge drainage from highways into any inland waters, whether natural or artificial, or any tidal waters (which includes groundwater). The powers relate only to drainage of the highway, which may be taken to include all land within the highway boundary.

3.2 The legal framework – water quality

3.2.1 The key piece of legislation with respect to the management of water resources and pollution control is the Water Framework Directive (WFD). The Directive was translated into English and Welsh law through The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003, which came into force in January 2004.

3.2.2 The key objectives of the WFD is the provision of River Basin Management Plans (RBMPs), which aim to:

- Prevent deterioration, enhance and restore bodies of surface water, achieve good chemical and ecological status of such water and reduce pollution from discharges and emissions of hazardous substances;
- Protect, enhance and restore all bodies of groundwater, achieve good chemical and quantitative status of groundwater, prevent the pollution and deterioration of groundwater, and ensure a balance between groundwater abstraction and replenishment; and
- Preserve protected areas.

3.2.3 It requires that the water environment be looked at, integrating water quality, quantity and physical habitat with ecological indicators. Information gathered through the Environment Agency's monitoring programmes will allow the classification of surface water bodies into one of five WFD ecological status classes (High, Good, Moderate, Poor, Bad) and one of two chemical status classes (Pass/Fail).

3.2.4 One of the main goals of the Directive was to aim for at least 'good' ecological and 'good chemical status for surface waters, and 'good' chemical and 'good' quantitative status for groundwater by 2015.

3.2.5 The RBMPs are subject to a 6-yearly cycle. The first cycle of river basin planning ran from the publication of RBMPs in 2009 until 2015, the second cycle of river basin planning will run from 2015 until 2021. The Environment Agency submitted the proposed updated plans to ministers for approval on 30 October 2015, with publication due in early 2016.

3.2.6 The Environment Agency have released data they've collected for Cycle 2 and have published results for waterbodies.

3.2.7 The following watercourses are either near or cross the existing / proposed A585 are classified under WFD:

- River Wyre - Waterbody ID GB531207212200) Heavily Modified, transitional waterbody (estuarine). Overall ecological status of Moderate Potential, limited by some supporting elements/conditions, including dissolved inorganic nitrogen concentrations. Chemical status of Fail against the priority substances and priority hazardous substances categories;

- Horsebridge Dyke not monitored under the WFD, we are likely to infer quality based on data for the Main Dyke;
- Main Dyke - known as the Hillylaid Pool, (Waterbody ID GB112072066120) is classified as a heavily modified waterbody overall ecological status of Moderate Potential, no info provided in the River Basin Management Plan on limited factors. Good status regarding chemical quality; and
- Pool Foot Creek - not monitored under the WFD, need to infer water quality, consider it is likely to be of low quality as available dilution is limited.

3.2.8 Normally, consent from the Environment Agency (EA) under Section 88 of the Water Resources Act 1991 is required to discharge into controlled waters. Section 89(5) of that Act says, however, that a highway authority draining a highway under Section 100 powers will not be committing an offence if it does not have consent under Section 88.

3.2.9 The existing A585 was originally constructed prior to the Water Resources Act and there are no records of any formal Flood Defence consents.

3.2.10 Highways England acknowledges its obligation not to pollute and has provide guidance on the assessment and management of the impacts that the new construction, have on the water environment in HD45/09.

3.2.11 The issue of Pollution Control (Water Quality) and Accidental Spillage Containment is discussed further in Section 3.7.

3.3 Design standards

3.3.1 The stage 3 drainage design has been undertaken in accordance with standards, advice notes and IAN given in the Design Manual for Roads and Bridges (DMRB).

3.4 Design principles

3.4.1 The drainage system shall be able to rapidly remove water from the carriageway and prevent flooding of the carriageway for the design storm return periods.

3.4.2 The drainage system shall accommodate such run-off from the highway and from adjacent (external) catchments and increased rainfall intensities (related to predicted climate change effects), where possible, within the various constraints of the scheme design – in particular the land constraints.

3.4.3 Both with respect to water quality and discharge rates the aim of the design is, where possible, to:

- Achieve the required DMRB standards;
- Improve on the existing situation; and
- Improve on the ease of maintenance to provide a long-term improvement in highway water quality discharges.

3.4.4 The Environment Agency has indicated that it would like to see discharge rates reduced to those for “greenfield sites”.

3.5 Climate change

3.5.1 Guidance from HD33/16 states that an allowance for climate change should be incorporated into the design. To achieve he rainfall intensities used to calculate the design storms must include an allowance for the effects of climate change. Where rainfall data exclude such an allowance, a sensitivity test on the design of the drainage system must be carried out by increasing rainfall intensities of the design storm by 20% and adjustment made to the design should the initial design fail this sensitivity test.

3.5.2 The National Planning Policy Framework (NPPF) Table 5 of the Technical Guidance Note states that a scheme with a design life extending to a point earlier than 2085 should adopt a 20% allowance for climate change as shown in **Figure 3-1**:

Table 5: Recommended national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak Rainfall Intensity	*5%*	*10%*	*20%*	*30%*
Peak river flow	*10%*	*20%*		
Offshore wind speed	*5%*		*10%*	
Extreme wave height	*5%*		*10%*	

Figure 3-1: Table 5 extract from technical guidance note to NPPF (DCLG – 2012)

3.5.3 This Technical Guidance Note was withdrawn in March 2014 and replaced with a new guidance on flood risk assessment: climate change allowances and that the upper end allowance of 40% is now recommended, shown in Figure **3-2**2:

Table 2: peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

Figure 3-2: Table 2 extract from flood risk assessment: climate change guidance

3.5.4 As the scheme has a design life extending to 2080 the design will be developed based on applying a 20% climate change allowance.

3.6 Water quality

3.6.1 As stated in Section 3.2 Highways England acknowledges its obligation not to pollute and the design will ensure that discharges from the carriageway will not lead to deterioration in the classification status of the receiving watercourses.

3.6.2 An assessment of the potential ecological impacts from the route runoff has been assessed using the Highways England Water Risk Assessment Tool (HAWRAT) to determine whether there is an environmental risk and if pollution mitigation measures need to be adopted.

3.6.3 The Environment Agency have approved the method of assessment used by HAWRAT and have agreed their output assessments can be used in eth Environmental Impact Assessment (EIA).

3.7 Pollution control

3.7.1 Spillages caused by accidents or other causes can occur anywhere on the road network and an assessment of the risk of acute pollution impact has been undertaken utilising Assessment Method D in HD45.

3.7.2 The proposed road catchment has been assessed, and targeted mitigation measures will be included in the design at high risk areas.

3.8 Consultations undertaken to inform the design

3.8.1 While investigating the existing drainage, and developing the Stage 3 drainage strategy for the scheme the following statutory consultees were contacted:

- Highways England Safety Engineering and Standards (S.E.S) Department
- Highways England Operations Directorate (O.D.) Department
- Environment Agency (EA)

- Lead Local Flood Authorities (LLFA's) – Lancashire County Council.

3.8.2 No non-statutory consultees have been contacted during the development of the Stage 3 drainage design.

3.8.3 Table 3-1show the liaison that has taken place to date:

ID	Stakeholder	Date	Comments
Stage 3 Design Consultation			
1	Highways England S.E.S Department	15/11/2017	Stage 3 design agreed in principle, close out 40% sensitivity allowance with Scheme Project Sponsor
2	Highways England O.D Department	16/11/2017	Stage 3 design agreed in principle
3	Environment Agency	Varies (email)	Stage 3 design discussed and request to design to DMRB and Ciria guidance confirmed.
4	Lancashire County Council	30/11/2017	Stage 3 – walk over survey
5	Lancashire County Council	28/11/2017 06/12/2017 11/01/2018 05/02/2018 (email)	Stage 3 – Email correspondence regarding setting up a drainage presentation – no response
6	Lancashire County Council	13/02/2018	Telephone to arrange meeting
7	Lancashire County Council	20-03-2018	Presentation to LCC
8	Environment Agency	30-04-2018	Introduction to the scheme

Table 3-1: Stage 3 Design consultation

3.8.4 Copies of the above correspondence, minutes of meetings and presentations can be found in Appendix F.

3.8.5 During consultation with Highways England S.E.S Department, the climate change allowance of 20% was raised and a requested was made to undertake a 40% sensitivity check on the design and the outcome reported back to them. They appreciated that the guidance in the DMRB was not clear regarding climate change.

3.8.6 Highways England confirmed that all edge drain details for collection of run off and carrier pipes/conduits for conveyance of that run off shall be designed based on the 'rainfall' experienced by the road catchment. River levels and sea levels are not part of this design consideration. However, all drainage design shall incorporate appropriate discharge controls to comply with the national requirements.

3.8.7 Highways England fully recognise the design standards described in the National Planning Policy Framework (NPPF) for climate change adaptation. NPPF provides the tools we need to ensure the SRN drainage network can be designed, constructed and operated in a safe way, and to meet our legal obligation not to increase the risk of flooding. All new schemes shall adopt the following approach to drainage design:

- For all new schemes that do not involve adaptation of an existing drainage network: Full compliance with the requirements described in NPPF
- For all new schemes that involve adaptation of an existing drainage network: Compliance in accordance with HD33, except for Smart Motorways where IAN 161 shall apply;
- In both 1 and 2, above, the design solution shall incorporate a 20% uplift in peak rainfall intensity. The proposal shall also sensitivity test the design with a 40% uplift in peak rainfall intensity. The difference between the 2 scenarios (Central and Upper) shall enable the end user to understand the range of impact between the climate change risk scenarios. In the light of this knowledge the Project Sponsor shall determine the appropriate course of action to be implemented
- For all schemes that use existing outfalls, the current discharge rates shall not be exceeded. The current discharge rates (no rates were historically pre-defined, or pre-agreed) shall be calculated using the current design methods available within DMRB 4.2
- All schemes shall be checked for a 1 in 100-year flooding compliance

3.8.8 For full details refer to the Minutes of Meeting (Document Number HE548643-ARC-HDG-A585-MM-Z-3008) in Appendix F.

3.8.9 During consultation with Lancashire County Council they confirmed that they agreed with our drainage proposals in principle.

3.9 Agreed design principles

3.9.1 Following discussions with Highways England S.E.S and O.D departments during Stage 3 design, it has been agreed with the Scheme Project Lead that the following drainage design principles be applied to the project:

- Draft drainage standards which are yet to be published shall be used in the design:
- Departures to maximise efficiency will be incorporated in the design;
- 40% climate allowance will be incorporated into the new offline bypass wetlands only and all other catchments will be designed to accommodate the 20% allowance; and
- Where existing outfalls are to be retained at the scheme tie-in locations the existing 1 in 5-year discharge rates with no allowance for climate change will be maintained. Attenuation will be provided to ensure these discharge rates are maintained and attenuation installed to accommodate the 1 in 5 years design storm only with a 1 in 100-year check undertaken.

3.10 Strategy for retaining the existing drainage

3.10.1 It is proposed to retain the existing drainage as part of the permanent works where it is not affected by the proposed highway works i.e. at tie-in locations and the sections of the existing A585 that will be de-trunked. The condition of this drainage will be reviewed, and remediation works will be carried out on category 4 and 5 defects within the scheme limits.

3.10.2 As stated in Section 2.10 data on the existing drainage is limited and a set of gap analysis plans have been produced to enable CCTV asset and condition data surveys to be undertaken to confirm the stage 3 existing drainage design. The stage 3 proposed drainage design utilises some of the existing drainage runs and outfalls and until the existing drainage pipe, line, level, diameters, condition and outfalls are confirmed, there is a risk that the stage 3 design will be needed to be revisited.

3.10.3 Currently it is proposed to retain sections of the existing drainage in catchment 1, 2, 3, 4, and 7 and the outfalls in catchment 2, 3, 7 and 9.

3.10.4 Minor modification works are required on the A588 Shard Road and at Little Singleton (Five Lane Ends) Junction.

3.11 Pre-earthworks drainage strategy

3.11.1 Surface water run-off from natural catchments drainage towards the proposed earthworks embankment shall be intercepted by cut-off ditches installed at the toe of the embankments. These ditches will be sufficiently deep to take the flow from the natural catchment and to intercept severed agricultural drainage systems.

3.11.2 Where existing watercourses or ditches will be severed by the proposed carriageway culvert will be installed to ensure water can flow from one side of the carriageway to the other.

3.11.3 There are currently 5no. new culverts (Culvert 1 to 5) proposed on the scheme and 2no. existing culverts (culvert 6 and 7) need to be extend due to widening of the existing carriageway west of Windy Harbour Junction. The location of these culverts can be seen on the Proposed Drainage Plans in Appendix G and size information is given in Table 3-2.

ID	Chainage (m)	Type (pipe / box)	Diameter (m)
Stage 3 Design Consultation			
1	1140	Pipe	1.5
2	1490	Pipe	1.5
3	1795	Pipe	1.5

ID	Chainage (m)	Type (pipe / box)	Diameter (m)
4	2005	Pipe	1.5
5	2490	Pipe	1.2
6	4300	Pipe	0.9
7	4350	Pipe	0.9

Table 3-2: Culverts Location and Size Information

3.11.4 Where proposed culvert has been installed some of the existing watercourse have been regraded.

3.11.5 Plan and sections for each culvert have been generated and can be seen in Appendix H.

3.11.6 The structural condition of the existing culverts (ID 6 and 7) is unknown, and as not surveyed as part of the drainage CCTV asset and condition surveys.

3.11.7 Skippool Clough Culvert is an existing culvert that carries Horsebridge Dyke under the A585 at Skippool roundabout. Horsebridge Dyke is defined by the Environment Agency as a "Main River". The culvert was originally constructed by Lancashire County Council in 1971 and was extended in 1980's. The culvert is formed from two distinct construction types. Due to the age, unknown condition and new carriageway being constructed above the culvert, it is proposed to replace the existing culvert. Refer to Structures Option Report for further details (document number: HE548643-ARC-GEN-A585-RP-S-3034).

3.12 Works within the floodplain

3.12.1 A section of the offline bypass is located within floodplain as per Section 2.6.

3.12.2 Wetlands 1 (catchment 4) is located within existing flood plain and have been designed to be above the proposed 1 in 100-year fluvial storm event which includes a 30% allowance for climate change. It was not possible to locate the wetland outside for the floodplain due to the low points of the proposed carriageway.

3.12.3 Wetlands 1 and 2 will be included in the Flood Risk Assessment and any detrimental effects mitigated.

3.12.4 At the time of writing this report the Flood Risk Assessment is being discussed with the EA ready for their approval.

3.13 Proposed drainage catchments

3.13.1 9no. proposed drainage catchments have been identified along the scheme length and can be seen on the Proposed Drainage Catchment Plan and Drainage Plans in Appendix G as mentioned in the next section.

3.14 Proposed drainage strategy – Catchments 1, 2 and 3

3.14.1 Catchment 1, 2 and 3 all discharge to existing watercourses utilising existing outfall discharge rates.

3.14.2 Catchment 1:

I. Starts approximately 200m (Chainage 0+000) west of the existing Skippool Junction and finishes at the centre of the junction (Chainage 0+340) and takes the north portion of the Junction and the B5412 Skippool Road;

II. The first 100m of existing drainage will be maintained following confirmation of its condition by CCTV asset and condition survey;

III. Surface water run-off will be removed from the carriageway using a combination of kerbs and gullies and combined kerb and drainage units;

IV. The surface water run-off will be conveyed to the outfall using a carrier pipe network;

V. A fin drain will be installed to drain the sub-grade drainage;

VI. As the existing Skippool Clough Culvert is to be replaced the existing highway drainage connection to the culvert will be abandoned and new highway drainage outfalls shall be provided on the downstream side of the new culvert. The new outlets through the headwall shall be fitted with flap valves as this section of the watercourse is tidal;

VII. The existing 1 in 5-year discharge rate to the existing Clough Culvert shall be provided by the proposed drainage network;

VIII. Attenuation in the form of oversized pipes has been provided to maintain the existing discharge rate while accommodating the additional paved area and 20% climate change allowance;

IX. A water quality assessment using HAWRAT show that pollution mitigation measures are not required (Refer to Appendix H for Method A and B calculations); and

X. An accident spillage risk assessment calculation for the catchment shows that the risk of a serious accidental pollution incident has a less than 1% probability of occurring, and as a result, no spillage control measure has been incorporated into the design (Refer to Appendix I for accidental spillage risk calculations).

3.14.3 Catchment 2:

I. Starts approximately 200m east (chainage 0+500) of the existing Skippool Junction and finishes at the centre of the junction (Chainage 0+340) and takes the southern portion of the Junction and Old Breck Road;

II. None of the existing drainage will be retained within this catchment, except for the existing outlet headwall into Horsebridge Dyke (subject to a pending condition survey);

III. Surface water run-off will be removed from the carriageway using a combination of kerbs and gullies and combined kerb and drainage units;

IV. The surface water run-off will be conveyed to the outfall using a carrier pipe network;

V. Combined Carrier filter pipes are proposed to drain the sub-grade drainage as well as surface runoff;

VI. It is proposed to maintain the existing discharge point to Horsebridge Dyke located on the A585 Breck Road south of the junction. At the time of writing this report it is assumed that the existing outlet headwall will need to be replaced with a new pre-cast headwall and flap value, as this asset has not been surveyed as part of the CCTV asset and condition survey;

VII. The existing 1 in 5-year discharge rate to the Skippool Clough Culvert will be maintained by the proposed drainage network;

XI. Attenuation in the form of oversized pipes has been provided to maintain the existing discharge rate while accommodating the additional paved area and 20% climate change allowance;

VIII. A water quality assessment using HAWRAT shows that pollution mitigation measures are not required (Refer to Appendix H for Method A and B calculations); and

IX. An accident spillage risk assessment calculation for the catchment shows that the risk of a serious accidental pollution incident has a less than 1% probability of occurring, and as a result, no spillage control measure has been incorporated into the design (Refer to Appendix I for accidental spillage risk calculations).

3.14.4 Catchment 3:

I. Starts approximately 200m east (chainage 0+400) of the existing Skippool Junction and finishes at 60m east of the A585 Mains Lane (Chainage 0+860) and the entire carriageway catchment and Old Mains Lane side road;

II. Approximately 100m of existing drainage is to be retained from the A585 Mains Lane and connected into the proposed drainage system;

III. Surface water run-off will be removed from the carriageway using a combination of kerbs and gullies and combined kerb and drainage units;

IV. The new eastbound and westbound Skippool Bridge will not require bridge deck drainage units as the surface water run-off flow width is maintained within the hard strip provided. Gullies have been provided upstream and downstream of the structures.

V. The surface water run-off will be conveyed to the outfall using a carrier pipe network;

VI. FIN drains will be installed to drain the sub-grade drainage;

VII. The existing outfalls to Main Dyke cannot be maintained due to the new northern bridge (eastbound carriageway). As a result, 2no. new outfalls to Main Dyke have been proposed. The new precast headwalls will incorporate flap valves as, although Main Dyke is not tidal, it is subject to changes is level due to the downstream Tidal Gate's flap valves;

XII. Attenuation in the form of oversized pipes has been provided to maintain the existing discharge rate while accommodating the additional paved area and 20% climate change allowance;

VIII. A water quality assessment using HAWRAT show that pollution mitigation measures are not required (Refer to Appendix H for Method A and B calculations); and

IX. An accident spillage risk assessment calculation for the catchment shows that the risk of a serious accidental pollution incident has a less than 1% probability of occurring, and as a result, no spillage control measure has been incorporated into the design (Refer to Appendix I for accidental spillage risk calculations).

3.15 Proposed drainage strategy – Catchments 4, 5, 6 and 7

3.15.1 Catchment 4, 5, 6 and 7 all discharge to receiving watercourse using a greenfield runoff rate of 11.9 litres per second per hectare which was calculated as part of the Flood Risk Assessment works.

3.15.2 Catchment 4:

I. Starts approximately 60m east of the A585 Mains Lane (Chainage 0+860 High point) and finishes east of the A586 Garstang Road East of Poulton Junction (Chainage 2+250). The low point of the road alignment is at Chainage 1+570;

II. The northern section of A586 Garstang Road East which will be connected to the new bypass through Poulton Junction. The existing gullies through the new junction will be abandoned and removed.

III. Surface water run-off from the offline bypass will be removed using Surface Water Channels (SWC). The SWC have a triangular profile and are 1.58m wide in the central reserve and 1.28m wide in the verge;

IV. Poulton Junction and the laybys utilise a combination of kerbs and gullies and combined kerb and drainage units to remove surface water run-off from the carriageway;

V. The surface water run-off will be conveyed to proposed Wetland no.1 using a carrier pipe network;

VI. Fin drain will be installed to drain the sub-grade drainage. Fin drains will be upgraded to narrow filter drains / filter drains to accommodate wide verges and earthworks run-off and groundwater flows. Where narrow filter drains / filter drains systems have been incorporated into the design to accommodate overland flow and groundwater, the systems have been kept separate from the surface water drainage systems and discharge directly into eth pre-earthworks ditches or watercourses;

VII. Wetland no.1 (Chainage 1+650) will provide attenuation to accommodate the 1 in 100-year storm return period with a 40% allowance for climate change, while maintaining the existing greenfield run-off rate;

VIII. Wetland 1 is located within Flood Zone 3 and forms part of the Flood Risk Assessment. To prevent the wetland being washed out, the access track around the pond has been set 300mm above the calculated 1 in 100-year fluvial storm event level as per HD45 and agreed with Highways England (refer to minutes in Appendix F);

IX. A wetland has been proposed as the water quality assessment using HAWRAT shows that pollution mitigation measures are required (Refer to Appendix H for Method A and B calculations); and

X. An accident spillage risk assessment calculation for the catchment show that the risk of a serious accidental pollution incident has a less than 1% probability (Refer to Appendix I for accidental spillage risk calculations). However, as this new catchment has a new wetland, the outlet headwall will incorporate an orifice plate built in to a penstock. The penstock will allow the wetland to be closed for maintenance activities and can be used for accidental spillage containment if needed.

3.15.3 Catchment 5:

I. Starts east of the A586 Garstang Road East Roundabout (Chainage 2+250) with a low point at Chainage 2+400 and finishes approximately 270m east of B5260 Lodge Lane (Chainage 3+400 – high point);

II. There are no existing drainage networks along the offline bypass;

XI. Surface water run-off from the offline bypass will be removed using Surface Water Channels (SWC). The SWC have a triangular profile and are 1.58m wide in the central reserve and 1.28m wide in the verge;

XII. The layby utilises a combination of kerbs and gullies and combined kerb and drainage units to remove surface water run-off from the carriageway;

III. The surface water run-off will be conveyed to proposed wetland no. 2 using a carrier pipe network;

IV. Filter drains will be installed to drain the sub-grade drainage. The fin drain will be upgraded to narrow filter drains / filter drains to accommodate wide verges, central reserve, earthworks run-off and groundwater flows. Where narrow filter drains / filter drains systems have been incorporated into the design to accommodate overland flow and groundwater, the systems have been kept separate from the surface water drainage systems and discharge directly into the pre-earthworks ditches or watercourses;

V. At Stage 2 there was an indication that the groundwater flows in Lodge Lane cutting could potentially have high flow rates due to the presence of glacial sand / gravel cap immediately east of Lodge Lane. There was also the possibility of artesian pressures in the Glacial Till that could be encountered when the cutting is constructed. Following receipt of Ground Investigation data at Stage 3 an analytical assessment of the flows for the entire 270m of the cutting has been undertaken based on dewatering of a 3m thick, fully saturated aquifer. The results for the 270m long cutting (the length that is below the water table) give a total flow of 7.5l/s. As a result, a separate filter drainage system has been provided to capture this potential groundwater flow. The filter drain system consists of 225mm diameter filter drain pipes located in the eastbound and westbound verge and low side of the central reserve. These filter drain have been set so that the top of the pipe is 1.6m below the finished road level to ensure that there is enough drawdown to prevent groundwater entering the carriageway foundation. The filter drains have been designed to cater for a ground water flow of 1.15x10-3 l/s/m;

VI. Wetland no.2 (Chainage 2+350) will provide attenuation to accommodate the 1 in 100-year storm return period with a 40% allowance for climate change, while maintaining the existing greenfield run-off rate;

VII. A wetland has been proposed as the water quality assessment using HAWRAT shows that pollution mitigation measures are required (Refer to Appendix H for Method A and B calculations); and

VIII. An accident spillage risk assessment calculation for the catchment show that the risk of a serious accidental pollution incident has a less than 1% probability (Refer to Appendix I for accidental spillage risk calculations). However, as this new catchment has a new wetland the outlet headwall will incorporate an orifice plate built in to a penstock. The penstock will allow the wetland to be closed to allow maintenance activities and can be used for accidental spillage containment if needed.

3.15.4 Catchment 6:

I. Starts approximately 270m east of B5260 Lodge Lane (Chainage 3+400) and finishes at the tie-in location to the existing A585 (Chainage 4+050);

II. Existing drainage along the existing Garstang New Road at chainage 4+050 will be retained and connected to proposed catchment.

III. Surface water run-off from the offline bypass will be removed using SWC. The SWC have a triangular profile and are 1.58m wide in the central reserve and 1.28m wide in the verge;

IV. The layby utilises a combination of kerbs and gullies and combined kerb and drainage units to

remove surface water run-off from the carriageway;

V. The surface water run-off will be conveyed to proposed Wetland no.3 using a carrier pipe network;

VI. Fin drains will be installed to drain the sub-grade drainage. The fin drain will be upgraded to narrow filter drains / filter drains to accommodate wide verges and central reserve;

VII. Wetland no.3 (Chainage 4+125) will provide attenuation to accommodate the 1 in 100-year storm return period with a 40% allowance for climate change, while maintaining the existing greenfield run-off rate;

VIII. A wetland has been proposed as the water quality assessment using HAWRAT shows that pollution mitigation measures are required (Refer to Appendix H for Method A and B calculations); and

IX. An accident spillage risk assessment calculation for the catchment show that the risk of a serious accidental pollution incident has a less than 1% probability (Refer to Appendix I for accidental spillage risk calculations). However, as this new catchment has a new wetland the outlet headwall will incorporate an orifice plate built in to a penstock. The penstock will allow the wetland to be closed to allow maintenance activities and can be used for accidental spillage containment if needed.

3.15.5 Catchment 7:

I. Starts at the tie-in location to the existing A585 (Chainage 4+050) and continues east towards Windy Harbour junction (Chainage 4+850 – high point). The existing A585 carriageway will become the new A585 eastbound carriageway and westbound carriageway will be completely new;

II. The existing drainage network of the recently upgraded Windy Harbour Junction (existing catchment 11) and its outfall is to be maintained, along with the eastbound drainage between Chainage4+570 and 4+860. However, a small section of the east drainage system will have to be revised between Chainage 4+400 and 4+580 and incorporated into catchment 7 to accommodate the additional paved area (0.45ha);

III. Surface water run-off from the carriageway will be removed using a SWC. The SWC have a triangular profile and are 1.58m wide in the central reserve and 1.28m wide in the verge;

IV. The existing drainage system (existing catchment 11) that is to be revised will remove surface water run-off from the eastbound carriageway using combined drainage and kerb units;

V. The surface water run-off will be conveyed to proposed wetland no. 4 using a carrier pipe network;

VI. A fin drain will be installed to drain the sub-grade of the carriageway and a filter drain will be installed to drain the verge and small cutting. As the filter is drainage a small area it will be connect to the drainage system prior to discharging to the outfall;

VII. Wetland no.4 (Chainage 4+460) will provide attenuation to accommodate the 1 in 100-year storm return period with a 40% allowance for climate change, while maintaining the existing greenfield run-off rate;

VIII. A wetland has been proposed as the water quality assessment using HAWRAT shows that pollution mitigation measures are required (Refer to Appendix H for Method A and B calculations); and

IX. An accident spillage risk assessment calculation for the catchment show that the risk of a serious accidental pollution incident has a less than 1% probability (Refer to Appendix I for accidental spillage risk calculations). However, as this new catchment has a new wetland the outlet headwall will incorporate an orifice plate built in to a penstock. The penstock will allow the wetland to be closed to allow maintenance activities and can be used for accidental spillage containment if needed.

3.16 Proposed drainage strategy – Catchment 8

3.16.1 Catchment 8 is split into 2no. proposed drainage networks. Catchment 8a which drains the northern section of Lodge Lane (B5260) up to the new proposed Lodge Lane Bridge, and Catchment 8b which drainages the proposed Lodge Lane Bridge and the southern length of carriageway that ties into the existing Lodge Lane. In the vicinity of the proposed bypass, Lodge Lane falls generally in a southerly direction.

3.16.2 Catchment 8a:

I. Starts at the existing highpoint on Lodge Lane (B5260) and north of the proposed Lodge Lane Bridge (60m from highpoint);

II. No drainage data is available for Lodge Lane (B5260) but road gullies have been noted along the road;

III. Surface water run-off from the carriageway will be removed using kerbs and gullies, which will discharge to a pre-earthworks ditch via a carrier pipe network;

IV. A water quality assessment using HAWRAT shows that pollution mitigation measures are not required (Refer to Appendix H for Method A and B calculations); and

V. An accident spillage risk assessment calculation for the catchment shows that the risk of a serious accidental pollution incident has a less than 1% probability of occurring, and as a result, no spillage control measure has been incorporated into the design (Refer to Appendix I for accidental spillage risk calculations).

3.16.3 Catchment 8b:

I. This proposed catchment will start at the north end of the proposed Lodge Lane bridge and continues to the tie-in with the existing carriageway which is approximately 100m south of the proposed Lodge Lane Bridge:

II. The proposed Lodge Lane Bridge (B5260) doesn't require drainage, due to the longitudinal fall;

III. Surface water run-off from the carriageway will be removed using kerbs and gullies, which will discharge to a pre-earthworks ditch via a carrier pipe network;

IV. A water quality assessment using HAWRAT shows that pollution mitigation measures are not required (Refer to Appendix H for Method A and B calculations); and

V. An accident spillage risk assessment calculation for the catchment shows that the risk of a serious accidental pollution incident has a less than 1% probability of occurring, and as a result, no spillage control measure has been incorporated into the design (Refer to Appendix I for accidental spillage risk calculations).

3.17 Proposed drainage strategy – Catchment 9

3.17.1 Catchment 9:

I. Starts west of Poulton Junction and finishes at the crossing with Main Dyke;

II. The existing drainage which ran from A586 Garstang Road East of Poulton Junction has been intercepted by catchment 4. The existing drainage along A586 Garstang Road East up to Main Dyke is to be abandoned and removed;

III. Surface water run-off from the carriageway will be removed using gullies;

IV. The surface water run-off will be conveyed to the outfall using a carrier pipe network;

V. Filter drains will be installed to drain the verge and small cutting. A small area of cutting will be drained to the carriageway drainage system prior to discharging to the outfall;

VI. The existing outfall to Main Dyke (north of the existing road crossing) is to be retained;

VII. A water quality assessment using HAWRAT show that pollution mitigation measures are not required (Refer to Appendix H for Method A and B calculations); and

VIII. An accident spillage risk assessment calculation for the catchment shows that the risk of a serious accidental pollution incident has a less than 1% probability of occurring, and as a result, no spillage control measure has been incorporated into the design (Refer to Appendix I for accidental spillage risk calculations).

3.18 Proposed drainage strategy – Catchment 10

3.18.1 Catchment 10 forms part of the existing Little Singleton junction and is a proposed drainage catchment which discharges to the existing drainage catchment 15:

I. Little Singleton Junction highway alignment has had minor modification to the junction to provide a U-turn arrangement east of the Junction;

II. The existing drainage has been modified to include new gullies to remove surface run-off from the carriageway;

III. The surface water run-off will be conveyed to the existing drainage networks using carrier pipes;

IV. At the time of writing this report HAWRAT and accidental spillage containment assessment had not been undertaken for this modification. However, due to the low traffic flows mitigation is not envisaged.

3.19 Proposed discharge rates

3.19.1 Hydraulic modelling of the proposed drainage networks has been completed for each catchment and a summary of the results can be seen in Table 3-3.

Catchment ID	Drainage Network Catchment Area (impermeable catchment)	Calculated Proposed Flow Rates in litres per second (1 in … year storm return period)		
(…)	(ha)	1 in 1 year	1 in 5 year	1 in 100 year
1	1.002	52.1	77.8	124
2	0.795	26.3	37.6	54.3
3	1.551	69	96.3	123.4
4	4.009	237.2	372.8	590.8
5	3.125	169.6	252.4	526
6	2.333	124.1	207.1	367.2
7	3.550	108.5	161.4	247.4
8a	0.042	5	8.3	15.7
8b	0.039	4.6	7.5	13.9
9	0.398	31.7	41.3	66.7

Table 3-3: Proposed catchment discharge rates

3.19.2 A summary of the discharge rate and the percentage difference when compared to the existing is given in Table 3-4:

Proposed		Existing		% Difference
Catchment ID	Calculated Flow Rates in litres per second (1 in 5-year storm return period)	Catchment ID	Calculated Flow Rates in litres per second (1 in 5-year storm return period)	
(…)		(…)		
1	77.8	1	91.1	14% less than existing
2	37.6	18	18	10% less than existing
		19	23.7	
3	96.3	3	50.4	13% less than existing
		4	60.2	
4	372.8	-	-	-
5	252.4	-	-	-
6	207.1	-	-	-
7	161.4	11	184.9	12.5% less than existing
8a	8.3	-	-	-
8b	7.5	-	-	-
9	41.3	13	43.5	5 % less than existing

Table 3-4: 1 in 5-year proposed discharge rates and % difference from existing

3.19.3 Proposed catchment 1, 2, 3, 7 and 9 outfall flow rates are less than the existing outfall rates of catchments.

3.20 Defects and remediation

3.20.1 As discussed in Section 2, there was very limited CCTV condition data available for the existing drainage on the A5036.

3.20.2 The drainage gap analysis plans include surveying the entire de-trunked section of the A585 to confirm the existing drainage asset locations and condition as there was no data available on HADMMS. This survey data would have confirmed the number of existing defects. As it is assumed that Lancashire County Council will want these defects remediating prior to accepting ownership of the de-trunked section of the A5036.

3.20.3 Highways England requested that the CCTV asset and condition survey was de-scoped in order to remove part of de-trucked section of the A585 due to additional data being made available by Highways England O.D. department. Refer to Appendix A for additional CCTV Data.

3.20.4 The data supplied showed that the surveys were undertaken in 2016 and the condition of the defects on the network may have changed in the last two years. As a result, it was agreed to de-scope the asset and condition works on the basis that the areas de-scoped could be surveyed at the detailed design stage.

3.20.5 The de-scoped CCTV asset and condition survey was received on 30/04/2018 and the design updated to reflect this survey information.

3.20.6 A review of the survey data confirmed that out of the 6.3km of existing pipework needing CCTV asset and condition survey and 2.5km requiring asset survey only (total of 9km), only 6.3km of data was received. This data was also made up of data outside of the scope of the works. For further details of the survey refer to Technical Note (TN22) – Drainage CCTV asset and condition survey review (document number: HE548643-ARC-HDG-A585-TN-D-3022) in Appendix J.

3.20.7 The outstanding survey data shall be included in the detailed design stage survey.

3.21 Off network access and future maintenance

3.21.1 Where possible, the design has sort to provide off network access for inspection and maintenance. Off network access has been provided for:

- Wetland 1 – To be accessed from the back of the proposed Lay-by; and
- Wetland 2 – To be accessed from the A586 Garstang Road East.

3.21.2 Wetlands 3 and 4 will need to be accessed directly from the offline bypass carriageway.

3.21.3 Vortex grit separators have been used in the design to replace the wetland sediment forebays as they provide a high level of sediment removal and use a very small plan area.

3.21.4 The ASC Area 13 currently do not have any vortex grit separators within their network and they have limited experience of maintaining the wetlands and they have requested training be provided on completion of the Scheme.

3.21.5 It was agreed with Highways England O.D Department that drainage training will be provided on completion of the works:

- Confined space training for operatives;
- Vortex grit separator inspection and maintenance training; and
- Wetland inspection and maintenance training.

3.21.6 This training will also include the creation of training videos for the operation, inspection and maintenance procedure for the following items;

- Penstock / orifice plates; and
- Vortex grit separators.

3.21.7 Pollution Control Device (PCD) signage in accordance with HD33/06 has been provide adjacent to:

- Hydrodynamic vortex grit separators;

- Penstock chambers and;
- Accidental spillage containment shut-off penstock.

3.21.8 A list of anticipated maintenance operations is presented in Appendix K.

3.22 Risk (Health and safety)

3.22.1 A Designer's Hazard Elimination Schedule (Document number: HE548643-ARC-GEN-A585-SC-PM-2006) has been carried out to identify risks that may be associated with the construction and maintenance of the new drainage systems to ensure that, wherever economically possible, hazards are eliminated, or the risks of hazards being encountered are identified, reduced and mitigated as appropriate.

3.22.2 As discussed in Section 2, due to the ages and fragmented nature of the existing drainage system, it is highly likely that the existing drainage assets will contain Asbestos Containing Materials (ACM's).

3.22.3 Highways England (Area 13) have provided their Asbestos Action Plan.

3.23 Buildability

3.23.1 The preliminary drainage design has sought to utilise modular construction materials to assist the installation of components to form larger units and to reduce the risk of injury whilst handling these items without the benefit of craneage. Products used in the detail design include:

- Twin wall thermoplastic pipes;
- Low capacity vortex grit separators;
- High capacity vortex grit separators;
- Composite orifice and penstocks;
- Concrete Storm water Cannel;
- Linear drainage channels; and
- Combined kerb and drain systems.

3.23.2 During the Stage 3 design, clash analysis has been undertaken utilising other disciplines 2D models. At the time of writing this report 3D models are being produced and further clash analysis and resolution will be undertaken.

3.24 Departures from standard

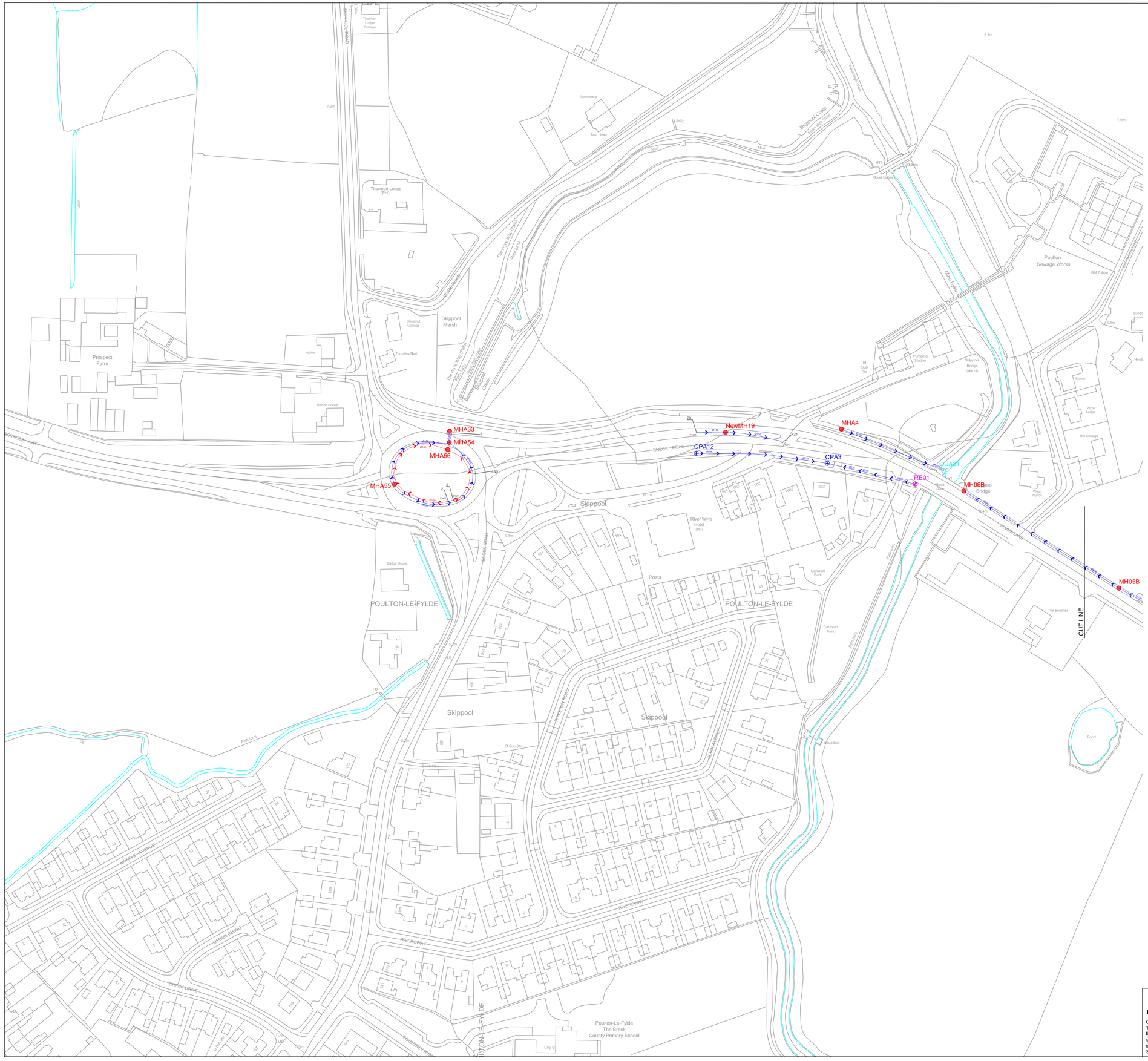
3.24.1 Elements of the design that do not comply with current design standards and advice given in the DMRB will be submitted to Highways England along with the justification for the departures and any appropriate mitigation measures provided.

3.24.2 At the time of writing this report the following departures have been discussed with Highways England S.E.S department:

- Increasing spacing for man access chambers from a maximum of 100m to 150m;
- Increasing the diameter of a Type 7 catch-pit from 1050m diameter to accommodate larger pipes; and
- 1 in 1 year surcharge of existing networks.

3.24.3 Highway England have confirmed that the departure listed above are common departures and in principle these will be approved. Refer to minute of meeting (Document number: HE548643-ARC-HDG-A585-MM-Z-3008-Highways England SES MoM) in Appendix F.

Appendix A – Existing CCTV asset and condition data



Defect No.	Survey No.	Start MH	Flow	End MH	m	Code	Description	Grade
1	4	MHA54	d/s	MHA33	5.7	SA	Survey abandoned, Remark: Unable to travel round bend	
2	5	MHA56	u/s	PN01	81.3	SA	Survey abandoned, Remark: To x-camera	
3	6	MHA56	u/s	PN02	42.9	SA	Survey abandoned, Remark: Extent of x-camera survey no.05	
4	7	MHA55	d/s	MHA54	62.9	SA	Survey abandoned, Remark: To x-camera	
5	8	MHA54	u/s	MHA55	21.3	SA	Survey abandoned, Remark: Extent of x-camera survey no.07	
6	32	MH09A	d/s	MH09	111.4	SA	Survey abandoned, Remark: To x-camera	
7	33	MH09	u/s	MH09A	10.69	SA	Survey abandoned, Remark: Extent of x-camera survey no.32	
8	34	MH11	d/s	MH09	70.7	SA	Survey abandoned, Remark: To x-camera	
9	35	MH11	u/s	MH13	31.1	SA	Survey abandoned, Remark: To x-camera	
10	36	MH19	d/s	MH15	78	SA	Survey abandoned, Remark: To x-camera	
11	43	NewMH01	u/s	RE02	15.9	SA	Survey abandoned, Remark: To x-camera	
12	44	RE02	d/s	NewMH01	70.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.43	
13	46	MH14	u/s	NewMH17	50.1	SA	Survey abandoned, Remark: To x-camera	
14	48	MH15	u/s	MH19	14.8	SA	Survey abandoned, Remark: Extent of x-camera survey no.36	
15	49	NewMH17	d/s	MH14	2	SA	Survey abandoned, Remark: Extent of x-camera survey no.46	
16	53	NewMH20	u/s	NewMH18	73.8	SA	Survey abandoned, Remark: To x-camera	
17	59	NewMH18	d/s	NewMH20	40.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.53	
18	61	MH09	u/s	MH11	51.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.34	
19	62	MH13	d/s	MH11	83	SA	Survey abandoned, Remark: Extent of x-camera survey no.35	
20	64	NewMH19	u/s	PN03	16.3	SA	Survey abandoned, Remark: Due to debris concrete	
21	65	NewMH19	d/s	PN04	32.9	SA	Survey abandoned, Remark: Joins main	

KEY

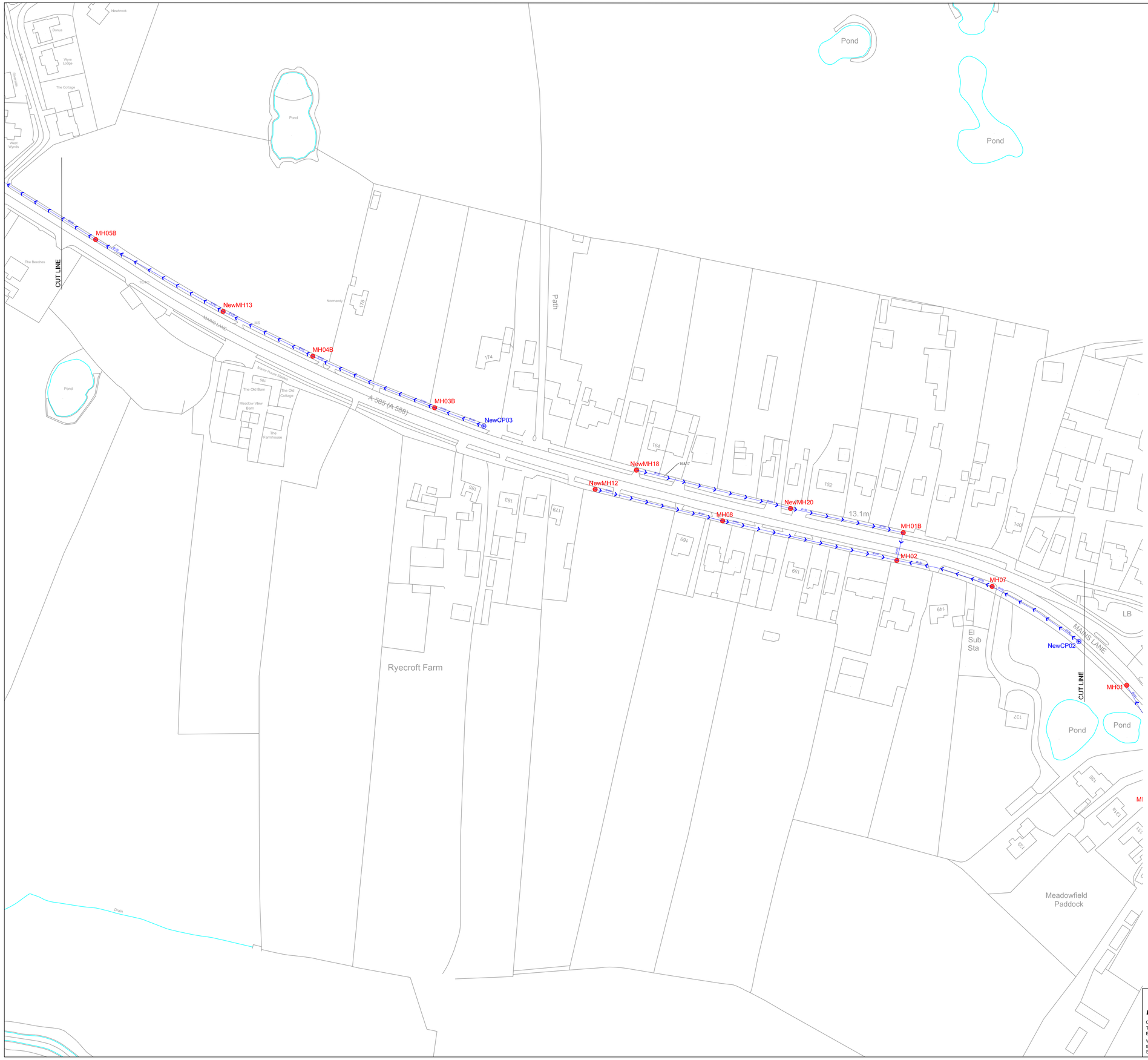
- CARRIER (SUB SURFACE CONT. ITEM)
- CARRIER ASSUMED (SUB SURFACE CONT. ITEM ASSUMED)
- SAFETY KERBS (SURFACE CONT. ITEM)
- FILTER/CARRIER (SUB SURFACE CONT. ITEM)
- FILTER/CARRIER ASSUMED (SUB FILTER/SURFACE CONT. ITEM ASSUMED)
- GRADE 4 DEFECT
- GRADE 5 DEFECT
- SURVEY ABANDONED DEFECT
- CATCHPIT (CP)
- CONNECTOR NODE
- GHOST NODE (GN)
- GULLY (GU)
- INSPECTION CHAMBER (IC)
- MANHOLE (MH)
- OIL INTERCEPTOR (OI)
- INLET
- OUTFALL (OU)
- OUTLET (OL)
- PHANTOM NODE (PN)
- RODDING EYE (RE)
- SILT INTERCEPTOR

ANDIDRAIN LIMITED
DRAIN CLEARANCE : SEWER SERVICES
Caron House, Kingmoor Park, Rockcliffe Estate, Rockcliffe, Carlisle, CA6 4RW
Tel : (01228) 672300 Fax : (01228) 672301
E-Mail : enquiries@andidrain.co.uk

Where Applicable mapping data is based upon the Ordnance Survey® map with the permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office, © Crown Copyright. Licence No. AL100031489

Client :	METCALFE PLANT HIRE LTD
Drawing Title :	A585 MAINS LANE
Scale :	NTS
Revision :	
Drawn By :	S[redacted]
Revision date:	
Date :	16.11.2016
Description :	
Job No :	27207-01
Drg No :	1
Rev :	0

K:\CCTV Surveys\Metcalfe\A585 Mains Lane



Defect No.	Survey No.	Start MH	Flow	End MH	m	Code	Description	Grade
1	4	MHAS4	d/s	MHA33	5.7	SA	Survey abandoned, Remark: Unable to travel round bend	
2	5	MHAS6	u/s	PN01	81.3	SA	Survey abandoned, Remark: To x-camera	
3	6	MHAS6	u/s	PN02	42.9	SA	Survey abandoned, Remark: Extent of x-camera survey no.05	
4	7	MHAS5	d/s	MHAS4	62.9	SA	Survey abandoned, Remark: To x-camera	
5	8	MHAS4	u/s	MHAS5	21.3	SA	Survey abandoned, Remark: Extent of x-camera survey no.07	
6	32	MH09A	d/s	MH09	111.4	SA	Survey abandoned, Remark: To x-camera	
7	33	MH09	u/s	MH09A	10.69	SA	Survey abandoned, Remark: Extent of x-camera survey no.32	
8	34	MH11	d/s	MH09	70.7	SA	Survey abandoned, Remark: To x-camera	
9	35	MH11	u/s	MH13	31.1	SA	Survey abandoned, Remark: To x-camera	
10	36	MH19	d/s	MH15	78	SA	Survey abandoned, Remark: To x-camera	
11	43	NewMH01	u/s	RE02	15.9	SA	Survey abandoned, Remark: To x-camera	
12	44	RE02	d/s	NewMH01	70.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.43	
13	46	MH14	u/s	NewMH17	50.1	SA	Survey abandoned, Remark: To x-camera	
14	48	MH15	u/s	MH19	14.8	SA	Survey abandoned, Remark: Extent of x-camera survey no.36	
15	49	NewMH17	d/s	MH14	2	SA	Survey abandoned, Remark: Extent of x-camera survey no.46	
16	53	NewMH20	u/s	NewMH18	73.8	SA	Survey abandoned, Remark: To x-camera	
17	59	NewMH18	d/s	NewMH20	40.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.53	
18	61	MH09	u/s	MH11	51.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.34	
19	62	MH13	d/s	MH11	83	SA	Survey abandoned, Remark: Extent of x-camera survey no.35	
20	64	NewMH19	u/s	PN03	16.3	SA	Survey abandoned, Remark: Due to debris concrete	
21	65	NewMH19	d/s	PN04	32.9	SA	Survey abandoned, Remark: Joins main	

KEY

- CARRIER (SUB SURFACE CONT. ITEM)
- CARRIER ASSUMED (SUB SURFACE CONT. ITEM ASSUMED)
- SAFETY KERBS (SURFACE CONT. ITEM)
- FILTER/CARRIER (SUB SURFACE CONT. ITEM)
- FILTER/CARRIER ASSUMED (SUB FILTER/SURFACE CONT. ITEM ASSUMED)
- GRADE 4 DEFECT
- GRADE 5 DEFECT
- SURVEY ABANDONED DEFECT
- CATCHPIT (CP)
- CONNECTOR NODE
- GHOST NODE (GN)
- GULLY (GU)
- INSPECTION CHAMBER (IC)
- MANHOLE (MH)
- OIL INTERCEPTOR (OI)
- INLET
- OUTFALL (OU)
- OUTLET (OL)
- PHANTOM NODE (PN)
- RODDING EYE (RE)
- SILT INTERCEPTOR

ANDIDRAIN LIMITED
DRAIN CLEARANCE : SEWER SERVICES
Caron House, Kingmoor Park, Rockcliffe Estate, Rockcliffe, Carlisle, CA6 4RW
Tel : (01228) 672300 Fax : (01228) 672301
E-Mail : enquiries@andidrain.co.uk

Where Applicable mapping data is based upon the Ordnance Survey© map with the permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office, © Crown Copyright. Licence No. AL100031489

Client :	METCALFE PLANT HIRE LTD		
Drawing Title :	A585 MAINS LANE		
Scale :	NTS	Revision :	
Drawn By :	S[redacted]	Revision date:	
Date :	16.11.2016	Description :	
Job No :	27207-01	Drg No : 2	Rev : 0

K:\CCTV Surveys\Metcalfe\A585 Mains Lane

Defect No.	Survey No.	Start MH	Flow	End MH	m	Code	Description	Grade
1	4	MHAS4	d/s	MHA33	5.7	SA	Survey abandoned, Remark: Unable to travel round bend	
2	5	MHAS6	u/s	PN01	81.3	SA	Survey abandoned, Remark: To x-camera	
3	6	MHAS6	u/s	PN02	42.9	SA	Survey abandoned, Remark: Extent of x-camera survey no.05	
4	7	MHAS5	d/s	MHAS4	62.9	SA	Survey abandoned, Remark: To x-camera	
5	8	MHAS4	u/s	MHAS5	21.3	SA	Survey abandoned, Remark: Extent of x-camera survey no.07	
6	32	MH09A	d/s	MH09	111.4	SA	Survey abandoned, Remark: To x-camera	
7	33	MH09	u/s	MH09A	10.69	SA	Survey abandoned, Remark: Extent of x-camera survey no.32	
8	34	MH11	d/s	MH09	70.7	SA	Survey abandoned, Remark: To x-camera	
9	35	MH11	u/s	MH13	31.1	SA	Survey abandoned, Remark: To x-camera	
10	36	MH19	d/s	MH15	78	SA	Survey abandoned, Remark: To x-camera	
11	43	NewMH01	u/s	RE02	15.9	SA	Survey abandoned, Remark: To x-camera	
12	44	RE02	d/s	NewMH01	70.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.43	
13	46	MH14	u/s	NewMH17	50.1	SA	Survey abandoned, Remark: To x-camera	
14	48	MH15	u/s	MH19	14.8	SA	Survey abandoned, Remark: Extent of x-camera survey no.36	
15	49	NewMH17	d/s	MH14	2	SA	Survey abandoned, Remark: Extent of x-camera survey no.46	
16	53	NewMH20	u/s	NewMH18	73.8	SA	Survey abandoned, Remark: To x-camera	
17	59	NewMH18	d/s	NewMH20	40.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.53	
18	61	MH09	u/s	MH11	51.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.34	
19	62	MH13	d/s	MH11	83	SA	Survey abandoned, Remark: Extent of x-camera survey no.35	
20	64	NewMH19	u/s	PN03	16.3	SA	Survey abandoned, Remark: Due to debris concrete	
21	65	NewMH19	d/s	PN04	32.9	SA	Survey abandoned, Remark: Joins main	

Brownlea Farm
Pond
Pond
Pond
Pond
Pond
Pond
Pond
Pond
Pond
LB
MAINS LANE
A 585
NewCP02
CUT LINE
MH01
13.4m
TCB
GP
MH04
NewMH11
MH09B
GU16
NewCP04
MH09A
Meadowfield Paddock
13.7m
Little Singleton
MH09
MH10
MH11
MH12
BM 15.72m
14.3m
BM 15.01m
MH13
NewMH10
CUT LINE
Red Trees Nursery
Burtonwood Nurseries
The Cottage
Drain
Drain
Little Singleton
MAINS LANE

KEY

- CARRIER (SUB SURFACE CONT. ITEM)
- CARRIER ASSUMED (SUB SURFACE CONT. ITEM ASSUMED)
- SAFETY KERBS (SURFACE CONT. ITEM)
- FILTER/CARRIER (SUB SURFACE CONT. ITEM)
- FILTER/CARRIER ASSUMED (SUB FILTER/SURFACE CONT. ITEM ASSUMED)
- GRADE 4 DEFECT
- GRADE 5 DEFECT
- SURVEY ABANDONED DEFECT
- CATCHPIT (CP)
- CONNECTOR NODE
- GHOST NODE (GN)
- GULLY (GU)
- INSPECTION CHAMBER (IC)
- MANHOLE (MH)
- OIL INTERCEPTOR (OI)
- INLET
- OUTFALL (OU)
- OUTLET (OL)
- PHANTOM NODE (PN)
- RODDING EYE (RE)
- SILT INTERCEPTOR

ANDIDRAIN LIMITED
DRAIN CLEARANCE : SEWER SERVICES
Caron House, Kingmoor Park, Rockcliffe Estate, Rockcliffe, Carlisle, CA6 4RW
Tel : (01228) 672300 Fax : (01228) 672301
E-Mail : enquiries@andidrain.co.uk

Where Applicable mapping data is based upon the Ordnance Survey® map with the permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office, © Crown Copyright. Licence No. AL100031489

Client :	METCALFE PLANT HIRE LTD
Drawing Title :	A585 MAINS LANE
Scale :	NTS
Revision :	
Drawn By :	S[redacted]
Revision date:	
Date :	16.11.2016
Description :	
Job No :	27207-01
Drg No :	3
Rev :	0

K:\CCTV Surveys\Metcalfe\A585 Mains Lane

Defect No.	Survey No.	Start MH	Flow	End MH	m	Code	Description	Grade
1	4	MHAS4	d/s	MHA33	5.7	SA	Survey abandoned, Remark: Unable to travel round bend	
2	5	MHAS6	u/s	PN01	81.3	SA	Survey abandoned, Remark: To x-camera	
3	6	MHAS6	u/s	PN02	42.9	SA	Survey abandoned, Remark: Extent of x-camera survey no.05	
4	7	MHAS5	d/s	MHAS4	62.9	SA	Survey abandoned, Remark: To x-camera	
5	8	MHAS4	u/s	MHAS5	21.3	SA	Survey abandoned, Remark: Extent of x-camera survey no.07	
6	32	MH09A	d/s	MH09	111.4	SA	Survey abandoned, Remark: To x-camera	
7	33	MH09	u/s	MH09A	10.69	SA	Survey abandoned, Remark: Extent of x-camera survey no.32	
8	34	MH11	d/s	MH09	70.7	SA	Survey abandoned, Remark: To x-camera	
9	35	MH11	u/s	MH13	31.1	SA	Survey abandoned, Remark: To x-camera	
10	36	MH19	d/s	MH15	78	SA	Survey abandoned, Remark: To x-camera	
11	43	NewMH01	u/s	RE02	15.9	SA	Survey abandoned, Remark: To x-camera	
12	44	RE02	d/s	NewMH01	70.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.43	
13	46	MH14	u/s	NewMH17	50.1	SA	Survey abandoned, Remark: To x-camera	
14	48	MH15	u/s	MH19	14.8	SA	Survey abandoned, Remark: Extent of x-camera survey no.36	
15	49	NewMH17	d/s	MH14	2	SA	Survey abandoned, Remark: Extent of x-camera survey no.46	
16	53	NewMH20	u/s	NewMH18	73.8	SA	Survey abandoned, Remark: To x-camera	
17	59	NewMH18	d/s	NewMH20	40.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.53	
18	61	MH09	u/s	MH11	51.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.34	
19	62	MH13	d/s	MH11	83	SA	Survey abandoned, Remark: Extent of x-camera survey no.35	
20	64	NewMH19	u/s	PN03	16.3	SA	Survey abandoned, Remark: Due to debris concrete	
21	65	NewMH19	d/s	PN04	32.9	SA	Survey abandoned, Remark: Joins main	

KEY

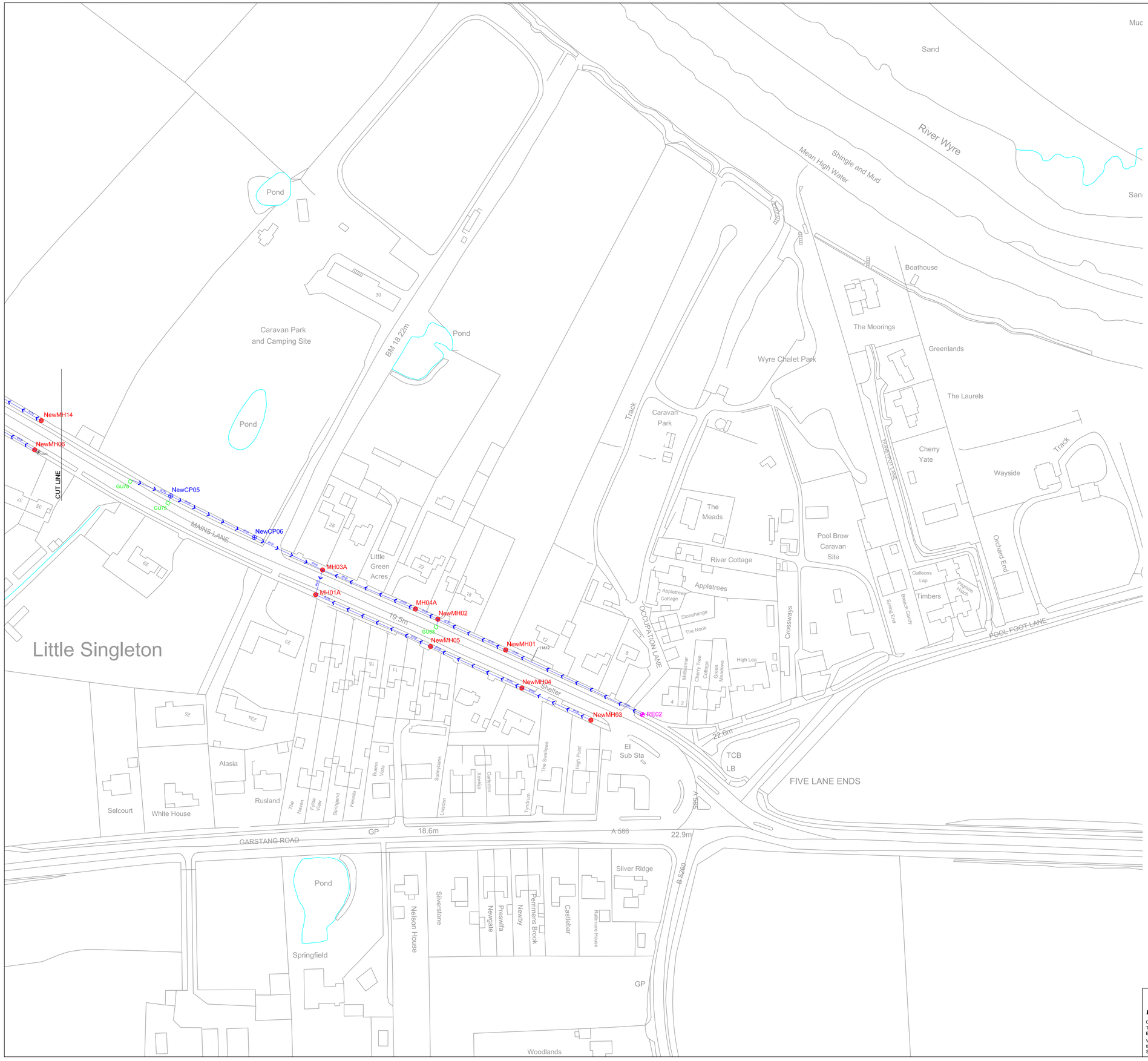
- CARRIER (SUB SURFACE CONT. ITEM)
- CARRIER ASSUMED (SUB SURFACE CONT. ITEM ASSUMED)
- SAFETY KERBS (SURFACE CONT. ITEM)
- FILTER/CARRIER (SUB SURFACE CONT. ITEM)
- FILTER/CARRIER ASSUMED (SUB FILTER/SURFACE CONT. ITEM ASSUMED)
- GRADE 4 DEFECT
- GRADE 5 DEFECT
- SURVEY ABANDONED DEFECT
- CATCHPIT (CP)
- CONNECTOR NODE
- GHOST NODE (GN)
- GULLY (GU)
- INSPECTION CHAMBER (IC)
- MANHOLE (MH)
- OIL INTERCEPTOR (OI)
- INLET
- OUTFALL (OU)
- OUTLET (OL)
- PHANTOM NODE (PN)
- RODDING EYE (RE)
- SILT INTERCEPTOR

ANDIDRAIN LIMITED
DRAIN CLEARANCE : SEWER SERVICES
Caron House, Kingmoor Park, Rockcliffe Estate, Rockcliffe, Carlisle, CA6 4RW
Tel : (01228) 672300 Fax : (01228) 672301
E-Mail : enquiries@andidrain.co.uk

Where Applicable mapping data is based upon the Ordnance Survey® map with the permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office, © Crown Copyright. Licence No. AL100031489

Client :	METCALFE PLANT HIRE LTD
Drawing Title :	A585 MAINS LANE
Scale :	NTS
Revision :	
Drawn By :	S [redacted]
Revision date:	
Date :	16.11.2016
Description :	
Job No :	27207-01
Drg No :	4
Rev :	0

K:\CCTV Surveys\Metcalfe\A585 Mains Lane



Defect No.	Survey No.	Start MH	Flow	End MH	m	Code	Description	Grade
1	4	MHAS4	d/s	MHA33	5.7	SA	Survey abandoned, Remark: Unable to travel round bend	
2	5	MHAS6	u/s	PN01	81.3	SA	Survey abandoned, Remark: To x-camera	
3	6	MHAS6	u/s	PN02	42.9	SA	Survey abandoned, Remark: Extent of x-camera survey no.05	
4	7	MHAS5	d/s	MHAS4	62.9	SA	Survey abandoned, Remark: To x-camera	
5	8	MHAS4	u/s	MHAS5	21.3	SA	Survey abandoned, Remark: Extent of x-camera survey no.07	
6	32	MH09A	d/s	MH09	111.4	SA	Survey abandoned, Remark: To x-camera	
7	33	MH09	u/s	MH09A	10.69	SA	Survey abandoned, Remark: Extent of x-camera survey no.32	
8	34	MH11	d/s	MH09	70.7	SA	Survey abandoned, Remark: To x-camera	
9	35	MH11	u/s	MH13	31.1	SA	Survey abandoned, Remark: To x-camera	
10	36	MH19	d/s	MH15	78	SA	Survey abandoned, Remark: To x-camera	
11	43	NewMH01	u/s	RE02	15.9	SA	Survey abandoned, Remark: To x-camera	
12	44	RE02	d/s	NewMH01	70.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.43	
13	46	MH14	u/s	NewMH17	50.1	SA	Survey abandoned, Remark: To x-camera	
14	48	MH15	u/s	MH19	14.8	SA	Survey abandoned, Remark: Extent of x-camera survey no.36	
15	49	NewMH17	d/s	MH14	2	SA	Survey abandoned, Remark: Extent of x-camera survey no.46	
16	53	NewMH20	u/s	NewMH18	73.8	SA	Survey abandoned, Remark: To x-camera	
17	59	NewMH18	d/s	NewMH20	40.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.53	
18	61	MH09	u/s	MH11	51.7	SA	Survey abandoned, Remark: Extent of x-camera survey no.34	
19	62	MH13	d/s	MH11	83	SA	Survey abandoned, Remark: Extent of x-camera survey no.35	
20	64	NewMH19	u/s	PN03	16.3	SA	Survey abandoned, Remark: Due to debris concrete	
21	65	NewMH19	d/s	PN04	32.9	SA	Survey abandoned, Remark: Joins main	

KEY

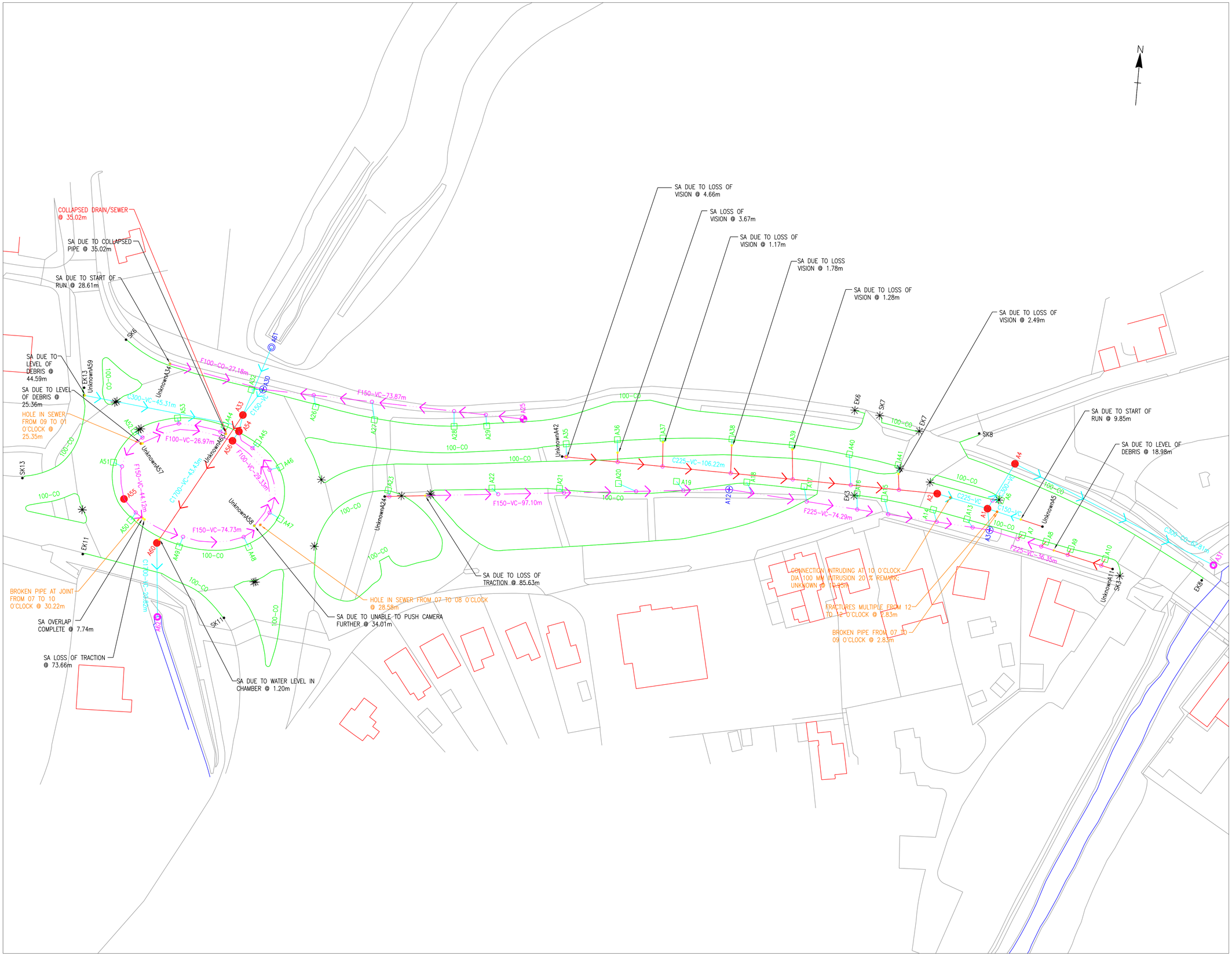
- CARRIER (SUB SURFACE CONT. ITEM)
- CARRIER ASSUMED (SUB SURFACE CONT. ITEM ASSUMED)
- SAFETY KERBS (SURFACE CONT. ITEM)
- FILTER/CARRIER (SUB SURFACE CONT. ITEM)
- FILTER/CARRIER ASSUMED (SUB FILTER/SURFACE CONT. ITEM ASSUMED)
- GRADE 4 DEFECT
- GRADE 5 DEFECT
- SURVEY ABANDONED DEFECT
- CATCHPIT (CP)
- CONNECTOR NODE
- GHOST NODE (GN)
- GULLY (GU)
- INSPECTION CHAMBER (IC)
- MANHOLE (MH)
- OIL INTERCEPTOR (OI)
- INLET
- OUTFALL (OU)
- OUTLET (OL)
- PHANTOM NODE (PN)
- RODDING EYE (RE)
- SILT INTERCEPTOR

ANDIDRAIN LIMITED
DRAIN CLEARANCE : SEWER SERVICES
Caron House, Kingmoor Park, Rockcliffe Estate, Rockcliffe, Carlisle, CA6 4RW
Tel : (01228) 672300 Fax : (01228) 672301
E-Mail : enquiries@andidrain.co.uk

Where Applicable mapping data is based upon the Ordnance Survey® map with the permission of Ordnance Survey on behalf of The Controller of Her Majesty's Stationery Office, © Crown Copyright. Licence No. AL100031489

Client :	METCALFE PLANT HIRE LTD		
Drawing Title :	A585 MAINS LANE		
Scale :	NTS	Revision :	
Drawn By :	S[redacted]	Revision date:	
Date :	16.11.2016	Description :	
Job No :	27207-01	Drg No : 5	Rev : 0

K:\CCTV Surveys\Metcalfe\A585 Mains Lane



SYMBOLOGY:

- SUB SURFACE CONTINUOUS ITEMS
- SUB SURFACE CONTINUOUS ITEMS UNSURVEYED
- COMBINED SURFACE AND SUB SURFACE ITEMS
- COMBINED SURFACE AND SUB SURFACE ITEMS UNSURVEYED
- SURFACE CONTINUOUS ITEMS
- PHANTOM CONNECTOR

SYMBOLS:

- MANHOLE
- OUTFALL
- OUTLET
- INLET
- PUMPING STATION
- GULLY
- GRIP INLET
- SOAKAWAY
- OIL INTERCEPTOR
- SILT INTERCEPTOR
- CATCHPIT
- GHOST NODE
- PHANTOM NODE
- RODDING EYE
- OTHER SPECIAL CHAMBER
- CONNECTOR NODE
- MARKER POST REF

C300-CO-100.000 (PIPE (e.g F=FILTER, C=CARRIER PIPES); DIAMETER; MATERIAL; PIPE LENGTH (m))

DEFECT SYMBOLS

- LOCATION OF GRADE 4 DEFECTS
- LOCATION OF GRADE 5 DEFECTS
- LOCATION OF SURVEY ABANDONED

NOTE:
GPS CHAMBERS / GULLY'S etc ARE SHOWN AS CO-ORDINATES AND MAY APPEAR TO BE IN CONFLICT WITH THEIR ACTUAL POSITION IN RELATION TO THE CARRIAGEWAY MARKINGS GIVEN

Rev	Description	By	Date	App
0	FIRST ISSUE	CL	02/13	RR

Carnell

Carnell Support Services Ltd

Gothic House
Market Place
Penkridge
Staffordshire
ST19 5DJ

0800 328 0914
info@carnellgroup.co.uk
www.carnellgroup.co.uk

HIGHWAYS AGENCY

enterprise mouchel

Project Title:
HIGHWAYS AGENCY
AREA 13
A585 AMOUNDERNESS WAY

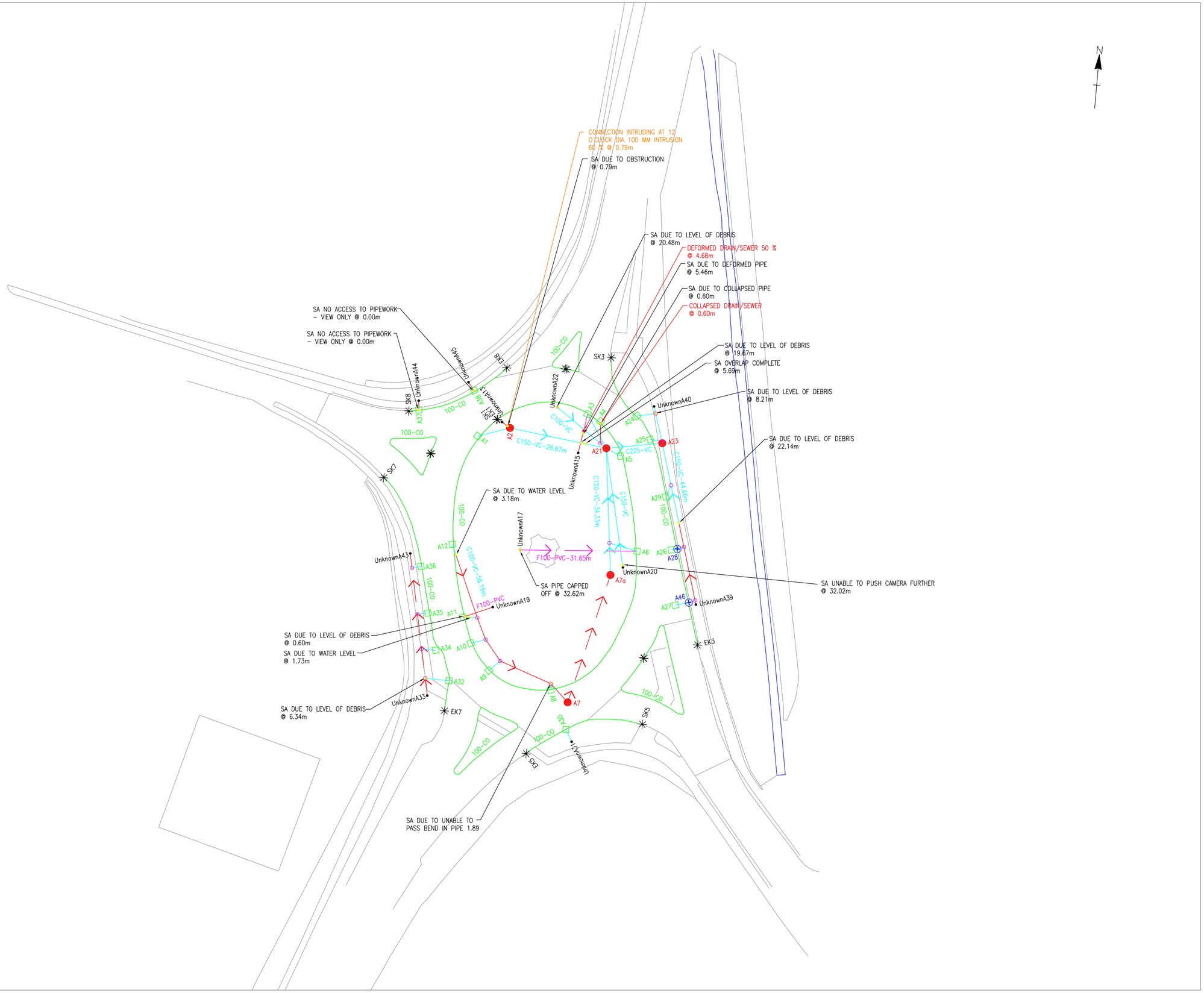
Drawing Title:
CONDITION DRAWING

Scheme No:	13_9038a		
Dwg Scale:	1:500 @ A1	Sheet No:	1 OF 1
Drawn By:	CL	Date:	08/02/13
Checked By:	MW	Date:	08/02/13
Approved By:	RR	Date:	08/02/13

Drawing Number: 9038a_CO_001

Revision: 0

File: Area 13\Water\2012 - 2013\9038 - A585 Amounderness Way (Inc Eros Rbt) Hotspot 254\Operational\Report\Report Documents\Final Report\Drawings



SYMBOLOGY:

SUB SURFACE CONTINUOUS ITEMS
SUB SURFACE CONTINUOUS ITEMS UNSURVEYED
COMBINED SURFACE AND SUB SURFACE ITEMS
COMBINED SURFACE AND SUB SURFACE ITEMS UNSURVEYED
SURFACE CONTINUOUS ITEMS
PHANTOM CONNECTOR

SYMBOLS:

MANHOLE
OUTFALL
OUTLET
INLET
PUMPING STATION
GULLY
GRIP INLET
SOAKAWAY
OIL INTERCEPTOR
SILT INTERCEPTOR
CATCHPIT
GHOST NODE
PHANTOM NODE
RODDING EYE
OTHER SPECIAL CHAMBER
CONNECTOR NODE
MARKER POST REF

C300–CO–100.000
PIPE (e.g F=FILTER, C=CARRIER PIPES)
DIAMETER
MATERIAL
PIPE LENGTH (m)

DEFECT SYMBOLS

LOCATION OF GRADE 4 DEFECTS
LOCATION OF GRADE 5 DEFECTS
LOCATION OF SURVEY ABANDONED

NOTE:
GPS CHAMBERS / GULLY'S etc ARE SHOWN AS CO–ORDINATES AND MAY APPEAR TO BE IN CONFLICT WITH THEIR ACTUAL POSITION IN RELATION TO THE CARRIAGEWAY MARKINGS GIVEN

Rev	Description	By	Date	App
0	FIRST ISSUE	CL	02/13	RR

Carnell

Carnell Support Services Ltd

Gothic House
Market Place
Penkridge
Staffordshire
ST19 5DJ

0800 328 0914
info@carnellgroup.co.uk
www.carnellgroup.co.uk

HIGHWAYS AGENCY

enterprise mouchel

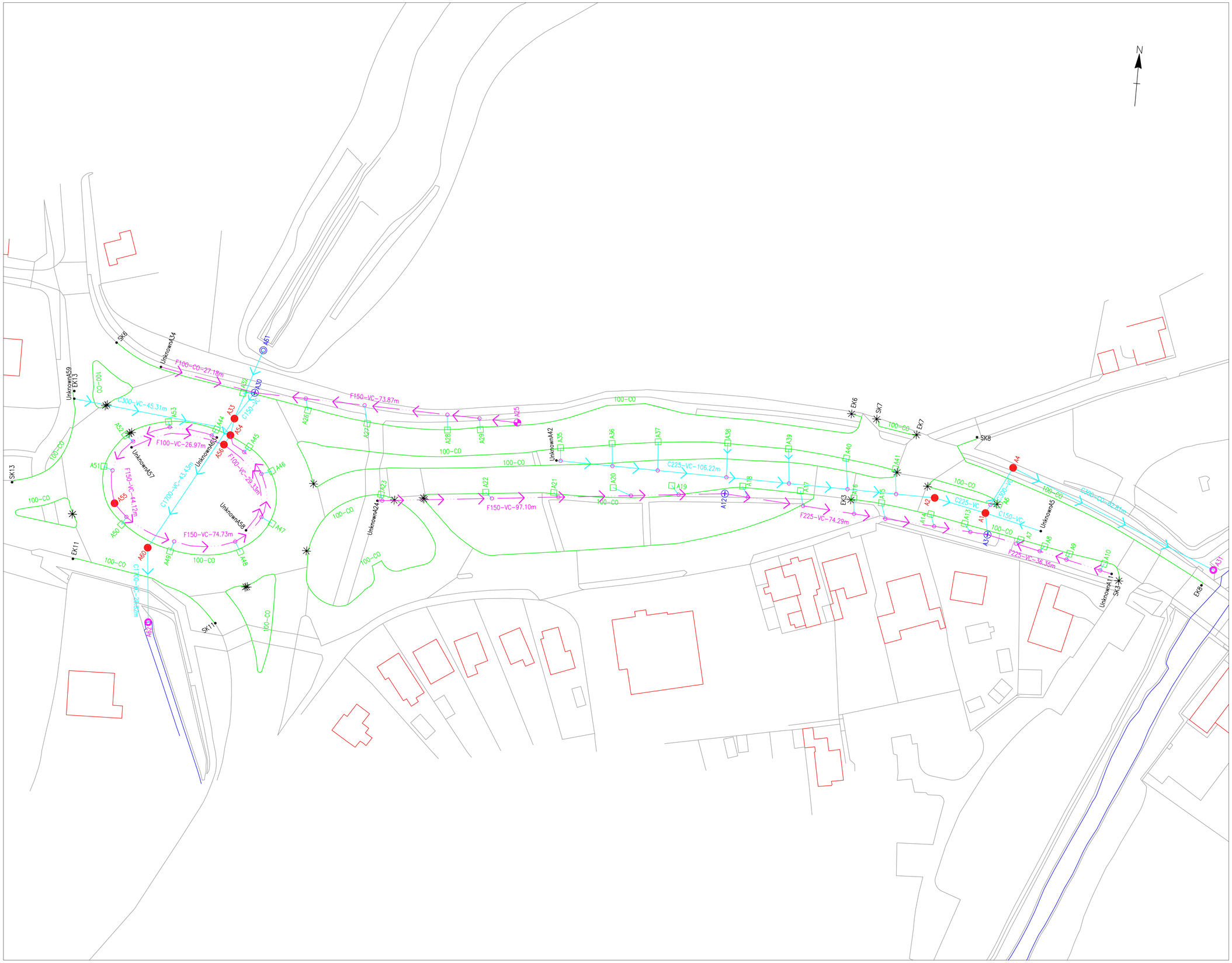
Project Title:
HIGHWAYS AGENCY
AREA 13
EROS ROUNDABOUT

Drawing Title:
CONDITION DRAWING

Scheme No:	13_9038b		
Dwg Scale:	1:500 @ A1	Sheet No:	1 OF 1
Drawn By:	CL	Date:	08/02/13
Checked By:	MW	Date:	08/02/13
Approved By:	RR	Date:	08/02/13

Drawing Number: 9038b_CO_001
Revision: 0

File: Area 13\Water\2012 - 2013\9038 - A585 Amounderness Way (Inc Eros Rbt) Hotspot 254\Operational\Report\Report Documents\Final Report\Drawings



SYMBOLOGY:

SUB SURFACE CONTINUOUS ITEMS

COMBINED SURFACE AND SUB SURFACE ITEMS

SURFACE CONTINUOUS ITEMS

PHANTOM CONNECTOR

SYMBOLS:

MANHOLE

OUTFALL

OUTLET

INLET

PUMPING STATION

GULLY

GRIP INLET

SOAKAWAY

OIL INTERCEPTOR

SILT INTERCEPTOR

CATCHPIT

GHOST NODE

PHANTOM NODE

RODDING EYE

OTHER SPECIAL CHAMBER

CONNECTOR NODE

MARKER POST REF

PIPE (e.g F=FILTER, C=CARRIER PIPES)
DIAMETER
MATERIAL
PIPE LENGTH (m)

C300-CO-100.000

NOTE:
GPS CHAMBERS / GULLY'S etc ARE SHOWN AS CO-ORDINATES AND MAY APPEAR TO BE IN CONFLICT WITH THEIR ACTUAL POSITION IN RELATION TO THE CARRIAGEWAY MARKINGS GIVEN

Rev	Description	By	Date	App
0	FIRST ISSUE	CL	02/13	RR

Carnell

Carnell Support Services Ltd

Gothic House
Market Place
Penkridge
Staffordshire
ST19 5DJ

0800 328 0914
info@carnellgroup.co.uk
www.carnellgroup.co.uk

HIGHWAYS AGENCY

enterprise mouchel

Project Title:
HIGHWAYS AGENCY
AREA 13
A585 AMOUNDERNESS WAY

Drawing Title:
ASSET INVENTORY DRAWING

Scheme No:	13_9038a		
Dwg Scale:	1:500 @ A1	Sheet No:	1 OF 1
Drawn By:	CL	Date:	08/02/13
Checked By:	MW	Date:	08/02/13
Approved By:	RR	Date:	08/02/13

Drawing Number: 9038a_AI_001

Revision: 0

File Area 13\Water\2012 - 2013\9038 - A585 Amounderness Way (Inc Eros Rbt) Hotspot 254\Operational\Report\Report Documents\Final Report\Drawings



SYMBOLOGY:

SUB SURFACE CONTINUOUS ITEMS

COMBINED SURFACE AND SUB SURFACE ITEMS

SURFACE CONTINUOUS ITEMS

PHANTOM CONNECTOR

SYMBOLS:

MANHOLE

OUTFALL

OUTLET

INLET

PUMPING STATION

GULLY

GRIP INLET

SOAKAWAY

OIL INTERCEPTOR

SILT INTERCEPTOR

CATCHPIT

GHOST NODE

PHANTOM NODE

RODDING EYE

OTHER SPECIAL CHAMBER

CONNECTOR NODE

MARKER POST REF

C300-CO-100.000
- PIPE (e.g F=FILTER, C=CARRIER PIPES)
- DIAMETER
- MATERIAL
- PIPE LENGTH (m)

NOTE:
GPS CHAMBERS / GULLY'S etc ARE SHOWN AS CO-ORDINATES AND MAY APPEAR TO BE IN CONFLICT WITH THEIR ACTUAL POSITION IN RELATION TO THE CARRIAGEWAY MARKINGS GIVEN

Rev	Description	By	Date	App
0	FIRST ISSUE	CL	02/13	RR

Carnell

Carnell Support Services Ltd

Gothic House
Market Place
Penkridge
Staffordshire
ST19 5DJ

0800 328 0914
info@carnellgroup.co.uk
www.carnellgroup.co.uk

HIGHWAYS AGENCY

enterprise mouchel

Project Title:
HIGHWAYS AGENCY
AREA 13
EROS ROUNDABOUT

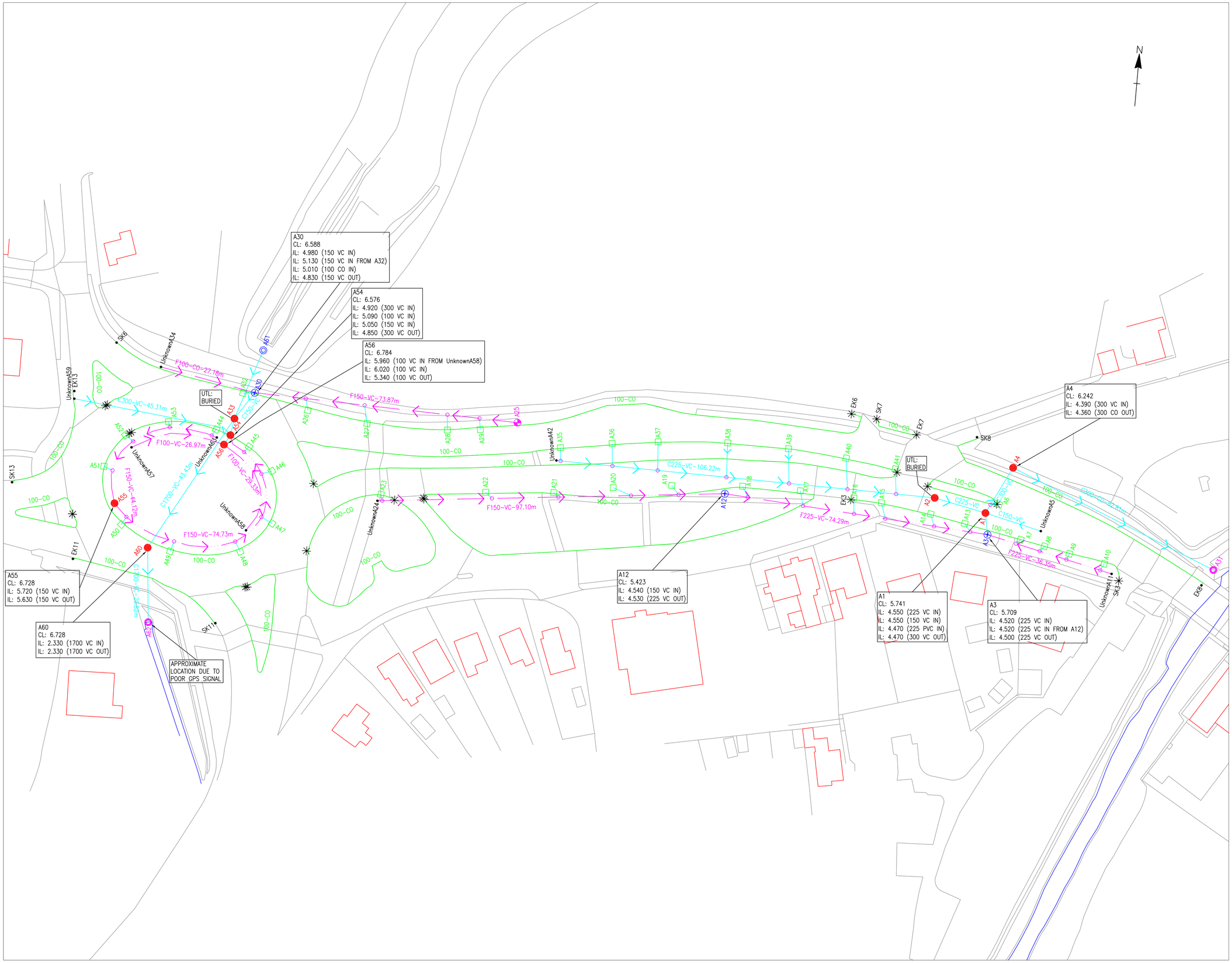
Drawing Title:
ASSET INVENTORY DRAWING

Scheme No:	13_9038b		
Dwg Scale:	1:500 @ A1	Sheet No:	1 OF 1
Drawn By:	CL	Date:	08/02/13
Checked By:	MW	Date:	08/02/13
Approved By:	RR	Date:	08/02/13

Drawing Number: 9038b_AI_001

Revision: 0

File: V:\Area 13\Water\2012 - 2013\9038 - A585 Amounderness Way (Inc Eros Rbt) Hotspot 254\Operational\Report\Report Documents\Final Report\Drawings



SYMBOLOGY:

SUB SURFACE CONTINUOUS ITEMS

COMBINED SURFACE AND SUB SURFACE ITEMS

SURFACE CONTINUOUS ITEMS

PHANTOM CONNECTOR

SYMBOLS:

MANHOLE

OUTFALL

OUTLET

INLET

PUMPING STATION

GULLY

GRIP INLET

SOAKAWAY

OIL INTERCEPTOR

SILT INTERCEPTOR

CATCHPIT

GHOST NODE

PHANTOM NODE

RODDING EYE

OTHER SPECIAL CHAMBER

CONNECTOR NODE

MARKER POST REF

PIPE (e.g F=FILTER, C=CARRIER PIPES)
DIAMETER
MATERIAL
PIPE LENGTH (m)

C300-CO-100.000

CL: COVER LEVEL

IL: INVERT LEVEL

NOTE:
GPS CHAMBERS / GULLY'S etc ARE SHOWN AS CO-ORDINATES AND MAY APPEAR TO BE IN CONFLICT WITH THEIR ACTUAL POSITION IN RELATION TO THE CARRIAGEWAY MARKINGS GIVEN

Rev	Description	By	Date	App
0	FIRST ISSUE	CL	02/13	RR

Carnell

Carnell Support Services Ltd

Gothic House
Market Place
Penkridge
Staffordshire
ST19 5DJ

0800 328 0914
info@carnellgroup.co.uk
www.carnellgroup.co.uk

HIGHWAYS AGENCY

enterprise mouchel

Project Title:
HIGHWAYS AGENCY
AREA 13
A585 AMOUNDERNESS WAY

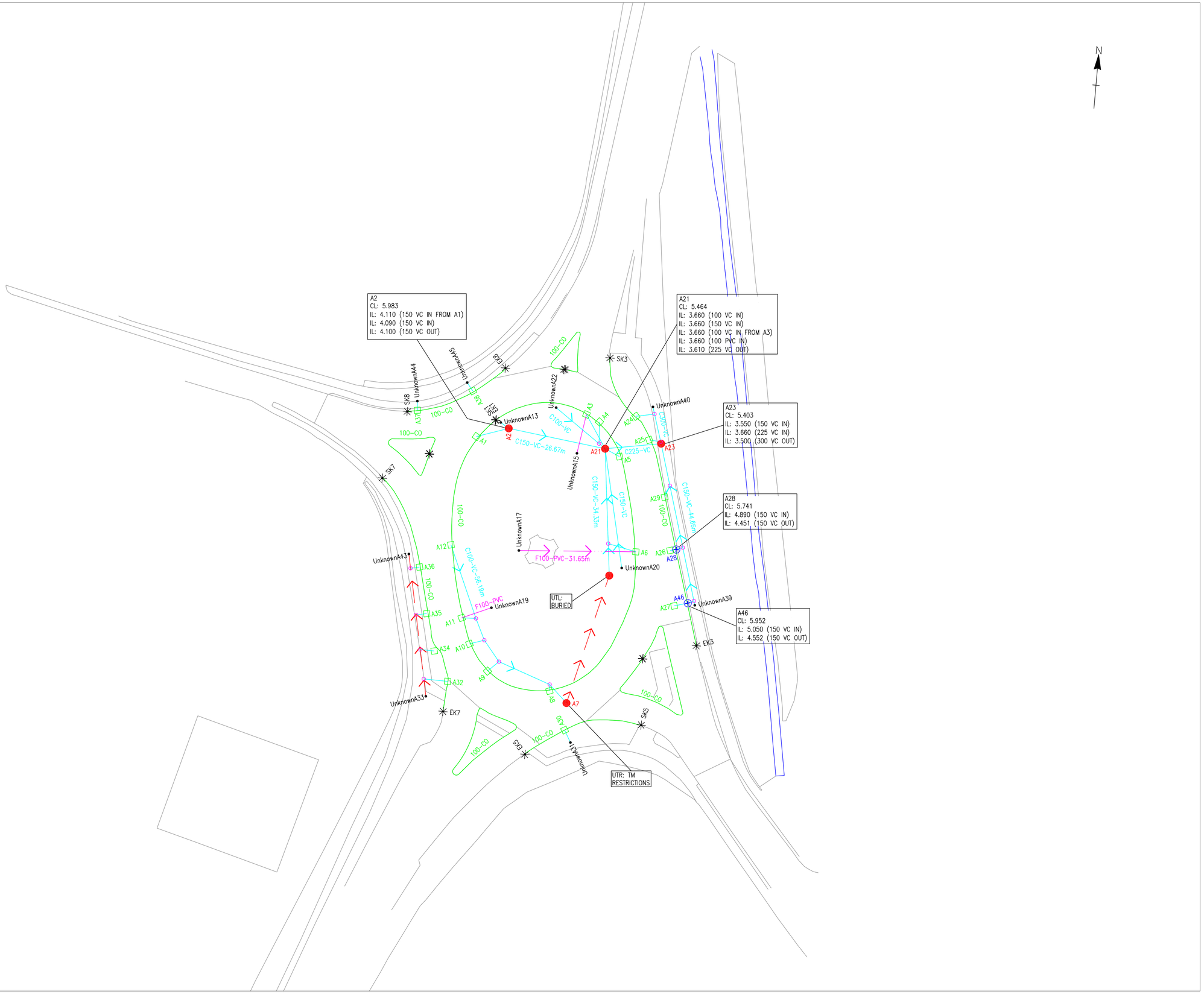
Drawing Title:
DESIGN DRAWING

Scheme No:	13_9038a		
Dwg Scale:	1:500 @ A1	Sheet No:	1 OF 1
Drawn By:	CL	Date:	08/02/13
Checked By:	MW	Date:	08/02/13
Approved By:	RR	Date:	08/02/13

Drawing Number: 9038a_DE_001

Revision: 0

File: Area 13\Water\2012 - 2013\9038 - A585 Amounderness Way (Inc Eros Rbt) Hotspot 254\Operational\Report\Report Documents\Final Report\Drawings



SYMBOLOGY:

SUB SURFACE CONTINUOUS ITEMS

COMBINED SURFACE AND SUB SURFACE ITEMS

SURFACE CONTINUOUS ITEMS

PHANTOM CONNECTOR

SYMBOLS:

MANHOLE

OUTFALL

OUTLET

INLET

PUMPING STATION

GULLY

GRIP INLET

SOAKAWAY

OIL INTERCEPTOR

SILT INTERCEPTOR

CATCHPIT

GHOST NODE

PHANTOM NODE

RODDING EYE

OTHER SPECIAL CHAMBER

CONNECTOR NODE

MARKER POST REF

C300–CO–100.000
- PIPE (e.g F=FILTER, C=CARRIER PIPES)
- DIAMETER
- MATERIAL
- PIPE LENGTH (m)

CL: COVER LEVEL

IL: INVERT LEVEL

NOTE:
GPS CHAMBERS / GULLY'S etc ARE SHOWN AS CO–ORDINATES AND MAY APPEAR TO BE IN CONFLICT WITH THEIR ACTUAL POSITION IN RELATION TO THE CARRIAGEWAY MARKINGS GIVEN

Rev	Description	By	Date	App
0	FIRST ISSUE	CL	02/13	RR

Carnell Support Services Ltd

Gothic House
Market Place
Penkridge
Staffordshire
ST19 5DJ

0800 328 0914
info@carnellgroup.co.uk
www.carnellgroup.co.uk

HIGHWAYS AGENCY

enterprise mouchel

Project Title:

HIGHWAYS AGENCY
AREA 13
EROS ROUNDABOUT

Drawing Title:

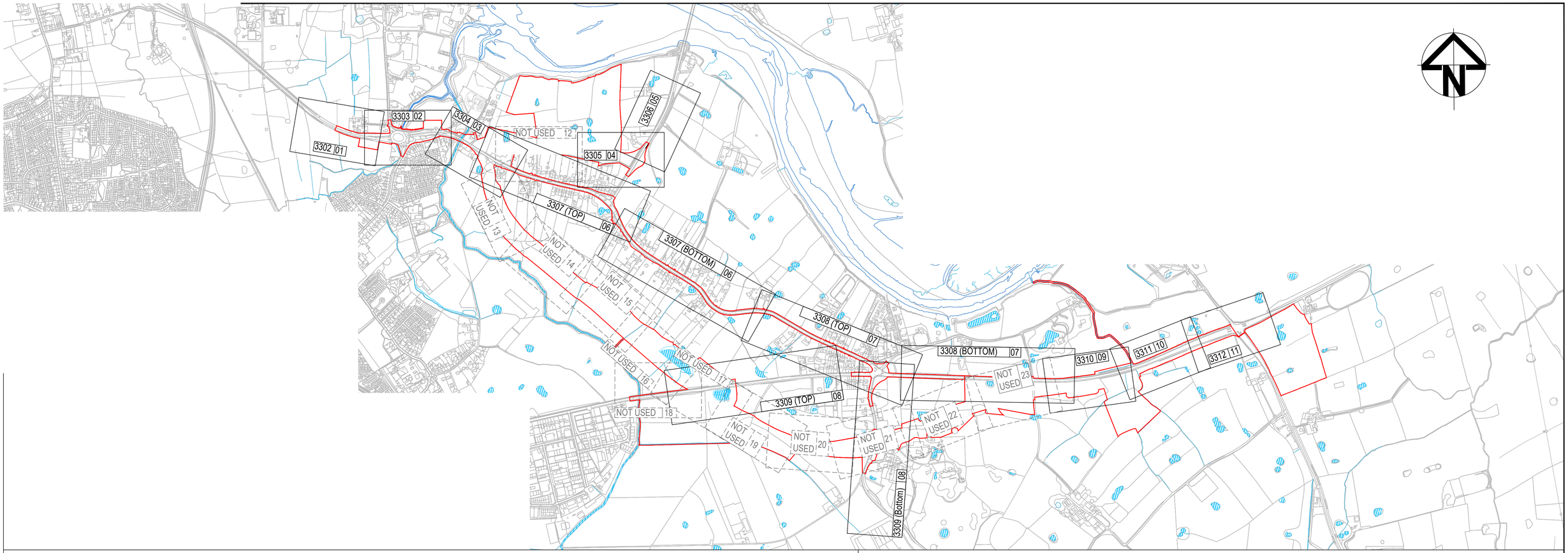
DESIGN DRAWING

Scheme No:	13_9038b		
Dwg Scale:	1:500 @ A1	Sheet No:	1 OF 1
Drawn By:	CL	Date:	08/02/13
Checked By:	MW	Date:	08/02/13
Approved By:	RR	Date:	08/02/13

Drawing Number: 9038b_DE_001

Revision: 0

Appendix B – Existing drainage asset and condition survey plans (Gap analysis plans)



DRAINAGE LEGEND :

PROPOSED REDLINE BOUNDARY

225 Ø — EXISTING DRAINAGE TO BE REMOVED - CCTV ASSET AND CONDITION SURVEY NOT REQUIRED

225 Ø — EXISTING DRAINAGE TO BE RETAINED -CCTV ASSET AND CONDITION SURVEY NOT REQUIRED

225 Ø — EXISTING DRAINAGE TO BE RETAINED - CCTV ASSET AND CONDITION SURVEY REQUIRED

225 Ø — EXISTING DRAINAGE TO BE REMOVED - ASSET SURVEY REQUIRED (NO CCTV CONDITION SURVEY)

EXISTING DRAINAGE GULLY POT WITH CONNECTIONTO BE REMOVED - CCTV ASSET AND CONDITION SURVEY NOT REQUIRED

EXISTING DRAINAGE GULLY POT WITH CONNECTION TO BE RETAINED - CCTV ASSET AND CONDITION SURVEY REQUIRED

EXISTING DRAINAGE GULLY POT WITH CONNECTION TO BE RETAINED -CCTV ASSET AND CONDITION SURVEY NOT REQUIRED

M1A-001/C1A-001 — EXISTING DRAINAGE MANHOLE/CATCHPITTO BE REMOVED - CCTV ASSET AND CONDITION SURVEY NOT REQUIRED

M1A-001/C1A-001 — EXISTING DRAINAGE MANHOLE/CATCHPIT TO BE RETAINED - CCTV ASSET AND CONDITION SURVEY REQUIRED

M1A-001/C1A-001 — EXISTING DRAINAGE MANHOLE/CATCHPIT TO BE REMOVED - ASSET SURVEY REQUIRED (NO CCTV CONDITION SURVEY)

M1A-001/C1A-001 — EXISTING DRAINAGE MANHOLE\CATCHPIT TO BE RETAINED -CCTV ASSET AND CONDITION SURVEY NOT REQUIRED

EXISTING DRAINAGE TO BE RETAINED -CCTV ASSET AND CONDITION SURVEY NOT REQUIRED

NO EXISTING DRAINAGE DATA AVAILABLE - LOCATE EXISTING DRAINAGE ASSETS AND UNDERTAKE CCTV ASSET AND CONDITION SURVEY

Pond — EXISTING WATERBODIES

ASSUMED EXISTING HEADWALL / OUTFALLL LOCATION

PROPOSED ROAD LAYOUT

ORDNANCE SURVEY

EXISTING ROAD

3311 | 10 — SHEET NO. / DRAWING NO.

DRAINAGE GENERAL NOTES :

1. ALL PIPE SIZES ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS STATED OTHERWISE.
2. WRITTEN SCALES (EG. 1:1000, 1:500, ETC.) APPLY TO DRAWINGS AT A1 PAPER SIZE UNLESS NOTED OTHERWISE.
3. DO NOT SCALE DIRECTLY FROM DRAWINGS, USE FIGURED DIMENSIONS ONLY.
4. REFER TO CCTV ASSET SPECIFICATION HE-548643-ARC- HDG-A585-RP-D-3037.
5. CCTV ASSET AND CONDITION SURVEYS ARE TO BE UNDERTAKEN ON ALL IDENTIFIED AND UNIDENTIFIED DRAINAGE ASSET AS HIGHLIGHTED ON THESE PLANS.
6. SHEET NO. 12 TO 23 NOT TO BE REFERRED FOR THIS PACKAGE.

Rev	Status	Rev. Date	Purpose of revision		Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S	A	N
P01	PD	26OCT2017	PRELIMINARY DESIGN	S	A	N

100mm on Original

Print Date:

File Path:

Notes

LOCATION PLAN

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) KEY PLAN

Status: PRELIMINARY DESIGN | Revision: P02

Scale: NTS | Date - 21FEB2018

Drawn By: [redacted]G.

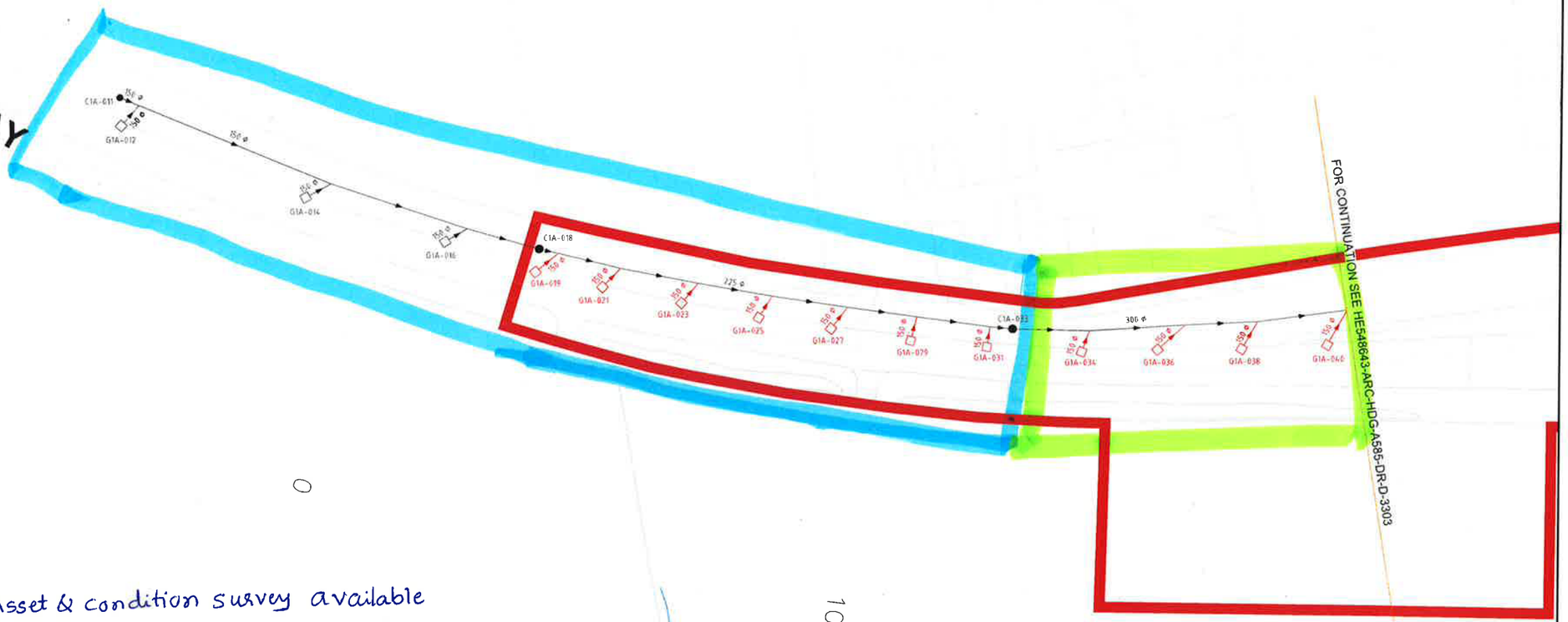
Checked By: A.[redacted]

Approved By: N.[redacted]

Project No.: UA008015 | HA PIN: HE548643 | Originator: ARC | Original Size: A1

Drawing number: HE548643-ARC-HDG-A585-DR-D-3301 (Volume | Location | Type | Role | Number)

A585 AMOUNDERNESS WAY



NO CCTV Asset & condition survey available

CCTV Asset & condition survey available

CCTV Asset & condition survey is incomplete

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S	A	N
P01	PD	26OCT2017	PRELIMINARY DESIGN	S	A	N

Notes

1. FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS
Registered office: Arcadis House 34 York Way London N1 9AB
Coordinating office: The Surrey Research Park 10 Mediaver Road Guildford GU2 7AR Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 1 OF 11

Status: PRELIMINARY DESIGN | Revision: P02

Scale: 1:500 | Date: 21FEB2018

Drawn By: [redacted]G

Checked By: A[redacted]

Approved By: N[redacted]

Project No: UA008015 | HA PIN: HE548643 | Originator: ARC | Original Size: A1

Drawing number: Volume | Location | Type | Role | Number: HE548643-ARC-HDG-A585-DR-D-3302

100mm on Original

Print Date:

File Path:

B5412 SKIPPOOL ROAD

A585 BRECK ROAD

A588 BRECK ROAD

DRAINAGE ASSETS ON SKIPPOOL ROAD (B5412) TO BE IDENTIFIED AND A CCTV ASSET AND CONDITION SURVEY TO THE OUTFALL IS TO BE UNDERTAKEN

STRUCTURAL CONDITION SURVEY REQUIRED, METHODOLOGY TO BE CONFIRMED WITH SPECIALIST SUPPLIER

OUTFALL CATCHMENT-02A DETAILS TBC

OUTFALL CATCHMENT-01A DETAILS TBC

OUTFALL CATCHMENT-02B DETAILS TBC

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3302

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3304

E 440600

E 440500

No CCTV asset & condition survey available

CCTV Asset & condition survey available

CCTV asset & condition survey is incomplete

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S	A	N
P01	PD	26OCT2017	PRELIMINARY DESIGN	S	A	N

Notes

1. FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS

Registered office: Arcadis House, 34 York Way, London N1 9AB

Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 2 OF 11

Status: PRELIMINARY DESIGN

Revision: P02

Scale: 1:500

Date: 21FEB2018

Drawn By: G

Checked By: A

Approved By: N

Project No: UA008015

HA PIN: HE548643

Originator: ARC

Original Size: A1

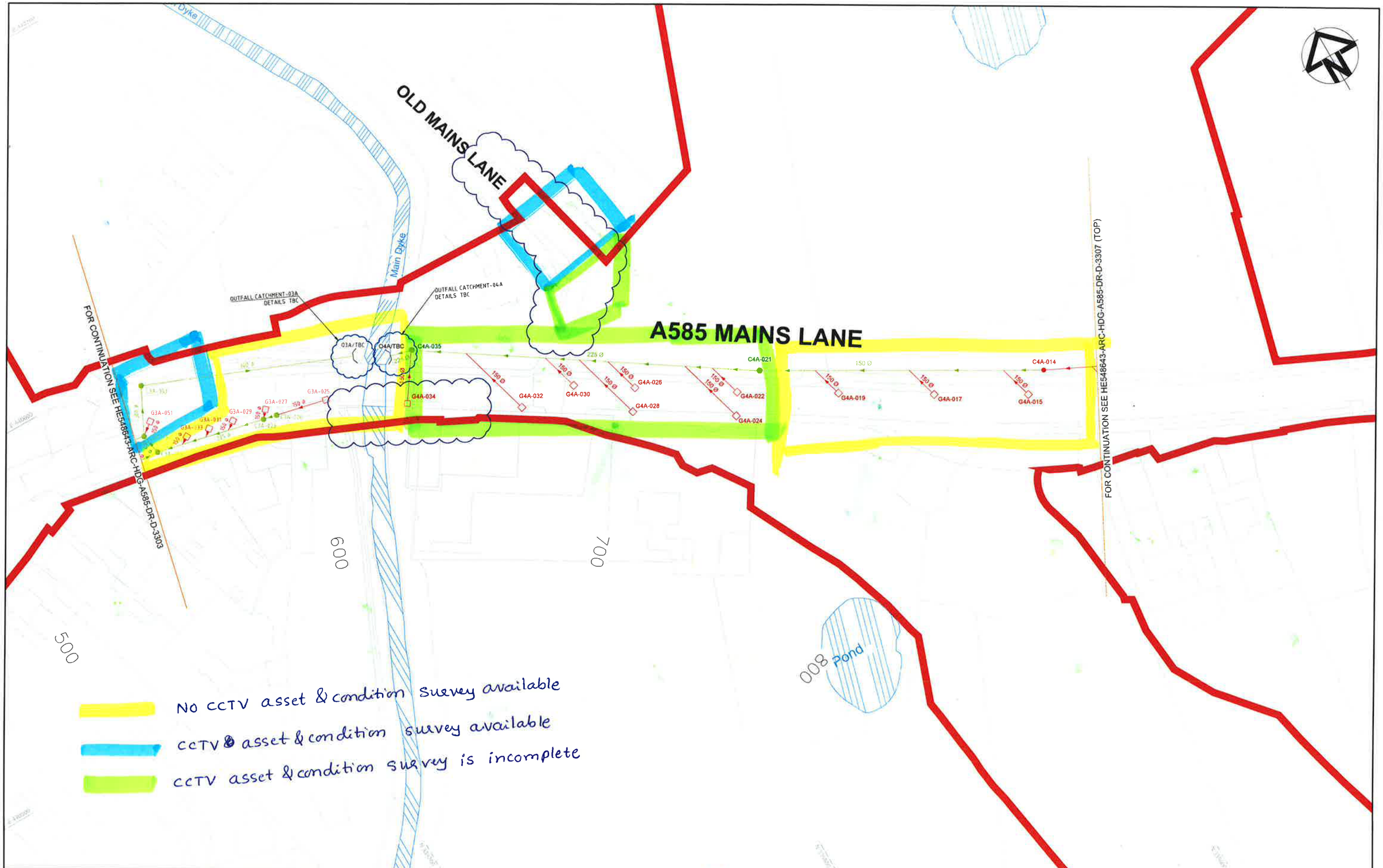
Drawing number: Volume | Location | Type | Role | Number

HE548643-ARC-HDG-A585-DR-D-3303

100mm on Original

Print Date:

File Path:



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S	A	N
P01	PD	26OCT2017	PRELIMINARY DESIGN	S	A	N

Notes

1. FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 3 OF 11

Status	PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	21FEB2018
Drawn By	[redacted]G
Checked By	A[redacted]
Approved By	N[redacted]
Project No	UA008015
HA PIN	HE548643
Originator	ARC
Original Size	A1
Drawing number	HE548643-ARC-HDG-A585-DR-D-3304

Volume | Location | Type | Role | Number

100mm on Original

Print Date: [redacted]

File Path: [redacted]

Pond

E 440590

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3306

A588 SHARD ROAD

DRAINAGE ASSETS ON A588 TO BE IDENTIFIED AND A CCTV ASSET AND CONDITION SURVEY TO THE OUTFALL IS TO BE UNDERTAKEN

E 440400

No CCTV asset & condition Survey available

CCTV asset & condition survey available

CCTV asset & condition Survey is incomplete

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3307 (TOP)

Pond

Pond

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chk'd	Appr'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

Print Date:

File Path:

Notes

1 . FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS
Registered office: Arcadis House, 34 York Way, London N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 4 OF 11

Status: PRELIMINARY DESIGN

Revision: P02

Scale: 1:500

Date: 21FEB2018

Drawn By: [redacted]G

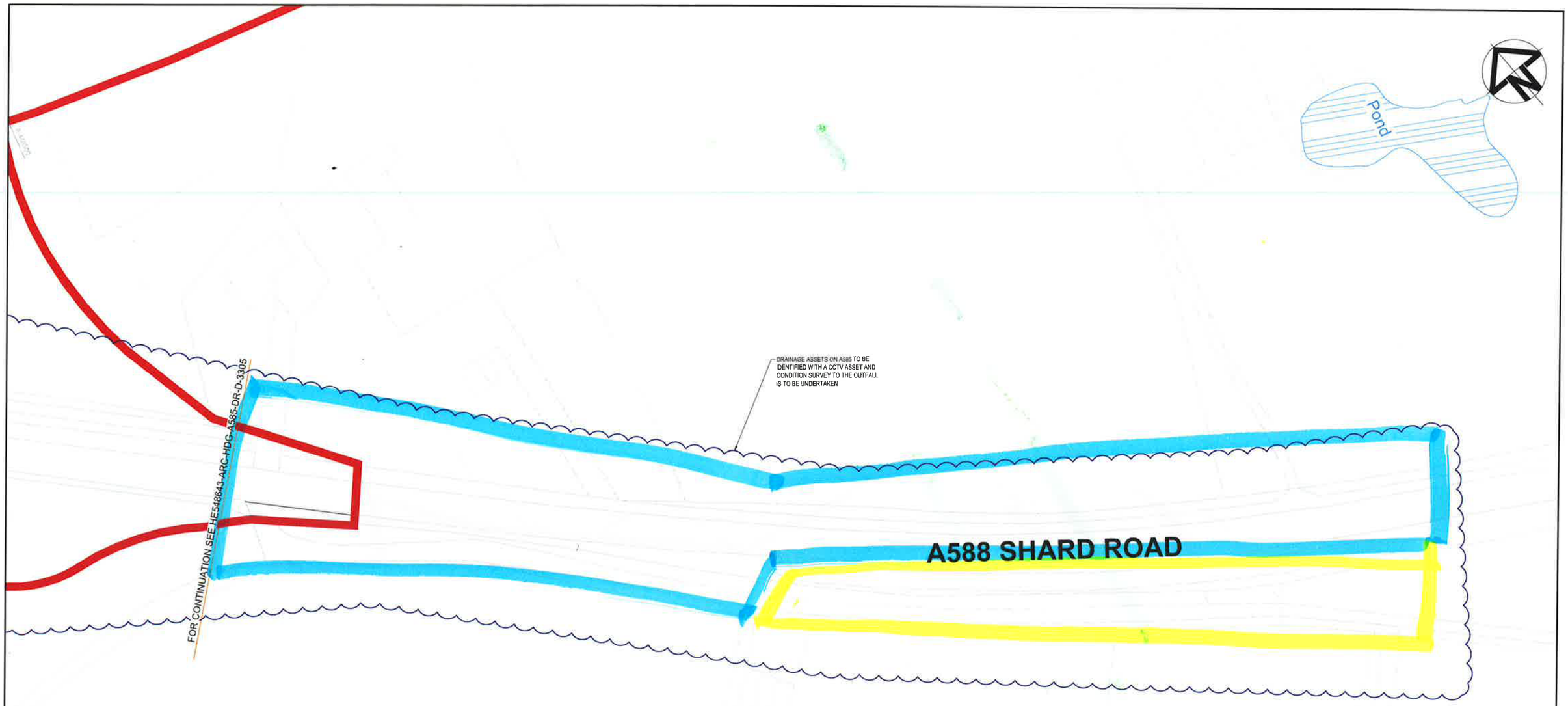
Checked By: A[redacted]

Approved By: N[redacted]

Project No: UA008015 | HA PIN: HE548643 | Originator: ARC | Original Size: A1

Drawing number: HE548643-ARC-HDG-A585-DR-D-3305

Volume | Location | Type | Role | Number



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Notes:

1 . FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS
Registered office: Arcadis House 34 York Way London N1 9AB
Coordinating office: The Surrey Research Park 10 Medawar Road Guildford GU2 7AR Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

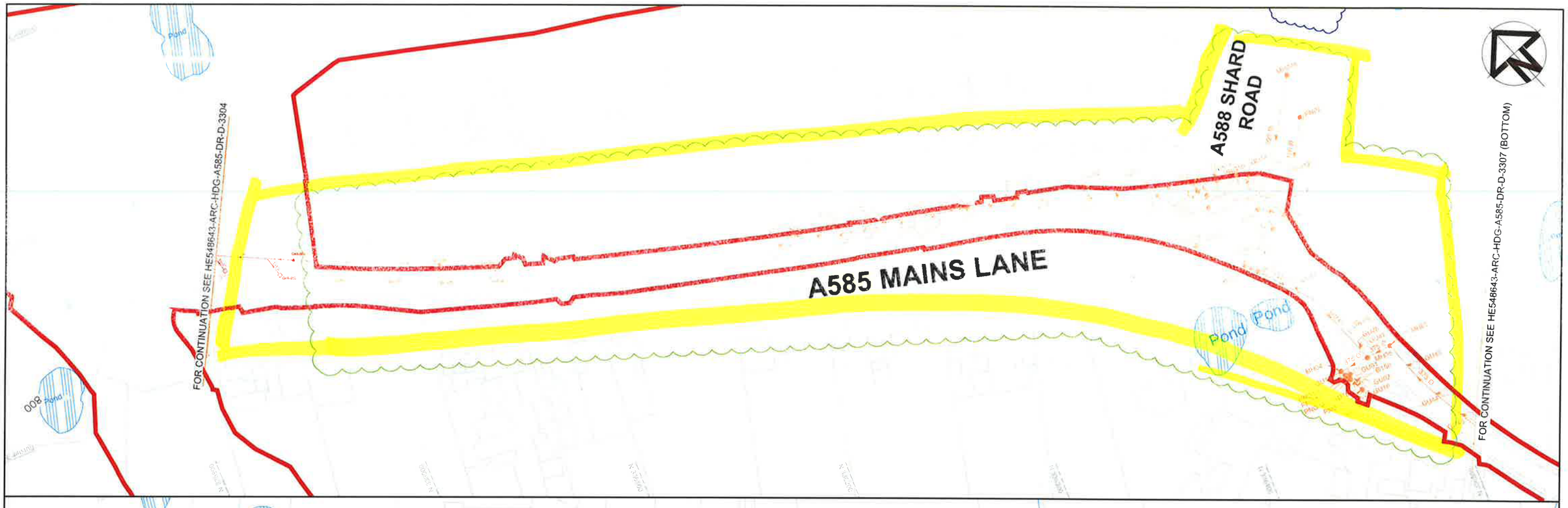
Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 5 OF 11

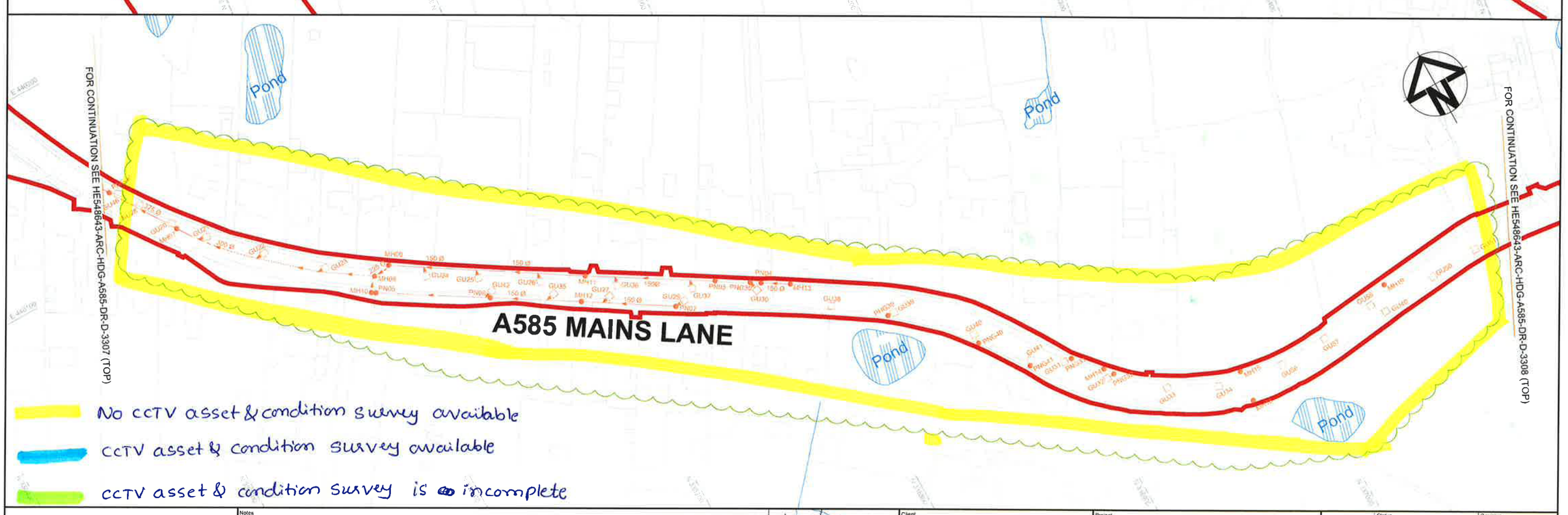
Status	PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date -	21FEB2018
Drawn By	[redacted]G
Checked By	A[redacted]
Approved By	N[redacted]
Project No	HA PIN UA008015 HE548643
Originator	ARC
Original Size	A1
Drawing number	Volume | Location | Type | Role | Number HE548643-ARC-HDG-A585-DR-D-3306

100mm on Original

Print Date:

File Path:





Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S	A	N
P01	PD	26OCT2017	PRELIMINARY DESIGN	S	A	N

Notes

1 . FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS

Registered office: Arcadis House 34 York Way London N1 9AB

Coordinating office: The Surrey Research Park 10 Mediawer Road Guildford GU2 7AR Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 6 OF 11

Status: PRELIMINARY DESIGN

Revision: P02

Scale: 1:1000

Date: 21FEB2018

Drawn By: G

Checked By: A

Approved By: N

Project No.: UA008015

HA: HE548643

PIN:

Originator: ARC

Original Size: A1

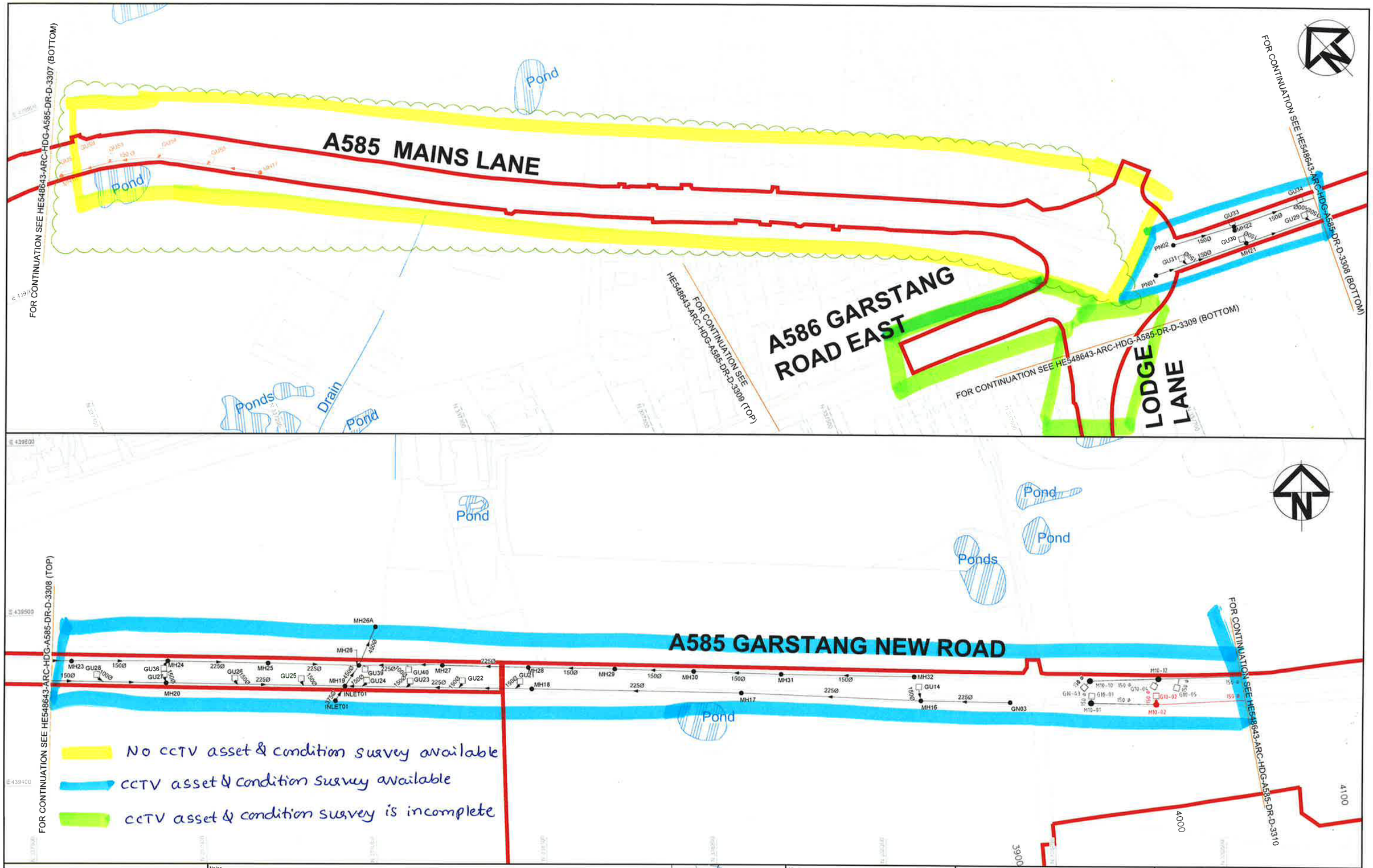
Drawing number: Volume | Location | Type | Role | Number

HE548643-ARC-HDG-A585-DR-D-3307

100mm on Original

Print Date:

File Path:



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Notes

1 . FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS

Registered office: Arcadis House 34 York Way London N1 9AB

Coordinating office The Surrey Research Park 10 Medawar Road Guildford GU2 7AR Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 7 OF 11

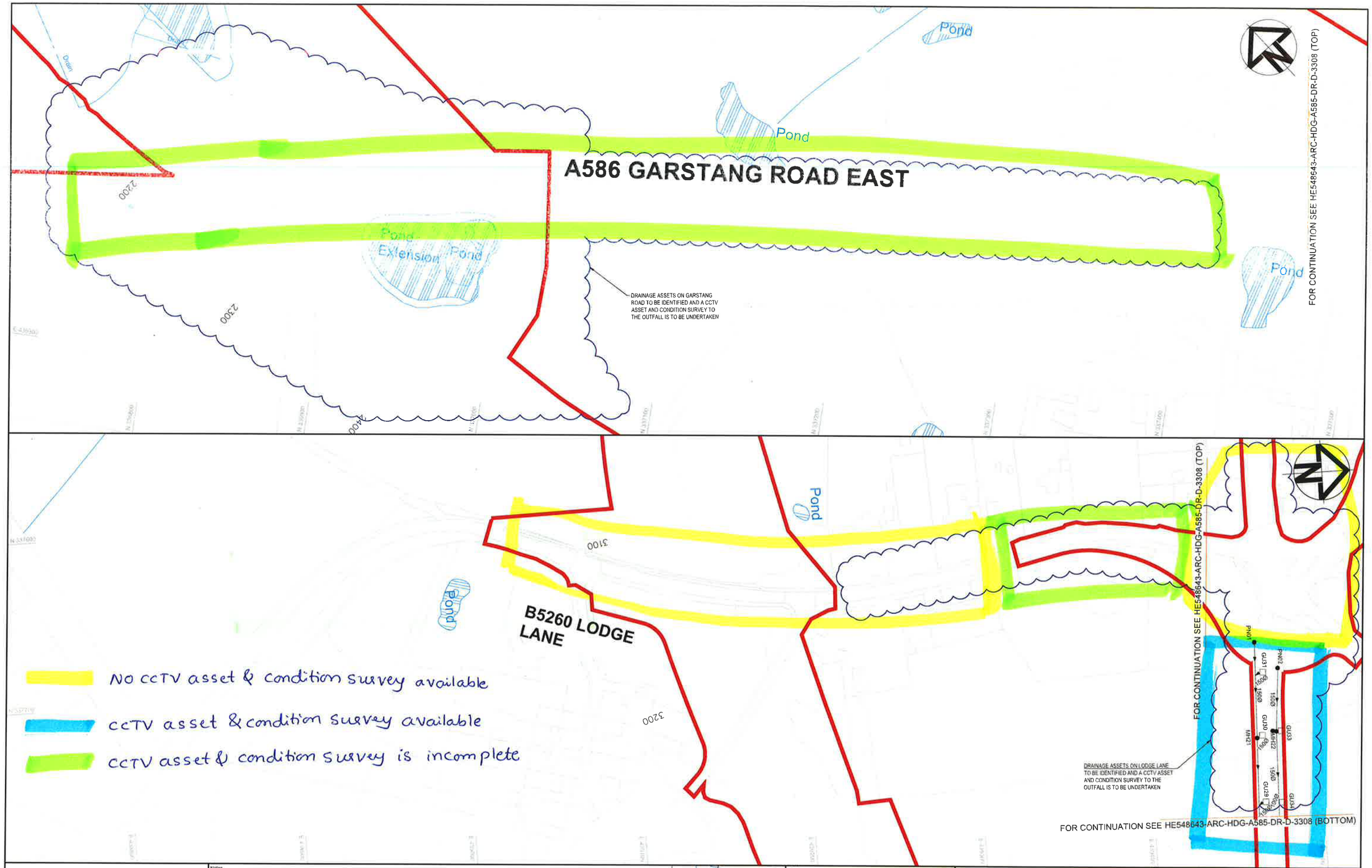
Status	PRELIMINARY DESIGN	Revision	P02
Scale	1:1000	Date -	21FEB2018
Drawn By	[redacted] G		
Checked By	A[redacted]		
Approved By	N[redacted]		
Project No.	HA PIN: UA006015	Originator: HE548643 ARC	Original Size: A1
Drawing number	Volume I Location	I Type I Role I Number	

HE548643-ARC-HDG-A585-DR-D-3308

100mm on Original

Print Date: [redacted]

File Path: [redacted]



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

Notes

1 . FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client

highways england

ARCADIS

Registered office: Arcadis House, 34 York Way, London, N1 9AB

Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

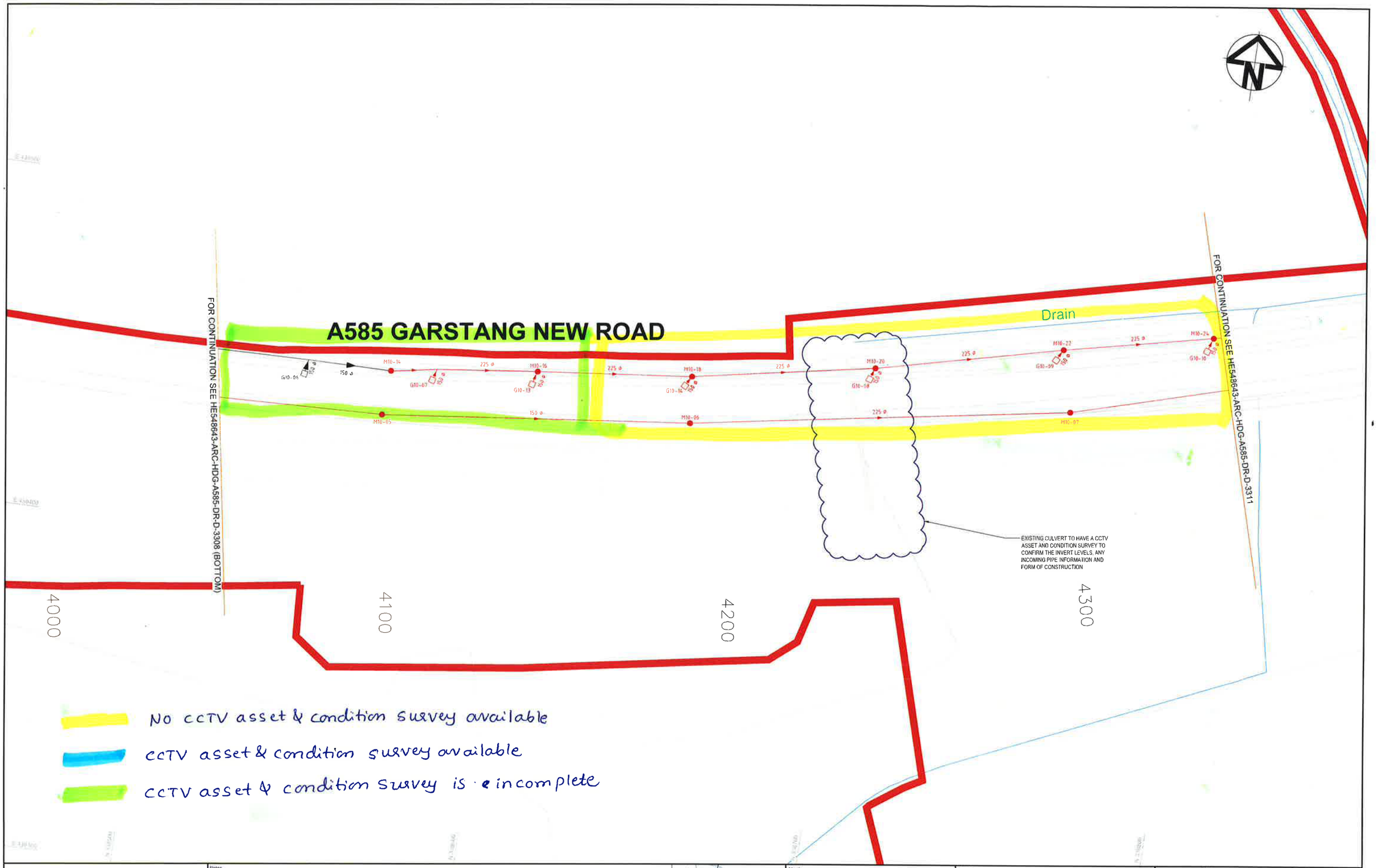
Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 8 OF 11

Status	PRELIMINARY DESIGN
Revision	P02
Scale	1:1000
Date	21FEB2018
Drawn By	[redacted]G
Checked By	A [redacted]
Approved By	N [redacted]
Project No	UA008015
HA PIN	HE548643
Originator	ARC
Original Size	A1
Drawing number	HE548643-ARC-HDG-A585-DR-D-3309

Print Date:

File Path:



P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
Rev	Status	Rev. Date	Purpose of revision	Drawn	Check'd	Apprv'd

Notes

1 . FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 9 OF 11

Status	PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	21FEB2018
Drawn By	[redacted]G
Checked By	A.[redacted]
Approved By	N.[redacted]
Project No.	UA008015
Originator	ARC
Original Size	A1
Drawing number	HE548643-ARC-HDG-A585-DR-D-3310

100mm on Original

Print Date:

File Path:

A585 GARSTANG NEW ROAD

EXISTING CULVERT TO HAVE A CCTV ASSET AND CONDITION SURVEY TO CONFIRM THE INVERT LEVELS, ANY INCOMING PIPE INFORMATION AND FORM OF CONSTRUCTION

Outfall Catchment - 010 & 011A

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3310

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3312

EXISTING CULVERT TO HAVE A CCTV ASSET AND CONDITION SURVEY TO CONFIRM THE INVERT LEVELS, ANY INCOMING PIPE INFORMATION AND FORM OF CONSTRUCTION

Pond

Pond

Pond

Drain

4400

4500

4600

4700

NO CCTV asset & condition survey available

CCTV asset & condition survey available

CCTV asset & condition survey is incomplete

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Notes

1. FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 10 OF 11

Status	PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	21FEB2018
Drawn By	[redacted]G
Checked By	A[redacted]
Approved By	N[redacted]
Project No.	HA PIN I Originator: UA008015 HE548643 ARC
Original Size	A1
Drawing number	Volume I Location I Type I Role I Number: HE548643-ARC-HDG-A585-DR-D-3311

100mm on Original

Print Date:

File Path:



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Appv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Notes
1 . FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301
2 . ALL GULLY OUTLET PIPES ARE 150mm DIAMETER UNLESS SPECIFIED.

LOCATION PLAN

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 11 OF 11

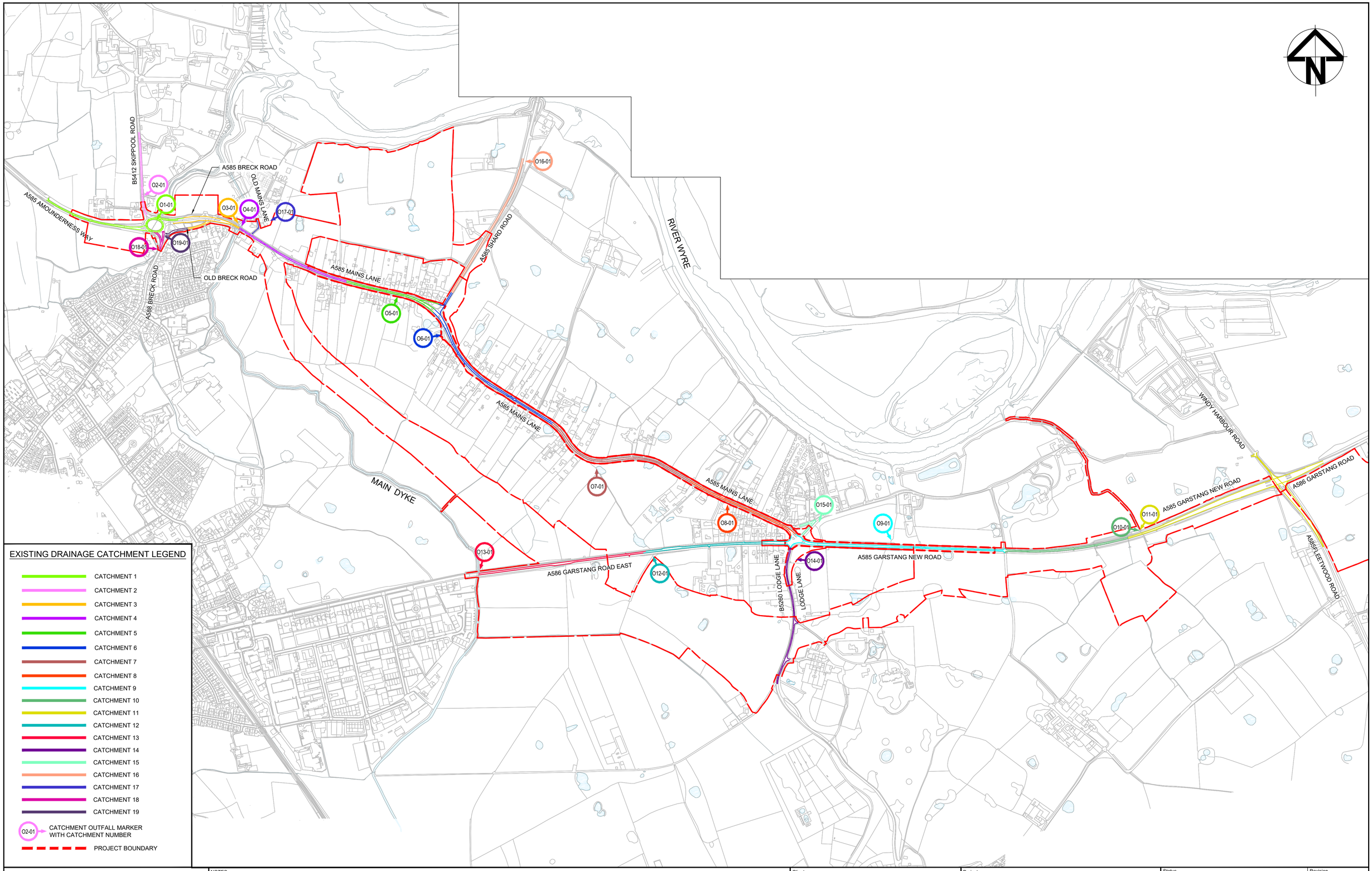
Status	PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	21FEB2018
Drawn By	[redacted] G
Checked By	A[redacted]
Approved By	N[redacted]
Project No.	UA008015
Originator	HA PIN HE548643 ARC
Original Size	A1
Drawing number	HE548643-ARC-HDG-A585-DR-D-3312
Volume | Location | Type | Role | Number	

100mm on Original

Print Date:

File Path:

Appendix C – Existing drainage catchment and waterbodies plans



EXISTING DRAINAGE CATCHMENT LEGEND

- CATCHMENT 1
- CATCHMENT 2
- CATCHMENT 3
- CATCHMENT 4
- CATCHMENT 5
- CATCHMENT 6
- CATCHMENT 7
- CATCHMENT 8
- CATCHMENT 9
- CATCHMENT 10
- CATCHMENT 11
- CATCHMENT 12
- CATCHMENT 13
- CATCHMENT 14
- CATCHMENT 15
- CATCHMENT 16
- CATCHMENT 17
- CATCHMENT 18
- CATCHMENT 19
- O2-01 → CATCHMENT OUTFALL MARKER WITH CATCHMENT NUMBER
- PROJECT BOUNDARY

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

NOTES

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

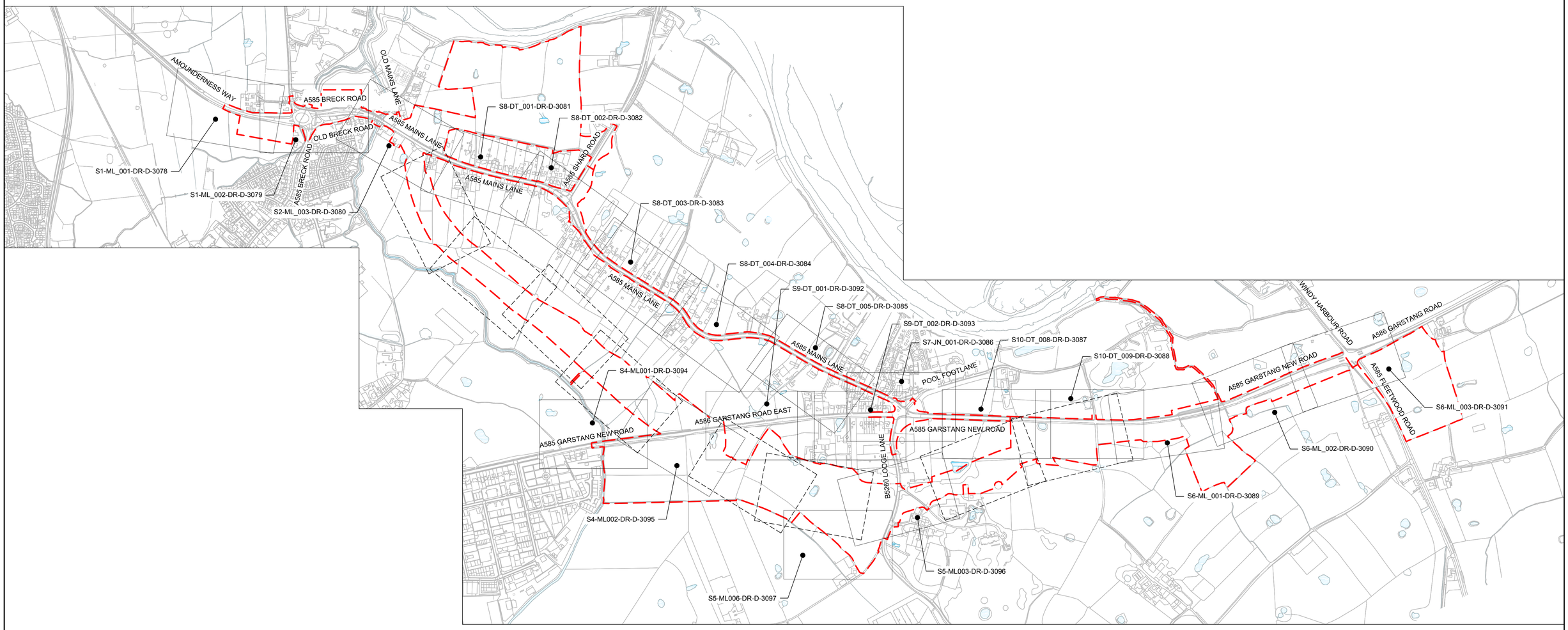
Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE CATCHMENT PLAN

Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	NTS
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number HE PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-SZ-GN_000-DR-D-3077

Appendix D – Existing drainage and site clearance plans



KEY PLAN LEGEND

DRAINAGE LAYOUT USED

DRAINAGE LAYOUT NOT USED

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

NOTES

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE KEY PLAN

Status: S3 - PRELIMINARY DESIGN

Revision: P02

Scale	NTS
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE548643-ARC-HDG-SZ-GN_000-DR-D-3075

HE PIN | Originator | Volume | Location | Type | Role | Number

DRAINAGE LEGEND :

PROPOSED REDLINE BOUNDARY

ORDNANCE SURVEY

300 Ø — EXISTING PIPE TO BE RETAINED

300 Ø, CKD — CKD — EXISTING COMBINED KERB DRAIN TO BE RETAINED

300 Ø — EXISTING PIPE TO BE REMOVED

300 Ø, CKD — CKD — EXISTING COMBINED KERB DRAIN TO BE REMOVED

EXISTING DRAINAGE GULLY POT WITH CONNECTION TO BE RETAINED

EXISTING DRAINAGE GULLY POT WITH CONNECTION TO BE REMOVED

EXM1-001/EXC1-001 — EXISTING DRAINAGE MANHOLE / CATCHPIT TO BE RETAINED

EXM1-001/EXC1-001 — EXISTING DRAINAGE MANHOLE / CATCHPIT TO BE REMOVED

BT — BRITISH TELECOM

SW — EXISTING SEWER WATER MAIN

EXISTING ELECTRIC CABLE

W — EXISTING WATER MAIN

G (MP) — EXISTING GAS MAIN HIGH

LV — EXISTING LOW VOLTAGE CABLE

G (LP) — EXISTING GAS MAIN LOW

HV — EXISTING HIGH VOLTAGE CABLE

O/H — EXISTING MEDIUM VOLTAGE OVERHEAD CABLE

CCTV AND ASSET CONDITION SURVEY TO BE COMPLETED AT STAGE 5

CCTV AND ASSET CONDITION SURVEY DATA NOT AVAILABLE, TO BE COMPLETED AT STAGE 5

EXISTING WATER BODIES

ASSUMED EXISTING HEADWALL / OUTFALL TO BE RETAINED

O1-01 — EXISTING OUTFALL LOCATION

H11 — SAFTY, HEALTH AND ENVIRONMENT INFORMATION

S8-DT_01-DR-D-3077 — DRAWING NO.

H - 4 — PIPE DEFECT CODE

EXISTING CULVERT

DRAINAGE GENERAL NOTES

1. ALL PIPE SIZES ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS STATED OTHERWISE.
2. ALL GULLY OUTLET PIPES ARE 150mm DIAMETER UNLESS SPECIFIED.
3. WRITTEN SCALES (EG. 1:1000, 1:500, ETC.) APPLY TO DRAWINGS AT A1 PAPER SIZE UNLESS NOTED OTHERWISE.
4. DO NOT SCALE DIRECTLY FROM DRAWINGS, USE FIGURED DIMENSIONS ONLY.
5. THE LOCATION AND EXTENT OF EXISTING DRAINAGE ASSETS HAVE BEEN BASED ON CCTV ASSET AND CONDITION SURVEY WHERE AVAILABLE, WHERE CCTV DATA IS NOT AVAILABLE EXISTING DRAINAGE ASSETS HAVE BEEN BASED ON AS-BUILTS OR HADDMS DATA.
6. CONTRACTOR TO CONFIRM WITH DESIGNER'S SITE REPRESENTATIVE ALL TIE IN LEVELS AND LOCATIONS PRIOR COMMENCING THE WORKS.
7. FOR EXISTING UTILITIES DETAILS REFER DRAWING NUMBER " HE548643-ARC-VUT-A585-M2-D-3102".

STRUCTURAL DEFECT LIST :

Code	Structural Defects Grade	Structural Defects
B	4	Broken pipe
BJ	4	Broken Pipe at joint
FM	4	Fractures multiple
H	4	Hole in sewer
HJ	4	Hole in sewer at joint
D	5	Deformed drain/sewer
Code	Construction Grade	Constructional Features
CXI	4	Connection intruding
Code	Service Defects grade	Service Defects
IGJ	4	Infiltration Gushing at joint
RM	5	Mass Roots
RMJ	5	Mass Roots at joint

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

NOTES

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

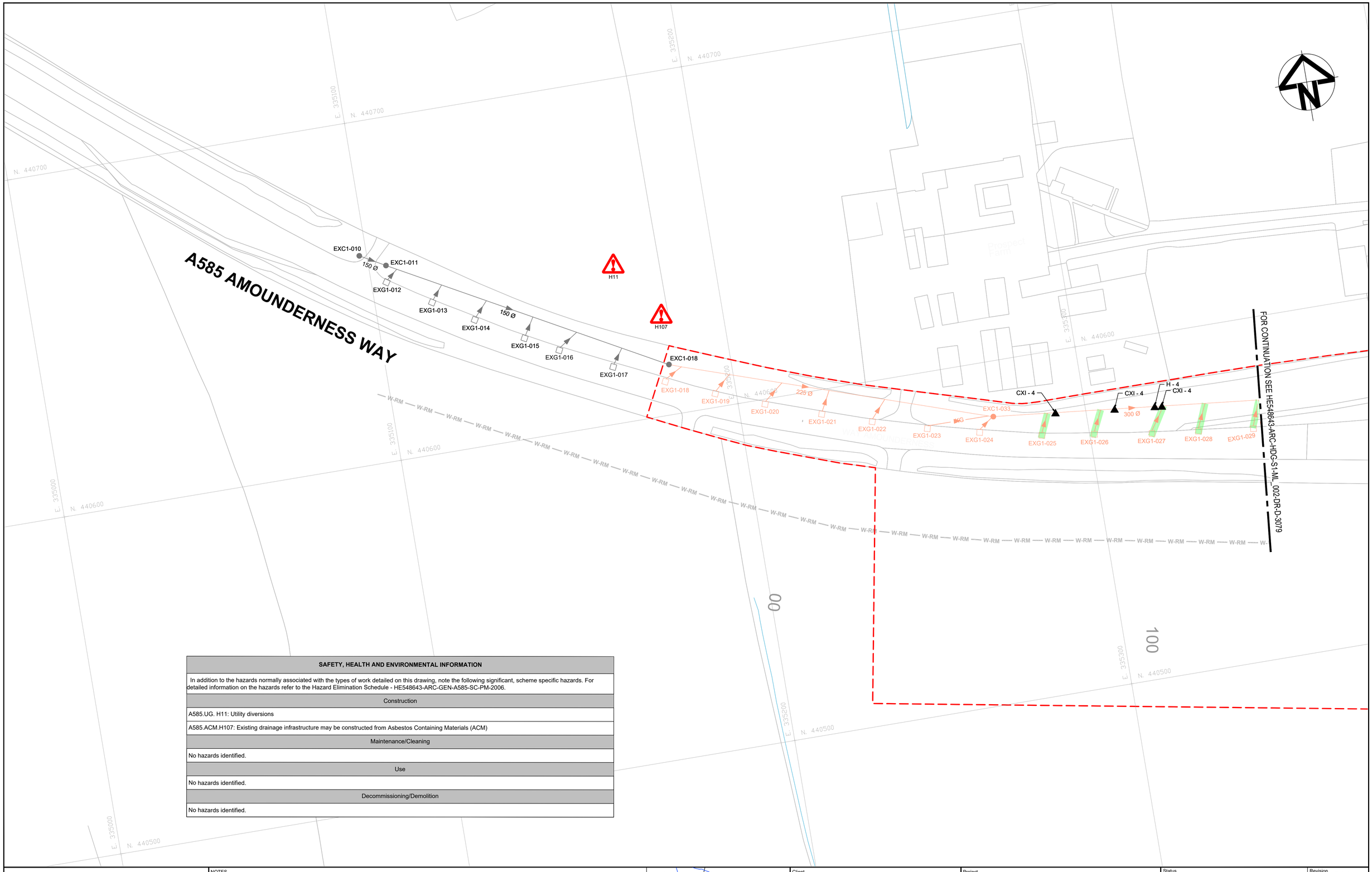
ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE NOTES & LEGEND

Status: S3 - PRELIMINARY DESIGN
Revision: P02
Scale: NTS
Date: 10JUL2018
Drawn By: G[redacted]
Checked By: A[redacted]
Approved By: N[redacted]
Original Size: A1

Drawing number: HE | PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-SZ-GN_000-DR-D-3076



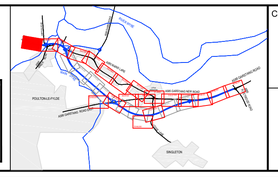
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.UG. H11: Utility diversions
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 1 OF 20

Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE | PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-S1-ML_001-DR-D-3078

100mm on Original

Print Date:

File Path:

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.UG.H108: Inundation of flood water
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
A585.UG.H11: Utility diversions
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

AMOUNDERNESS WAY

A585 BRECK ROAD

OLD BRECK ROAD

A585 BRECK ROAD

Skippool Creek

FOR CONTINUATION SEE HE548643-ARC-HDG-S1-ML_001-DR-D-3078

FOR CONTINUATION SEE HE548643-ARC-HDG-S2-ML_003-DR-D-3080

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 603 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 2 OF 20

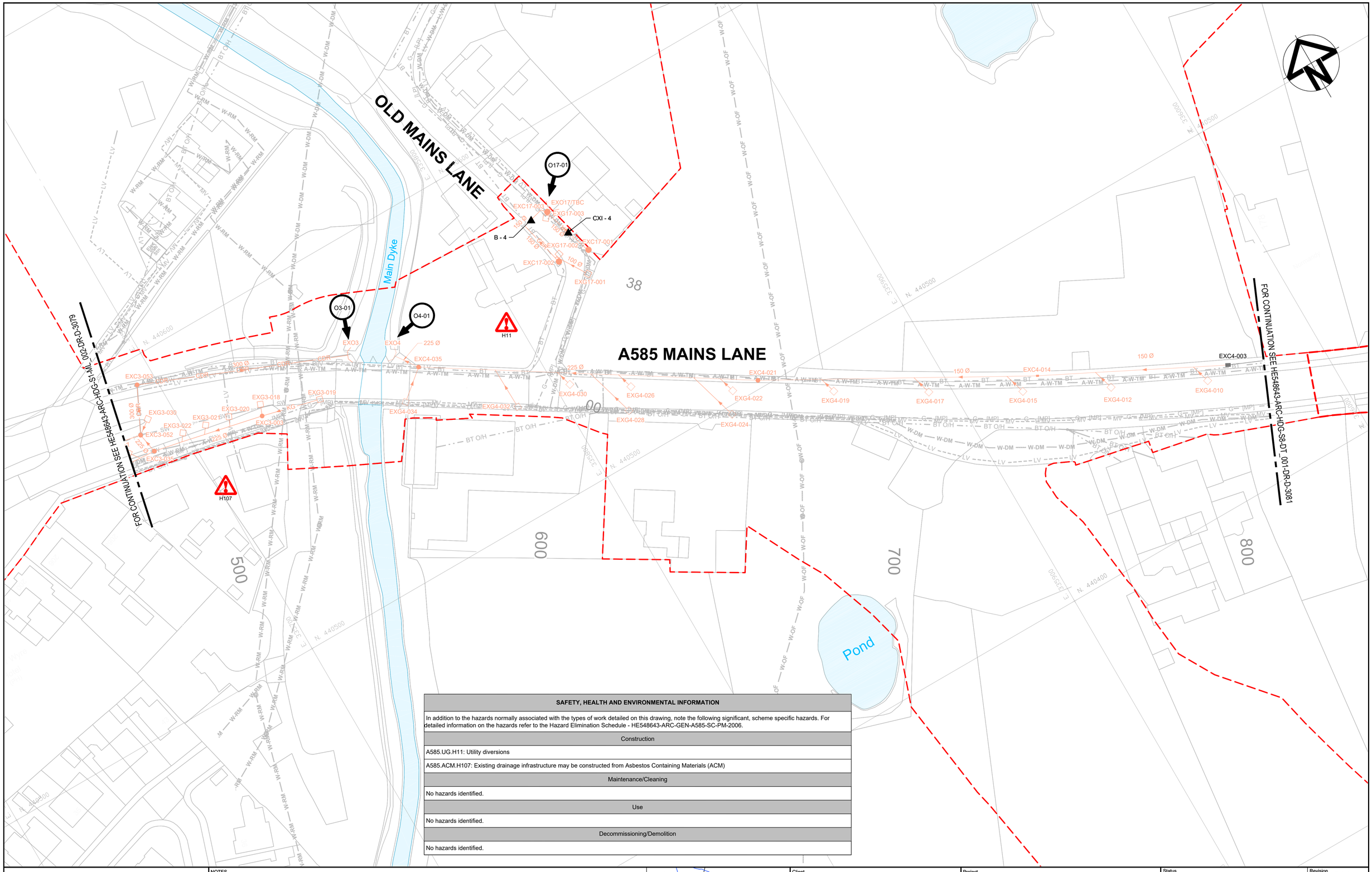
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE548643-ARC-HDG-S1-ML_002-DR-D-3079

100mm on Original

Print Date:

File Path:



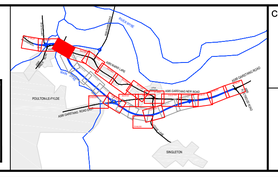
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.UG.H11: Utility diversions
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 3 OF 20

Status	S3 - PRELIMINARY DESIGN	Revision	P02
Scale	1:500	Date	10JUL2018
Drawn By	G[redacted]		
Checked By	A[redacted]		
Approved By	N[redacted]		
		Original Size	A1

Drawing number: HE PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-S2-ML_003-DR-D-3080

100mm on Original

Print Date:

File Path:



NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Rev	Status	Date	Description	Drawn	Chck'd	ApprVd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]

100mm on Original

Print Date:

File Path:

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 4 OF 20

Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE548643-ARC-HDG-S8-DT_001-DR-D-3081

A585 SHARD ROAD

EXM16-013
EXG16-014
EXG16-012
EXM5-001
EXG5-001
EXG16-011
EXG16-013
EXG16-015
EXM16-002
EXM16-003
EXG5-002
EXG5-003
EXG5-004
EXG5-005
EXG5-006
EXG5-007
EXG6-003
EXG5-017
EXG6-004
EXG5-018
EXG5-019
EXG5-020
EXG5-021
EXM5-004
EXM5-005
EXM5-006
EXM6-001
EXG6-005
EXG6-006
EXG6-048
EXM6-006
EXM6-005
EXG6-043
EXC6-004
EXG6-044
EXG6-045
EXG6-046
EXM6-007
EXG6-028
EXG6-020
EXG6-021
EXG6-001
EXG6-002
EXG6-016
EXG6-017
EXG6-018
EXG6-019
EXM6-004
EXO6-TBC
O6-01
EXM5-009
EXO-5TBC
O5-01

150 Ø
225 Ø
375 Ø

Pond
Pond
Pond
1200
1300
1400
1500

FOR CONTINUATION SEE HE548643-ARC-HDG-S8-DT_001-DR-D-3081

FOR CONTINUATION SEE HE548643-ARC-HDG-S8-DT_003-DR-D-3083

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 5 OF 20

Status: S3 - PRELIMINARY DESIGN
Revision: P02
Scale: 1:500
Date: 10JUL2018
Drawn By: G[redacted]
Checked By: A[redacted]
Approved By: N[redacted]
Original Size: A1

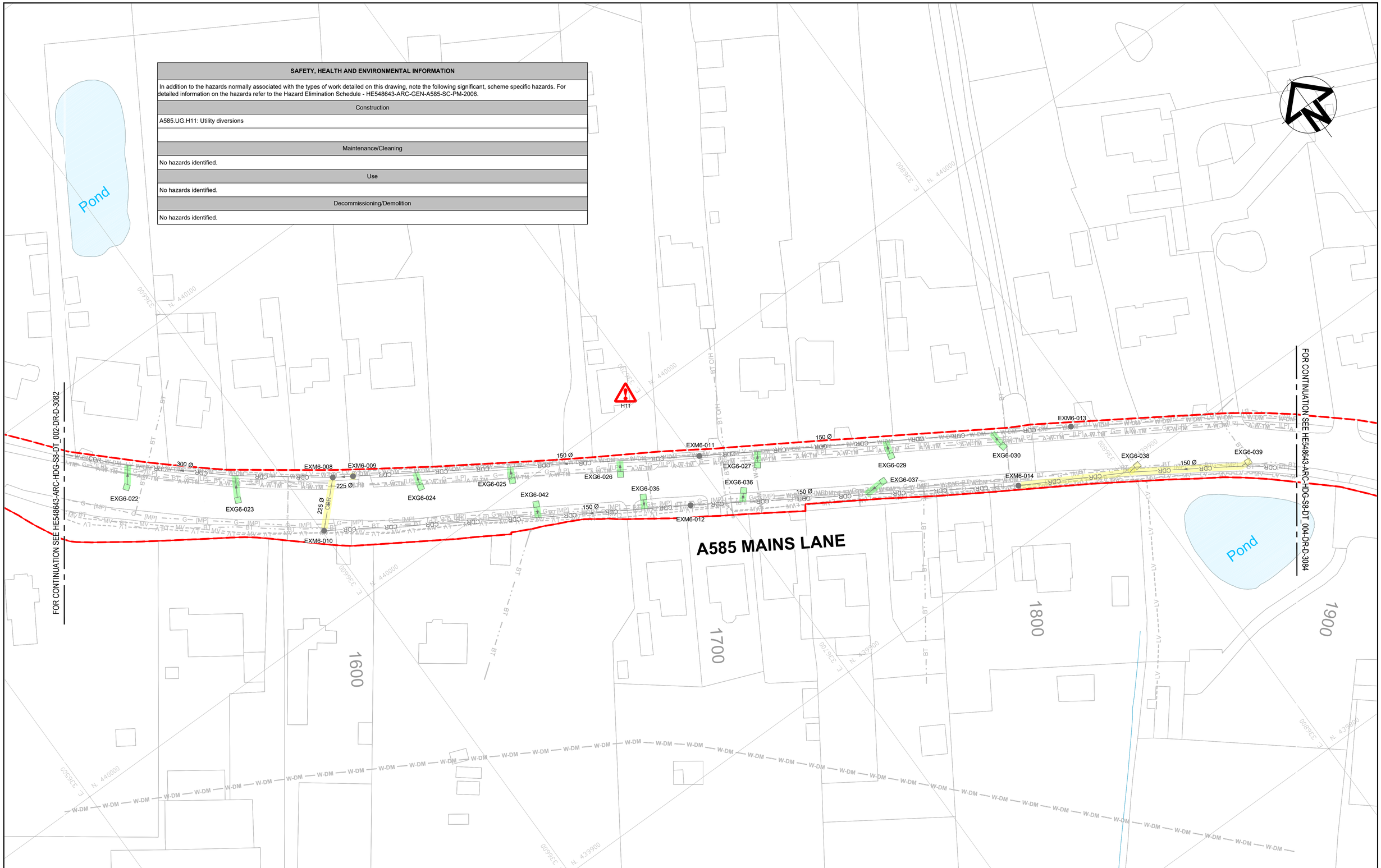
Drawing number: HE | PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-S8-DT_002-DR-D-3082

100mm on Original

Print Date:

File Path:

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.UG.H11: Utility diversions
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

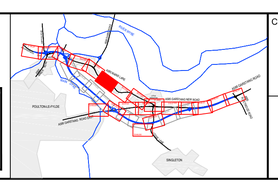


Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 6 OF 20

Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

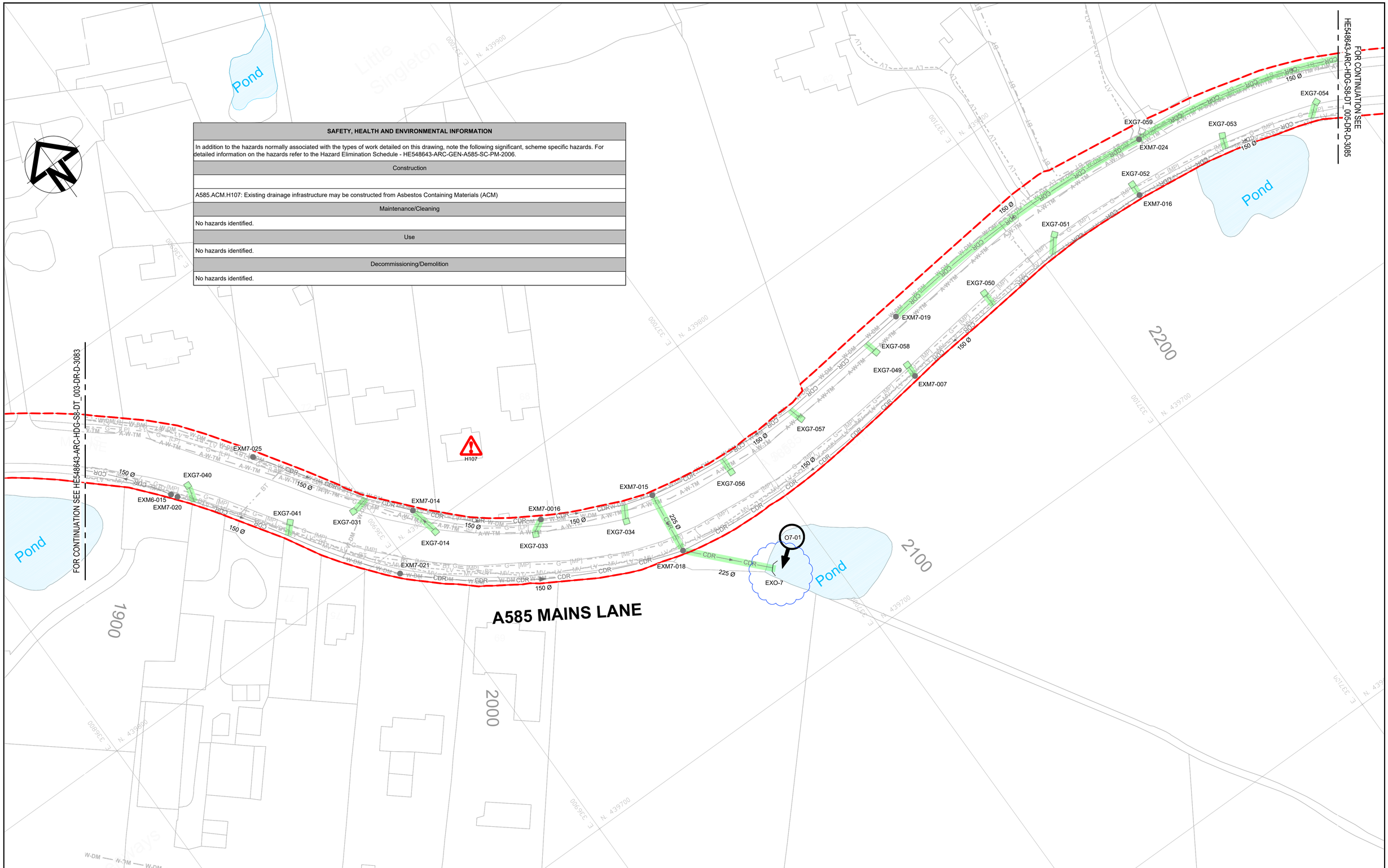
Drawing number: HE | PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-S8-DT_003-DR-D-3083

100mm on Original

Print Date:

File Path:

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

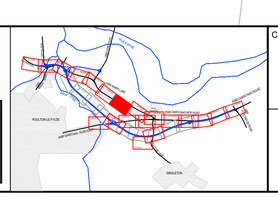


Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 7 OF 20

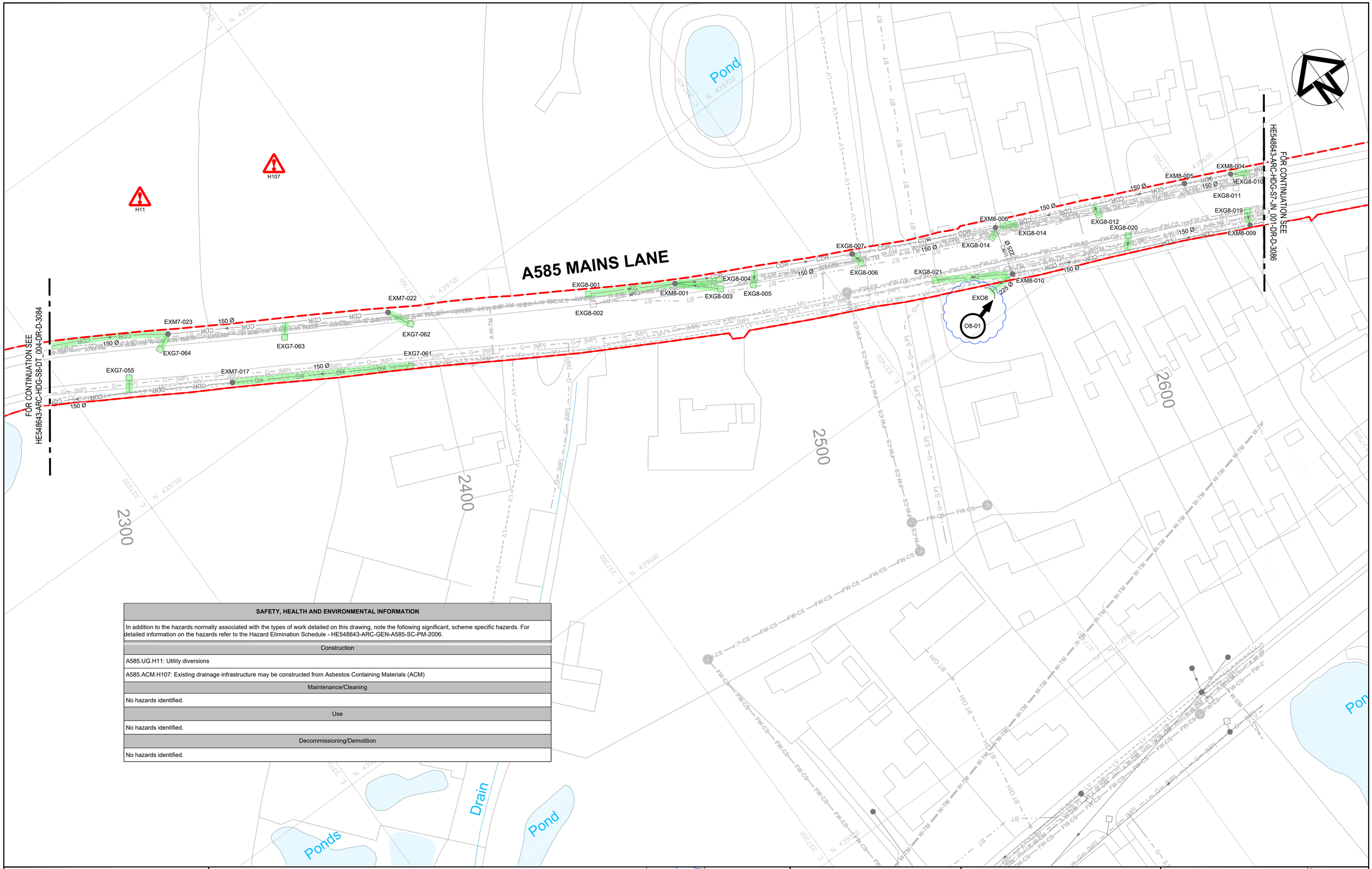
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE | PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-S8-DT_004-DR-D-3084

100mm on Original

Print Date:

File Path:

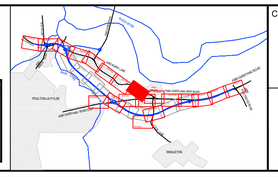


SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.UG.H11: Utility diversions
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]

NOTES
1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 8 OF 20

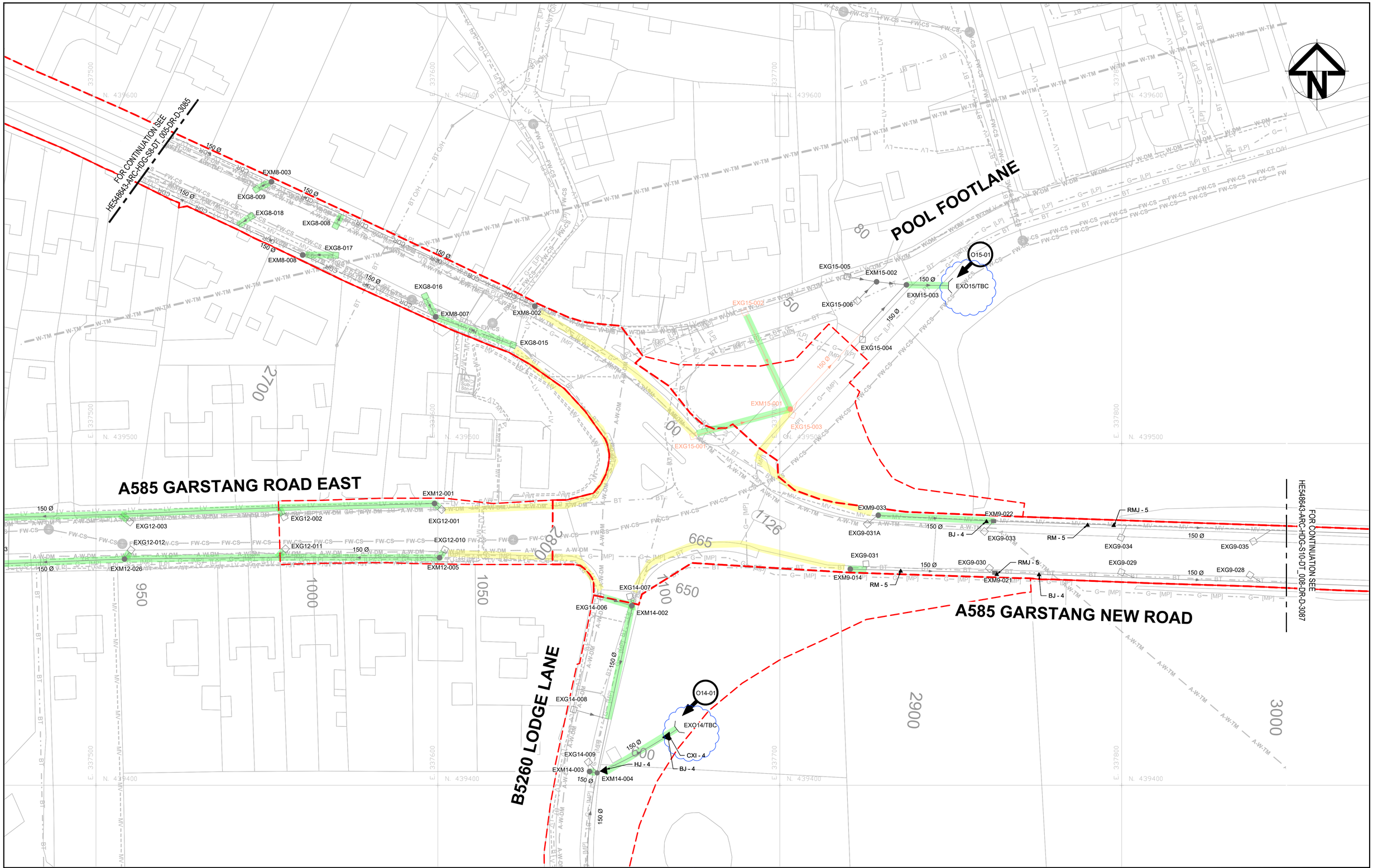
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE | PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-S8-DT_005-DR-D-3085

100mm on Original

Print Date:

File Path:



Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]

100mm on Original

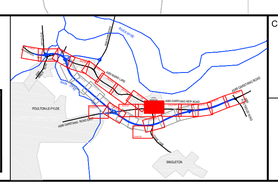
Print Date:

File Path:

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

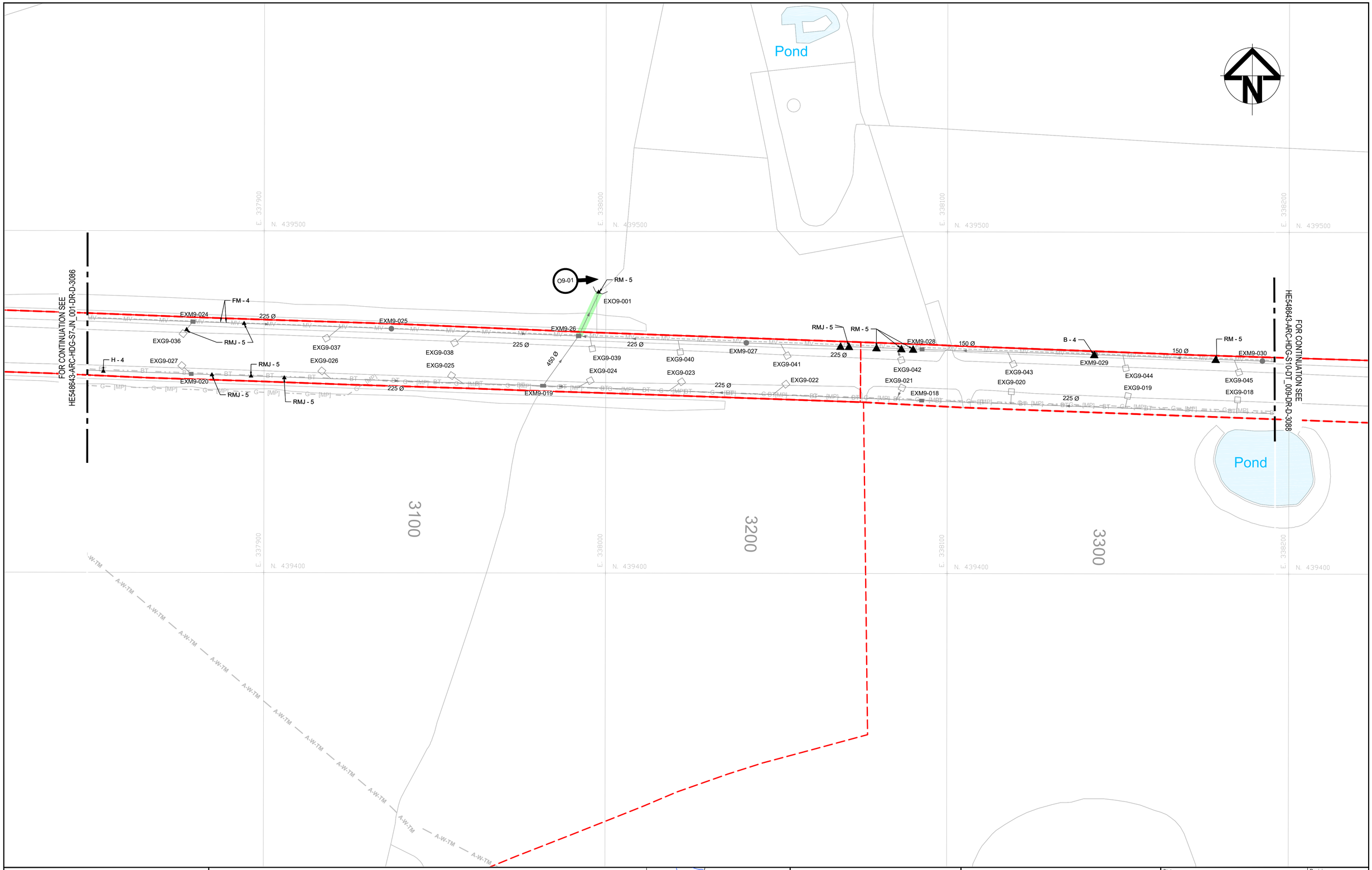
Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 9 OF 20

Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number HE PIN | Originator | Volume | Location | Type | Role | Number

HE548643-ARC-HDG-S7-JN_001-DR-D-3086



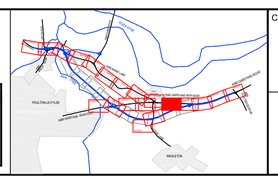
Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Print Date:

File Path:

Client

highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project

A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title

EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 10 OF 20

Status: S3 - PRELIMINARY DESIGN

Revision: P02

Scale: 1:500

Date: 10JUL2018

Drawn By: G[redacted]

Checked By: A[redacted]

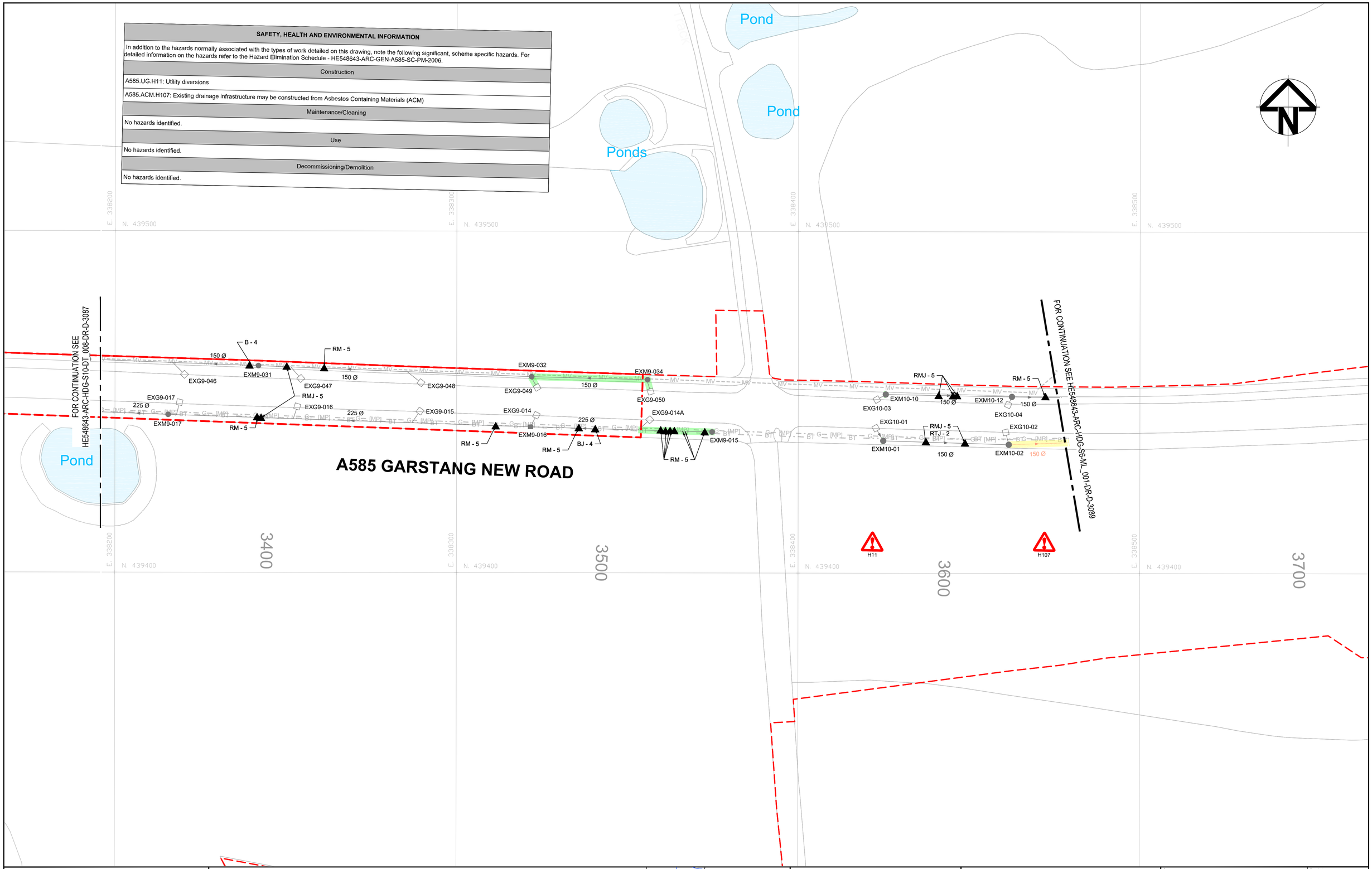
Approved By: N[redacted]

Original Size: A1

Drawing number: HE PIN | Originator | Volume | Location | Type | Role | Number

HE548643-ARC-HDG-S10-DT_008-DR-D-3087

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.UG.H11: Utility diversions
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.



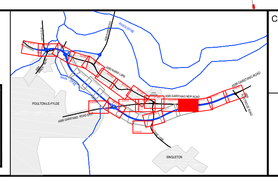
Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Print Date:

File Path:

Client

highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project
A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 11 OF 20

Status: S3 - PRELIMINARY DESIGN

Revision: P02

Scale: 1:500

Date: 10JUL2018

Drawn By: G[redacted]

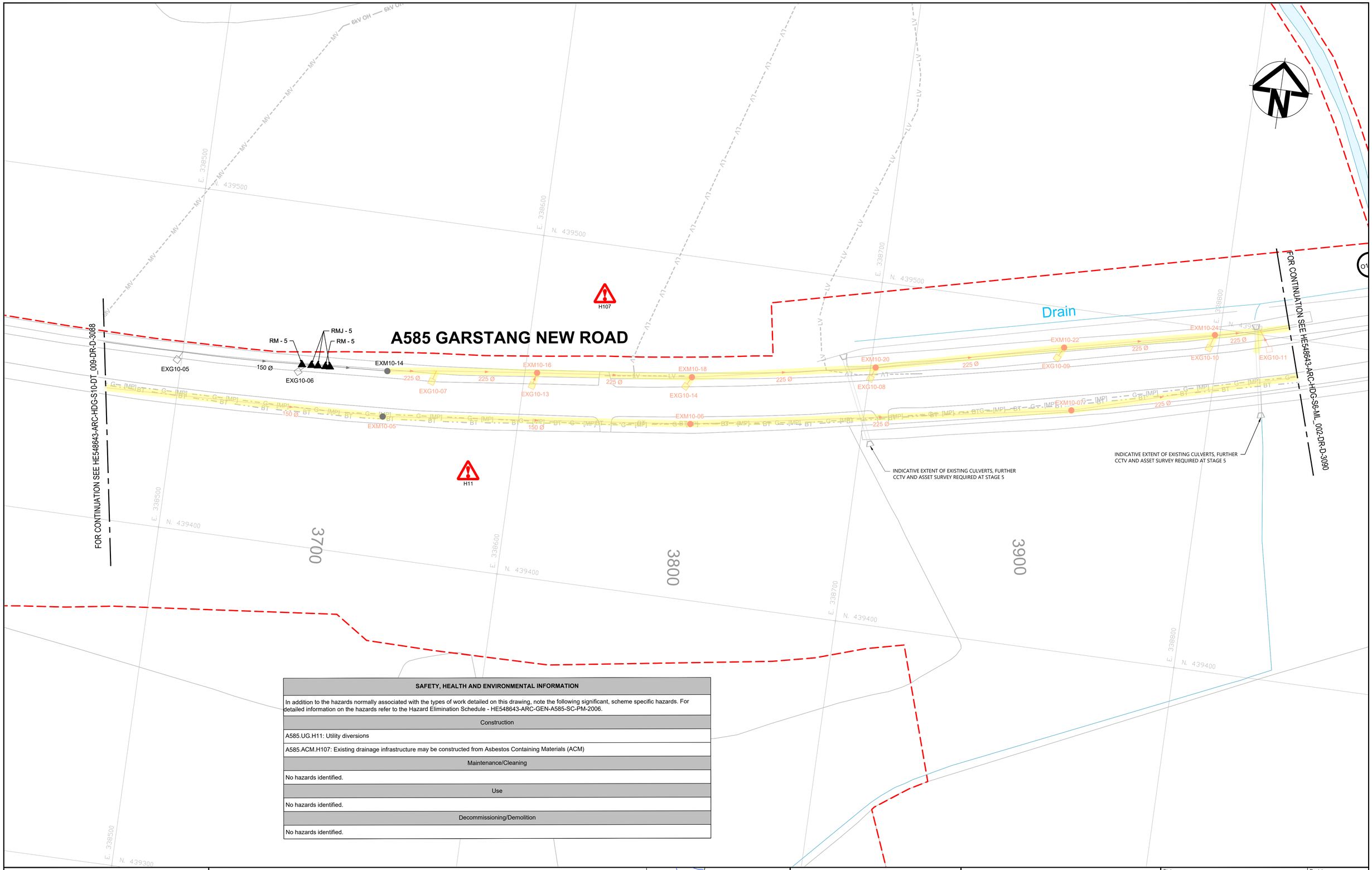
Checked By: A[redacted]

Approved By: N[redacted]

Original Size: A1

Drawing number: HE PIN | Originator | Volume | Location | Type | Role | Number

HE548643-ARC-HDG-S10-DT_009-DR-D-3088



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.UG.H11: Utility diversions
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 12 OF 20

Status: S3 - PRELIMINARY DESIGN | Revision: P02

Scale: 1:500 | Date: 10JUL2018

Drawn By: G[redacted]

Checked By: A[redacted]

Approved By: N[redacted]

Original Size: A1

Drawing number: HE548643-ARC-HDG-S6-ML_001-DR-D-3089

100mm on Original

Print Date:

File Path:

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.UG.H91.Constraint: Existing large drainage and hydrobrake
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
A585.UG.H11: Utility diversions
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

A585 GARSTANG NEW ROAD

FOR CONTINUATION SEE HE548643-ARC-HDG-S6-ML_001-DR-D-3089

FOR CONTINUATION SEE HE548643-ARC-HDG-S6-ML_003-DR-D-3091

H91 H107 H11

O10-01 O11-01 EXO11/TBC EXO 10

EXM11-105 EXM11-140 EXM11-093 EXC11-103 EXM11-090 EXC11-102 EXC11-101

EXG10-12 EXM10-28 EXM10-08 EXG11-139 EXG11-106 EXC11-138 EXG11-136 EXG11-098 EXG11-096 EXG11-094 EXG11-092 EXG11-134 EXG11-132 EXC11-131 EXG11-129 EXC11-128 EXG11-127 EXG11-125 EXC11-124 EXG11-122 EXG11-120 EXG11-118 EXG11-116 EXG11-089 EXG11-086 EXM11-087

D - 5

225 Ø 300 Ø 375 Ø 750 Ø 150 Ø

CKD [MP] G BT

INDICATIVE EXTENT OF EXISTING CULVERTS, FURTHER CCTV AND ASSET SURVEY REQUIRED AT STAGE 5

Pond Pond Pond Drain

4000 4100 4200 4300

E. 338900 E. 339000 E. 339100 E. 339200

N. 439400 N. 439500 N. 439600 N. 439700

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 13 OF 20

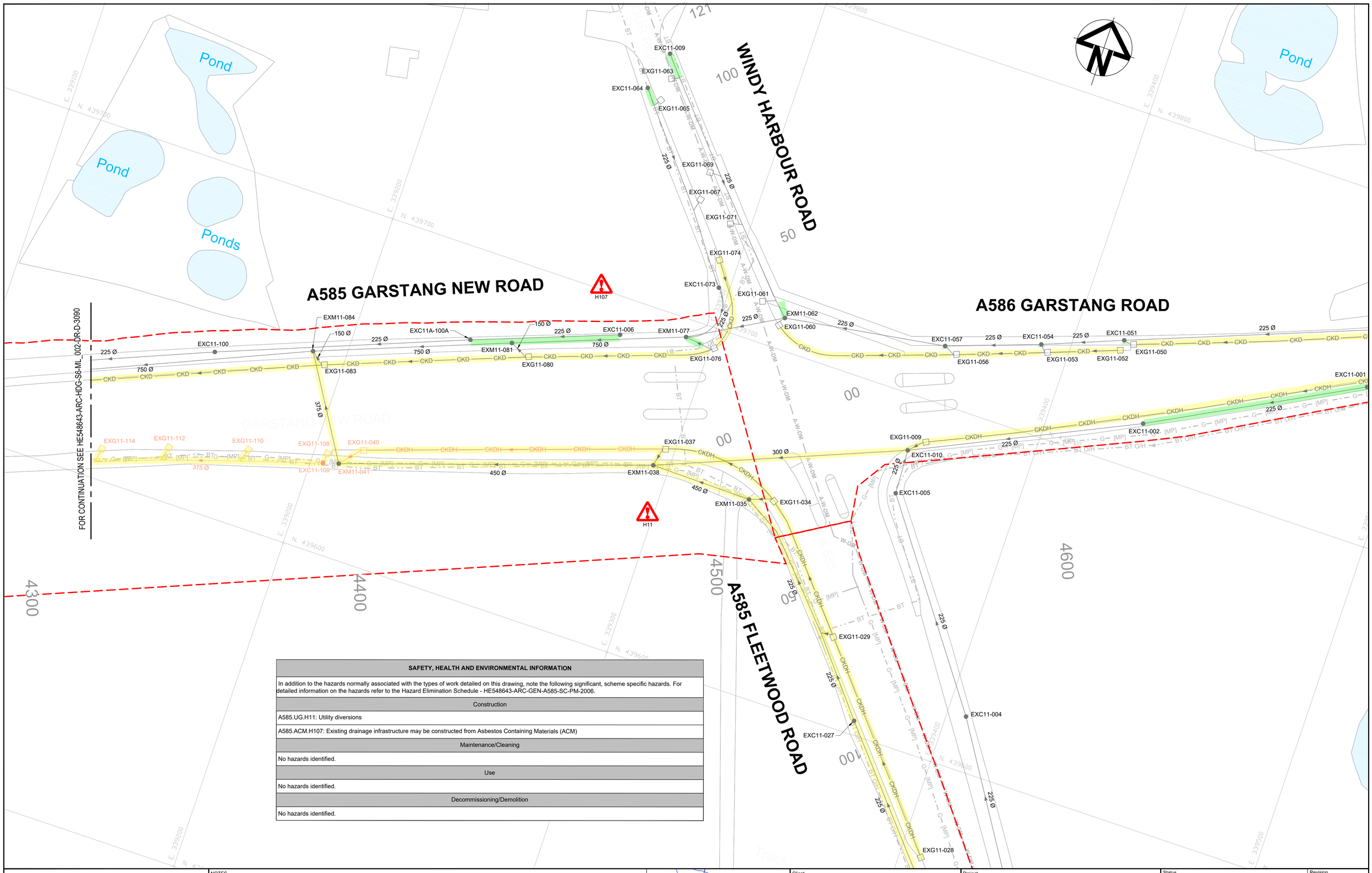
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number HE | PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-S6-ML_002-DR-D-3090

100mm on Original

Print Date:

File Path:



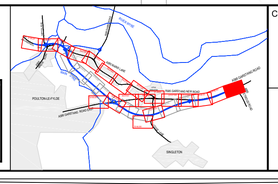
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.UG.H11: Utility diversions
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 14 OF 20

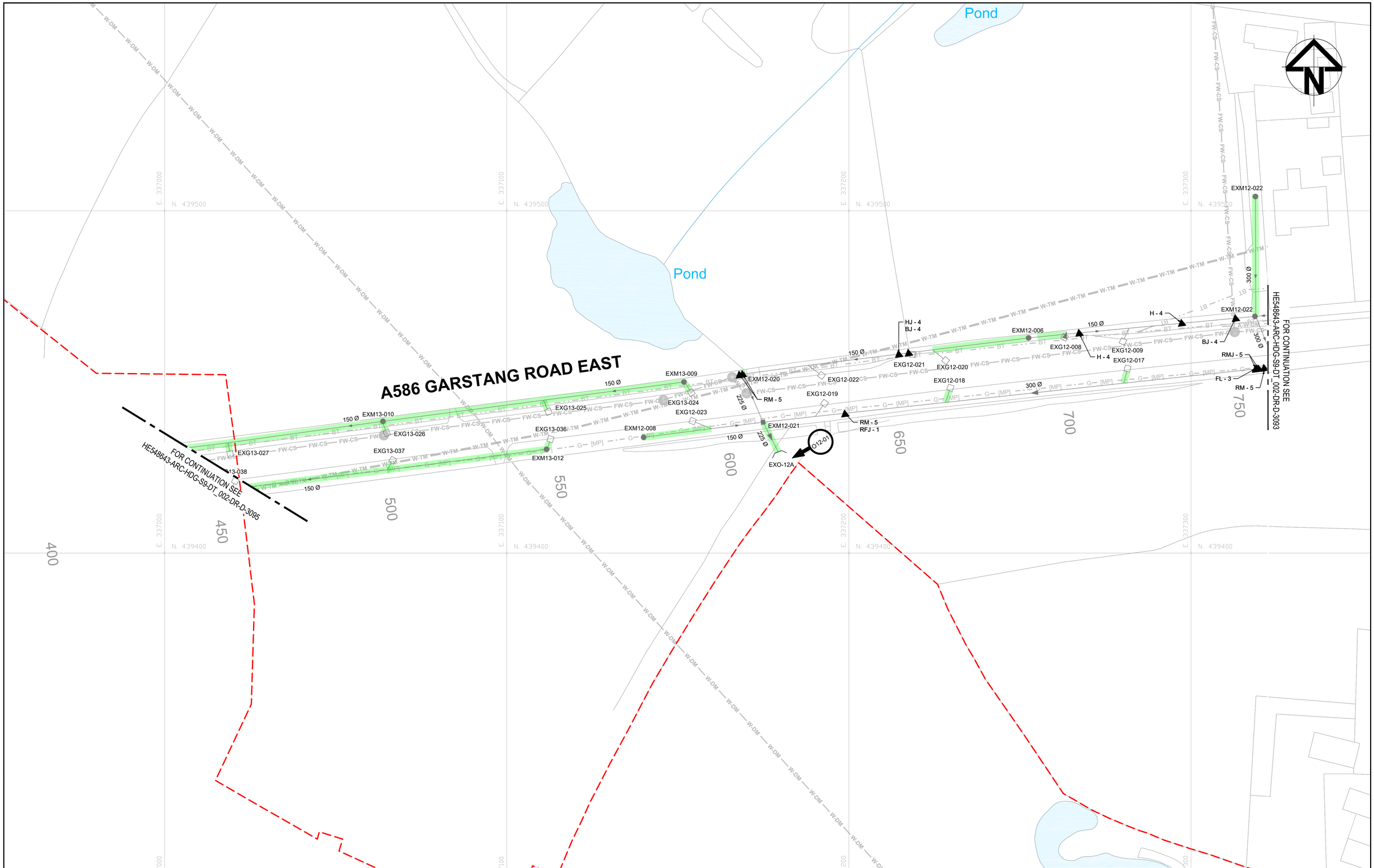
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE548643-ARC-HDG-S6-ML_003-DR-D-3091

100mm on Original

Print Date:

File Path:



Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 15 OF 20

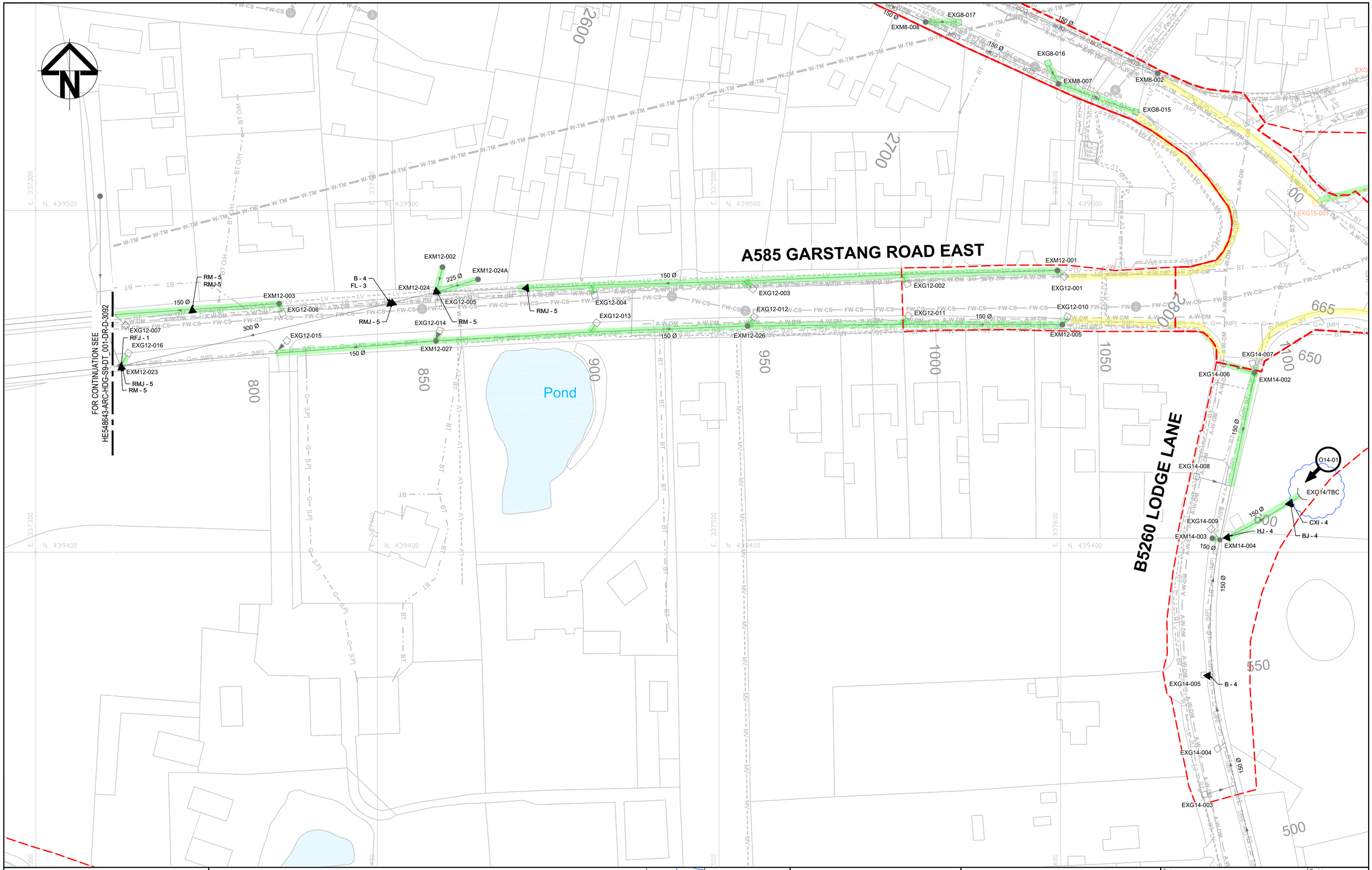
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE | PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-S9-DT_001-DR-D-3092

100mm on Original

Print Date:

File Path:

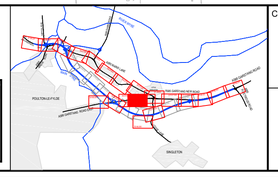


Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 16 OF 20

Status: S3 - PRELIMINARY DESIGN | Revision: P02

Scale: 1:500 | Date: 10JUL2018

Drawn By: G[redacted]

Checked By: A[redacted]

Approved By: N[redacted]

Original Size: A1

Drawing number: HE548643-ARC-HDG-S9-DT_002-DR-D-3093

100mm on Original

Print Date:

File Path:

Pond

Pond

E. 336400 N. 439500

E. 336500 N. 439500

E. 336600 N. 439500

E. 336700 N. 439500

E. 336400 N. 439400

E. 336500 N. 439400

E. 336600 N. 439400

E. 336700 N. 439400

E. 336400 N. 439300

E. 336500 N. 439300

E. 336600 N. 439300

E. 336700 N. 439300

W-RM W-TM G [MP] BT FW-CS

Main Dyke

A585 GARSTANG NEW ROAD

O13-01

EXO-13

EXG13-048

EXG13-047

EXM13-025

EXM13-016

EXM13-019

EXM13-015

EXG13-035

EXG13-046

225 Ø

150 Ø

RM - 5

RMJ - 5

RM - 5

RM - 5

50

00

100

FOR CONTINUATION SEE HE548643-ARC-HDG-S9DT002-DR-D-3095

N

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

Print Date:

File Path:

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office: Arcadis House 34 York Way London N1 9AB

Coordinating office: The Surrey Research Park 10 Medawar Road Guildford GU2 7AR Tel: 44 (0)1483 803 000

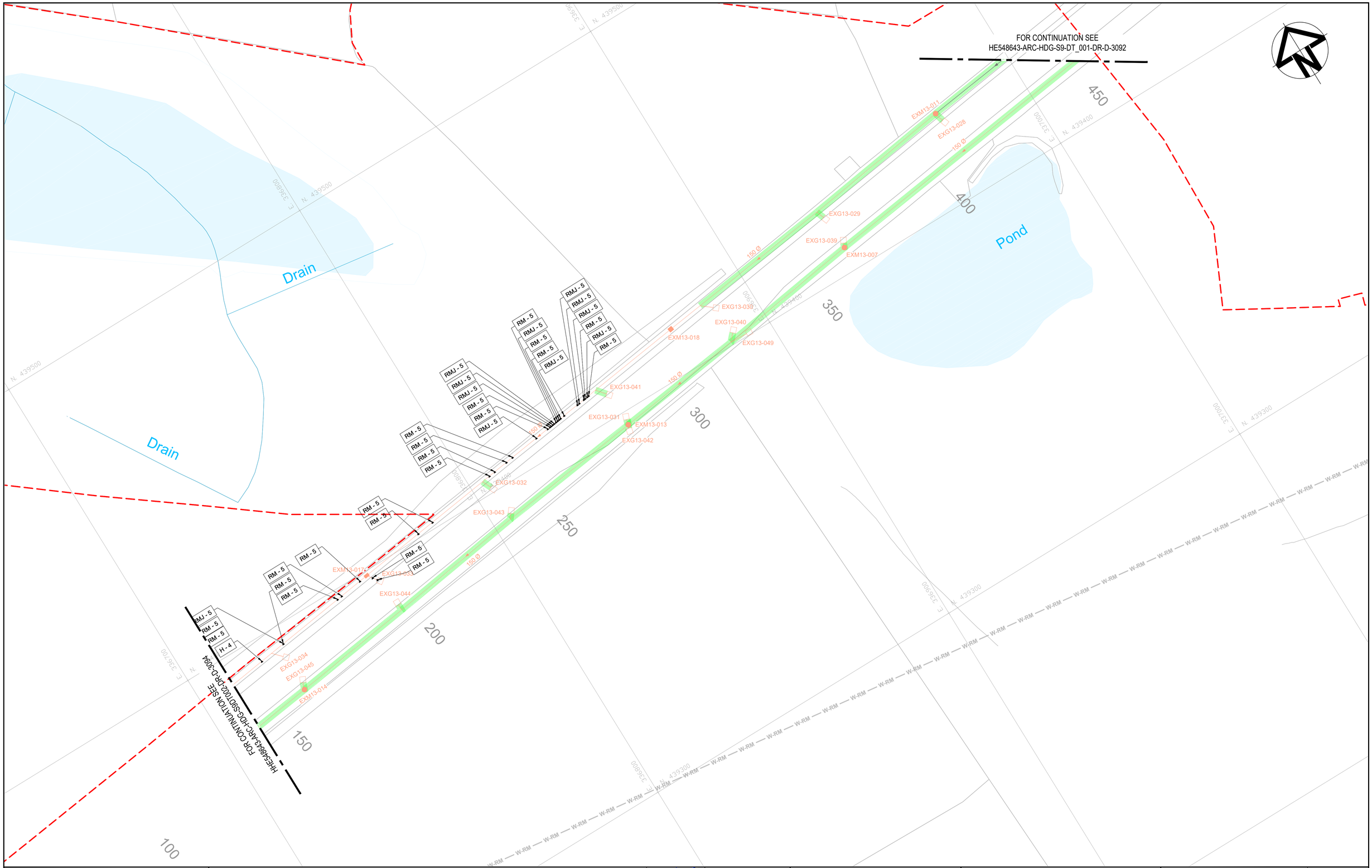
Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 17 OF 20

Status	S3 - PRELIMINARY DESIGN	Revision	P02
Scale	1:500	Date	10JUL2018
Drawn By	G[redacted]		
Checked By	A[redacted]		
Approved By	N[redacted]		
HE548643	ARC	Original Size	A1

Drawing number HE:PIN | Originator | Volume | Location | Type | Role | Number

HE548643-ARC-HDG-S4_ML_001-DR-D-3094



NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 18 OF 20

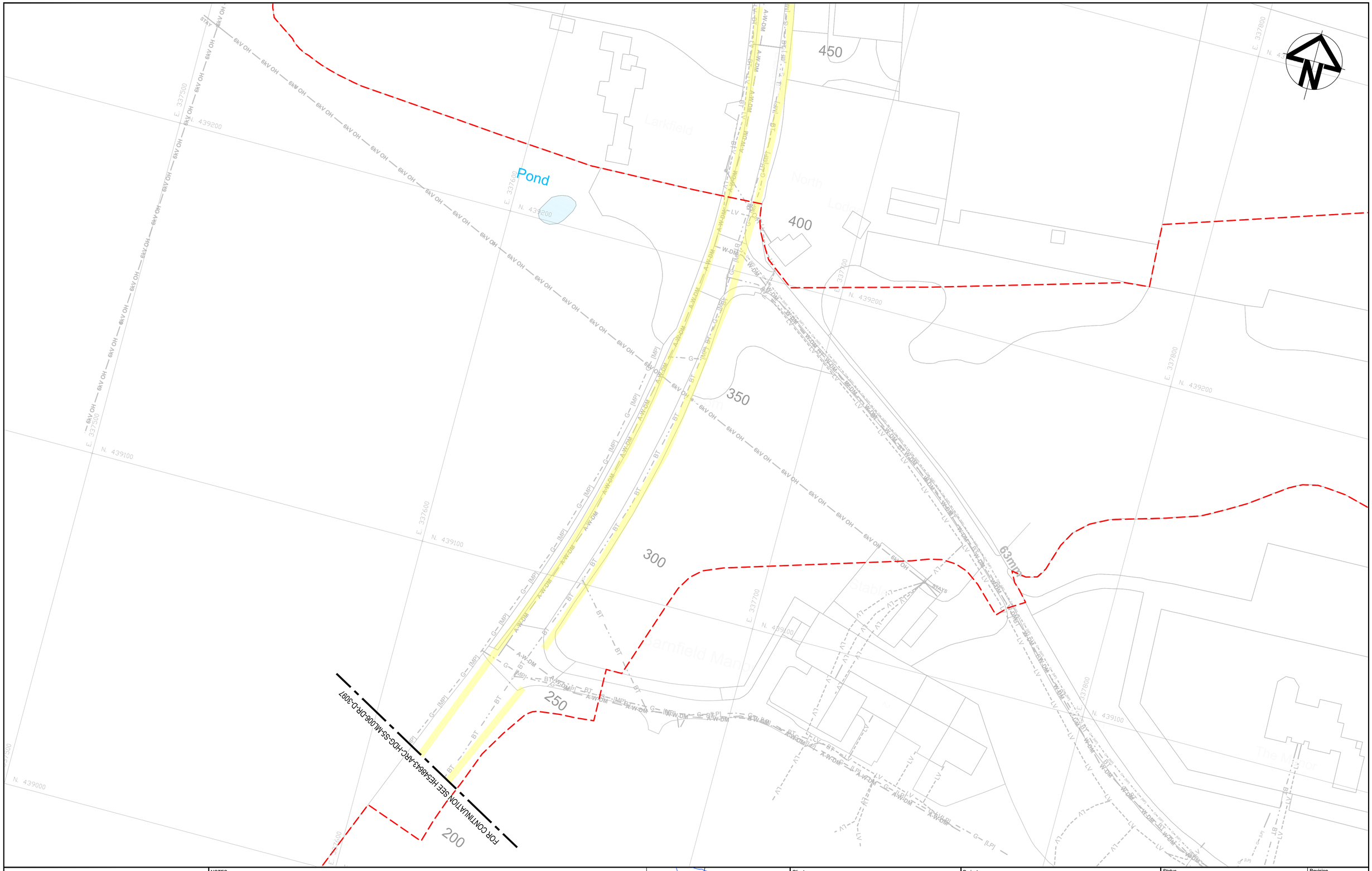
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
HE548643	ARC
Original Size	A1

Drawing number: HE548643-ARC-HDG-S4_ML_002-DR-D-3095

100mm on Original

Print Date:

File Path:

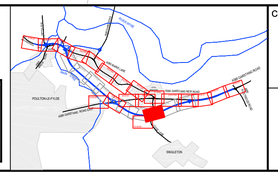


Rev	Status	Date	Description	Drawn	Chck'd	ApprVd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN PLAN SHEET 19 OF 20

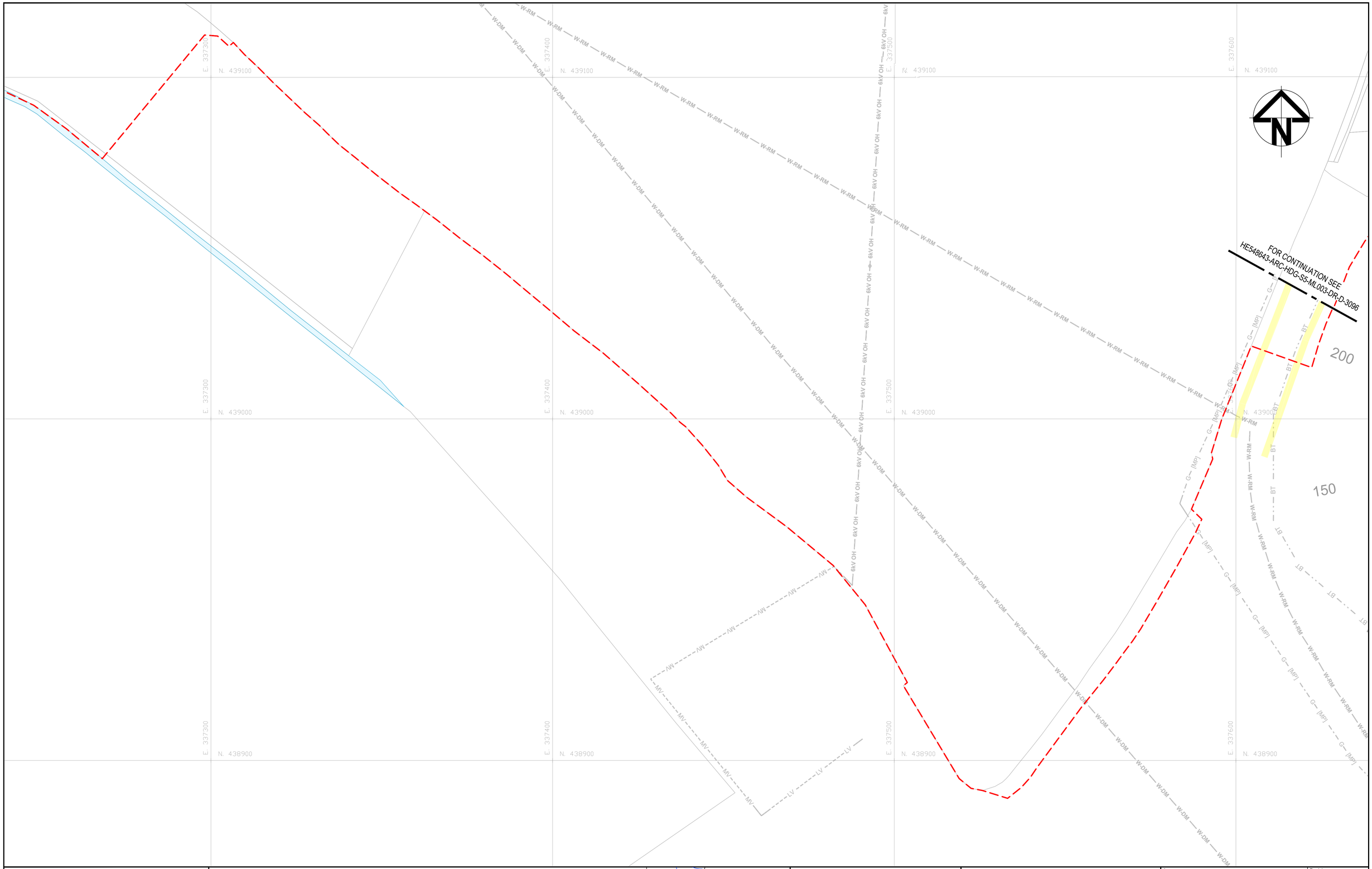
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE548643 | ARC | HDG | S5 | ML003 | DR | D | 3096

100mm on Original

Print Date:

File Path:

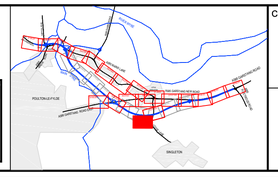


Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3076

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: EXISTING DRAINAGE AND SITE CLEARANCE PLAN PLAN SHEET 20 OF 20

Status: S3 - PRELIMINARY DESIGN

Revision: P02

Scale: 1:500

Date: 10JUL2018

Drawn By: G[redacted]

Checked By: A[redacted]

Approved By: N[redacted]

Original Size: A1

Drawing number: HE548643-ARC-HDG-S5-ML006-DR-D-3097

HE PIN | Originator | Volume | Location | Type | Role | Number

100mm on Original

Print Date:

File Path:

Appendix E – Priority outfall register extract

Priority Outfall Register Extract

Asset ID 34853

Outfall Register

Outfall Register ID	34853
HD43 asset ref	SD3540_4552b
Baseline Category	D (Low)
Spillage risk	Not determined
EQS	Not determined
Soluble pollution	Not determined
Sediment pollution	Not determined
Deposition Index	0
Verification status	Baseline assessment carried out
Action status	Not determined
Overall risk status	D (Low)
Proposed solution	
Actual solution	Not yet built
Last updated	28/06/2014

Asset ID 34855

Outfall Register

Outfall Register ID	34855
HD43 asset ref	SD3540_4861b
Baseline Category	D (Low)
Spillage risk	Not determined
EQS	Not determined
Soluble pollution	Not determined
Sediment pollution	Not determined
Deposition Index	0
Verification status	Baseline assessment carried out
Action status	Not determined
Overall risk status	D (Low)
Proposed solution	
Actual solution	Not yet built
Last updated	28/06/2014

Asset ID 34854

Outfall Register

Outfall Register ID	34854
HD43 asset ref	SD3540_4861a
Baseline Category	D (Low)
Spillage risk	Not determined
EQS	Not determined
Soluble pollution	Not determined
Sediment pollution	Not determined
Deposition Index	0
Verification status	Baseline assessment carried out
Action status	Not determined
Overall risk status	D (Low)
Proposed solution	
Actual solution	Not yet built
Last updated	28/06/2014

Asset ID 34851

Outfall Register ID	34851
HD43 asset ref	SD3540_7556c
Baseline Category	D (Low)
Spillage risk	Not determined
EQS	Not determined
Soluble pollution	Not determined
Sediment pollution	Not determined
Deposition Index	0
Verification status	Baseline assessment carried out
Action status	Not determined
Overall risk status	D (Low)
Proposed solution	
Actual solution	Not yet built
Last updated	28/06/2014

Outfall Register

Asset ID 34852

Outfall Register ID	34852
HD43 asset ref	SD3540_7656a
Baseline Category	D (Low)
Spillage risk	Not determined
EQS	Not determined
Soluble pollution	Not determined
Sediment pollution	Not determined
Deposition Index	0
Verification status	Baseline assessment carried out
Action status	Not determined
Overall risk status	D (Low)
Proposed solution	
Actual solution	Not yet built
Last updated	28/06/2014

Outfall Register

Asset ID 32992

Outfall Register ID	32992
HD43 asset ref	SD3839_6948a
Baseline Category	C (Moderate)
Spillage risk	Not determined
EQS	Not determined
Soluble pollution	Not determined
Sediment pollution	Not determined
Deposition Index	0
Verification status	Baseline assessment carried out
Action status	Not determined
Overall risk status	C (Moderate)
Proposed solution	
Actual solution	Not yet built
Last updated	17/05/2013

Outfall Register

Asset ID 13236

Outfall Register ID	13236
HD43 asset ref	SD3839_8150d
Baseline Category	C (Moderate)
Spillage risk	Not determined
EQS	Not determined
Soluble pollution	Not determined
Sediment pollution	Not determined
Deposition Index	0
Verification status	Baseline assessment carried out
Action status	Not determined
Overall risk status	C (Moderate)
Proposed solution	
Actual solution	Not yet built
Last updated	16/06/2010

Outfall Register

Asset ID 32966

Outfall Register ID	32966
HD43 asset ref	SD3839_8151a
Baseline Category	C (Moderate)
Spillage risk	Not determined
EQS	Not determined
Soluble pollution	Not determined
Sediment pollution	Not determined
Deposition Index	0
Verification status	Baseline assessment carried out
Action status	Not determined
Overall risk status	C (Moderate)
Proposed solution	
Actual solution	Not yet built
Last updated	17/05/2013

Outfall Register

Asset ID 32964

Outfall Register ID	32964
HD43 asset ref	SD3839_8551g
Baseline Category	C (Moderate)
Spillage risk	Not determined
EQS	Not determined
Soluble pollution	Not determined
Sediment pollution	Not determined
Deposition Index	0
Verification status	Baseline assessment carried out
Action status	Not determined
Overall risk status	C (Moderate)
Proposed solution	
Actual solution	Not yet built
Last updated	17/05/2013

Outfall Register

Asset ID 32965

Outfall Register

Outfall Register ID	32965
HD43 asset ref	SD3839_8552a
Baseline Category	C (Moderate)
Spillage risk	Not determined
EQS	Not determined
Soluble pollution	Not determined
Sediment pollution	Not determined
Deposition Index	0
Verification status	Baseline assessment carried out
Action status	Not determined
Overall risk status	C (Moderate)
Proposed solution	
Actual solution	Not yet built
Last updated	17/05/2013

Appendix F – Correspondence

A585 Skippool to Windy Harbour Improvement Scheme – Drainage S.E.S Scheme Introduction Presentation

15th November 2017/ 9:30am

Arcadis House, kings Cross Office – Room 2.6

Attendees:

[redacted] – Arcadis Consulting – Drainage Lead
[redacted] – Arcadis Consulting – Drainage Senior Engineer
[redacted] – Highways England – S.E.S Department
[redacted] – Highways England – S.E.S Department

Apologies:

[redacted] Arcadis Consulting – Project Manager
[redacted] – Highways England – S.E.S Department
[redacted] – Highway England – Scheme Project Manager

Item no.	Notes/actions	Action owner
1	**Introduction**	-
1.1	AC stated that the purpose of the meeting was to introduce the A585 Skippool to Windy Harbour Improvement Scheme and discuss the existing water environment, existing highway drainage and our proposed drainage strategy.	-
1.2	AC stated that do this he had produced a presentation (document number: HE548643-ARC-GEN-A585-PR-ZM-3000). The presentation will cover the following agenda: 1. Location overview; 2. Existing road network and the main constraints; 3. Existing A585 issues; 4. Scheme objectives; 5. Summary of options; 6. Proposed route; 7. Existing overland flow catchments; 8. Existing drainage; 9. Proposed drainage strategy; 10. Proposed drainage and catchments; and 11. Proposed Departures.	-
2	**Agenda items 1 to 6**	
2.1	AC gave a brief introduction to the scheme explaining that the Preferred Route Announcement (PRA) had been issued on 24th October 2017 and the preliminary design (Stage 3) for the scheme was being developed to set the red line boundary ready for the Development Control Order (DCO).	-
2.2	SS emphasized it is not within the remit of Highways England S.E.S department to approve any proposed drainage design, rather they are here to advise and provide necessary guidance.	-
3	**Agenda item 7 - Existing overland flow catchments**	
3.1	AC stated that there are 4no. Main Rivers within the scheme extents, these being the River Wyre, Horsebridge Dyke, Main Dyke and Pool Foot Creek.	-
3.2	AC stated that a Flood Risk Assessment was being produced and discussions had been held with the Environment Agency with regards the effect of the proposed embankment on the fluvial and tidal flood zones.	-
3.3	QD asked if any local watercourses were to be culverted.	-
3.4	AC explained that 5no. new 1.5m diameter culverts would be required along the offline bypass and the extension of 2no. existing 900mm diameter culverts to accommodate the dualling of the existing carriageway at Windy Harbour Junction.	-

3.5	QD asked if the culverts were included in the FRA and what their effect was on the tidal flooding.	-
3.6	AC stated that the culverts and proposed wetlands were included in both the fluvial and tidal models.	-
3.7	QD enquired about the effect this had on the fluvial and tidal flood water levels.	-
3.8	AC stated that as part of the scheme the existing Skippool Bridge was going to be replaced and 2no. structures constructed. The new structures would be larger clear span structures (bridge / box culverts) which actually reduced the flood water levels, even though the new embankment took up floodplain storage. AC stated that this will all form part of the FRA.	-
3.9	AC stated that due to the anticipated ground conditions the culverts are likely to be constructed from twin wall thermoplastic pipes. This is to cater for the anticipated differential settlement of 150mm at the culvert headwalls and 300mm at the midpoint.	-
3.10	SS stated that all pipes greater than 900mm diameter are classified as a structure. SS also stated that he was currently developing the detailed specification for thermoplastic pipes in the MCHW to include pipes greater than 900mm diameter.	-
3.11	AC stated that he had been asked a question by the Structures S.E.S department via the Arcadis structures team with regards fire protection of thermoplastic twin wall pipes used as culverts	-
3.12	SS stated that if the culvert is open at both ends i.e. no trash or security screens and it only takes overland flow i.e. no road drainage, then the risk of a fire starting is negligible.	-
3.13	AC confirmed this to be the case and already stated this in his response to the structures team.	-
4	**Agenda item 8 – Existing drainage**	
4.1	AC explained that there was limited existing drainage data available and gap analysis plans had been created along with an CCTV asset and condition survey specification to allow asset data to be gathered to confirm our current design.	-
4.2	AC explained that the existing drainage networks along the existing A585 utilised kerb and gullies, which discharge via carrier drains to the ditches and ultimately the watercourses.	-
4.3	QD asked what would happen to the existing A585 when are scheme was complete.	-
4.4	AC stated that the existing A585 would be de-trunked and given to Lancashire County Council (LCC).	-
4.5	QD asked if the existing drainage on the de-trucked section was in good condition.	--
4.6	AC stated that we have limited information and the gap analyses included the de-truckned section. AC stated that the team was aware that LCC may ask for defects to be repaired prior to them accepting ownership.	-
4.7	AC stated that apart from the Windy Harbour Junction improvement works where an oversized pipe and penstock value had been installed, the remainder of the existing drainage catchments current have no form of attenuation, water quality treatment or accidental spillage control.	-
5	**Agenda items 9 & 10 – Proposed drainage strategy and catchments**	
5.1	AC stated that all existing drainage catchments had been hydraulically modelled based on eth 1 in 1, 5 and 100 year return periods, and where we planned to re-use existing outfalls the existing 1 in 5 year discharge rate would be maintained.	-
5.2	SS stated that modelling of the existing 1 in 5 year discharge rate should not include the 20% climate change allowance.	-
5.3	AC stated that the existing hydraulic modelling did not include an allowance for climate change.	-
5.4	networks as per HD33 and the National Planning Policy Framework (NPPF) i.e. Table 5 of the Guidance Note in NPPF states that a scheme with a design life extending to a point earlier than 2085 should adopt 20%.	-

Table 5: Recommended national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak Rainfall Intensity	*5%*	*10%*	*20%*	*30%*
Peak river flow	*10%*	*20%*		
Offshore wind speed	*5%*		*10%*	
Extreme wave height	*5%*		*10%*	

(Table 5 extract from Technical guidance to NPPF (DCLG – 2012))

<table>
<tr><td>5.5</td><td>SS and QD stated that the relevant NPPF Guidance note on Climate Change factors has been withdrawn on March 2014 and replaced with new guidance on flood risk assessments: climate change allowances and that an upper end allowance of 40% is now recommended.

Post Meeting Note:
Current government guidance on climate change allowances are provided in Table 2 as shown below:

Table 2: peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)<table><tr><th>Applies across all of England</th><th>Total potential change anticipated for the ‘2020s’ (2015 to 2039)</th><th>Total potential change anticipated for the ‘2050s’ (2040 to 2069)</th><th>Total potential change anticipated for the ‘2080s’ (2070 to 2115)</th></tr><tr><td>Upper end</td><td>10%</td><td>20%</td><td>40%</td></tr><tr><td>Central</td><td>5%</td><td>10%</td><td>20%</td></tr></table></td><td>-</td></tr>
<tr><td>5.6</td><td>AC stated that a 40% allowance had not been incorporated and as the scheme was already over budget with a low CBR, it would be unlikely that 40% could be included.</td><td></td></tr>
<tr><td>5.7</td><td>SS / QD requested that a 40% sensitivity check is undertaken, and the results reported back to them.

Post Minute Note:

A 40% sensitivity test had been undertaken on the proposed catchments on the offline bypass i.e. new catchments with new outfalls. The check has confirmed that there is sufficient capacity within the currently designed wetlands to accommodate the 40% and this allowance would be accommodated for catchments 4,5 6 and 7 only. Catchment 1,2 3 and 8 utilise existing outfalls and the 40% allowance will not be accommodated.</td><td>AC</td></tr>
<tr><td>5.8</td><td>AC stated that pre-earthworks ditches and filter drains would be used to drainage third party run-off and these would be kept separate from the surface water drainage systems.</td><td>-</td></tr>
<tr><td>5.9</td><td>AC stated that a separate filter drain system would be incorporated in the mainline verges and central reserve at lodge lane cutting to accommodate the potential high groundwater flows. AC stated that we have no Ground Investigate (GI) data at the moment, but the geology in the area suggest that groundwater flows could be high, so the design has progressed on a worst-case basis.</td><td>-</td></tr>
<tr><td>5.10</td><td>QD asked what would happen if the flow rates were found to be low.</td><td>-</td></tr>
<tr><td>5.11</td><td>AC stated that as the scheme was only at stage 3, once the GI came in, the design could be updated accordingly.</td><td>-</td></tr>
<tr><td>5.12</td><td>AC stated that at the junctions / tie in locations kerb and gullies or combined kerb and drainage units (CDKU) had been used. On the mainline bypass concrete triangular Surface Water Channel SWC) had been adopted (1.28m wide in the verge and 1.58m wide in the central reserve).</td><td>-</td></tr>
<tr><td>5.13</td><td>SS asked why grassed channels hadn’t been used.</td><td>-</td></tr>
<tr><td>5.14</td><td>AC confirmed that the maintaining agents normal reject the use of grass channels has they require the grass to be cut and can they can become easy damaged if they are tracked by errant vehicles. AC stated that the drainage design was based on providing the most efficient / safe solution which required the minimum amount of maintenance.</td><td>-</td></tr>
<tr><td>5.15</td><td>QD asked why we had used a triangular channel and not a trapezoidal channel as they have a greater hydraulic capacity</td><td>-</td></tr>
<tr><td>5.16</td><td>AC stated that on previous scheme the maintaining agents had requested triangular channel over trapezoidal channels as they required greater passes with the road sweeper to clean, which had health and safety implications for the operatives.</td><td>-</td></tr>
<tr><td>5.17</td><td>AC stated that the scheme had 7no. catchments which would increase to 9no. catchments if Shard Link Road was included in the scheme.</td><td>-</td></tr>
<tr><td>5.18</td><td>AC stated that catchments 1,2 and 3 utilised existing outfalls and would be drained via kerb and gullies or combined kerb and drainage units (CDKU). These would discharge through carrier drains and oversized pipe would be used for attenuation with a penstock and orifice plate for spillage containment and flow control. A vortex grit separator has been installed upstream of the attenuation pipe to removed sediment. The new bridges have a 1m hard strip and due to the cross fall and longitudinal fall no bridge deck drainage is required. Gullies will be provided upstream and downstream of the bridge.</td><td>-</td></tr>
<tr><td>5.19</td><td>AC stated that catchment 4 to 7 used SWC which discharges to a carrier system, prior to discharge to a wetland which will provide water quality treatment and accidental spillage containment. The</td><td>-</td></tr>
</table>

	wetland forebay has been replaced with a vortex grit separate to capture sediment and floatables as they have a smaller footprint and are easier to clean.	
5.20	AC stated that catchment 8 covered existing Lodge lane which will now be on a bridge over the mainline. No drainage is required on the bridge. The small catchment upstream of the bridge will be connected into the pre-earthworks ditch. The catchment downstream of the bridge will connect into the existing drainage system following verification by CCTV asset and condition survey. Lodge lane is a local authority road and discussion are to be held with LCC.	-
5.21	AC stated that catchment 9 covers Shard Link Road which is drained by a SWC discharging to a wetland. There is still debate if this link road will be included in the scheme. **Post Minute Note:** Shard Link Road has been removed from the scheme following a written instruction from Highways England (17/11/2017)	-
5.22	AC confirmed that: ▪ Oversized pipes are designed to accommodate the 1 in 5 years storm return period with the discharge restricted to existing discharge rates (1 in 5 year flow rates); ▪ Wetlands had been designed to accommodate 1 in 100 year storm event with a 20% allowance for climate change with the discharge restricted to greenfield run-off rates; ▪ Wetlands located in flood zones protected against the 1 in 100 year fluvial flood level (300mm free board); and ▪ Wetland maintenance access provided off network (where possible).	-
6	**Agenda Item 11 – Proposed departures**	
6.1	AC stated that 3no. drainage departures will be applied for on the scheme, these being: ▪ Surcharging of the drainage networks during 1 in 1 year storm events; ▪ Increased spacing for man access chambers from a maximum of 100m to 150m; and ▪ Increase the diameter of a Type 7 catch-pit from 1050m diameter to accommodate larger pipes.	-
6.2	SS stated that these are now common departures and in principle these will be approved.	-
6.3	SS also confirmed that a departure will be required for the use of the vortex grit separator as the standard is still in draft format.	AC
6.4	SS confirmed that in principle they had no objections to the drainage proposals	-
7	**Post Meeting Note**	**-**
	Following issue of the draft minutes by AC, Highways England felt it would be beneficial in the longer term if a post meeting note to the MoM regarding climate change design requirements was added and is as follows: When it comes to Design of Road Drainage HE advises that designers would normally be expected to adopt the following approach: ▪ All edge drain details for collection of run off and carrier pipes/conduits for conveyance of that run off shall be designed based on the 'rainfall' experienced by the road catchment. River levels and sea levels are not part of this design consideration. However, all drainage design shall incorporate appropriate discharge controls to comply with the national requirements. Highways England fully recognise the design standards described in the National Planning Policy Framework (NPPF) for climate change adaptation. NPPF provides the tools we need to ensure the SRN drainage network can be designed, constructed and operated in a safe way, and in order to	

	meet our legal obligation not to increase the risk of flooding. All new schemes shall adopt the following approach to drainage design: ▪ For all new schemes that do not involve adaptation of an existing drainage network: Full compliance with the requirements described in NPPF; ▪ For all new schemes that involve adaptation of an existing drainage network: Compliance in accordance with HD33, with the exception of Smart Motorways where IAN 161 shall apply; ▪ In both 1 and 2, above, the design solution shall incorporate a 20% uplift in peak rainfall intensity. The proposal shall also sensitivity test the design with a 40% uplift in peak rainfall intensity. The difference between the 2 scenarios (Central and Upper) shall enable the end user to understand the range of impact between the climate change risk scenarios. In the light of this knowledge the Project Sponsor shall determine the appropriate course of action to be implemented; ▪ For all schemes that use existing outfalls, the current discharge rates shall not be exceeded. The current discharge rates (no rates were historically pre-defined, or pre-agreed) shall be calculated using the current design methods available within DMRB 4.2 ▪ All schemes shall be checked for a 1 in 100 year flooding compliance Where rivers and the sea have the potential to influence a highway design the regional effects of climate change must again be taken into account. In this case the impact of climate change on river flows and sea level rise must be taken into account as part of a flood risk assessment. Our HD45 publication, which covers flood risk assessment, signposts the end-user back to Volume 4.2 (HA107) for Culvert design. However, the end user should be aware of, and implement, the most up-to-date climate change guidance to assess risk and design culverts in accordance with the new regional variations defined in NPPF, and to use the higher risk levels when doing so. *Note on Peak Rainfall Intensity allowances: The working assumption is that all new road infrastructure shall have a design lifetime of 60 years. Under the climate change scenarios for peak rainfall intensity described in NPPF Table 2 the design lifetime of new road infrastructure now places them in the "2080s" banding (Note that NPPF Table 2 brackets the "2080s" peak rainfall intensity scenarios over the 2070 to 2115 period). NPPF text on peak rainfall intensity simply states the need to "understand the range of impact" and refers to the Central and Upper values across all of England that will facilitate this understanding. NPPF Table 2 then defines the "2080s" Central and Upper Peak Rainfall Intensity values as 20% and 40%, respectively. It is in this context that HE requirements are defined. You will note that for completely new road drainage designs our requirements are in full accordance with NPPF, whilst ensuring due diligence is exercised when "understanding" and evaluating the potential effects of a changing climate.*	

A585 WINDY HARBOUR TO SKIPPOOL

STAGE 3 PRELIMINARY DRAINAGE DESIGN

HIGHWAYS ENGLAND S.E.S. DRAINAGE DEPARTMENT
INTRODUCTION TO THE SCHEME

HE548643-ARC-GEN-A585-PR-ZM-3001-HE OD Presentation

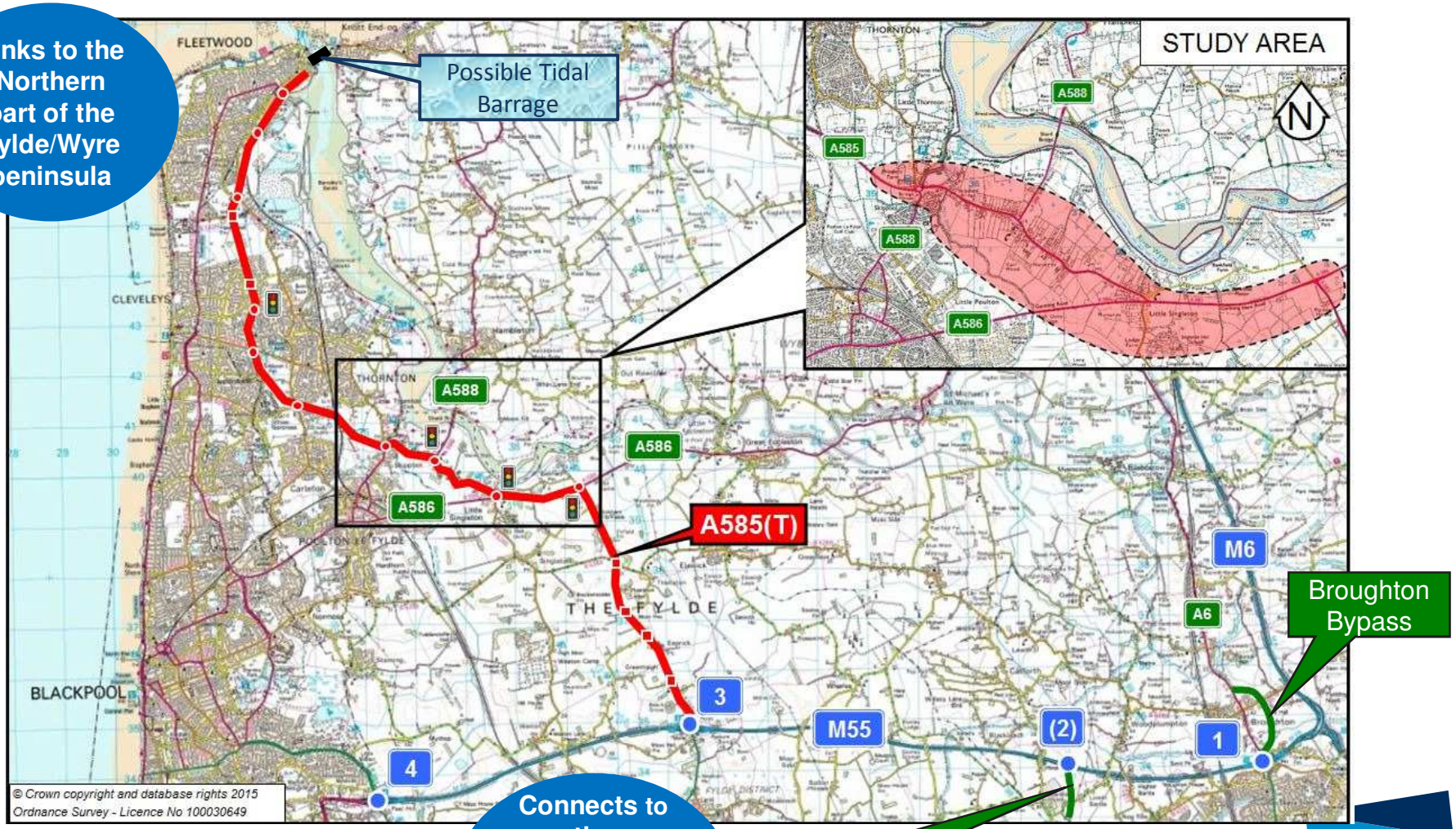
16th November 2017

Presented by: Alan [redacted]

Agenda

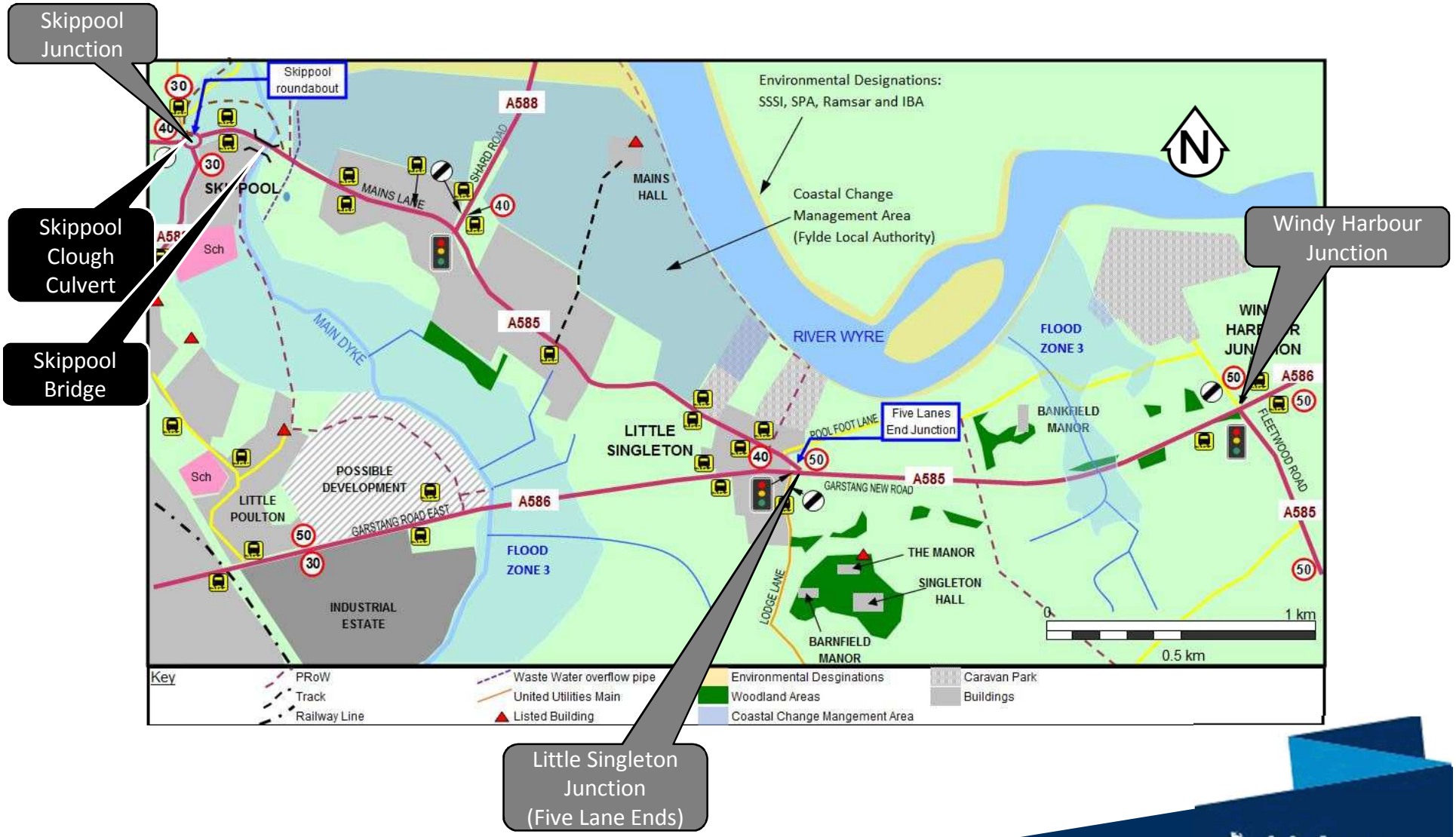
- Location Overview;
- Existing Road Network & Main Constraints;
- Existing A585 Issues;
- Background - existing route;
- Scheme objectives;
- Summary of Options;
- Proposed route;
- Existing overland flow catchments;
- Existing drainage;
- Proposed drainage strategy;
- Proposed drainage and catchments; and
- Proposed departures.

Location Overview



highways england

Existing Road Network & Main Constraints



highways england

Existing A585 Issues



- The Scheme Objective Business case (SOBC) identifies that the A585 is in the worst 10% of routes in the NW for reliability;
- A585 route is ranked 81st and 202nd on national top 250 for casualty rates;
- A585 was not originally constructed to Highways England standards but now forms part of the trunk road network;
- The South Pennines Route Bases Strategy (RBS) highlighted significant issues for cyclists and vulnerable road users. Including difficulties at junctions, difficulties crossing and navigating the road safely and poor maintenance of facilities for cyclists;
- The route runs close to the southern end of Morecambe Bay Estuary which is designated as SAC, Ramsar, SPA and Nature Improvement Area;
- Northern end of Scheme (including Skippool Bridge) and much of the southern bypass route to A586 Garstang Road East are within flood risk areas; and
- Skippool Bridge may have to be raised significantly (subject to discussion with EA).

Background – Existing Route

- The existing A585 within the Scheme is a 4.5km long single carriageway with 3 main junctions and extensive ribbon development fronting both sides over 3km of its length;



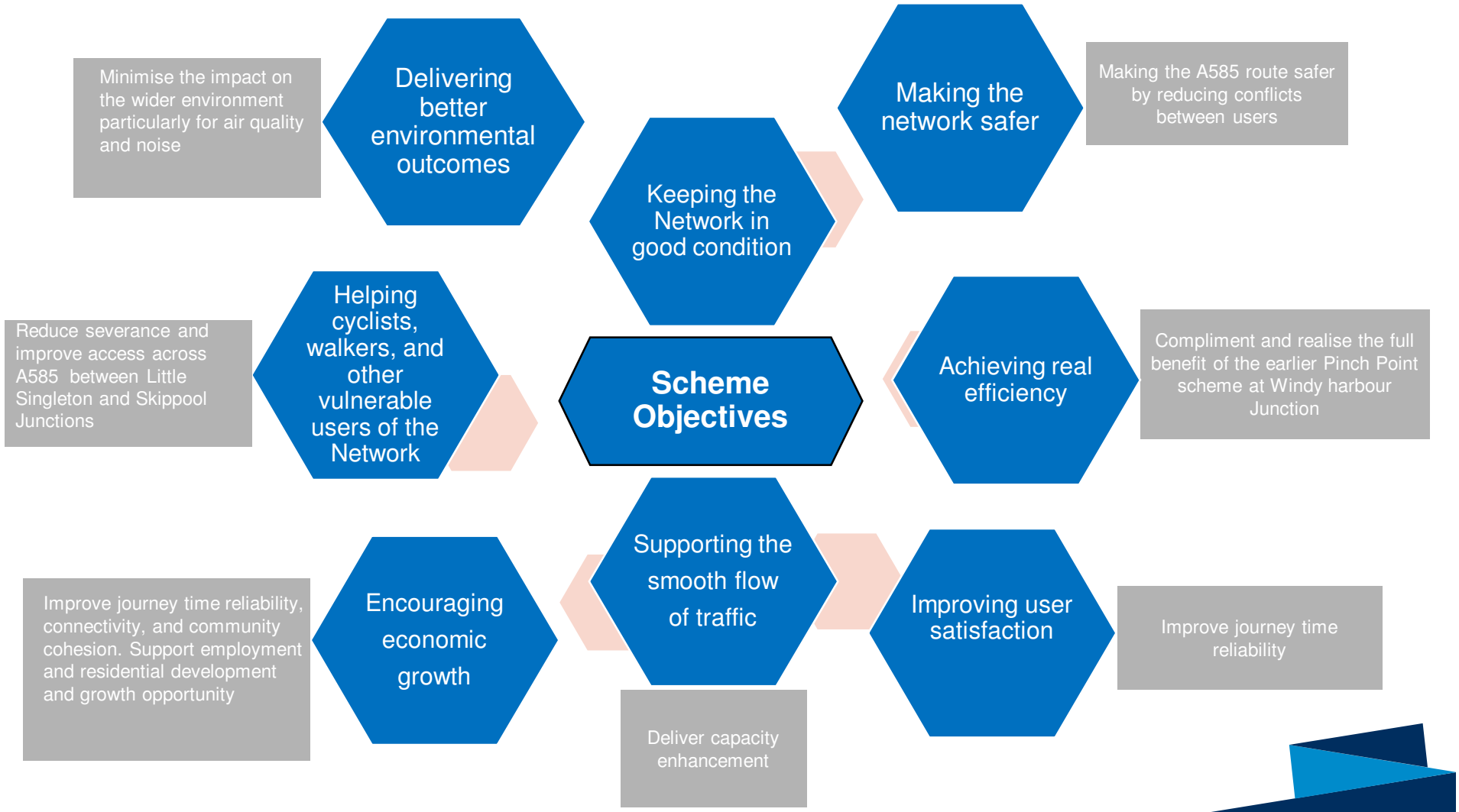
- A585 Mains Lane has more than 130 properties and 3 caravan parks that have direct access to the road;

- It is also used by several bus routes and has a speed limit of 40mph; and

- Skippool bridge, which is over 100 years old (widened in 1920's), would need further widening for dualling and has been fitted with flood containment gates.

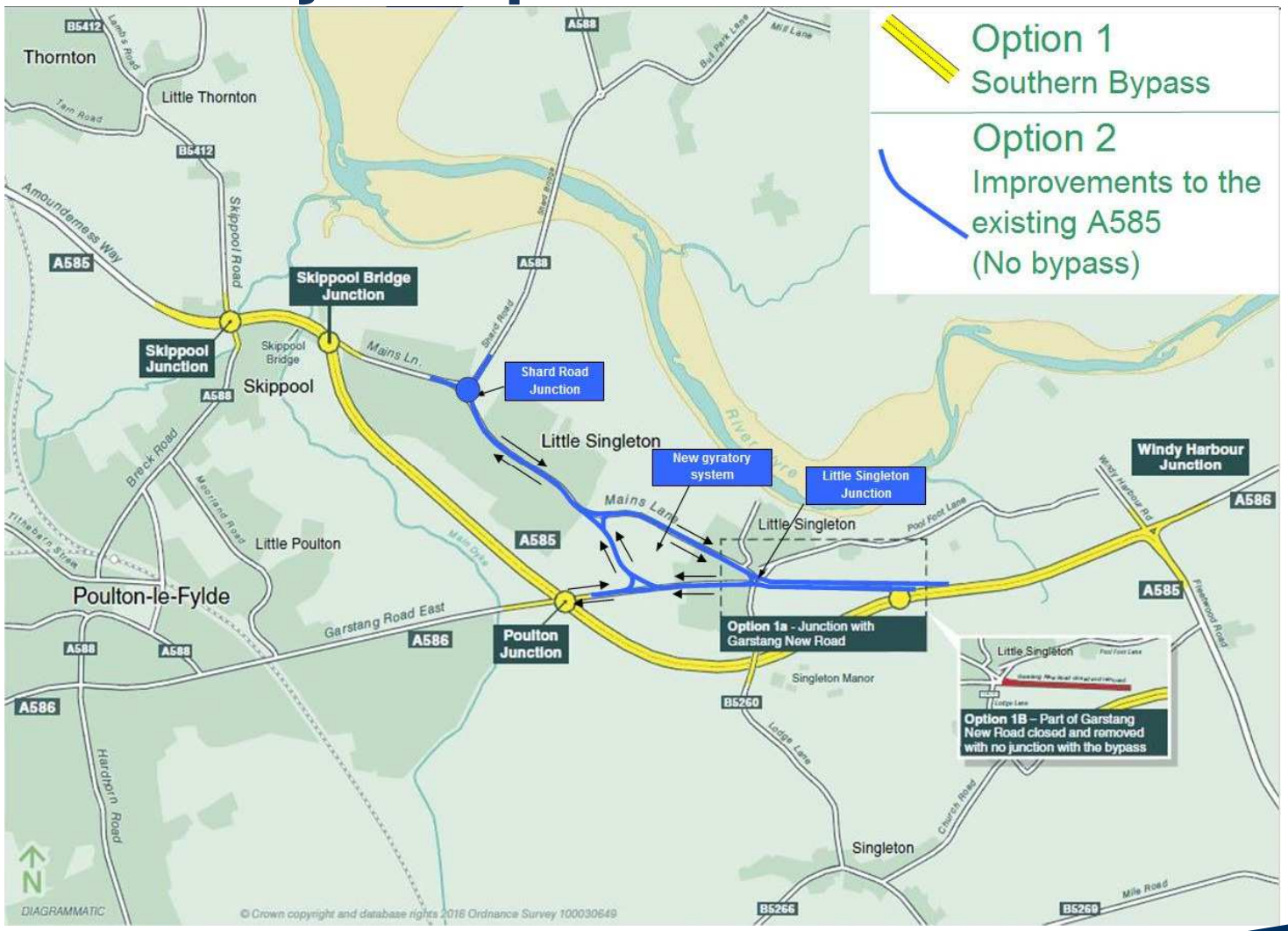
highways england

Scheme Objectives



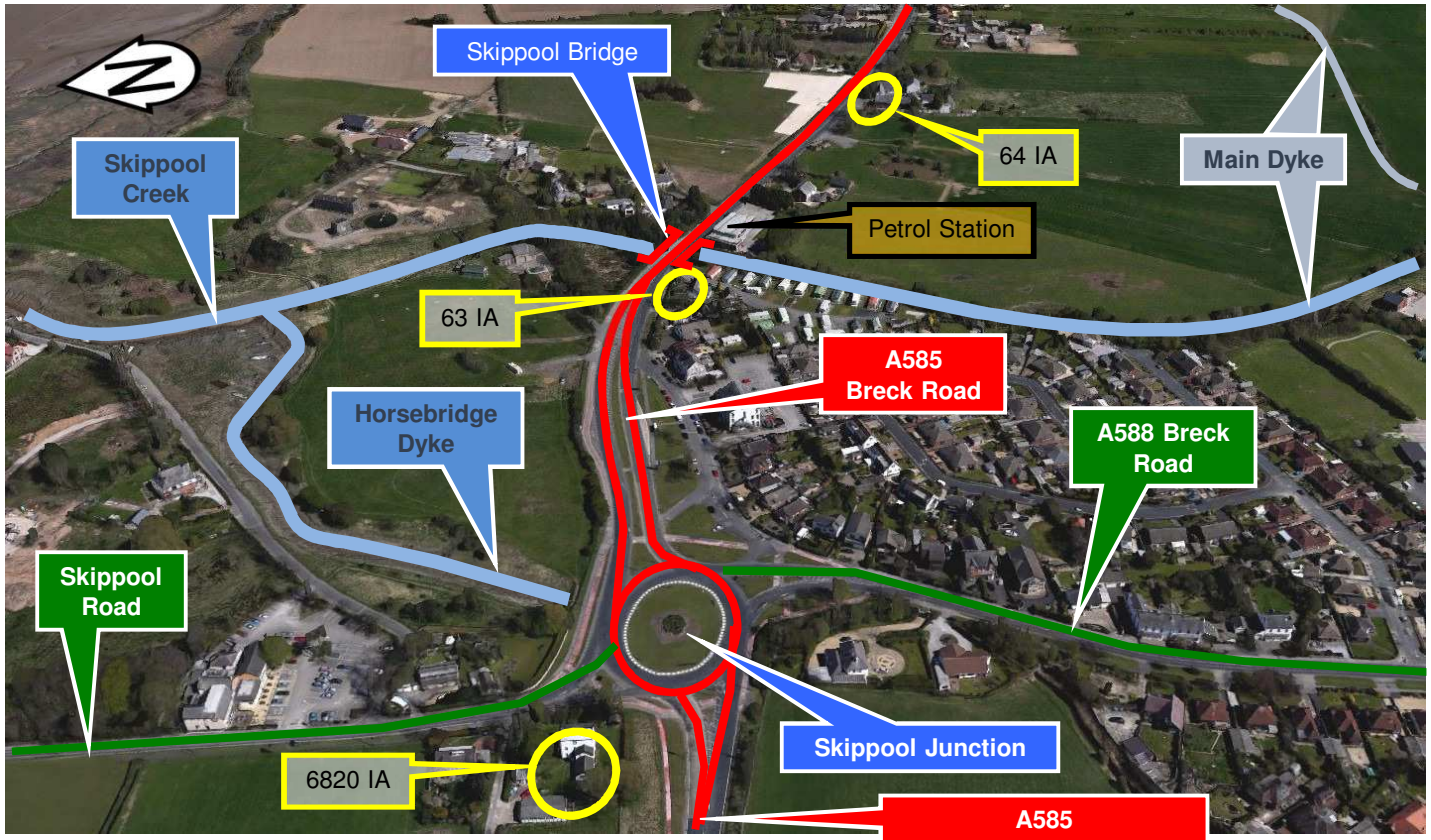
highways england

Summary of Options



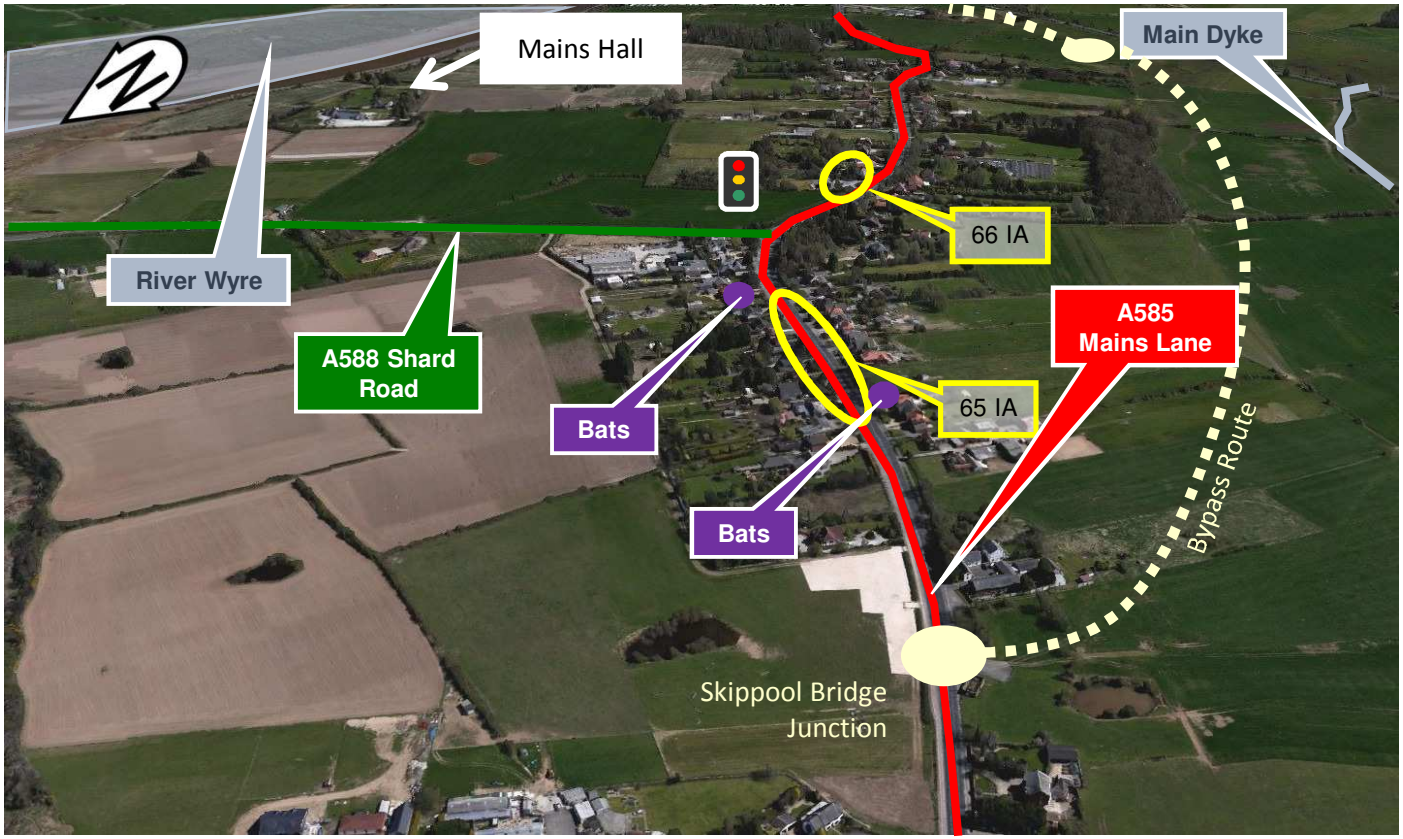
highways england

Skippool Junction and Skippool Bridge



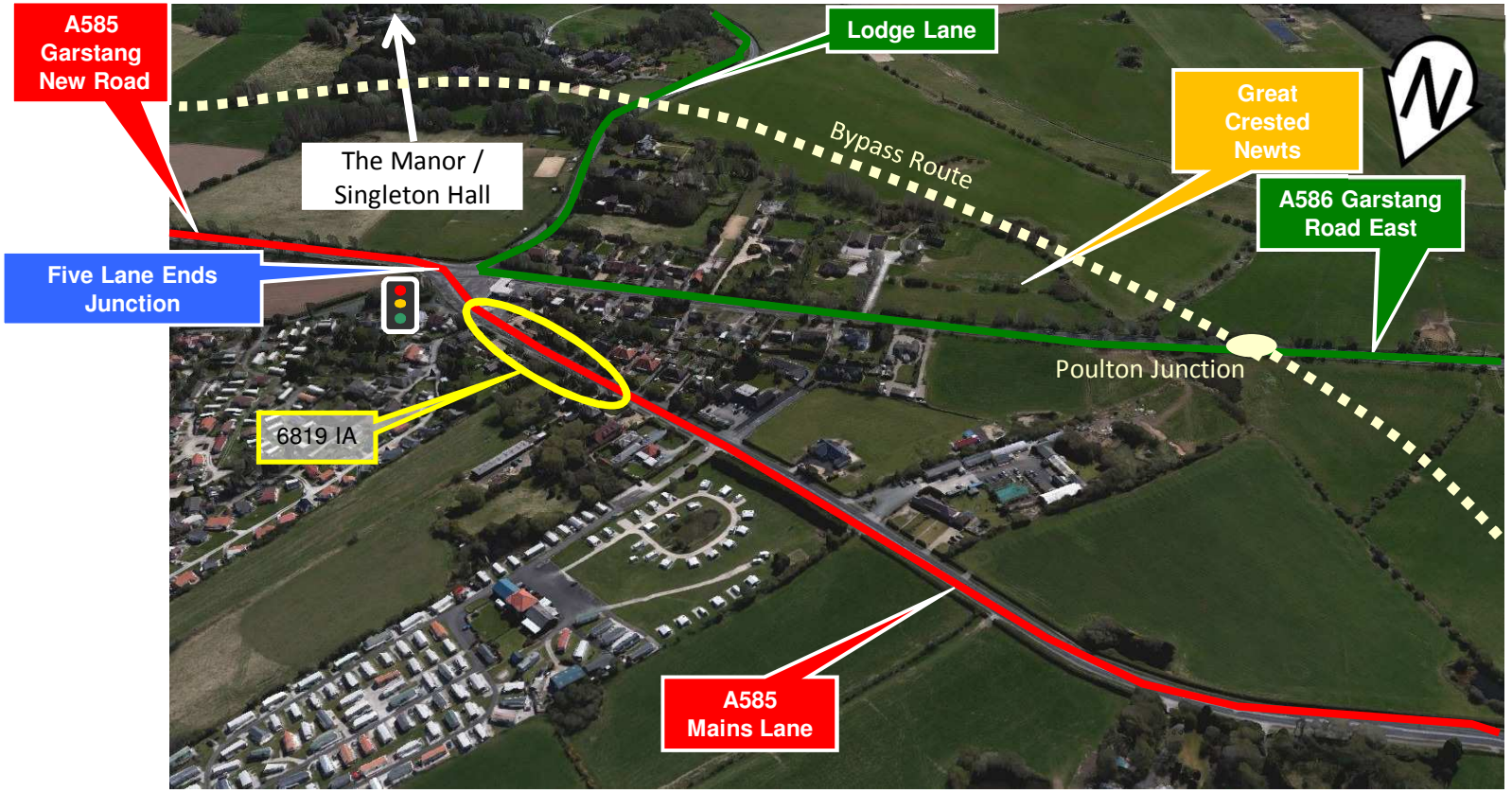
highways england

Skippool Bridge to Shard Road



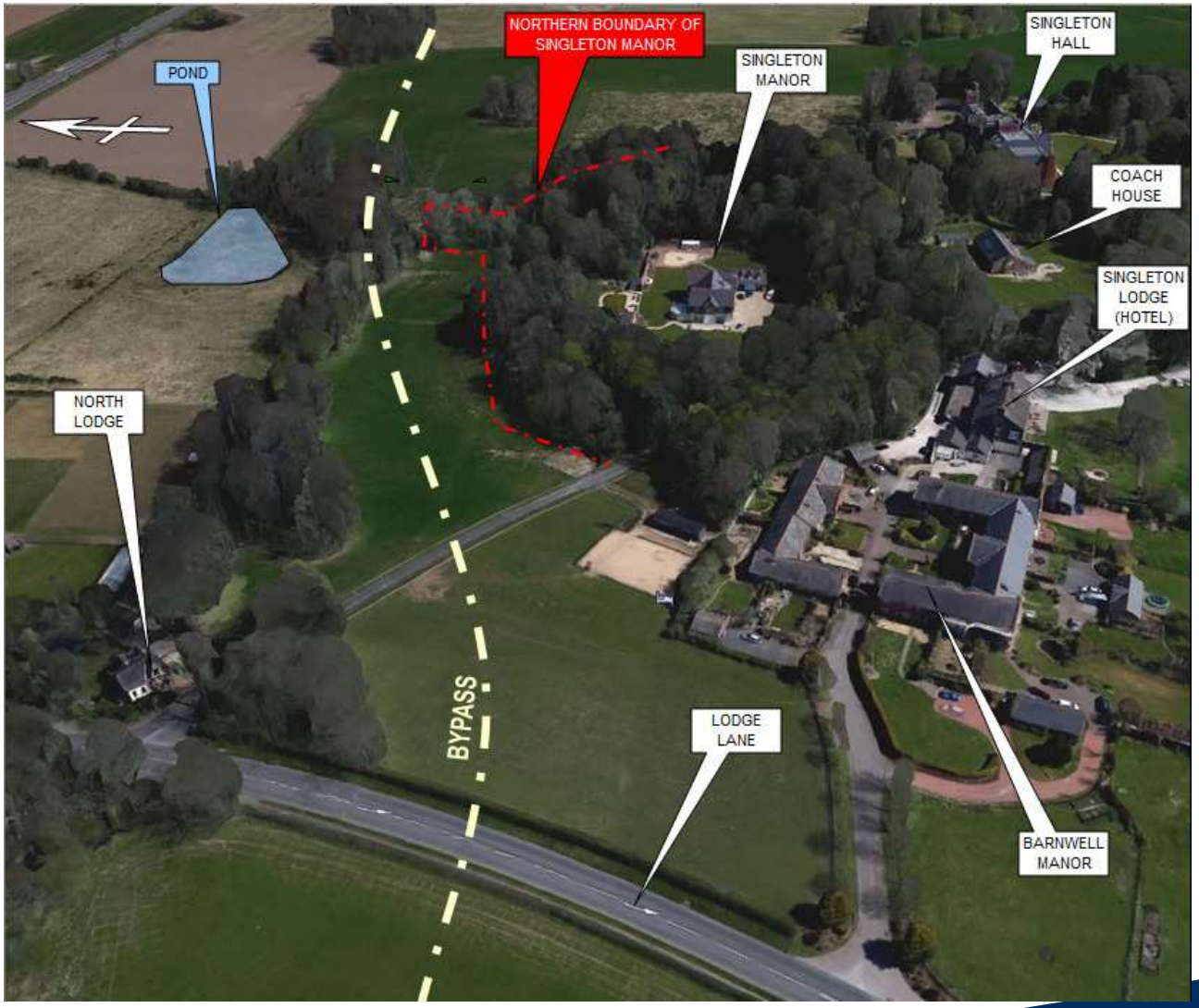
highways england

Little Singleton (Five Lane Ends Junction)



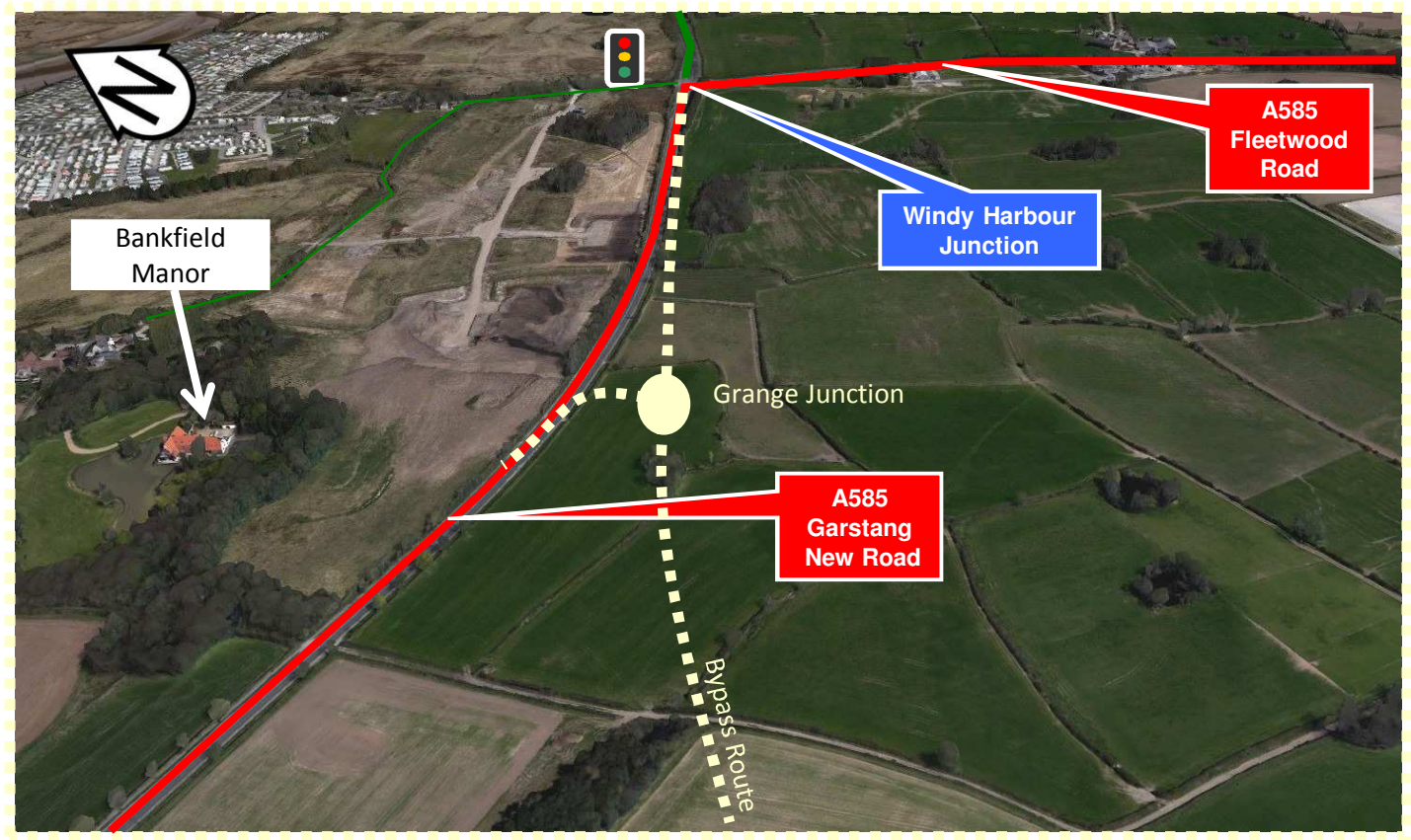
highways england

Lodge Lane (looking east)



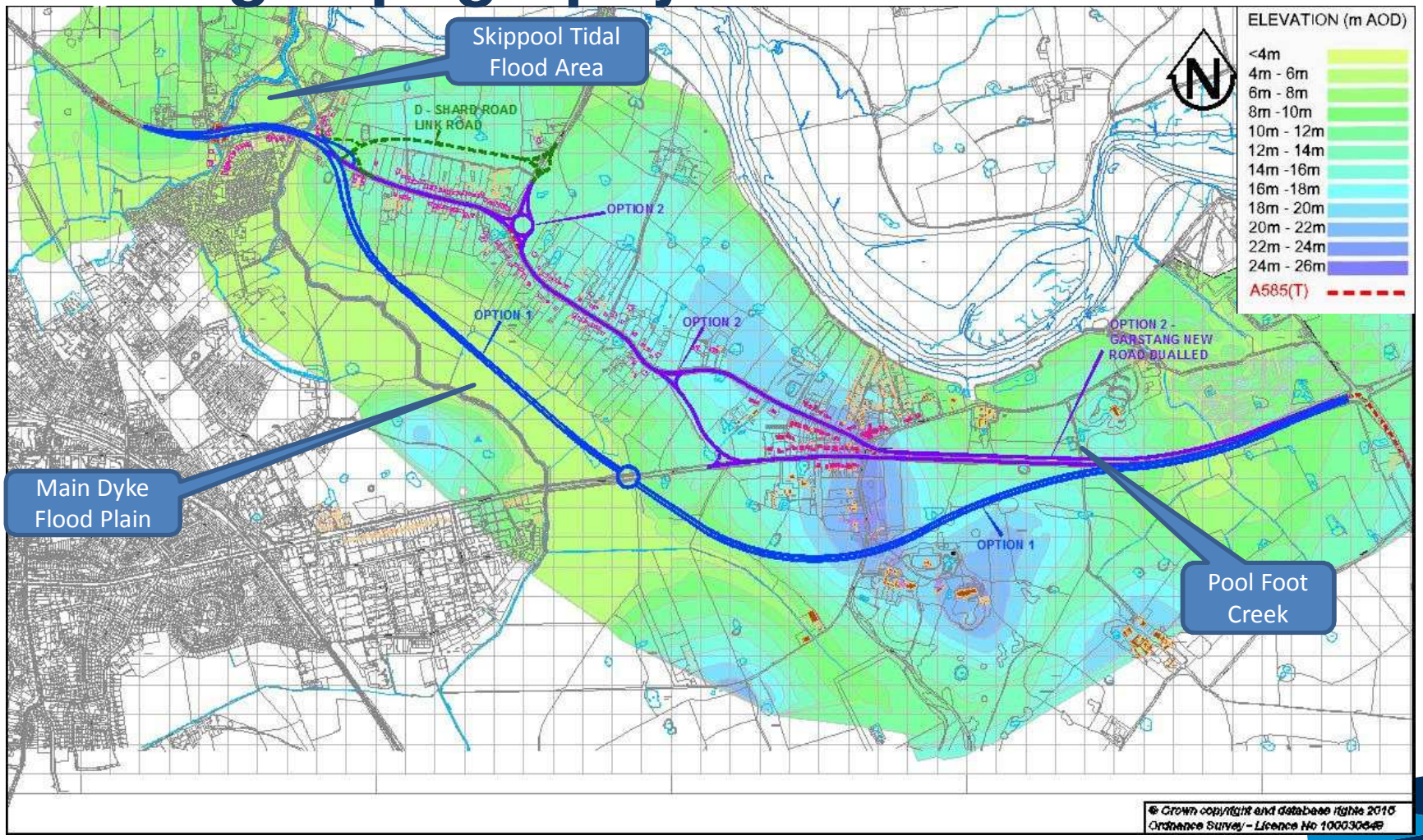
highways england

New Garstang Road and Windy Harbour Junction



highways england

Existing Topography

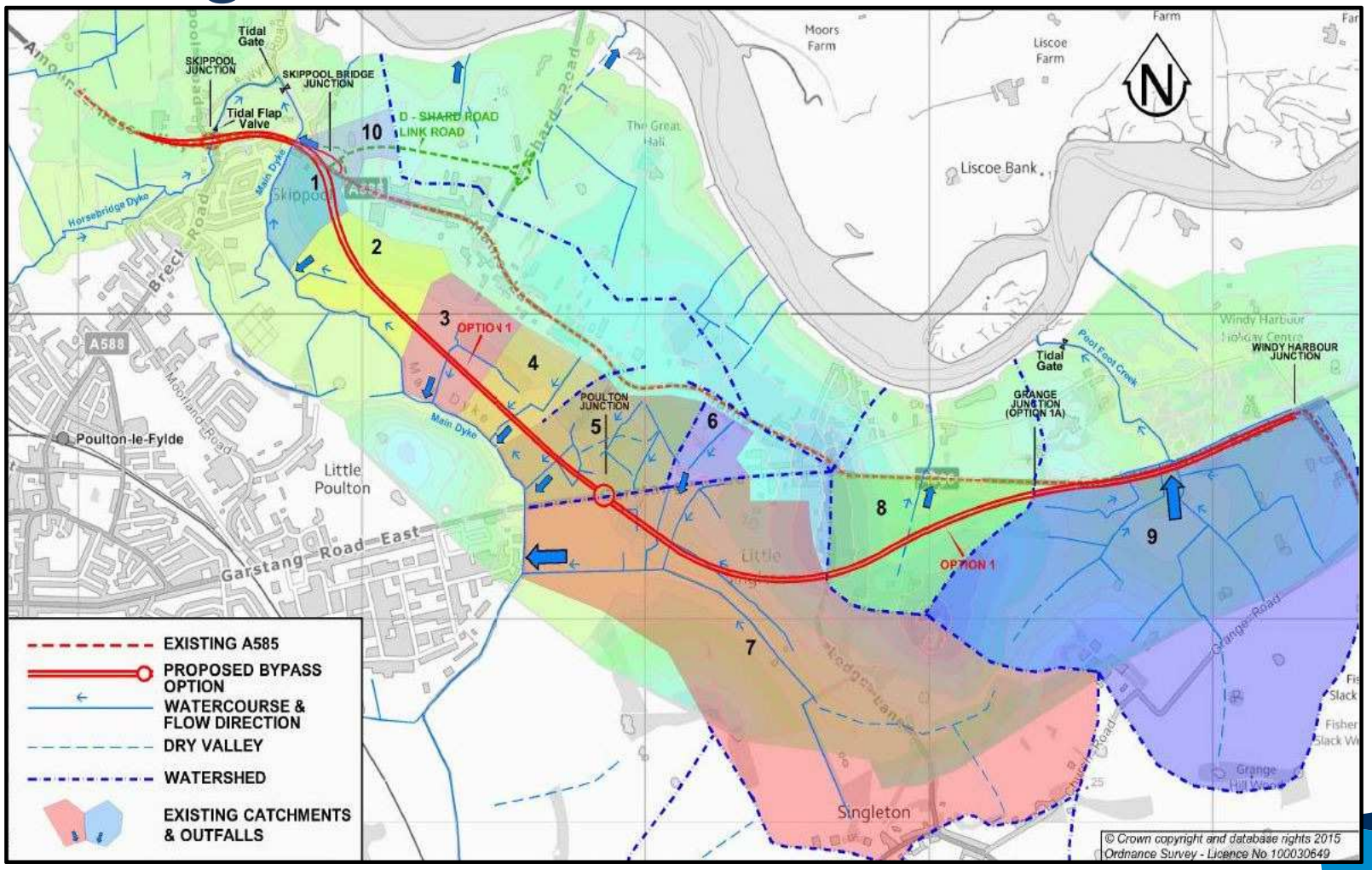


highways england

Existing Drainage – Water Environment

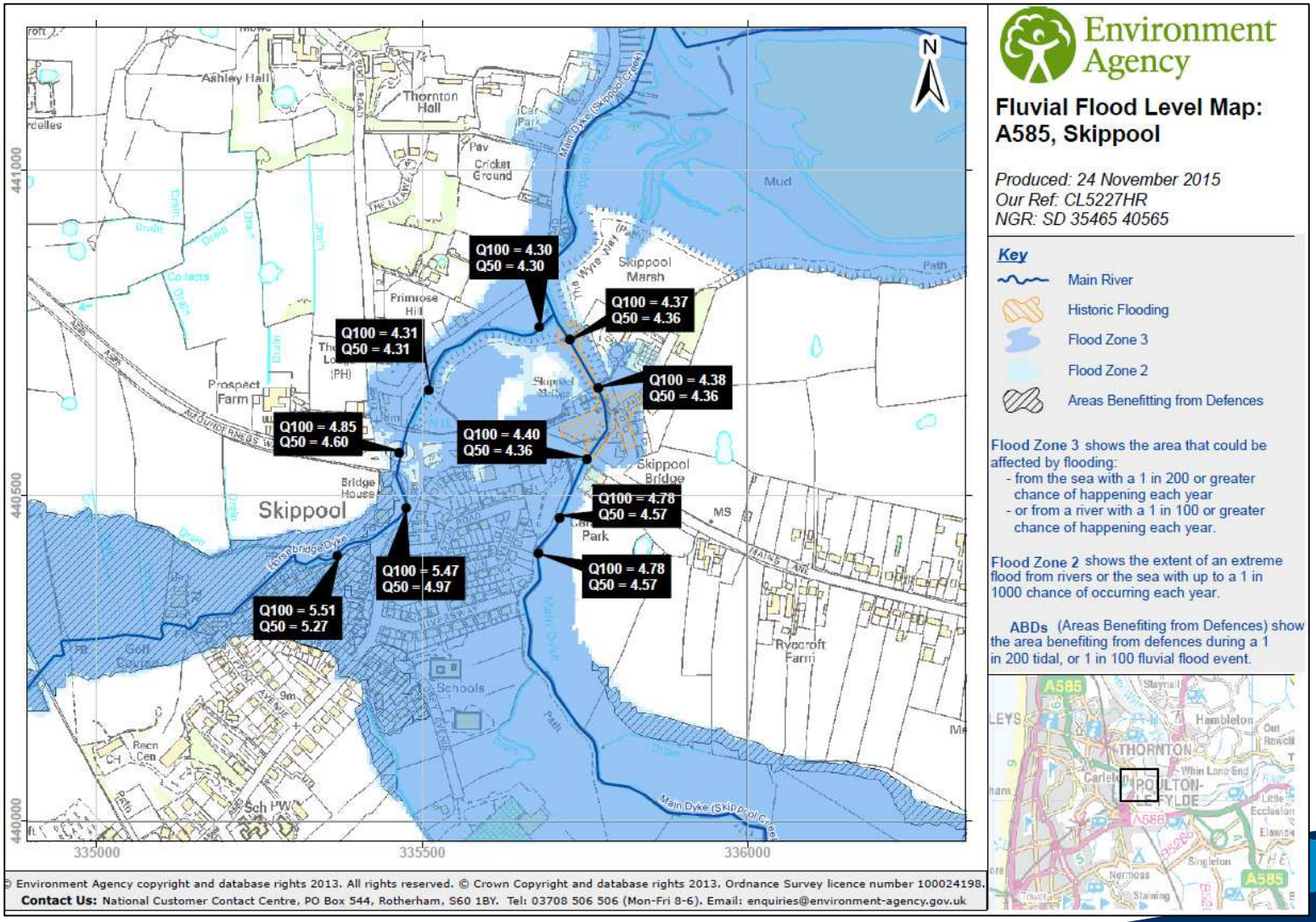
- 3no. Main Rivers (Horsebridge Dyke, Main Dyke and Pool Foot Creek);
- Groundwater condition is unknown – limited GI.
- Groundwater is assumed to be present at Lodge Lane cutting due to the glacial sands / gravel cap; and
- Majority of the scheme is within flood zone 1, with a smaller portion within flood zones 2 and 3.

Existing Overland Flow Catchments



highways england

Existing Drainage – Water Environment



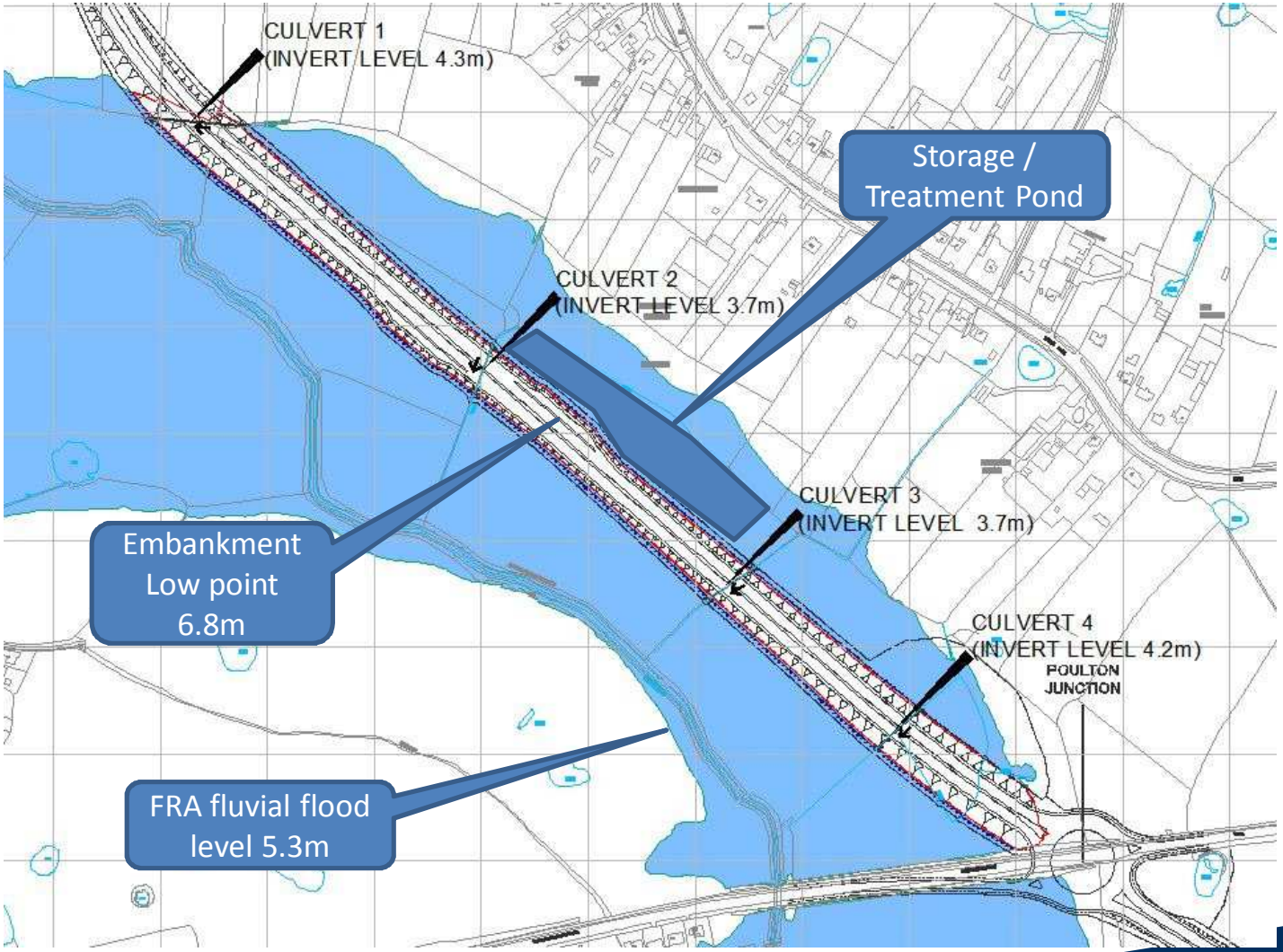
highways england

Skippool Tidal Flood Area



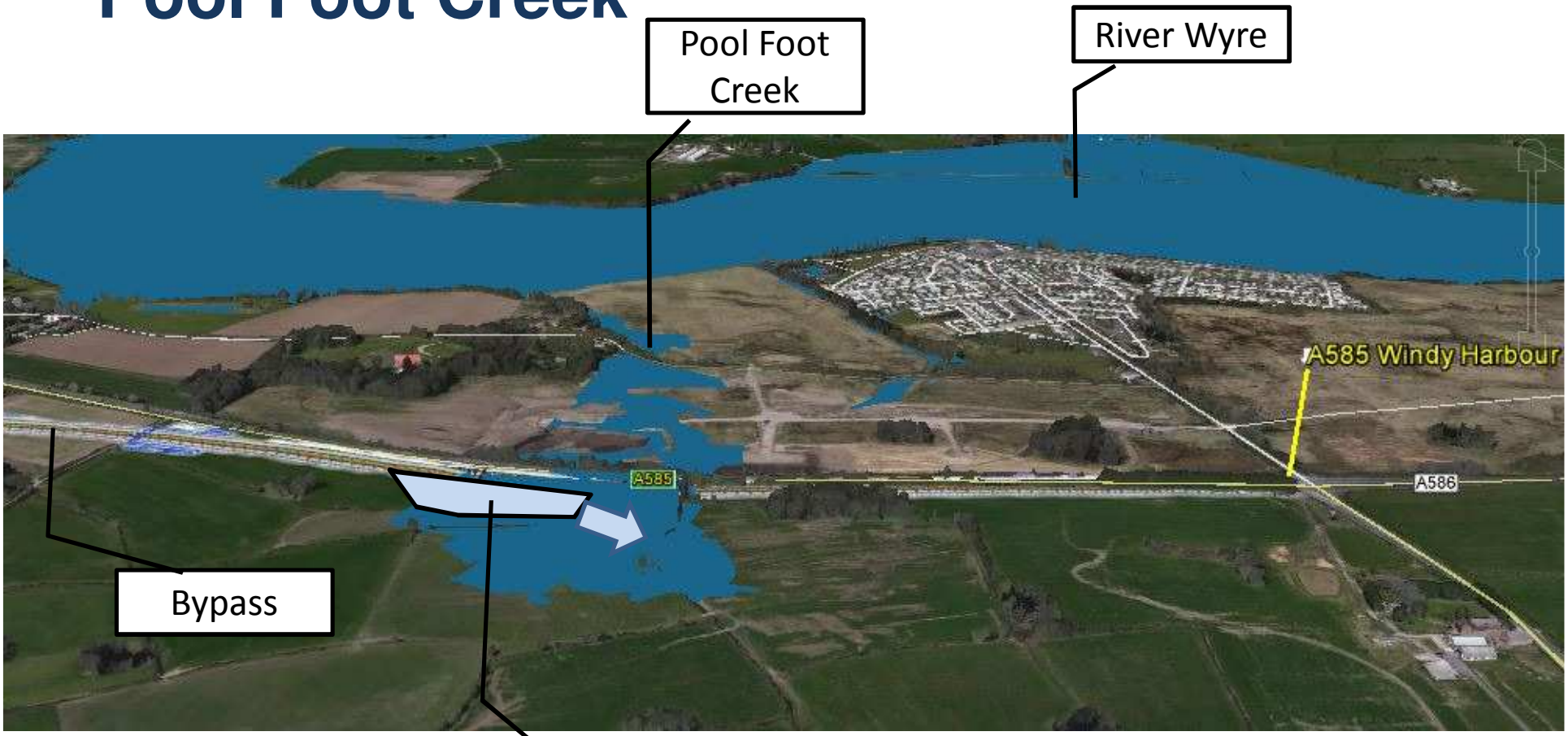
highways england

Main Dyke Flood Plain



highways england

Pool Foot Creek



highways england

Pool Foot Creek

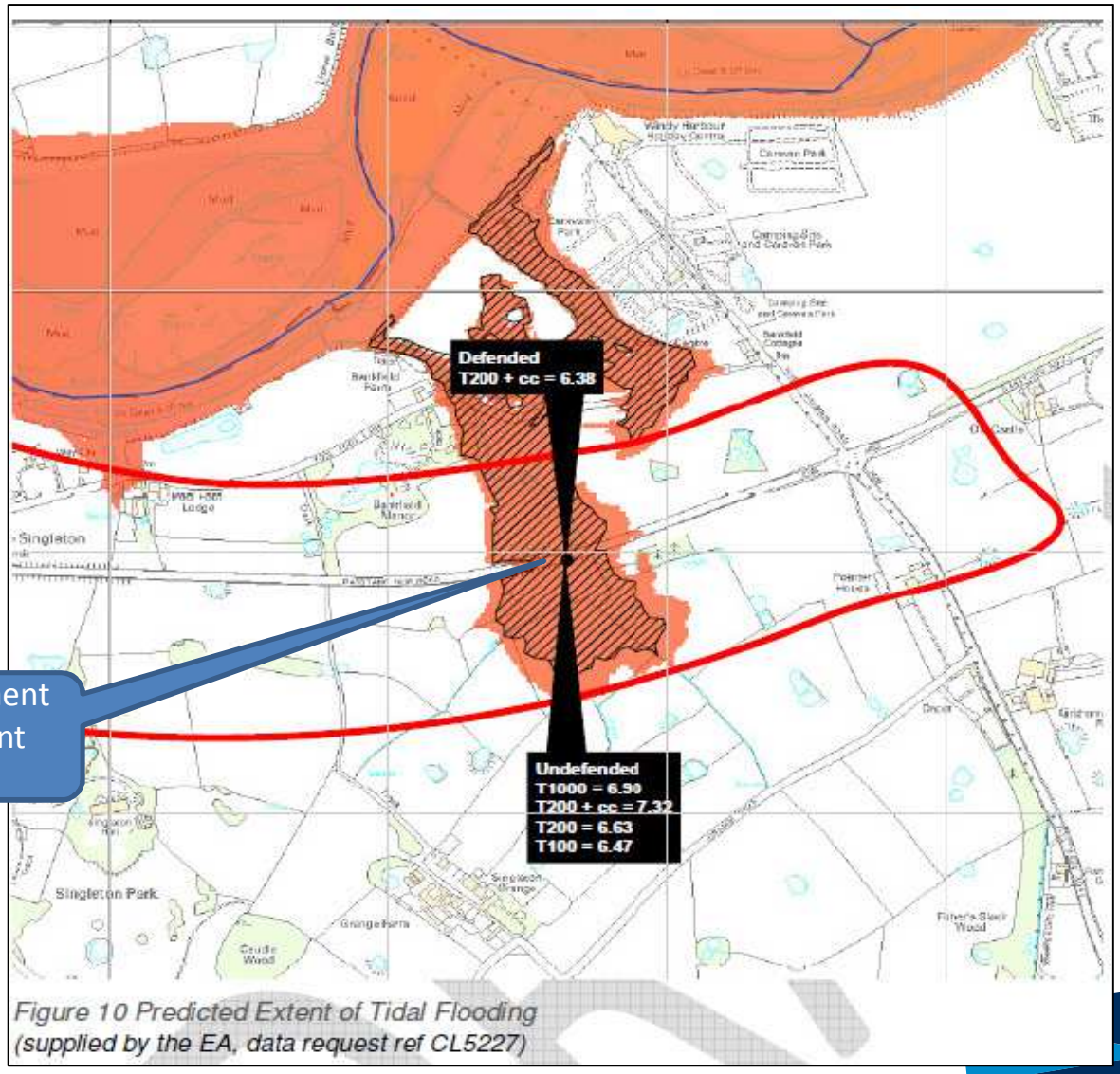


Figure 10 Predicted Extent of Tidal Flooding
(supplied by the EA, data request ref CL5227)

highways england

Existing Drainage - Data

- Limited drainage information available;
- HADMMS data used for Skippool Junction;
- As-built data used for Windy Harbour Junction;
- Limited CCTV data available for Windy Harbour and Skippool Junctions only; and
- Gap analysis plans and specification have been produced to allow CCTV asset and condition surveys to be undertaken.

Existing Drainage – System / Catchments

- There are currently 13no. existing drainage catchments;
- Existing highway drainage predominantly consists of gullies discharging to carrier drainage systems which outfall direct to ditches or watercourses; and
- There are currently no attenuation or pollution control measures; except for the recently updated Windy Harbour junction where CDK and oversized pipes with a penstock have been provided for spillage containment.

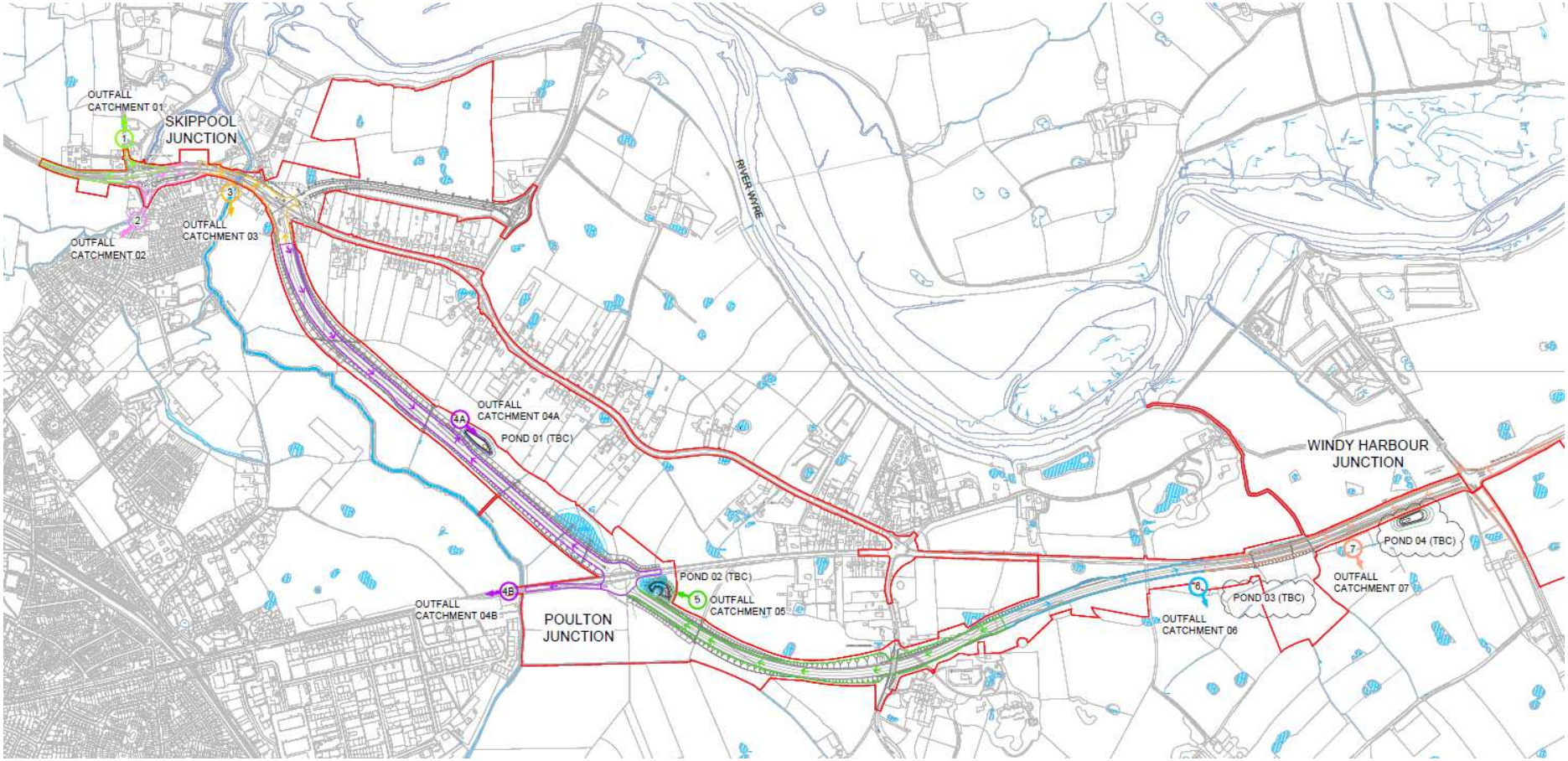


highways england

Proposed Drainage – Strategy

- Maintain existing drainage outfalls at tie-in locations and discharge rates;
- Separate filter drain system in Lodge Lane cutting to deal with groundwater;
- Pre-earthworks ditches and filter drains;
- No bridge deck drainage required at Skippool Bridge and Lodge Lane;
- 20% climate change allowance incorporated into the design < 2085 (table 5 of NPPF);
- Designed for maintenance;
- 5no. new 1.5m diameter culverts; and
- 2no. Existing 0.9m diameter culverts to be extended.
- HAWRAT assessment to dictate vortex separators

Proposed Drainage - Catchments



- 7No. Catchments on the mainline; and
- 9No. Catchments if Shard Link road is included.

highways england

Proposed Drainage - Catchments

Catchment 1 and 2 :

- Maintain existing outfall to Horsebridge Dyke culvert and flow rate – oversized pipes with orifice flow control / penstock and vortex oil and grit separator.



highways england

Proposed Drainage - Catchments

Catchment 3 and 5b:

- Replacement connection to Main Dyke – oversized pipes with orifice flow control / penstock and vortex oil and grit separator.



highways england

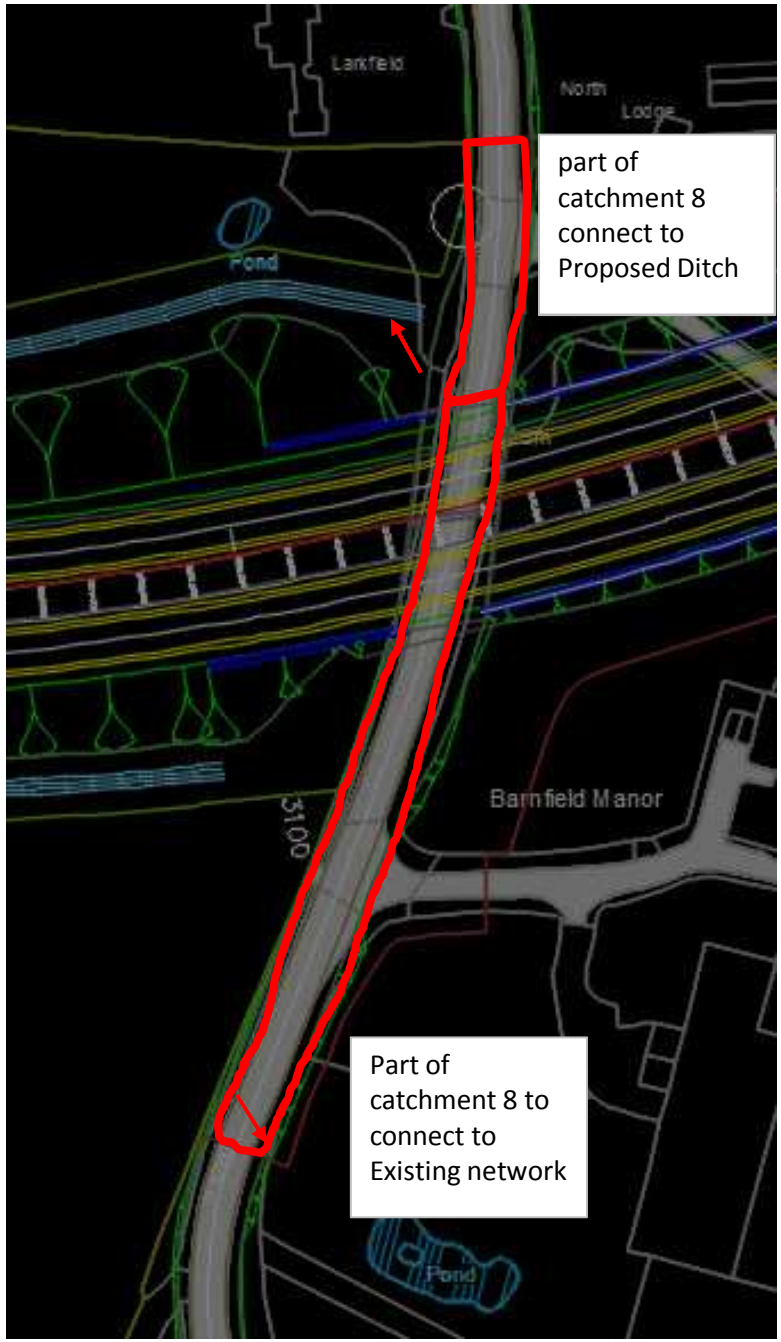
Proposed Drainage - Catchments

Catchment 4 to 7 :

- Proposed storm water drainage to discharge to existing / proposed ditches which discharge to Main Dyke – wetlands with vortex oil and grit separators.



highways england



Proposed Drainage - Catchments

Catchment 8:

- Connection to proposed ditch and existing Network (subject to verification following CCTV asset and condition survey)

highways england

Proposed Drainage - Catchments



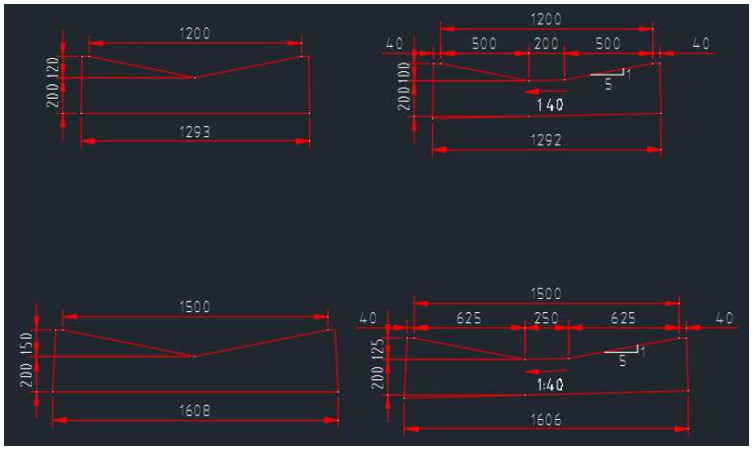
Catchment 9:

- Part of the proposed catchment will discharge to a proposed Wetland and the other part to an exiting network (subject to CCTV asset and condition survey)

highways england

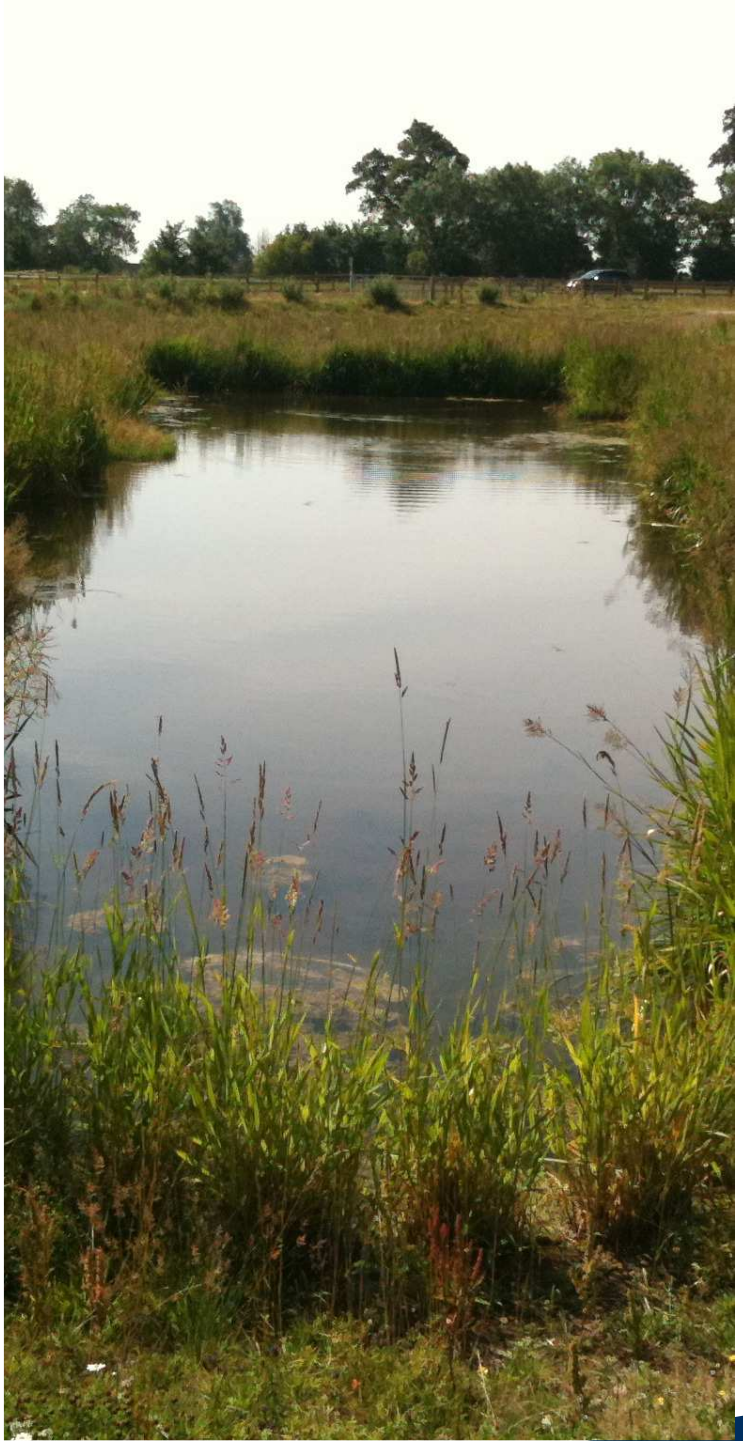
Proposed Drainage – Systems to be used

- Verge drainage to be SWC / filter drains;
- Central reserve drainage to be SWC with a separate filter drain within the large width areas;
- Junctions to be either gullies or combined kerb and drainage units; and
- SWC to be triangular (1.2m in the verge and 1.5m for central reserves).



SWC typical sections

highways england



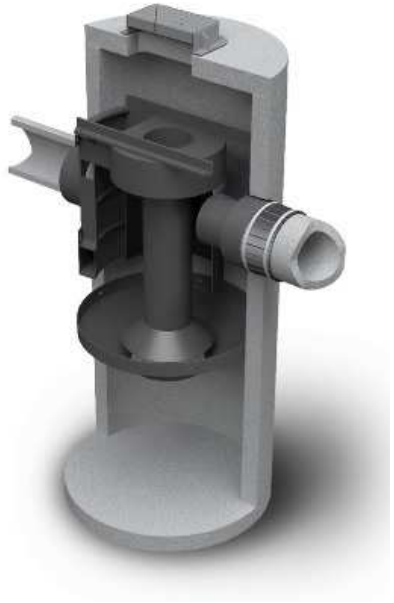
Proposed Drainage – Attenuation / Water Quality

- Oversized pipes designed to accommodate the 1 in 5 years storm return period and discharge restricted to existing discharge rates (1 in 5 year flow rates).
- Wetlands designed to accommodate 1 in 100 year storm event with a 20% allowance for climate change, discharge restricted to greenfield run-off rates.
- Wetlands located in flood zones protected against the 1 in 100 year fluvial flood level (300mm free board); and
- Wetland maintenance access provided off network (where possible).

highways england

Proposed Drainage – Flow control / Spillage containment

- Flow control – orifice plates;
- Pollution control values – penstocks; and
- Sediment and oil removal – vortex separators.







highways england

Proposed Drainage - Departures

- Surcharging of the drainage networks during 1 in 1 year storm events.
- Increased spacing for man access chambers from a maximum of 100m to 150m; and
- Increase the diameter of a Type 7 catch-pit from 1050m diameter to accommodate larger pipes;

A585 Skippool to Windy Harbour Improvement Scheme – Drainage O.D Scheme Introduction Presentation

16th November 2017/ 10:30am

Falcon House, Ground Floor (Unit 1), Fulwood Park, Caxton Road, Fulwood, Preston, PR2 9NZ - Room: Peregrine

Attendees:

[redacted] – Arcadis Consulting – Drainage Lead
[redacted] – Arcadis Consulting – Drainage Senior Engineer
[redacted] – Highways England – O.D Department
[redacted] – Highways England – O.D Department

Apologies:

[redacted] – Arcadis Consulting – Project Manager
[redacted] – Highways England – O.D Department
[redacted] – Highway England – Scheme Project Manager

Item no.	Notes/actions	Action owner
1	**Introduction**	-
1.1	AC stated that the purpose of the meeting was to introduce the A585 Skippool to Windy Harbour Improvement Scheme and discuss the existing water environment, existing highway drainage and our proposed drainage strategy.	-
1.2	AC stated that do this he had produced a presentation (document number: HE548643-ARC-GEN-A585-PR-ZM-3000). The presentation will cover the following agenda: 1. Location overview; 2. Existing road network and the main constraints; 3. Existing A585 issues; 4. Scheme objectives; 5. Summary of options; 6. Proposed route; 7. Existing overland flow catchments; 8. Existing drainage; 9. Proposed drainage strategy; 10. Proposed drainage and catchments; and 11. Proposed Departures.	-
2	**Agenda items 1 to 6**	
2.1	AC gave a brief introduction to the scheme explaining that the Preferred Route Announcement (PRA) had been issued on 24th October 2017 and the preliminary design (Stage 3) for the scheme was being developed to set the red line boundary ready for the Development Control Order (DCO).	-
2.2	AC stated that Option 1b (Southern offline bypass) was being taken forward as per the PRA.	
3	**Agenda item 7 - Existing overland flow catchments**	
3.1	AC stated that there are 4no. Main Rivers within the scheme extents, these being the River Wyre, Horsebridge Dyke, Main Dyke and Pool Foot Creek.	-
3.2	AC stated that a Flood Risk Assessment was being produced and discussions had been held with the Environment Agency with regards the effect of the proposed embankment on the fluvial and tidal flood zones.	-
3.4	AC explained that 5no. new 1.5m diameter culverts would be required along the offline bypass and the extension of 2no. existing 900mm diameter culverts to accommodate the dualling of the existing carriageway at Windy Harbour Junction.	-
3.5	BS asked if the culvert size was based on the hydraulic capacity required	-
3.6	AC stated that the DMRB (HA107) states that all culverts under the carriageway greater than 12m long need to be a minimum of 1.2m in diameter. However, as the culverts need to accommodate	-

	mammal shelves the diameter has been increased to 1.5m diameter. The increase in size also helps with future inspections and maintenance.	
3.7	DW asked if the culverts were included in the FRA and what their effect was on the tidal flooding.	-
3.8	AC stated that the culverts and proposed wetlands were included in both the fluvial and tidal models.	-
3.9	DW enquired about the effect this had on the fluvial and tidal flood water levels.	-
3.10	AC stated that as part of the scheme the existing Skippool Bridge was going to be replaced and 2no. structures constructed. The new structures would be larger clear span structures (bridge / box culverts) which actually reduced the flood water levels, even though the new embankment took up floodplain storage. AC stated that this will all form part of the FRA.	-
3.11	Agenda item 8 – Existing drainage	-
3.12	AC explained that there was limited existing drainage data available and gap analysis plans had been created along with an CCTV asset and condition survey specification to allow asset data to be gathered to confirm our current design.	-
3.13	AC explained that the existing drainage networks along the existing A585 utilised kerb and gullies, which discharge via carrier drains to the ditches and ultimately the watercourses.	-
3.14	BS asked what would happen to the existing A585 when are scheme is complete.	
3.15	AC stated that the existing A585 would be de-trunked and given to Lancashire County Council (LCC).	-
3.16	DW asked if the existing drainage on the de-trucked section was in good condition.	-
3.17	AC stated that we have limited information and the gap analysis included the de-trunked section. AC stated that the team was aware that LCC may ask for defects to be repaired prior to them accepting ownership.	-
3.18	BS stated that Area 13 had undertaken some drainage works / CCTV surveys along the existing A585 and he will forward this data.	-
3.19	BS stated that a lot of the existing properties along the existing A585 discharged their foul / surface water drainage to septic tanks. United Utilities (UU) have just undertaken a scheme to separate the foul and storm water and have built a new sewer line and pumping station.	--
3.20	AC stated that we had statutory undertakers plant information on our drawings, but if BS had plans he could share with us that showed the constructed route that would be great. **Post Minute Note:** BS has attempted to make contact with UU but all telephone numbers are not in use. He will try to email PM to see if she is still with UU.	BS
3.21	AC stated that apart from the Windy Harbour Junction improvement works where an oversized pipe and penstock value had been installed, the remainder of the existing drainage catchments current have no form of attenuation, water quality treatment or accidental spillage control.	-
4	**Agenda items 9 & 10 – Proposed drainage strategy and catchments**	
4.1	AC stated that all existing drainage catchments had been hydraulically modelled based on eth 1 in 1, 5 and 100 year return periods, and where we planned to re-use existing outfalls the existing 1 in 5 year discharge rate would be maintained.	-
4.2	DW asked if climate change would be included in the proposed design.	-
4.3	AC stated that the existing hydraulic modelling did not include an allowance for climate change, but confirmed that a 20% climate change allowance would be included to proposed drainage networks as per HD33. A 40% sensitivity check would also be undertaken.	-
4.4	AC stated that pre-earthworks ditches and filter drains would be used to drainage third party run-off and these would be kept separate from the surface water drainage systems.	-
4.5	AC stated that a separate filter drain system would be incorporated in the mainline verges and central reserve at lodge lane cutting to accommodate the potential high groundwater flows. AC stated that we have no Ground Investigate (GI) data at the moment, but the geology in the area suggest that groundwater flows could be high, so the design has progressed on a worst-case basis.	-
4.6	BS asked when the survey would be undertaken and if the design would be reviewed	-
4.7	AC stated that as the scheme was only at stage 3, once the survey had been undertaken in Feb/March 2018, the design could be updated accordingly.	AC
4.8	AC stated that at the junctions / tie in locations kerb and gullies or combined kerb and drainage units (CDKU) had been used. On the mainline bypass concrete triangular Surface Water Channel SWC) had been adopted (1.28m wide in the verge and 1.58m wide in the central reserve).	-

4.9	BS understood that the standards propose the use of SWC, but in this personnel opinion, they do require a lot of maintenance.	-
4.10	AC stated that the drainage design was based on providing the most efficient / safe solution which required the minimum amount of maintenance.	-
4.11	AC stated that trapezoidal channels have a greater hydraulic capacity, but are harder to maintain as they required greater passes with the road sweeper to clean, which had health and safety implications for the operatives. So, the scheme has adopted triangular channels.	-
4.12	AC stated that the scheme had 7no. catchments which would increase to 9no. catchments if Shard Link Road was included in the scheme.	-
4.13	AC stated that catchments 1,2 and 3 utilised existing outfalls and would be drained via kerb and gullies or combined kerb and drainage units (CDKU). These would discharge through carrier drains and oversized pipe would be used for attenuation with a penstock and orifice plate for spillage containment and flow control. A vortex grit separator has been installed upstream of the attenuation pipe to remove sediment. However, the need for the separators would be reviewed once the HAWRAT assessment had been undertaken. If the assessments show they are not required, then they will be removed. The new bridges have a 1m hard strip and due to the cross fall and longitudinal fall no bridge deck drainage is required. Gullies will be provided upstream and downstream of the bridge.	-
4.14	BS requested a copy of the HAWRAT assessment, so his team could review, as there may be some localised issues that may need to be addressed.	AC
4.15	AC stated that catchment 4 to 7 used SWC which discharges to a carrier system, prior to discharge to a wetland which will provide water quality treatment and accidental spillage containment. The wetland forebay has been replaced with a vortex grit separate to capture sediment and floatables as they have a smaller footprint and are easier to clean.	-
4.16	BS stated that he had seen them on the network, but wasn't sure if the workforce had been trained to use them.	-
4.17	AC stated that on another scheme he designed, training had been incorporated in the 500 series specification and he can do this in the draft preliminary design specification.	-
4.18	BS stated that we need to review the offline bypass against the UU drawings he can provide to make sure that we do not damage the existing A585 drainage outfalls that discharge into Main Dyke.	-
4.19	BS to provide drawings following receipt of the minutes of the meeting. **Post Minute Note:** BS has attempted to make contact with UU but all telephone numbers are not in use. He will try to email PM to see if she is still with UU.	BS
4.20	AC to review UU drawing and update the design as required.	-
4.21	AC stated that catchment 8 covered existing Lodge lane which will now be on a bridge over the mainline. No drainage is required on the bridge. The small catchment upstream of the bridge will be connected into the pre-earthworks ditch. The catchment downstream of the bridge will connect into the existing drainage system following verification by CCTV asset and condition survey. Lodge lane is a local authority road and discussion are to be held with LCC.	-
4.22	AC stated that catchment 9 covers Shard Link Road which is drained by a SWC discharging to a wetland. There is still debate if this link road will be included in the scheme. **Post Minute Note:** Shard Link Road has been removed from the scheme following a written instruction from Highways England (17/11/2017)	-
4.23	AC confirmed that: ▪ Oversized pipes are designed to accommodate the 1 in 5 years storm return period with the discharge restricted to existing discharge rates (1 in 5 year flow rates); ▪ Wetlands had been designed to accommodate 1 in 100 year storm event with a 20% allowance for climate change with the discharge restricted to greenfield run-off rates; ▪ Wetlands located in flood zones protected against the 1 in 100 year fluvial flood level (300mm free board); and ▪ Wetland maintenance access provided off network (where possible).	-

5	**Agenda Item 11 – Proposed departures**	
5.1	1.1 AC stated that 3no. drainage departures will be applied for on the scheme, these being: ▪ Surcharging of the drainage networks during 1 in 1 year storm events; ▪ Increased spacing for man access chambers from a maximum of 100m to 150m. ▪ Increase the diameter of a Type 7 catch-pit from 1050m diameter to accommodate larger pipes; and ▪ Use of draft standard for vortex grit separators.	-
5.2	AC stated that concluded the presentation and asked DW if he had any concerns.	-
5.3	DW confirmed that in principal he had no issue with the proposed drainage works as described in the presentation.	-
5.4	AC asked if DW could provide contact details for Lancashire County Council as he had tried to get hold of them via their website but had received a reply.	-
5.5	DW stated that the Lancashire County Council Network Manager was Danie[redacted] and his contact detail are: ▪ [redacted] ▪ [redacted] ▪ [redacted]	-
5.6	DW stated that we could also contact Paul Binks, but he didn't have any contact details for him	-

Alan Cope

From: Alan [redacted]
Sent: 23 November 2017 13:26
To: NWNorthPlanning
Subject: RE: F.A.O Alex [redacted] - A585 Windy Harbour to Skippool Improvement Scheme

Hi Alex,

Thank you for your email.

See me response below in Orange.

In summary

- Our design is in accordance with the DMRB and current best practice (C753);
- Catchment 4 wetland is located within flood zone 3 and will form part of the Flood Risk Assessment works being undertaken by Lisa [redacted] / Claire [redacted] which will be issued in due course; and
- Permits will be issued at detailed design stage (currently at preliminary design) for new outfalls to the Main Rivers.

Regards

Alan

From: NWNorthPlanning [redacted]
Sent: 07 November 2017 11:12
To: Alan [redacted]
Subject: RE: F.A.O Alex [redacted] - A585 Windy Harbour to Skippool Improvement Scheme

Good morning Alan,

Further to my previous emails, we do not have the expertise to provide detailed advice on sustainable drainage systems (SUDS) noted, and commenting on a detailed surface water drainage scheme is not within our remit anymore noted. However, in addition to surface water management SUDS should incorporate pollution control elements to prevent a detrimental impact on local water quality and the Wyre Estuary. We also recommend that green infrastructure opportunities in managing water resources, reducing flood risk, encouraging biodiversity and adapting to climate change, are maximised along the proposed route to provide multiple benefits to the local environment, economy and society.

We recommend you refer to latest Volume 4 of the Design Manual for Roads and Bridges (DMRB) guidance which was updated in August 2017 is available at http://www.standardsforhighways.co.uk/ha/standards/dmrb/index.htm. This replaces the withdrawn guidance which is available on GOV.UK: https://www.gov.uk/guidance/standards-for-highways-online-resources. The guidance contains detail on the treatment efficiencies of a variety of treatment devices.

We also recommend the CIRIA C753 document SUDS manual also provides guidance provides best practice guidance on the planning, design, construction, operation and maintenance of sustainable drainage systems. This, along with other guidance, is available via the Susdrain website: http://www.susdrain.org/resources/ciria-guidance.html

I can confirm that our design is in accordance with the DMRB and our SUDS systems are designed to HA and incorporate best practice from CIRIA C753.

The plan you forwarded to us shows indicative locations for surface water attenuation ponds. It should be taken into consideration that if these ponds are located in Flood Zone 3 they will not operate correctly if they are already flooded from fluvial and/or tidal sources, and are needed to attenuate surface water run-off. We therefore recommend that any attenuation ponds currently within Flood Zone 3 are re-located along the highway to areas in Flood Zone 1. The wetland in Flood Zone 3 is set above the 1 in 100 year fluvial flood level as agreed with Highway England. The wetland is included in the fluvial and todal flooding modelling which will be issued as part of the flood risk assessment for the scheme.

Please note that the Flood Defence Consent regime has moved into the Environmental Permitting Regulations, as of 6 April 2016. An Environmental Permit may be required and in particular, no trees or shrubs may be planted, nor fences, buildings, pipelines (including outfalls) or any other structure erected within 8 metres of any non-tidal Main River watercourses without an Environmental Permit. You should refer to the GOV.UK website for further information: https://www.gov.uk/guidance/flood-risk-activities-environmental-permits. Our Flood and Coastal Risk Management team may be able to provide advice in relation to any forthcoming permit application. Noted, we are proposing new outfalls into Main Dyke and I will submit the relevant permit. Any works to Ordinary Watercourses may require the consent of the Lead Local Flood Authority. Noted, and I have arranged a meeting with the LLFA to discuss this works.

Our Billing team have informed me that if our planning advice is required via our charged-for service for any other issues within our remit, we are able to re-open the agreement initially set up with Lisa Driscoll, i.e. agreement number ENVPAC/CMBLNC/00088. Unfortunately, due to resourcing issues we are unable to attend any meetings or provide written comments on detailed plans and documents via our charged planning advice service at this current time. Noted.

I trust the above is of assistance to you. Thanks

Best regards,

Alex

[redacted]

Lutra House, Dodd Way, Off Seedlee Road, Walton Summit, Bamber Bridge, Preston PR5 8BX
020 302 51215
[redacted]

Working in partnership to enable sustainable growth and create better places for people and wildlife

Follow us on Twitter @EnvAgencyNW
Visit the website - https://www.gov.uk/environment-agency
Visit our blog - https://environmentagency.blog.gov.uk/



From: Alan [redacted]
Sent: 01 November 2017 16:24
To: NWNorthPlanning [redacted]
Subject: RE: F.A.O Alex [redacted] - A585 Windy Harbour to Skippool Improvement Scheme

Hi Alex,

Thanks for the email and LLFA information.

I look forward to hearing from you.

Regards

Alan

From: NWNorthPlanning [redacted]
Sent: 01 November 2017 16:23
To: Alan [redacted]
Subject: RE: F.A.O Alex [redacted] - A585 Windy Harbour to Skippool Improvement Scheme

Hello Alan,

I will check with our functional teams regarding your points.

The Lead Local Flood Authority is Lancashire County Council, their email address is [redacted]. Further information is on their website: http://www.lancashire.gov.uk/council/planning/sustainable-drainage-systems.aspx.

In relation to point 4, ordinary watercourses are under the remit of the LLFA: http://www.lancashire.gov.uk/flooding/drains-and-sewers/alterations-to-a-watercourse.aspx.

Best regards,

Alex

[redacted]
[redacted]
[redacted]

Lutra House, Dodd Way, Off Seedlee Road, Walton Summit, Bamber Bridge, Preston PR5 8BX
020 302 51215
CLPlanning@environment-agency.gov.uk

Working in partnership to enable sustainable growth and create better places for people and wildlife

Follow us on Twitter @EnvAgencyNW
Visit the website - https://www.gov.uk/environment-agency
Visit our blog - https://environmentagency.blog.gov.uk/



From: Alan [redacted]
Sent: 31 October 2017 20:19
To: NWNorthPlanning [redacted]
Subject: RE: F.A.O Alex [redacted] - A585 Windy Harbour to Skippool Improvement Scheme

Hi Alex,

Thank you for coming back to me.

As part of the drainage design for the scheme we plan to introduce:

1. New drainage outfalls to the watercourses (re-use of existing outfalls to main river and others to ordinary watercourses);
2. New SuDs systems upstream of the outfalls to deal with water quality and attenuation;
3. Pollution control measures; and
4. New culverts to ordinary watercourses.

Do you have contact details for the Local Lead Flood Authority?

Regards

Alan

From: NWNorthPlanning [redacted]
Sent: 31 October 2017 16:59
To: Alan [redacted]
Subject: RE: F.A.O Alex [redacted] - A585 Windy Harbour to Skippool Improvement Scheme

Hello Alan,

Thank you for your email.

Our attendance at a meeting would fall under our voluntary charged planning advice service which allows us to recover our costs. Please can you expand on what you are seeking our advice on in relation to the drainage scheme, as we no longer have the remit for surface water issues in relation to developments exceeding 1 hectare. This is now under the remit of the Lead Local Flood Authority.

Please note that we may have an existing charging agreement in place under reference ENVPAC/CMBLNC/00088, but I will have to check with our Billing team if it is still open. We provided our free preliminary opinion response (attached) to Lisa [redacted], and in April 2017 we responded to a request from Lisa to review a Flood Risk Assessment.

Any request for further planning advice should be submitted to [redacted] Your request should specify the additional services that you require from us. We will review your request and provide you with a written offer based on our planning advice charges of £84 per person per hour. We will not undertake any additional work until an offer has been accepted.

Please be aware that our charged advice service is voluntary and that we may be unable to provide charged advice where other operational activities and issues prevent us from doing so.

Best regards,

Alex

[redacted]

Lutra House, Dodd Way, Off Seedlee Road, Walton Summit, Bamber Bridge, Preston PR5 8BX
020 302 51215
CLPlanning@environment-agency.gov.uk

Working in partnership to enable sustainable growth and create better places for people and wildlife

Follow us on Twitter @EnvAgencyNW
Visit the website - https://www.gov.uk/environment-agency
Visit our blog - https://environmentagency.blog.gov.uk/

DO YOU KNOW WHAT TO DO? FLOODS DESTROY BE PREPARED

From: Alan [redacted]
Sent: 31 October 2017 14:47
To: NWNorthPlanning [redacted]
Cc: A[redacted] David [redacted] Lina [redacted]>; Nick [redacted]
Subject: F.A.O Alex [redacted] - A585 Windy Harbour to Skippool Improvement Scheme

Hi Alex,

Good to speak to you earlier today.

As discussed, my colleague Claire [redacted] has been in discussions with Pippa [redacted] with regards the Flood Risk Assessment for the scheme and has given me your contact details. I'm responsible for the surface water drainage strategy for the scheme, and I would like to give you a presentation to allow you to provide any comments that you might have.

I attach a draft plan which shows the scheme extents and drainage catchments.

Can you please confirm a date, time and location when you are available.

Regards

[redacted]

www.arcadis.com

ARCADIS Design & Consultancy for natural and built assets

Be green, leave it on the screen.

Arcadis Consulting (UK) Limited is a private limited company registered in England & Wales (registered number 02212959). Registered office at Arcadis House, 34 York Way, London, N1 9AB. Part of the Arcadis Group of Companies along with other entities in the UK.

This email and any files transmitted with it are the property of Arcadis and its affiliates. All rights, including without limitation copyright, are reserved. This email contains information that may be confidential and may also be privileged. It is for the exclusive use of the intended recipient(s). If you are not an intended recipient, please note that any form of distribution, copying or use of this communication or the information in it is strictly prohibited and may be unlawful. If you have received this communication in error, please return it to the sender and then delete the email and destroy any copies of it. While reasonable precautions have been taken to ensure that no software or viruses are present in our emails, we cannot guarantee that this email or any attachment is virus free or has not been intercepted or changed. Any opinions or other information in this email that do not relate to the official business of Arcadis are neither given nor endorsed by it.

This message has been scanned and no issues were discovered.
Click here to report this email as spam

Information in this message may be confidential and may be legally privileged. If you have received this message by mistake, please notify the sender immediately, delete it and do not copy it to anyone else.

We have checked this email and its attachments for viruses. But you should still check any attachment before opening it.
We may have to make this message and any reply to it public if asked to under the Freedom of Information Act, Data Protection Act or for litigation. Email messages and attachments sent to or from any Environment Agency address may also be accessed by someone other than the sender or recipient, for business purposes.
Click here to report this email as spam

This email and any files transmitted with it are the property of Arcadis and its affiliates. All rights, including without limitation copyright, are reserved. This email contains information that may be confidential and may also be privileged. It is for the exclusive use of the intended recipient(s). If you are not an intended recipient, please note that any form of distribution, copying or use of this communication or the information in it is strictly prohibited and may be unlawful. If you have received this communication in error, please return it to the sender and then delete the email and destroy any copies of it. While reasonable precautions have been taken to ensure that no software or viruses are present in our emails, we cannot guarantee that this email or any attachment is virus free or has not been intercepted or changed. Any opinions or other information in this email that do not relate to the official business of Arcadis are neither given nor endorsed by it.

This message has been scanned and no issues were discovered.
Click here to report this email as spam

Information in this message may be confidential and may be legally privileged. If you have received this message by mistake, please notify the sender immediately, delete it and do not copy it to anyone else.

We have checked this email and its attachments for viruses. But you should still check any attachment before opening it.
We may have to make this message and any reply to it public if asked to under the Freedom of Information Act, Data Protection Act or for litigation. Email messages and attachments sent to or from any Environment Agency address may also be accessed by someone other than the sender or recipient, for business purposes.
Click here to report this email as spam

This email and any files transmitted with it are the property of Arcadis and its affiliates. All rights, including without limitation copyright, are reserved. This email contains information that may be confidential and may also be privileged. It is for the exclusive use of the intended recipient(s). If you are not an intended recipient, please note that any form of distribution, copying or use of this communication or the information in it is strictly prohibited and may be unlawful. If you have received this communication in error, please return it to the sender and then delete the email and destroy any copies of it. While reasonable precautions have been taken to ensure that no software or viruses are present in our emails, we cannot guarantee that this email or any attachment is virus free or has not been intercepted or changed. Any opinions or other information in this email that do not relate to the official business of Arcadis are neither given nor endorsed by it.

This message has been scanned and no issues were discovered.
Click here to report this email as spam

Information in this message may be confidential and may be legally privileged. If you have received this message by mistake, please notify the sender immediately, delete it and do not copy it to anyone else.

We have checked this email and its attachments for viruses. But you should still check any attachment before opening it.
We may have to make this message and any reply to it public if asked to under the Freedom of Information Act, Data Protection Act or for litigation. Email messages and attachments sent to or from any Environment Agency address may also be accessed by someone other than the sender or recipient, for business purposes.
Click here to report this email as spam

A585 Skippool to Windy Harbour Improvement Scheme – Lancashire County Council – Drainage Scheme Introduction Presentation

20th March 2018/ 13:00

Lancashire County Council Highways offices, Cuerden Way, Bamber Bridge, Preston PR5 6BS.

Attendees:

[redacted] – Arcadis Consulting – Drainage Lead
[redacted] – Arcadis Consulting – Drainage Senior Engineer
[redacted] – Lancashire County Council – Flood Risk Assistant Engineer
[redacted] – Lancashire County Council – Principal Flood Risk Officer
[redacted] – Lancashire County Council – Senior Flood Risk Engineer

Apologies:

None

Item no.	Notes/actions	Action owner
1	**Introduction**	-
1.1	AC stated that the purpose of the meeting was to introduce the A585 Skippool to Windy Harbour Improvement Scheme and discuss the existing water environment, existing highway drainage and our proposed drainage strategy.	-
1.2	AC stated that do this he had produced a presentation (document number: HE548643-ARC-HDG-A585-PP-ZM-3006). The presentation will cover the following agenda: 1. Location overview; 2. Existing road network and the main constraints; 3. Existing A585 issues; 4. Scheme objectives; 5. Summary of options; 6. Proposed route; 7. Existing overland flow catchments; 8. Existing highway drainage; 9. Proposed drainage strategy; 10. Proposed drainage and catchments; and 11. Proposed Departures.	-
2	**Agenda items 1 to 6**	-
2.1	AC gave a brief introduction to the scheme explaining that the Preferred Route Announcement (PRA) had been issued on 24th October 2017 and the preliminary design (Stage 3) for the scheme is being developed to set the red line boundary ready for the Development Control Order (DCO) in June 2018.	-
2.2	AC stated that Option 1b (Southern offline bypass) was being taken forward as per the PRA.	-
3	**Agenda item 7 - Existing overland flow catchments**	-
3.1	AC stated that there are 4no. Main Rivers within the scheme extents, these being the River Wyre, Horsebridge Dyke and Main Dyke **Post Minute Note** Pool Foot Creek is note main river.	-
3.2	AC stated that a Flood Risk Assessment was being produced and discussions had been held with the Environment Agency (EA) with regards the effect of the proposed embankment on the fluvial and tidal flood zones.	-
3.4	AC explained that 5no. new 1.5m diameter culverts would be required along the offline bypass to maintain the existing land ditches. There would also be an extension of 2no. existing 900mm diameter culverts to accommodate the dualling of the existing carriageway at Windy Harbour Junction (subject to a condition survey)..	-
3.5	PB / DT asked if the culvert size was based on the hydraulic capacity required.	-
3.6	AC stated that the DMRB (HA107) states that all culverts under the carriageway greater than 12m long need to be a minimum of 1.2m in diameter. However, as the culverts need to accommodate	-

	mammal shelves the diameter has been increased to 1.5m diameter. The increase in size also helps with future inspections and maintenance.	
3.7	DT asked if the culverts were included in the FRA and what their effect was on the tidal flooding.	-
3.8	AC stated that the culverts and proposed wetlands were included in both the fluvial and tidal models.	-
3.9	DT enquired about the effect this had on the fluvial and tidal flood water levels.	-
3.10	AC stated that as part of the scheme the existing Skippool Bridge was going to be replaced and a replacement two deck bridge structure constructed. The new bridge would be larger clear span structures (bridge / box culverts) which reduced the existing flood water levels, even though the new road embankment took up floodplain storage. AC stated that this will all form part of the FRA analysis.	-
3.11	PB / DT requested a copy of the FRA. AC to provide a copy once it has been issued to EA	AC
3.12	AC stated as the scheme is it the preliminary design stage, he wasn't going to ask for formal Land Drainage Consents (LDC) for the 5no. new culverts and the extension to the 2no. existing culverts. However, he would like to get an agreement in principle to culvert design.	-
3.13	DT stated LDC could take up to 8 weeks for formal approval.	-
3.14	AC requested a copy of the LDC checklist so he can ensure the design complies with their requirements.	DT
3.15	DT / PB stated in principle we agree to your proposals but consent for the permanent works should be applied for, temporary works consent will then be applied for by the appointed contractor at a later date.	-
3.15a	**Post Minute note** AC to discuss with Scheme PM as previous understanding was to include this agreement in principle in the Statement of Common Ground.	AC
4.	**Agenda item 8 – Existing highways drainage**	-
4.1	AC explained that there was limited existing highway drainage data available and gap analysis plans had been created along with an CCTV asset and condition survey specification to allow asset data to be gathered to confirm our current design.	-
4.2	AC explained that the existing drainage networks along the existing A585 utilised kerb and gullies, which discharge via carrier drains to the ditches and ultimately the watercourses.	-
4.3	PB asked what would happen to the existing A585 when are scheme is complete.	
4.4	AC stated that the existing A585 would be de-trunked and given to Lancashire County Council (LCC).	-
4.5	PB asked if the existing drainage on the de-trunked section was in good condition. As their Highway team is unlikely to take it back in poor condition.	-
4.6	AC stated that we have limited information and the gap analysis included the de-trunked section.	-
4.7	AC stated that Area 13 had undertaken some drainage works / CCTV surveys along the existing A585 in 2016, and as the existing drainage could deteriorate further between now and when works starts on site. The existing A585 drainage would not be surveyed until the detailed design stage.	-
4.8	AC stated that the team was aware that LCC may ask for defects to be repaired prior to them accepting ownership.	--
4.9	AC asked if they had any existing drainage information for Lodge Lane?	
4.10	PB stated he would have to ask the highways team as he did not have any carriageway drainage information.	PB
4.11	AC stated that apart from the Windy Harbour Junction improvement works (early scheme) where an oversized pipe and penstock value had been installed, the remainder of the existing drainage catchments currently have no form of attenuation, water quality treatment or accidental spillage control.	-
5	**Agenda items 9 & 10 – Proposed highways drainage strategy and catchments**	-
5.1	AC stated that all existing drainage catchments effected by the works had been hydraulically modelled based on the 1 in 1, 5 and 100 year return periods, and where we planned to re-use existing outfalls the existing 1 in 5 year discharge rate would be maintained.	-
5.2	DT asked if climate change would be included in the proposed design.	-
5.3	AC stated that the existing hydraulic modelling did not include an allowance for climate change but confirmed that a 20% climate change allowance had be included in proposed drainage networks as per HD33. A 40% sensitivity check had also been undertaken.	-

5.4	AC stated that pre-earthworks ditches and filter drains would be used to drain third party run-off and these would be kept separate from the bypass surface water drainage systems.	-
5.5	AC stated that a separate filter drain system would be incorporated in the mainline verges and central reserve at lodge lane cutting to accommodate the potential high groundwater flows. AC stated that we have no Ground Investigate (GI) data at the moment, but the geology in the area suggest that groundwater flows could be high, so the design has progressed on a worst-case basis.	-
5.6	PB asked when the CCTV survey would be undertaken and if the design would be reviewed	-
5.7	AC stated that as the scheme was only at stage 3 (preliminary design), once the survey had been undertaken in April/May 2018, the design could be updated accordingly.	AC
5.8	AC stated that at the junctions / tie in locations kerb and gullies or combined kerb and drainage units (CDKU) had been used. On the mainline bypass concrete triangular Surface Water Channel (SWC) had been adopted (1.28m wide in the verge and 1.58m wide in the central reserve).	-
5.9	PB asked what drainage system(s) has been provided on the Local Authority roads, Lodge lane for example.	-
5.10	AC stated that kerb and gullies had been used on the Local Authority Roads, as he understood that they didn't like combined drainage and kerb units.	-
5.11	PB confirmed that LCC preferred kerb and gullies as combined drainage and kerb units where a maintenance issue.	-
5.12	AC stated that the drainage design was based on providing the most efficient / safe solution which required the minimum amount of maintenance.	-
5.13	AC stated that trapezoidal surface water channels provided along the bypass have a greater hydraulic capacity but are harder to maintain as they required greater passes with the road sweeper to clean, which had health and safety implications for the operatives. So, the scheme has adopted triangular channels.	-
5.14	AC stated that the scheme had 7no. catchments and not 9no. as stated as Shard Link Road had been removed from the scheme.	-
5.15	AC stated that catchments 1,2 and 3 utilised existing outfalls and would be drained via kerb and gullies or combined kerb and drainage units (CKDU's). These would discharge through carrier drains and oversized pipe would be used for attenuation with a penstock and orifice plate for spillage containment and flow control. The new bridges have a 1m hard strip and due to the cross fall and longitudinal fall so no bridge deck drainage is required. Gullies will be provided upstream and downstream of the bridge.	-
5.16	AC stated that vegetative SUD's could not be used in these catchments due to the land constraints adjacent to the carriageway.	-
5.17	AC stated that catchment 4 to 7 used SWC which discharges to a carrier system, prior to discharge to a wetland which will provide water quality treatment and accidental spillage containment. The wetland forebay has been replaced with a vortex grit separate to capture sediment and floatables as they have a smaller footprint and are easier to maintain.	-
5.18	AC stated that catchment 8 covered existing Lodge lane which will now be on a bridge over the bypass. No drainage is required on the bridge. The small catchment upstream (north) of the bridge will be connected into the pre-earthworks ditch. The catchment downstream (south) of the bridge will connect into the existing drainage system following verification by CCTV asset and condition survey. Lodge lane is a local authority road and will be handed back to LCC following the works.	-
5.19	PB / DT asked if the proposed ditch to the north west of Lodge Lane bridge could be widened up to provide some additional treatment. AC to review.	AC / LA
5.20	AC stated that catchment 9 covered Shard Link Road, but Shard Link Road has been removed from the scheme following a written instruction from Highways England.	-
5.21	AC confirmed that: ▪ Oversized pipes are designed to accommodate the 1 in 5 years storm return period with the discharge restricted to existing discharge rates (1 in 5 year flow rates); ▪ Wetlands had been designed to accommodate 1 in 100 year storm event with a 40% allowance for climate change with the discharge restricted to greenfield run-off rates; ▪ Wetland 1 (catchment 4) located in flood zone 3 protected against the 1 in 100 year fluvial flood level (300mm free board); and ▪ Wetland maintenance access provided off network (where possible).	-
5.22	DT asked why the wetland was in flood zone 3 and if it had been included in the FRA.	-

5.23	AC confirmed that the ultimate low point of the road meant that the wetland had to be located with flood zone 3. AC confirmed that the wetland had been included in the FRA.	-
6	**Agenda Item 11 – Proposed departures**	-
6.1	1.1 AC stated that 3no. drainage departures will be applied for on the scheme, these being: ▪ Surcharging of the drainage networks during 1 in 1 year storm events; ▪ Increased spacing for man access chambers from a maximum of 100m to 150m; and ▪ Increase the diameter of a Type 7 catch-pit from 1050m diameter to accommodate larger pipes.	-
6.2	AC stated that concluded the presentation and asked if AG, DT and PB had any concerns with the proposed design.	-
6.3	DT and PB confirmed that in principal they had no issues with the proposed drainage works as described in the presentation.	-
6.4	AC to issue a copy of the Drainage Design Development Report once the preliminary design has been finalised.	AC

A585 WINDY HARBOUR TO SKIPPOOL

STAGE 3 PRELIMINARY DRAINAGE DESIGN

LANCASHIRE COUNTY COUNCIL
DRAINAGE - INTRODUCTION TO THE SCHEME

HE548643-ARC-HDG-A585-PP-ZM-3006_Lancashire County Council - Drainage Introduction

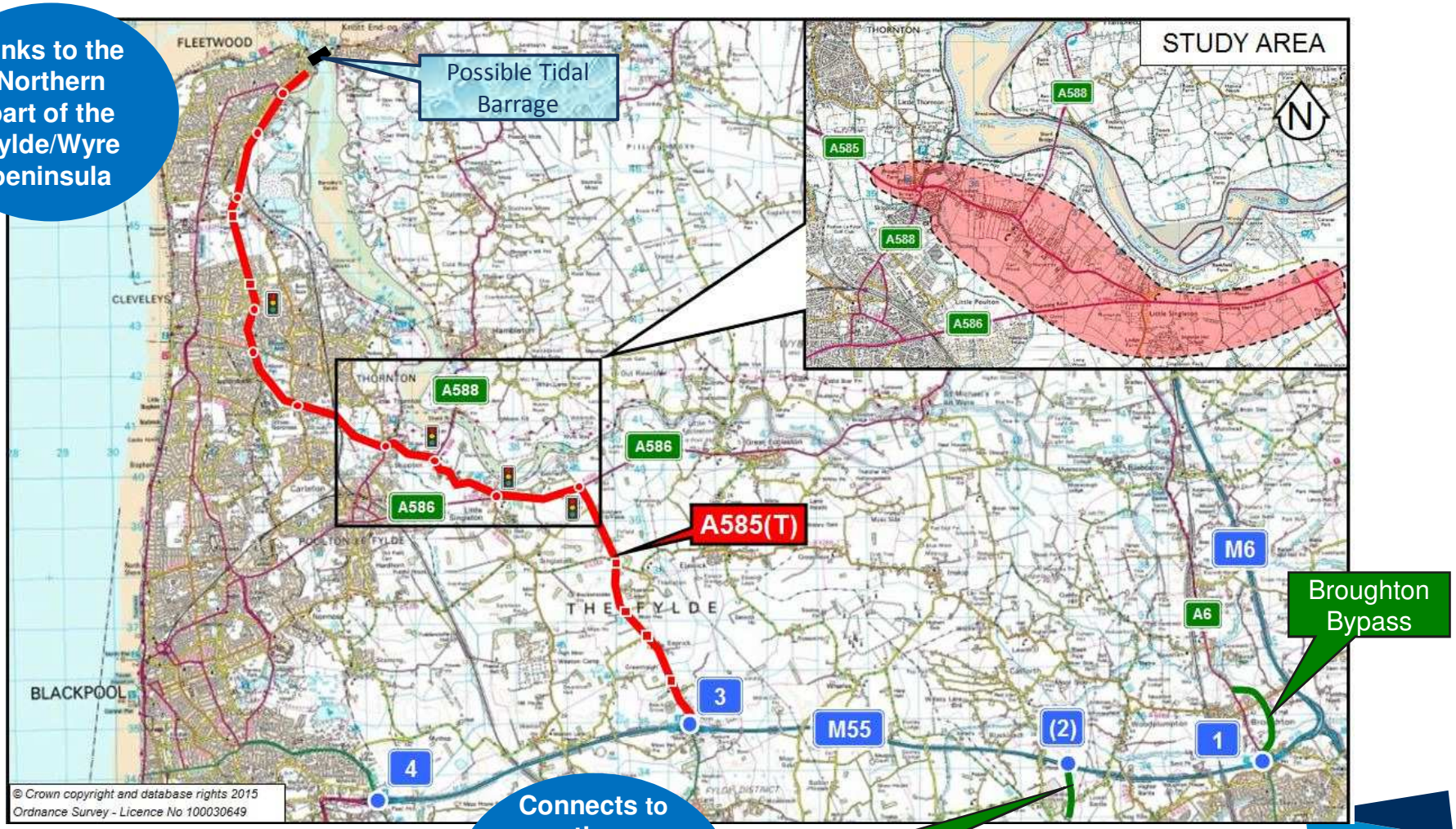
20th MARCH 2018

Presented by: Alan [redacted]

Agenda

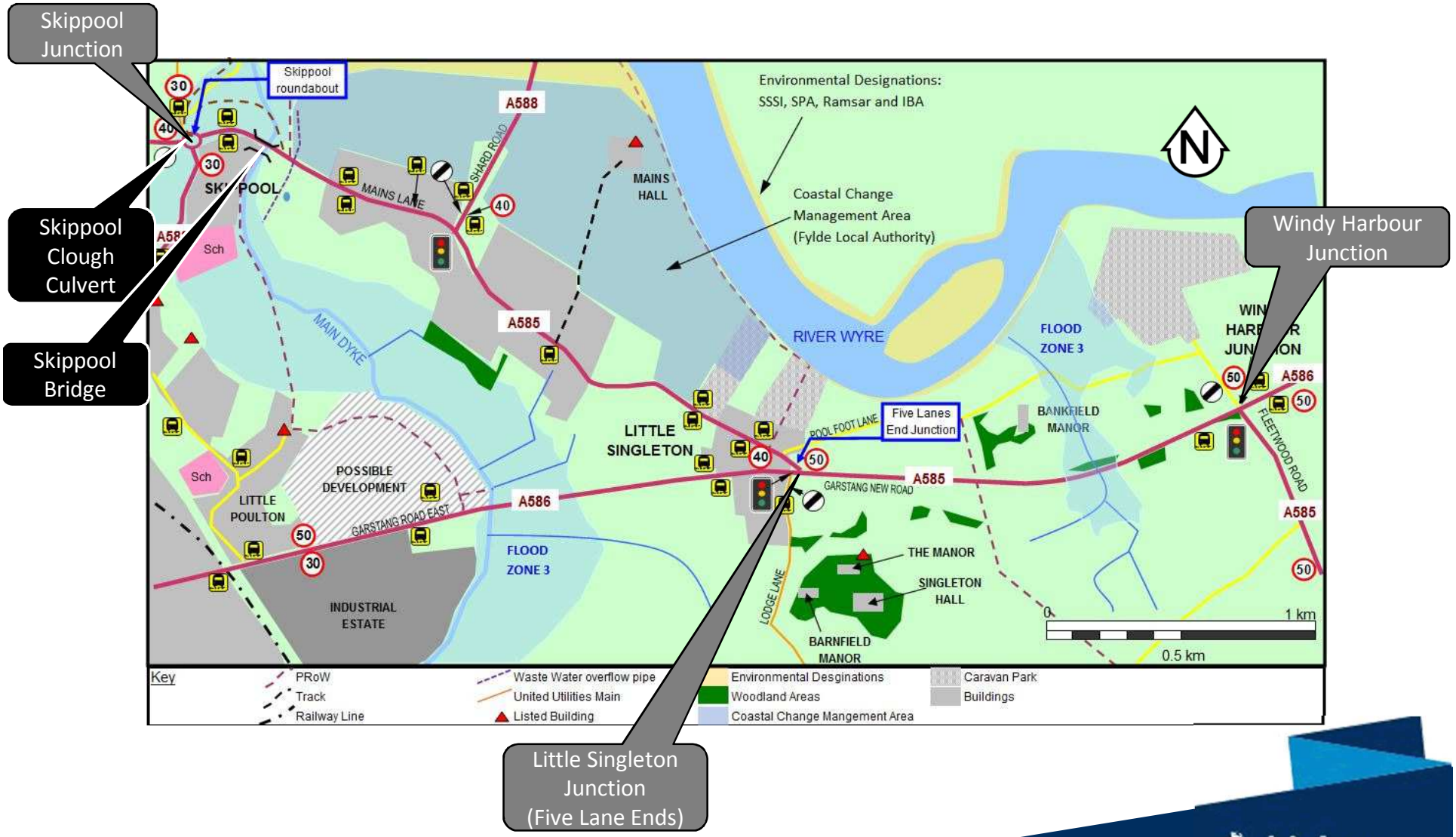
- Location Overview;
- Existing Road Network & Main Constraints;
- Existing A585 Issues;
- Background - existing route;
- Scheme objectives;
- Summary of Options;
- Proposed route;
- Existing overland flow catchments;
- Existing drainage;
- Proposed drainage strategy;
- Proposed drainage and catchments; and
- Proposed departures.

Location Overview



highways england

Existing Road Network & Main Constraints



highways england

Existing A585 Issues



- The Scheme Objective Business Case (SOBC) identifies that the A585 is in the worst 10% of routes in the NW for reliability;
- A585 route is ranked 81st and 202nd on national top 250 for casualty rates;
- A585 was not originally constructed to Highways England standards but now forms part of the trunk road network;
- The South Pennines Route Bases Strategy (RBS) highlighted significant issues for cyclists and vulnerable road users. Including difficulties at junctions, difficulties crossing and navigating the road safely and poor maintenance of facilities for cyclists;
- The route runs close to the southern end of Morecambe Bay Estuary which is designated as SAC, Ramsar, SPA and Nature Improvement Area;
- Northern end of Scheme (including Skippool Bridge) and much of the southern bypass route to A586 Garstang Road East are within flood risk areas; and
- Skippool Bridge may have to be raised significantly (subject to discussion with EA).

Background – Existing Route

- The existing A585 within the Scheme is a 4.5km long single carriageway with 3 main junctions and extensive ribbon development fronting both sides over 3km of its length;



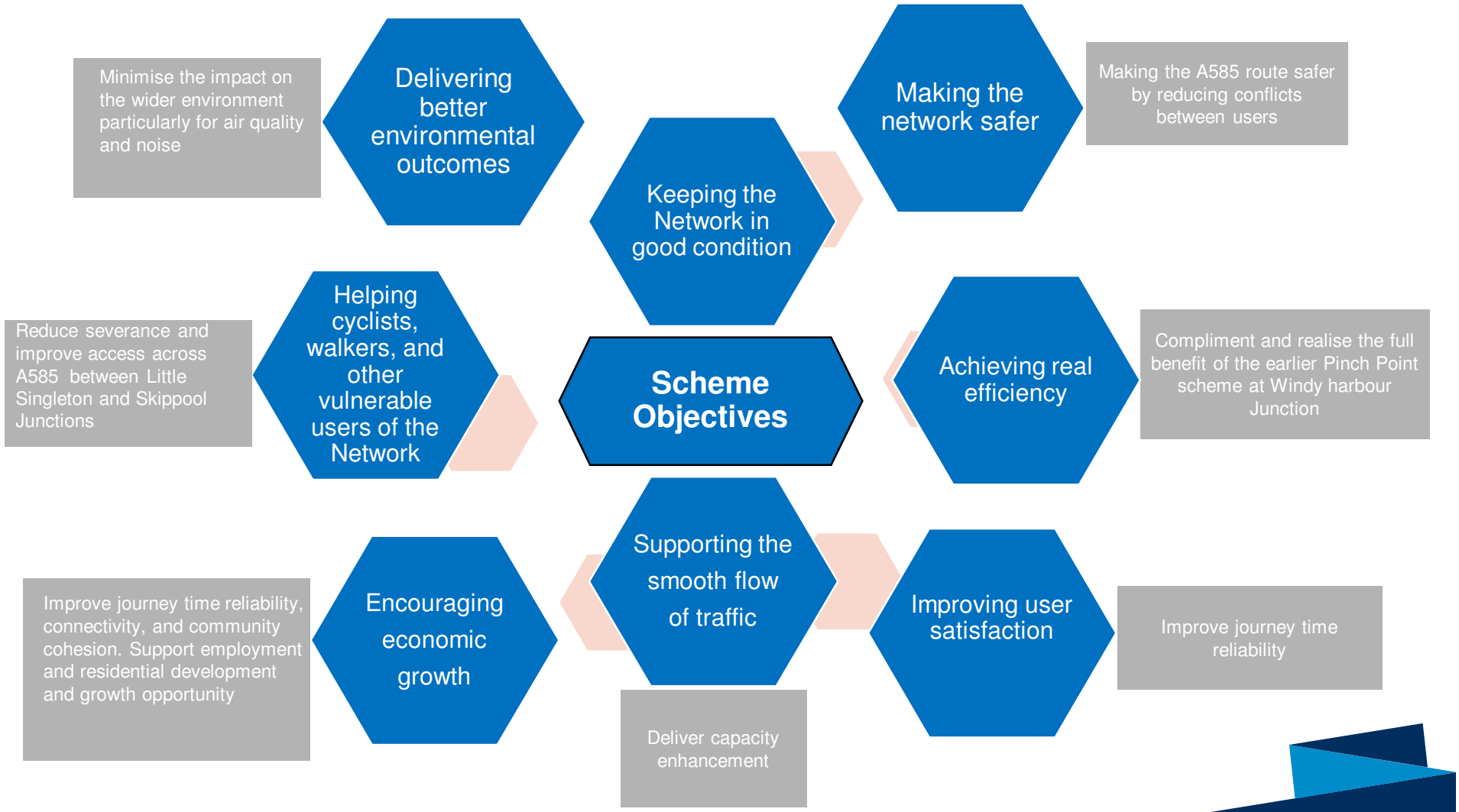
- A585 Mains Lane has more than 130 properties and 3 caravan parks that have direct access to the road;

- It is also used by several bus routes and has a speed limit of 40mph; and

- Skippool bridge, which is over 100 years old (widened in 1920's), would need further widening for dualling and has been fitted with flood containment gates.

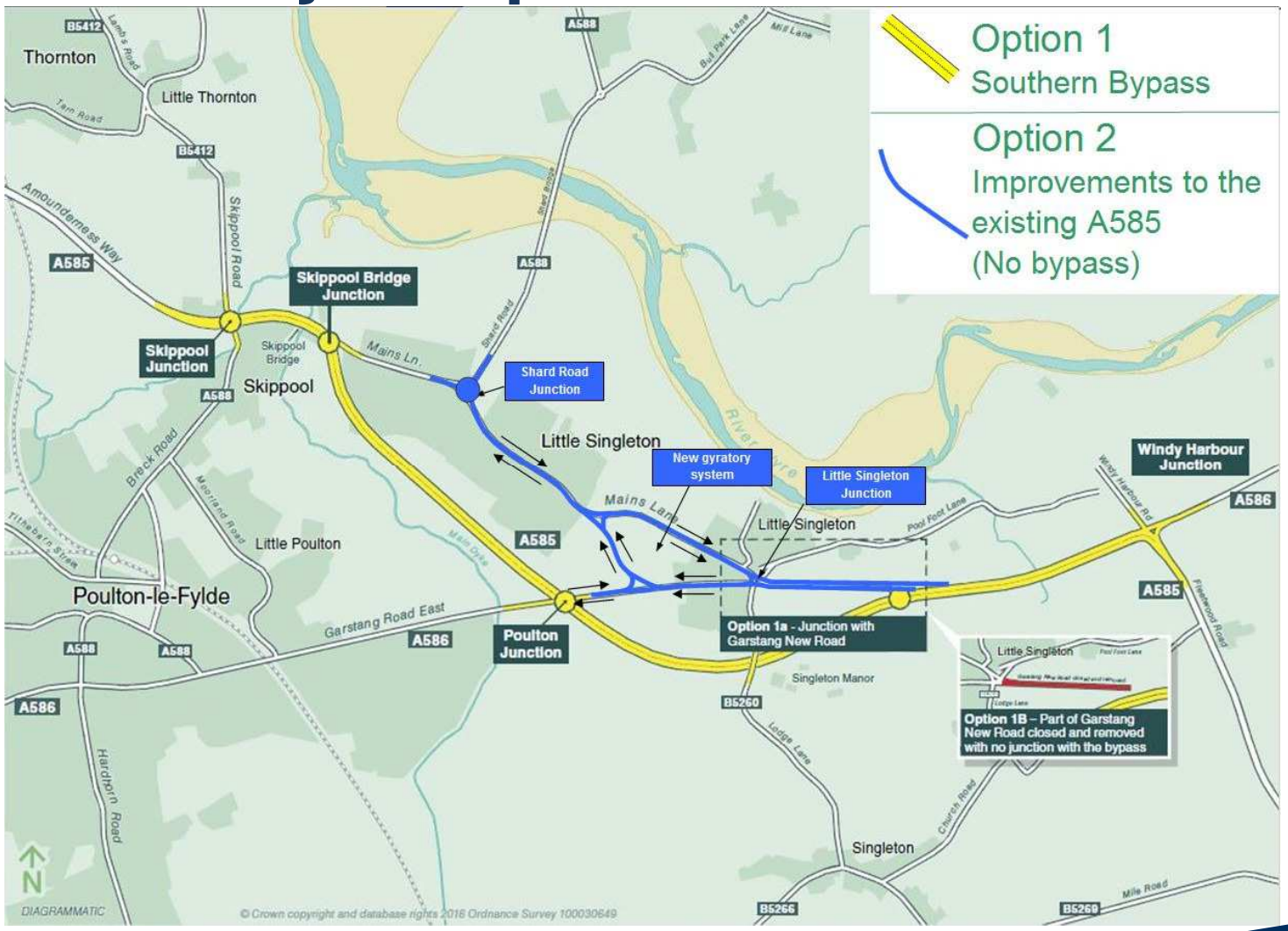
highways england

Scheme Objectives



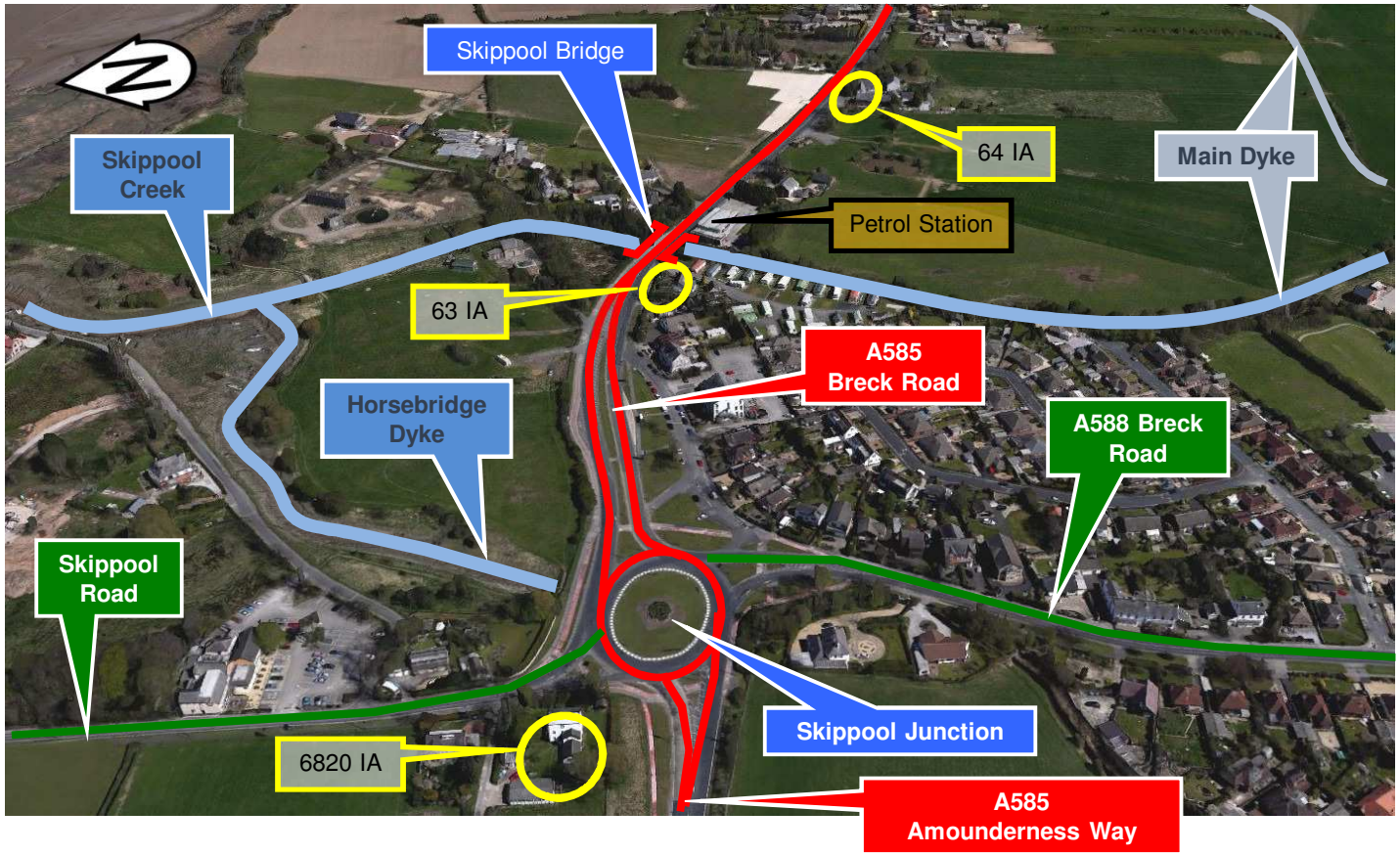
highways england

Summary of Options



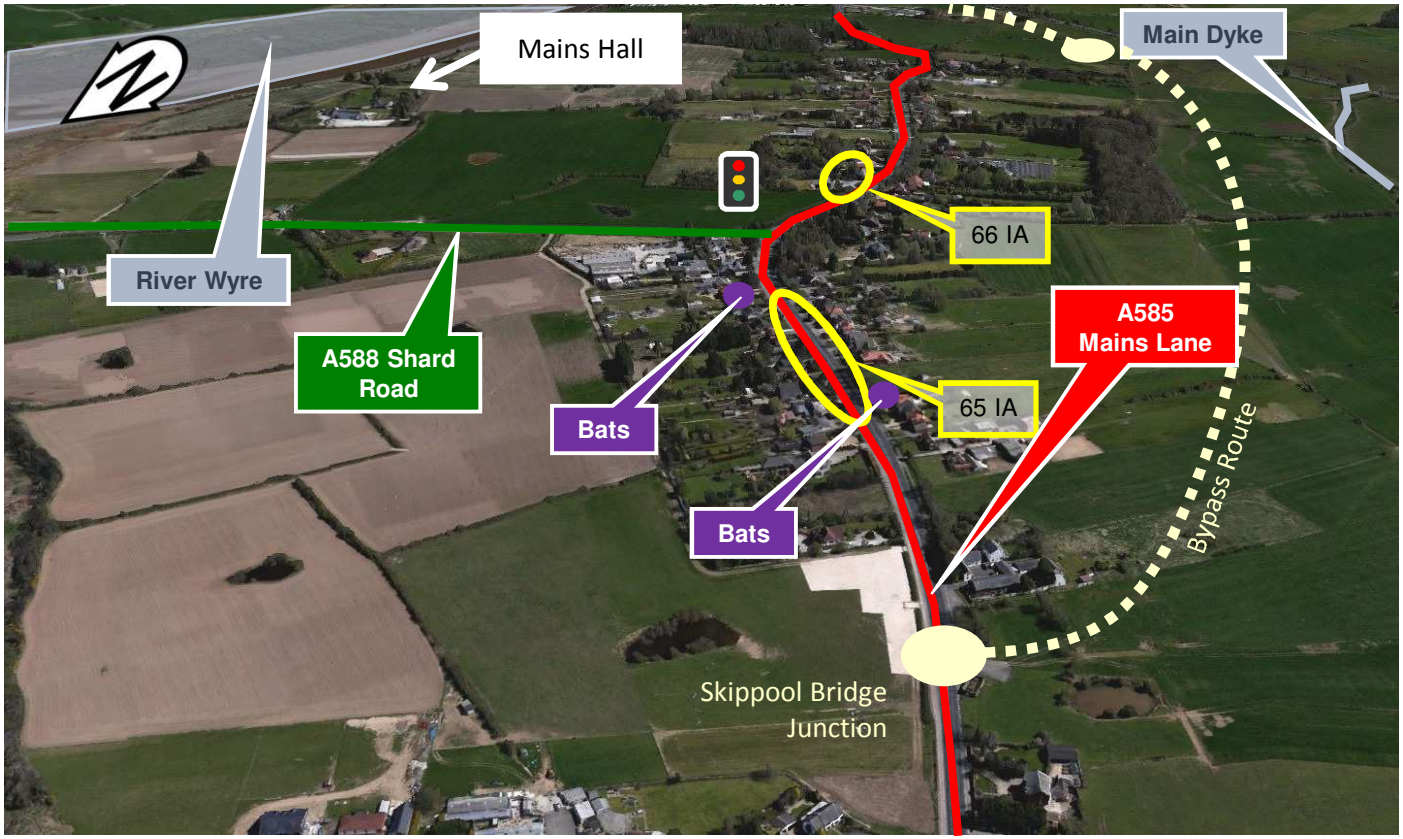
highways england

Skippool Junction and Skippool Bridge



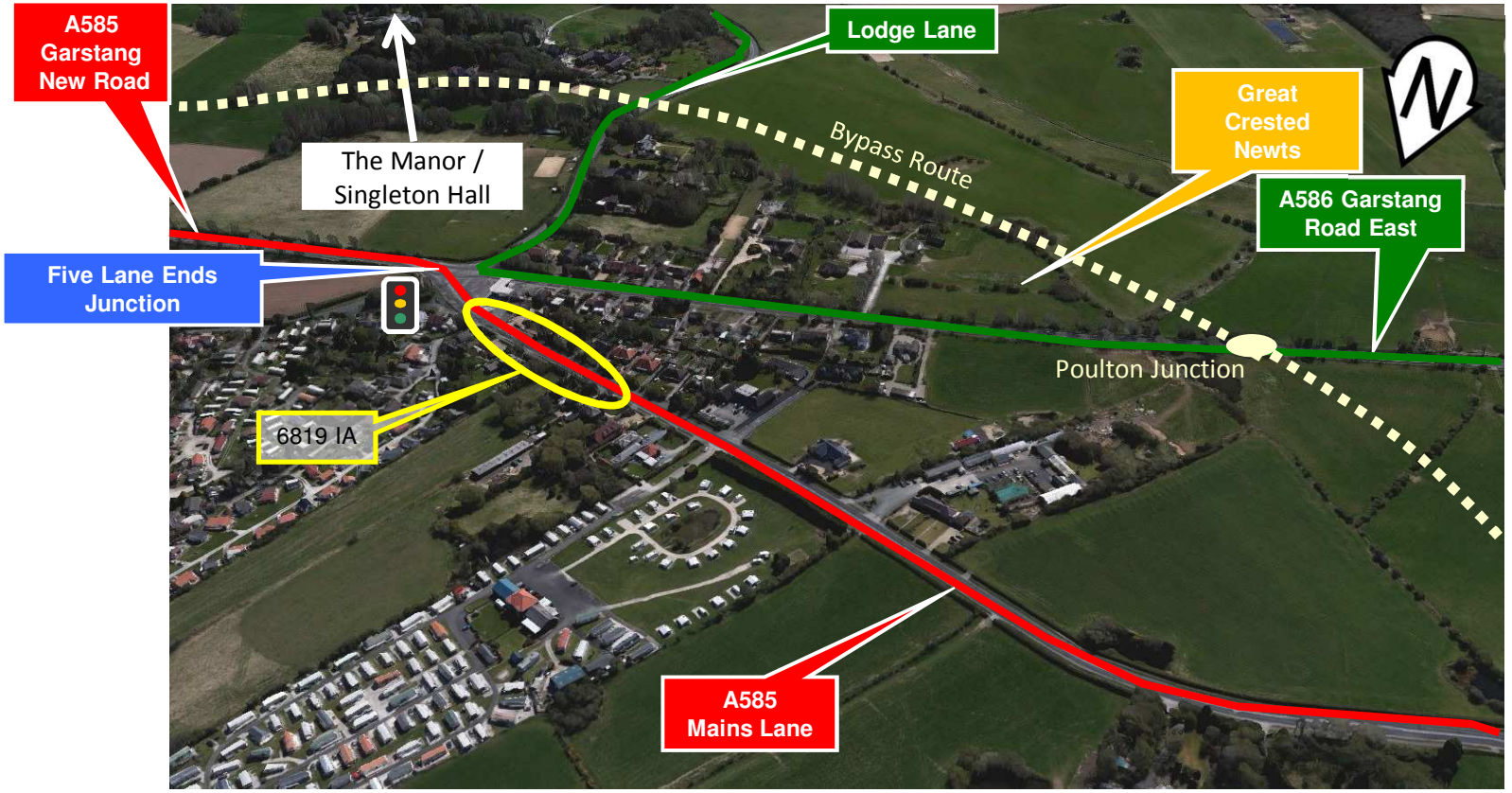
highways england

Skippool Bridge to Shard Road



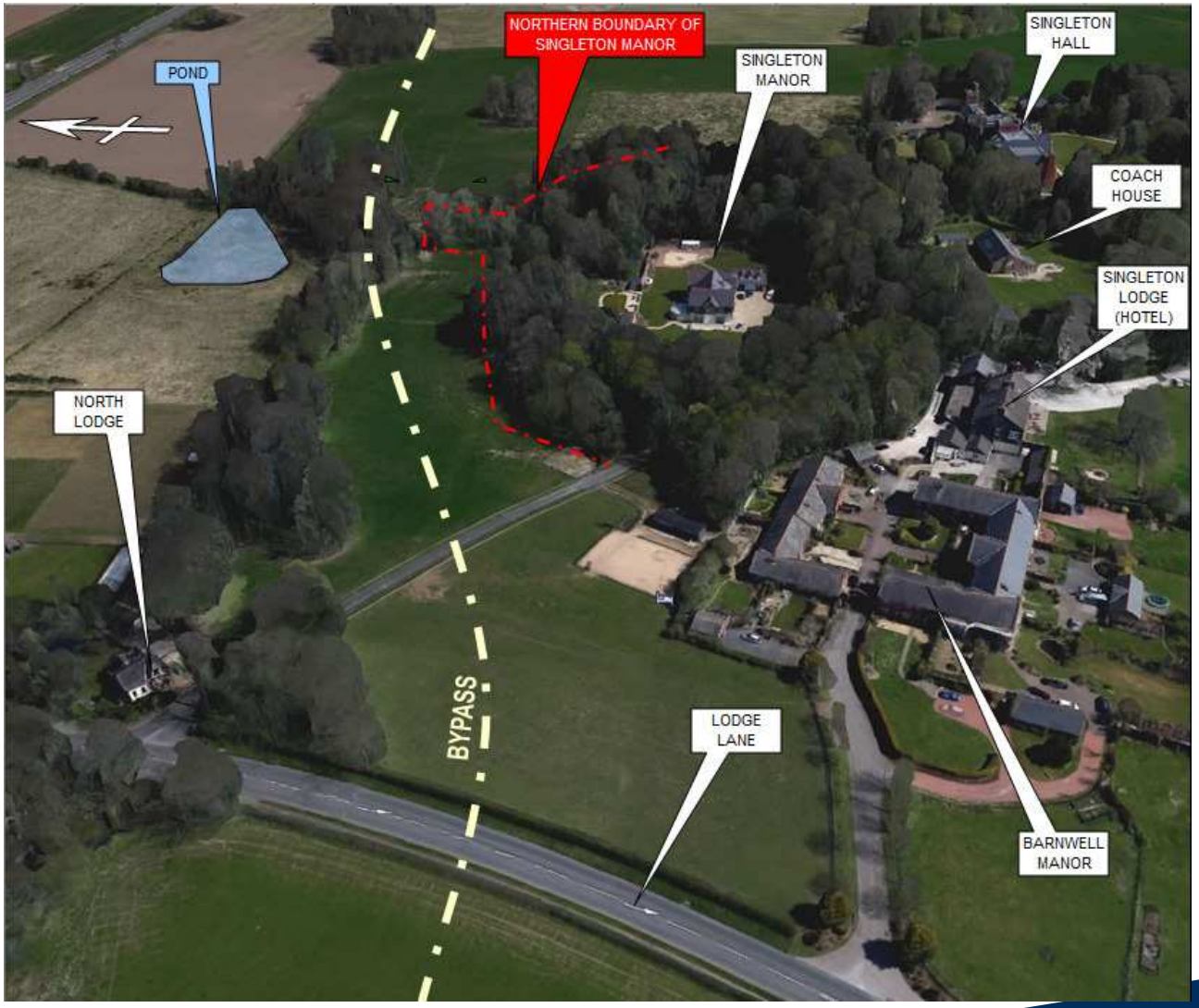
highways england

Little Singleton (Five Lane Ends Junction)



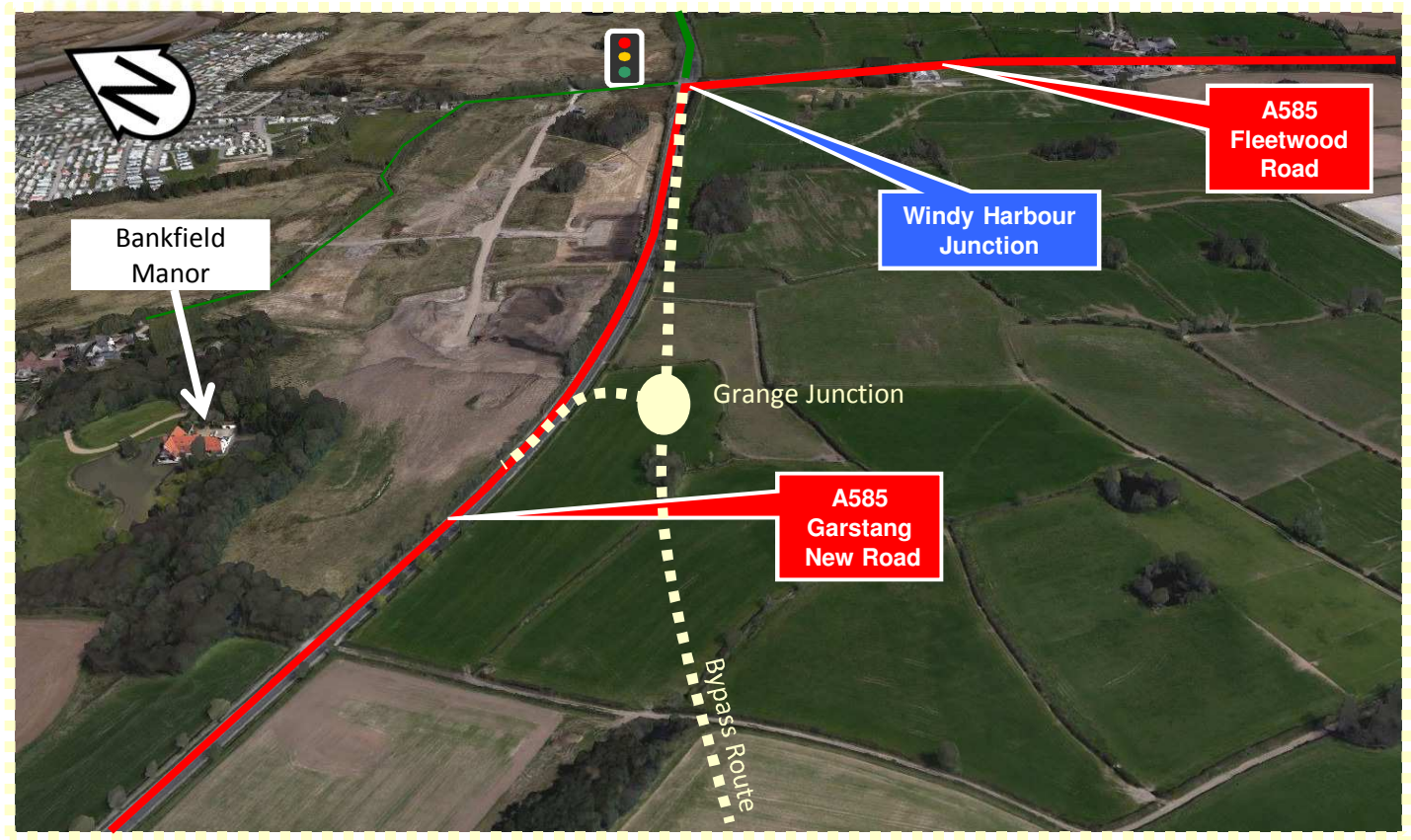
highways england

Lodge Lane (looking east)



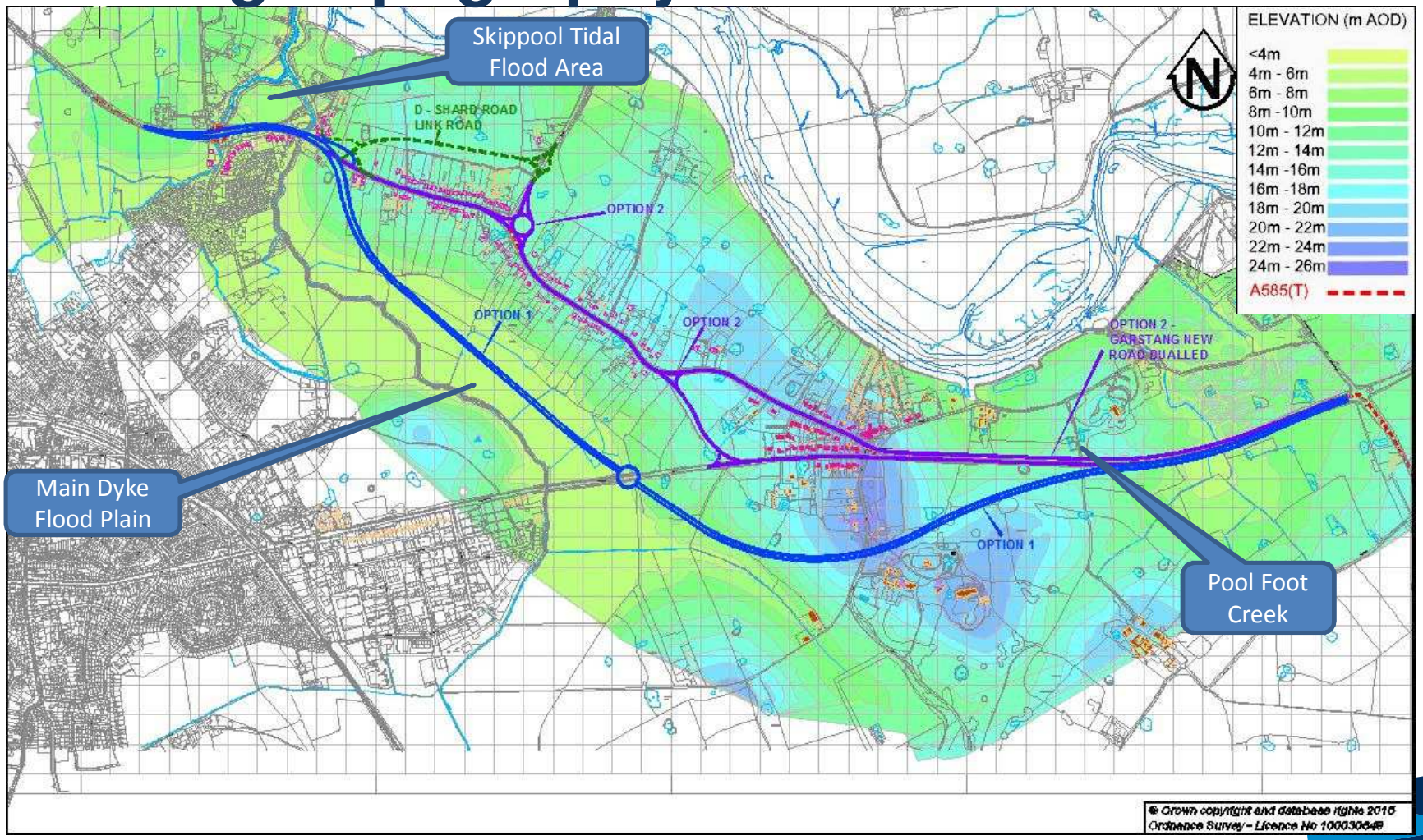
highways england

New Garstang Road and Windy Harbour Junction



highways england

Existing Topography

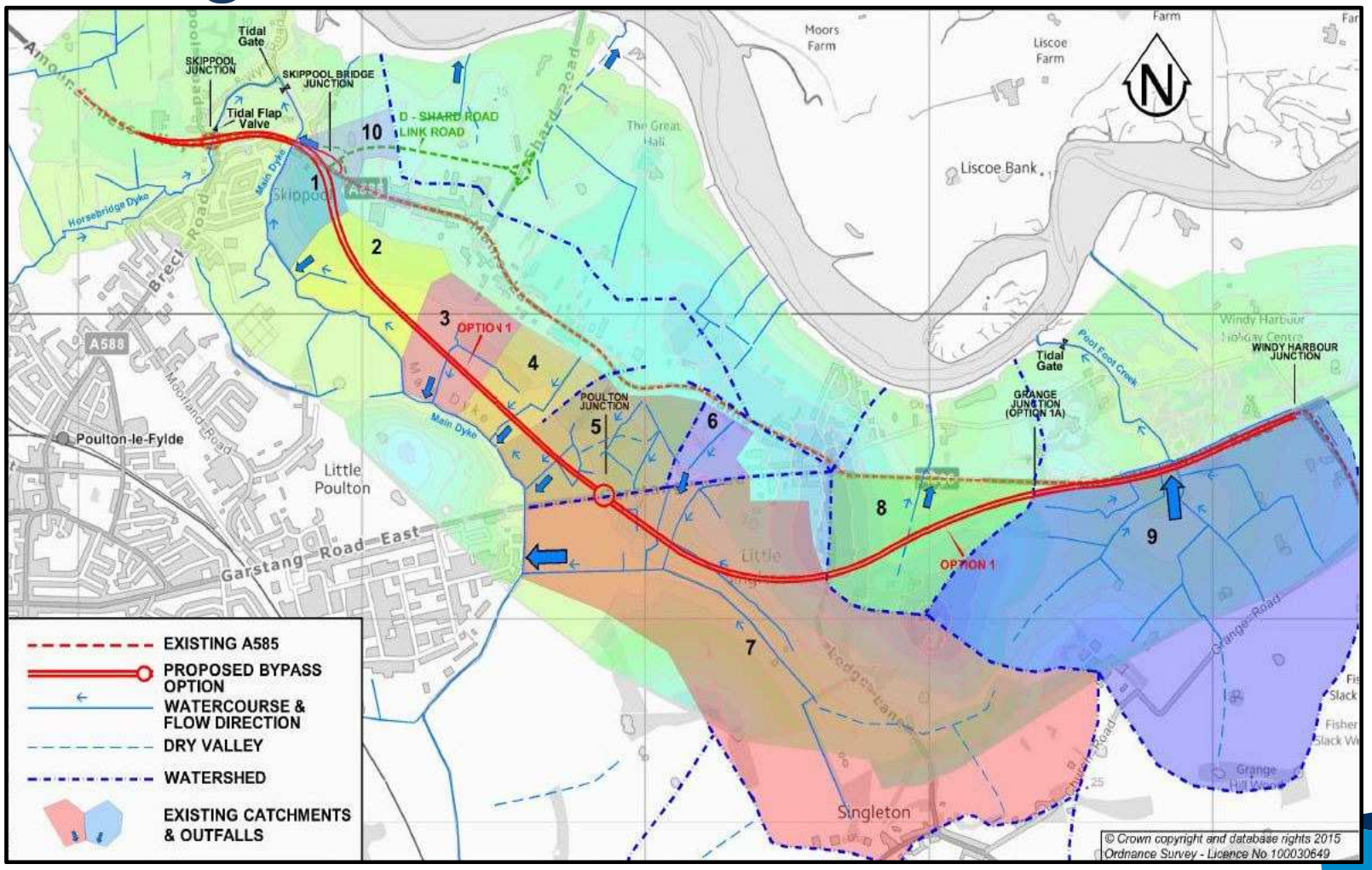


highways england

Existing Drainage – Water Environment

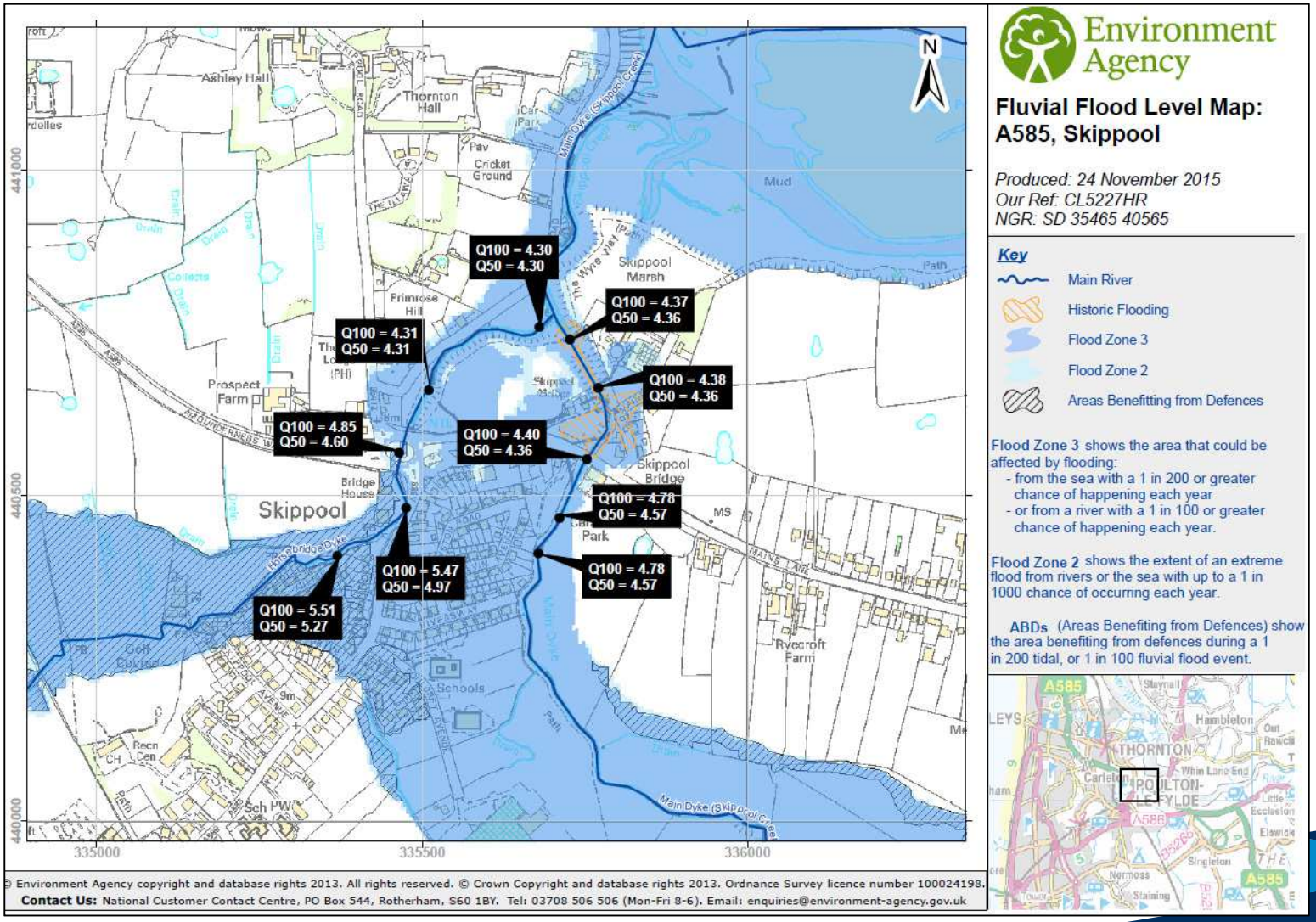
- 3no. Main Rivers (Horsebridge Dyke, Main Dyke and Pool Foot Creek);
- Groundwater condition is unknown – limited GI / survey works currently being undertaken.
- Groundwater is assumed to be present at Lodge Lane cutting due to the glacial sands / gravel cap; and
- Majority of the scheme is within flood zone 1, with a smaller portion within flood zones 2 and 3.

Existing Overland Flow Catchments



highways england

Existing Drainage – Water Environment



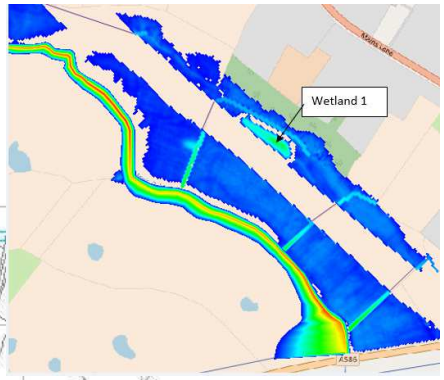
highways england

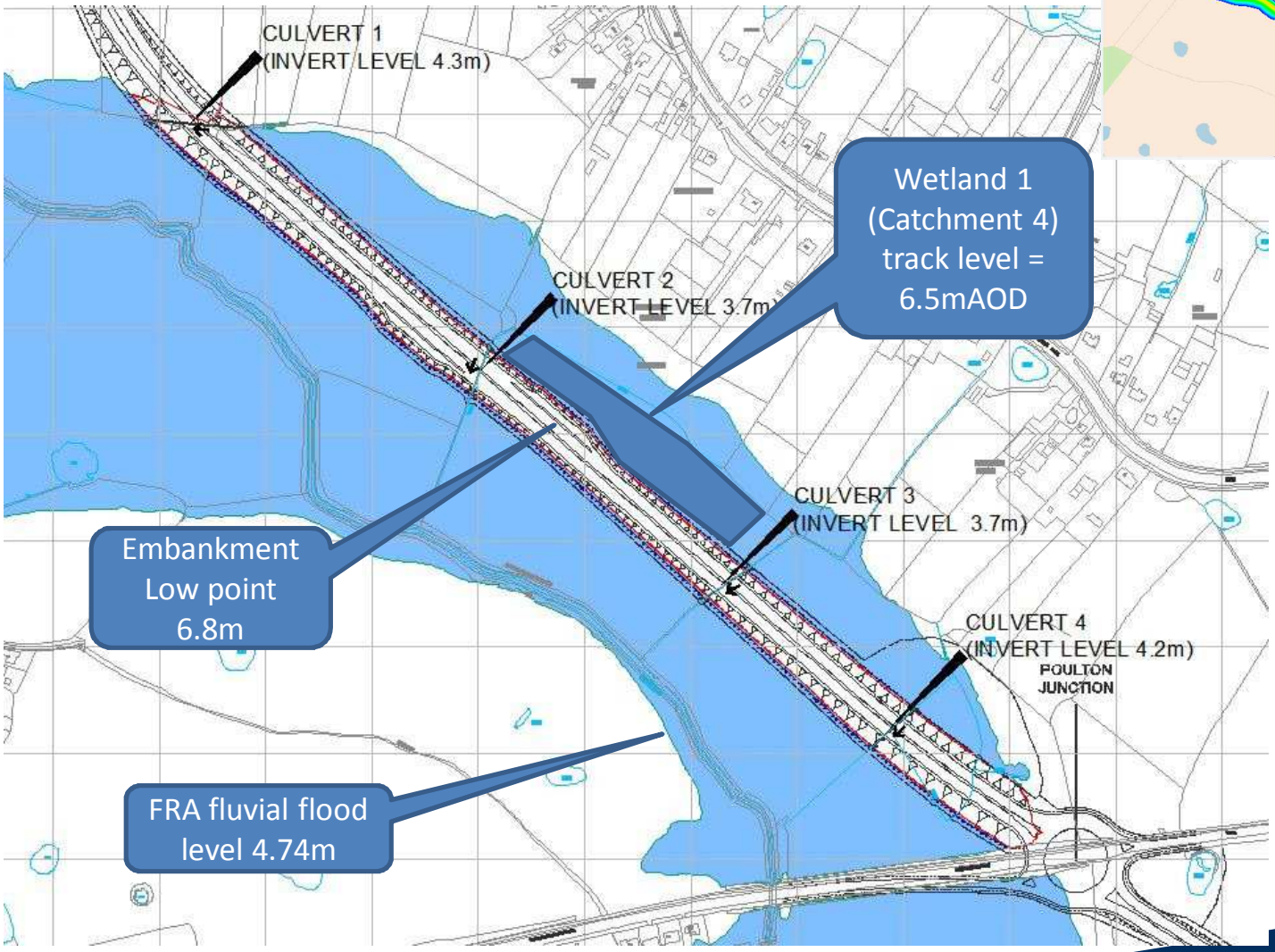
Skippool Tidal Flood Area



highways england

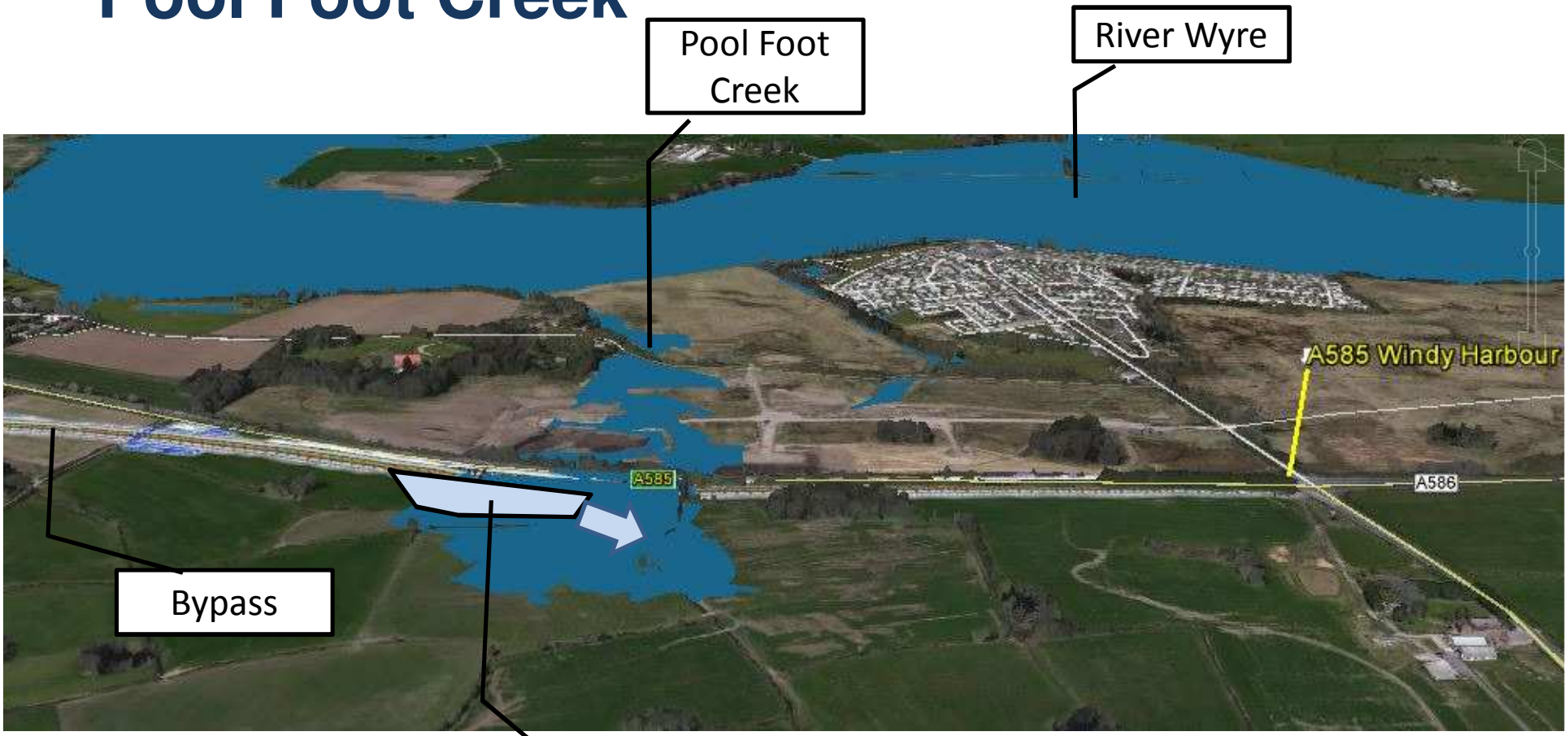
Main Dyke Flood Plain





highways england

Pool Foot Creek



highways england

Pool Foot Creek

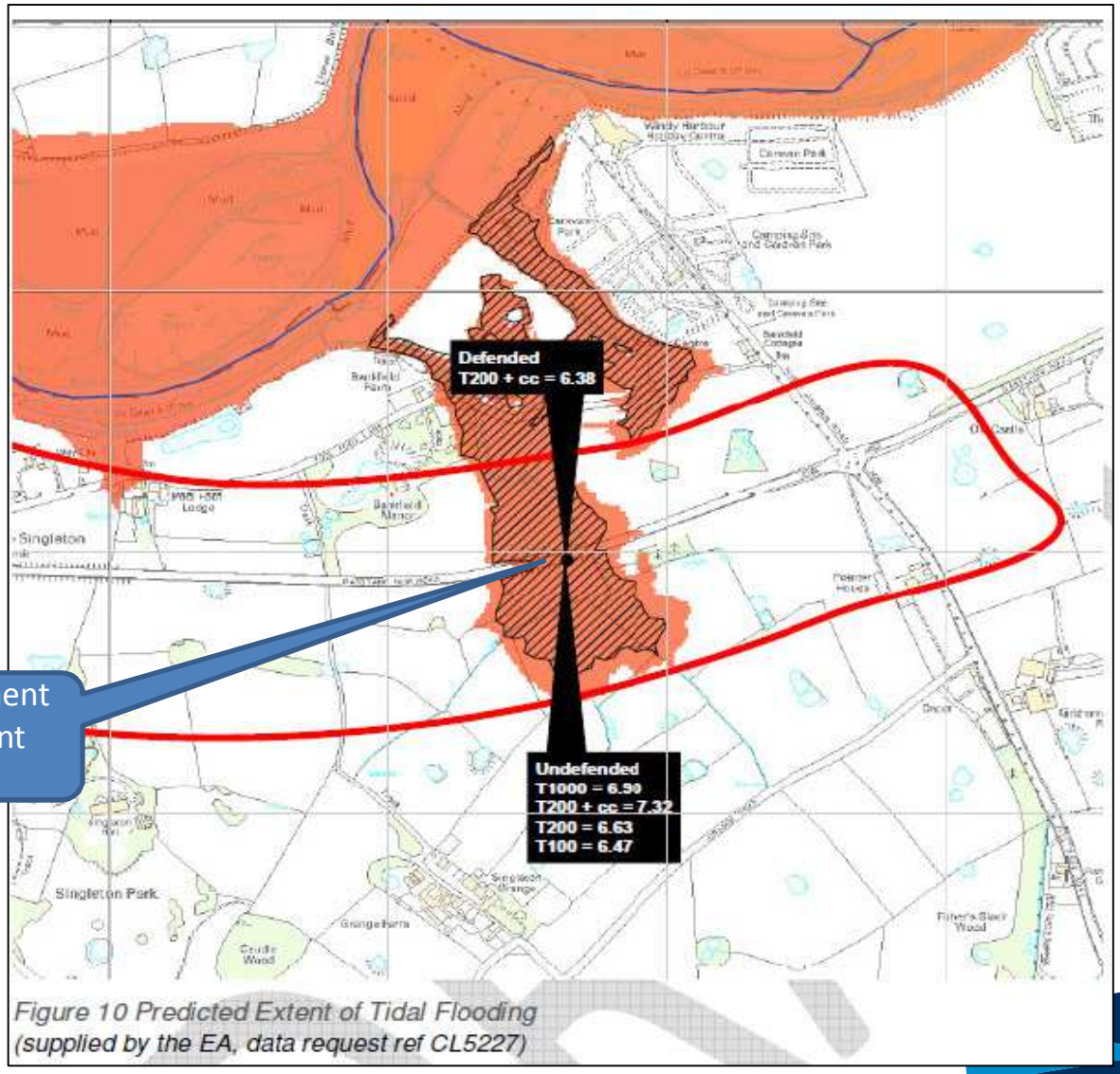


Figure 10 Predicted Extent of Tidal Flooding
(supplied by the EA, data request ref CL5227)

highways england

Existing Drainage - Data

- Limited drainage information available;
- HADMMS data used for Skippool Junction;
- As-built data used for Windy Harbour Junction;
- Limited CCTV data available for Windy Harbour and Skippool Junctions only; and
- Gap analysis plans and specification have been produced to allow CCTV asset and condition surveys to be undertaken.

Existing Drainage – System / Catchments

- There are currently 13no. existing drainage catchments;
- Existing highway drainage predominantly consists of gullies discharging to carrier drainage systems which outfall direct to ditches or watercourses; and
- There are currently no attenuation or pollution control measures; except for the recently updated Windy Harbour junction where CDK and oversized pipes with a penstock have been provided for spillage containment.

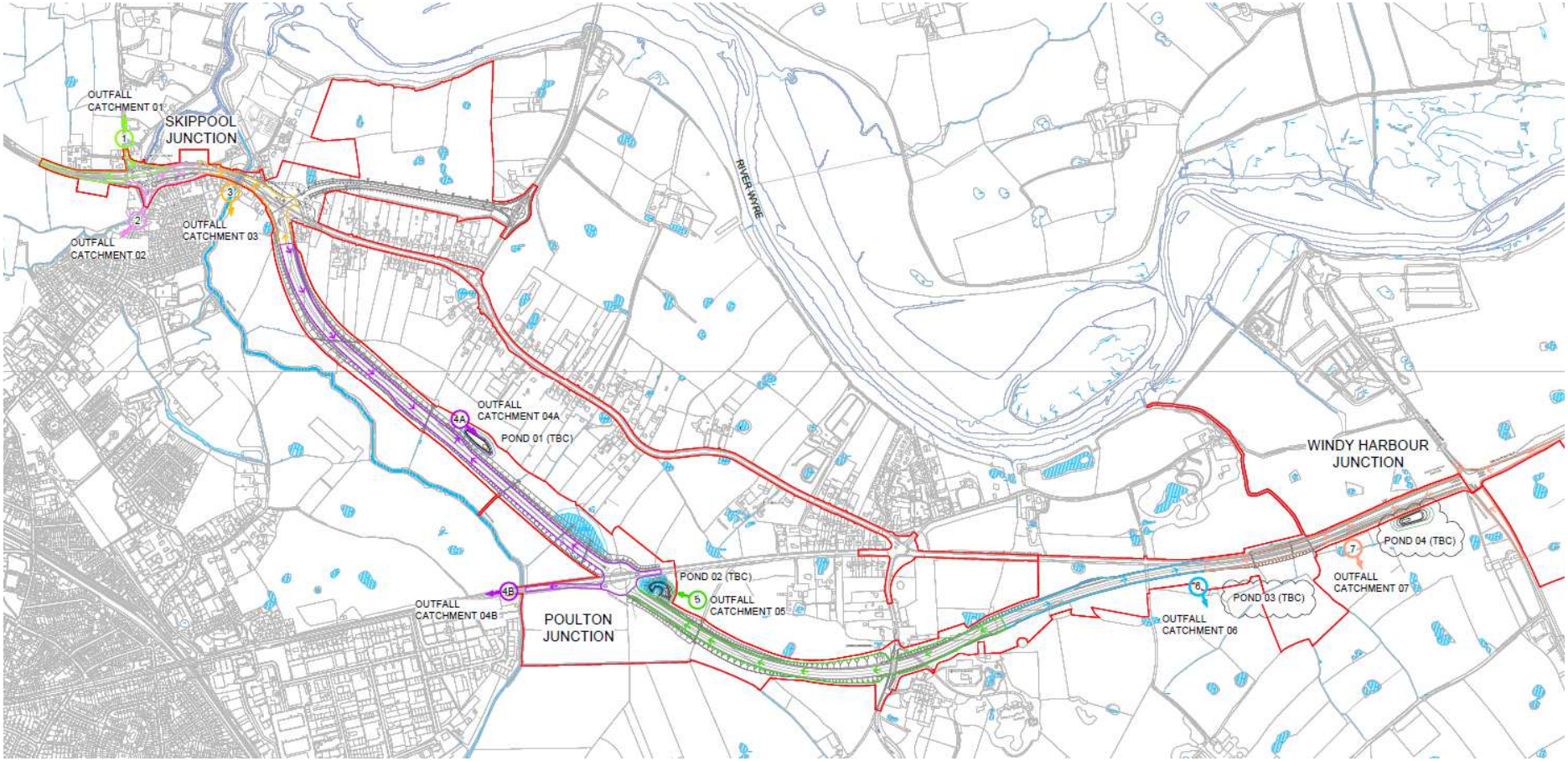


highways england

Proposed Drainage – Strategy

- Maintain existing drainage outfalls at tie-in locations and discharge rates;
- Separate filter drain system in Lodge Lane cutting to deal with groundwater;
- Pre-earthworks ditches and filter drains;
- No bridge deck drainage required at Skippool Bridge and Lodge Lane;
- 20% climate change allowance incorporated into the pipe design and 40% allowance in the wetland design (NPPF) ;
- Designed for maintenance;
- 5no. new 1.5m diameter culverts;
- 2no. Existing 0.9m diameter culverts to be extended; and
- HAWRAT assessment to dictate vortex separators.

Proposed Drainage - Catchments



- 7No. Catchments on the mainline; and
- 9No. Catchments if Shard Link road is included.

highways england

Proposed Drainage - Catchments

Catchment 1 and 2 :

- Maintain existing outfall to Horsebridge Dyke culvert and flow rate – oversized pipes with orifice flow control / penstock and vortex oil and grit separator.



highways england

Proposed Drainage - Catchments

Catchment 3 and 5b:

- Replacement connection to Main Dyke – oversized pipes with orifice flow control / penstock and vortex oil and grit separator.



highways england

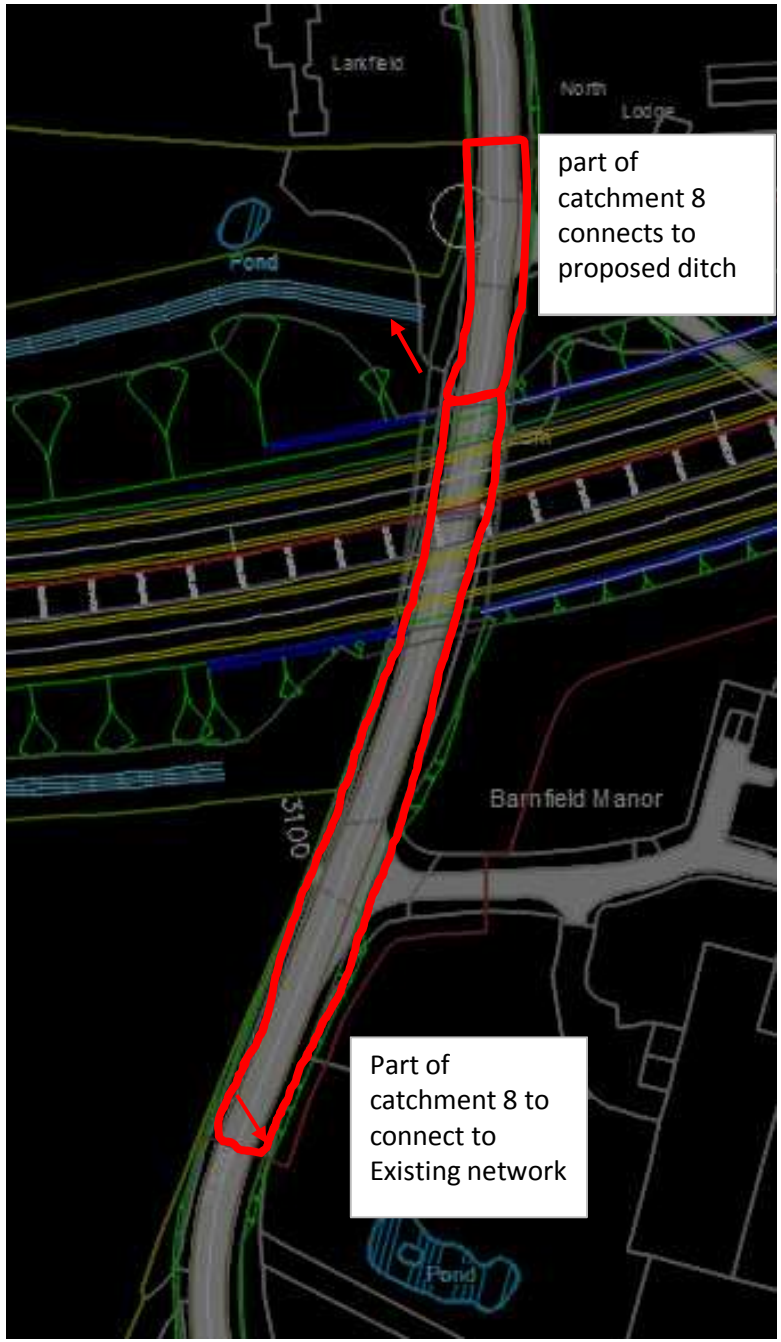
Proposed Drainage - Catchments

Catchment 4 to 7 :

- Proposed storm water drainage to discharge to existing / proposed ditches which discharge to Main Dyke – wetlands with vortex oil and grit separators.



highways england



Proposed Drainage - Catchments

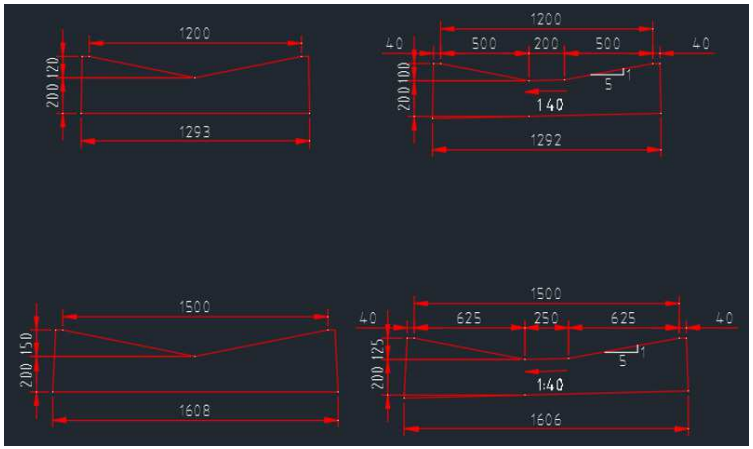
Catchment 8:

- Connection to proposed ditch and existing Network (subject to verification following CCTV asset and condition survey)

highways england

Proposed Drainage – Systems to be used

- Verge drainage to be SWC / filter drains;
- Central reserve drainage to be SWC with a separate filter drain within the large width areas;
- Junctions to be either gullies or combined kerb and drainage units; and
- SWC to be triangular (1.2m in the verge and 1.5m for central reserves).



SWC typical sections

highways england



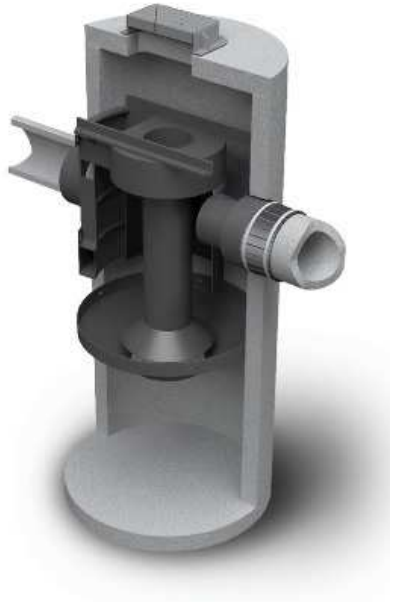
Proposed Drainage – Attenuation / Water Quality

- Oversized pipes designed to accommodate the 1 in 5 years storm return period and discharge restricted to existing discharge rates (1 in 5 year flow rates).
- Wetlands designed to accommodate 1 in 100 year storm event with a 40% allowance for climate change, discharge restricted to greenfield run-off rates.
- Wetland 1 located in flood zone 3 protected against the 1 in 100 year fluvial flood level (300mm free board); and
- Wetland maintenance access provided off network (where possible).

highways england

Proposed Drainage – Flow control / Spillage containment

- Flow control – orifice plates;
- Pollution control values – penstocks; and
- Sediment and oil removal – vortex separators.







highways england

Proposed Drainage - Departures

- Surcharging of the drainage networks during 1 in 1 year storm events.
- Increased spacing for man access chambers from a maximum of 100m to 150m; and
- Increase the diameter of a Type 7 catch-pit from 1050m diameter to accommodate larger pipes;

MINUTES

ARCADIS Design & Consultancy for natural and built assets

MEETING TITLE
A585 Windy Harbour to Skippool Improvement Scheme

DATE
30 April 2018

TIME
10:00 AM

LOCATION
EA Office Bamber Bridge

CHAIR PERSON
[redacted]

ORGANISER
[redacted]

COPIES TO
[redacted] – Highways England
[redacted] – Highways England
[redacted] – Arcadis
[redacted] – Arcadis
[redacted] – Arcadis

PARTICIPANTS
[redacted] – Arcadis
[redacted] – Arcadis
[redacted] – Arcadis
[redacted] – EA
[redacted] – EA
[redacted] – EA

APOLOGIES
[redacted] – EA

ACTION	WHO	WHEN

1. Introduction to the Scheme / Work Completed to Date

1.1 SP gave an overview of the Scheme

1.2 CG gave an overview of the current status of the FRA / hydraulic modelling

2. Construction Phasing

2.1 SP ran through the construction phasing of the Scheme and how the bypass will be built. SP explained that it would not be feasible for the new Skippool Bridge to be constructed and in place before the road embankments for the new bypass, which cross the Main Dyke floodplain are in place. This is because the embankments require a settlement period and therefore the work on this aspect needs to start first with the construction of the bridge started after. The works need to be constructed in parallel.

2.2 SP explained that it would take 9 months for the first phase of the new Skippool Bridge to be replaced, the new larger culvert in place and all utilities diverted. Overall construction period of the Scheme would be 2 years.

2.3 PH and AH stated that there is a need to mitigate for any increases in flood risk to third parties during construction for all events up to and including 1% AEP plus 30% for climate change. Note that we only need to consider a 30% allowance for climate change as the construction phase only lasts for 9 months. Therefore, the FRA needs to identify and provide additional mitigation within the red line boundary to allow the Scheme to be constructed / phased the way it needs to be.

SP 16/05/2018

ACTION	WHO	WHEN
2.4 AH asked if there were any schematics they could be sent of the new Skippool Bridge. SP said there are draft drawings and he would email them to AH.		
2.5 PH stated that there are significant issues with PR / local community flooding and awareness would need to be considered.		
3. Tidal Modelling		
3.1 CG provided background to the tidal model and asked the EA about acceptable tolerances [CG also noted that it appears the central reserve at Skippool Junction (locally known as the River Wyre Junction after the pub) is controlling tidal flooding]		
3.2 PH / AH and PS said there wasn't a simple answer to this and that they would have to take this query away and look at reasonable tolerances.	AH	As part of the FRA review process.
3.3 CG to liaise with the EA over tolerances for increases in levels – i.e. what would be considered a detriment and what is acceptable within the bounds of model / data accuracy.	CG	As part of the FRA review process.
4. Flood Risk During Construction		
4.1 PH stated that flood risk during construction should be covered within the FRA and that detail of site compounds and haul roads should be provided.		
4.2 Arcadis noted that they have site compound locations but are awaiting the appointment of a buildability consultant to confirm haul roads.		
4.3 AH outlined the FRA needs to consider any temporary changes in ground levels in relation to site compounds / haul roads.		
4.4 PH and PS stated that the FRA needs to consider key receptors and their vulnerabilities and to ensure there would be no detriment to third parties and that run off is controlled.		
5. Timescales		
5.1 KB gave a brief overview of the DCO submission timescales and queried the EAs review timescales. PS confirmed that the EA would need 6 weeks for model reviews (to be carried out by external consultants on behalf of the EA).		
5.2 PS also said he was happy for the EA to review the model and would be easier to work with us. PS stated a preference to receiving everything all at once rather than being drip fed. **Post note – AH has agreed that CG can send just the baseline and with scheme fluvial models prior to completing the mitigation model.**		
5.3 AH said anything that is being submitted though to the EA should go through him as the first point of contact.		
5.4 PH Suggested that the EA could also offer permitting advice.		

ACTION	WHO	WHEN

6. AOB

6.1 Future Planning Applications – PH noted there are a lot of development proposed in this area therefore it is critical to take account of this in the FRA i.e. what is rural land now may not be in future. KB noted she maintains a register of potential cumulative developments which is regularly updated.

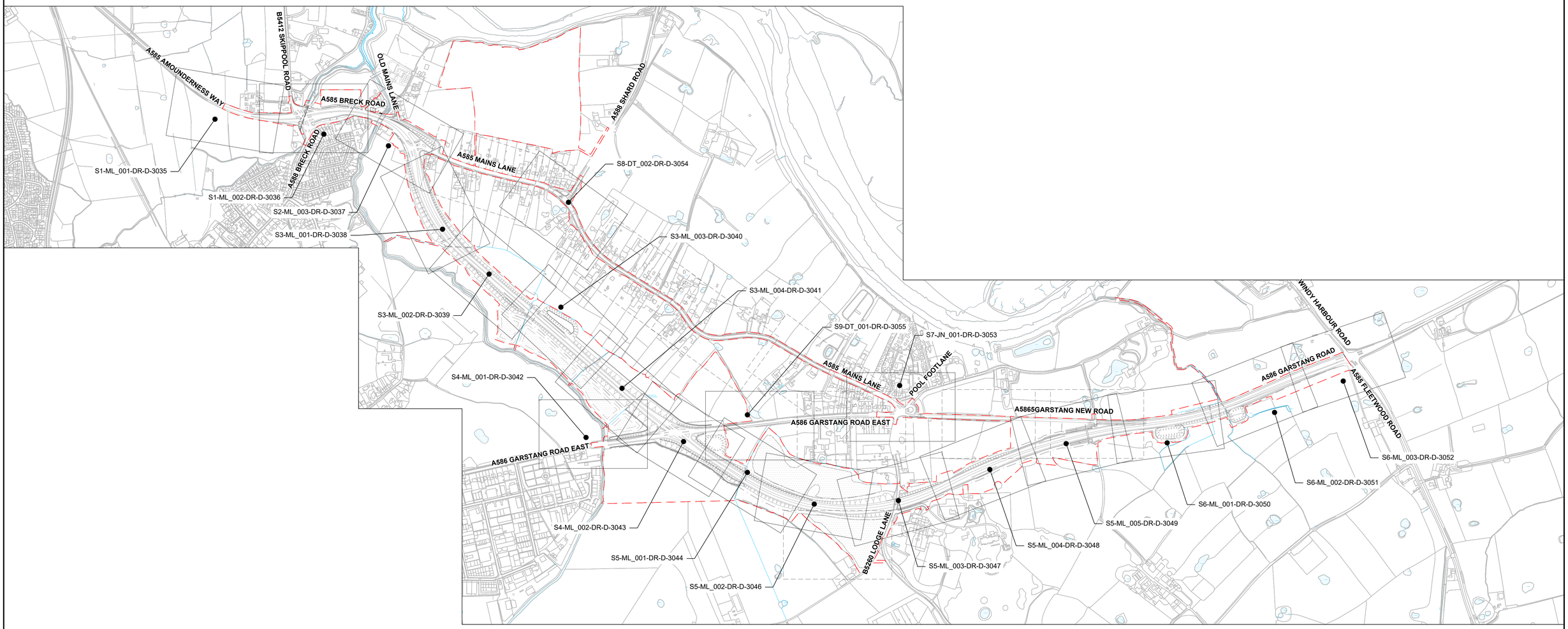
6.2 The EA noted left bank of Horsebridge Dyke (just by the ‘d’ in Breck Road on OS opensource mapping) there is an application for ‘agricultural access’ and it is likely this may be a precursor to future housing development - Wyre Council Ref: 18/00243/FUL.

6.3 The EA noted there should be no drainage ponds in FZ3 – and this needs to clearly be identified in the FRA.

6.4 SP outlined the preliminary drainage design. New outfalls are designed in accordance with current standards. There are 2 general designs for new outfalls, first of which discharges to wetlands before discharging to highway ditches and ultimately into local watercourse. Arcadis have gained agreement with Lancashire County Council for this. Wetlands have been designed to accommodate a 1 in 100-year storm with 40% climate change allowance. Second discharges directly into watercourse, consents/permits for these will be sought at detail design stage.

6.5 SP stated where existing outfalls will be maintained and re-used, the design has maintained the existing 1 in 5-year discharge rate by providing attenuation and water quality mitigation.

Appendix G – Proposed drainage catchment plan and proposed drainage plans



KEY PLAN LEGEND

DRAWING LAYOUT USED

DRAWING LAYOUT NOT USED

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE KEY PLAN

Status: S3 - PRELIMINARY DESIGN

Revision: P02

Scale: NTS

Date: 10JUL2018

Drawn By: G[redacted]

Checked By: A[redacted]

Approved By: N[redacted]

Original Size: A1

Drawing number: HE HE PIN | Originator | Volume | Location | Type | Role | Number

HE548643-ARC-HDG-SZ-GN_000-DR-D-3031

100mm on Original

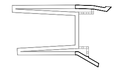
Print Date:

File Path:

PROPOSED DRAINAGE LEGEND :

- REDLINE BOUNDARY
- PROPOSED ROAD LAYOUT
- ORDNANCE SURVEY
- CKD1-001 CKD ◄ CKD — EXISTING COMBINED KERB AND DRAINAGE SYSTEM TO BE RETAINED
- 300 Ø — EXISTING PIPE TO BE RETAINED
- 300 Ø — EXISTING CARRIER DRAIN TO BE RELOCATED / ADJUSTED
- 300 Ø — PROPOSED CARRIER DRAIN
- 600 Ø — PROPOSED STORAGE PIPE
- 150 Ø FDR ◄ FDR — PROPOSED FILTER DRAIN
- 100 Ø FIN ◄ FIN — PROPOSED FIN DRAIN
- CKD01-001 CKD ◄ CKD — PROPOSED KERB AND DRAINAGE SYSTEM
- 225 Ø CCF ◄ CCF — PROPOSED COMBINED CARRIER FILTER PIPE
- LD01-001 LDC ◄ LDC — PROPOSED LINEAR DRAINAGE CHANNEL
- SW01-002 SWC ◄ SWC — PROPOSED STORM WATER CHANNEL
- SW01-002 SWC ◄ SWC 300 Ø — PROPOSED STORM WATER CHANNEL (BELOW)
- M1-001/C1-001 — EXISTING MANHOLE / CATCHPIT WITH REFERENCE NUMBER TO BE RELOCATED AND REINSTATED
- EXM1-001/EXC1-001 — EXISTING MANHOLE / CATCHPIT WITH REFERENCE NUMBER
- M1-001/C1-001 — PROPOSED MANHOLE / CATCHPIT WITH REFERENCE NUMBER
- S5-018-2 — PROPOSED SURFACE WATER OUTFALL CHAMBER WITH NO. OF PAIRS GRATING
- R4-01 — PROPOSED RODDING EYE CHAMBER WITH REFERENCE NUMBER
- K1-001 — PROPOSED CDK ACCESS / OUTFALL CHAMBER WITH REFERENCE NUMBER
- M1-P-01 — PROPOSED VORTEX GRIT SEPARATOR
- M1-F-01 — PROPOSED MANHOLE WITH FLOW CONTROL
- EXG1-001 — EXISTING GULLY WITH REFERENCE NUMBER
- G1-001 — PROPOSED GULLY WITH REFERENCE NUMBER
- EXG1-001 — EXISTING GULLY WITH REFERENCE NUMBER TO BE RELOCATED AND REINSTATED
- DI-DN006 — PROPOSED DRAINAGE DITCH WITH REFERENCE NUMBER
- PROPOSED HEADWALL
- EXISTING HEADWALL
- PIPE FLOW ARROW

- CARRIAGEWAY ROLL-OVER
- H107 — SAFETY, HEALTH AND ENVIRONMENT INFORMATION
- HIGH POINT
- LOW POINT
- PROPOSED STORM WATER WETLAND
- O1-01 — PROPOSED OUTFALL
- O1-01 — EXISTING OUTFALL TO BE RETAINED
- DITCH FLOW ARROW
- EXISTING WATERBODIES
- EXISTING WATERCOURSE
- PROPOSED CULVERT WITH HEADWALL
- PROPOSED BADGER TUNNEL
- PROPOSED FENCING LINE
- PROPOSED PIPED DITCH WITH HEADWALL
- PROPOSED FOOT OVER BRIDGE



SZ-ML_001-DR-D-3035 — DRAWING NUMBER

S5|018|2
- NUMBER OF GRATINGS FOR STORM WATER CHANNEL ONLY
- SERIAL NUMBER
- CATCHMENT NUMBER

DRAINAGE GENERAL NOTES :

1. ALL PIPE SIZES ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS STATED OTHERWISE.
2. WRITTEN SCALES (EG. 1:500, ETC.) APPLY TO DRAWINGS AT A1 PAPER SIZE UNLESS NOTED OTHERWISE.
3. DO NOT SCALE DIRECTLY FROM DRAWINGS, USE FIGURED DIMENSIONS ONLY.
4. FOR EXISTING DRAINAGE LAYOUT PLANS REFER TO HE548643-ARC-HDG-SZ-GN000-DR-D-3071 TO 3089.
5. THE OUTFALL MARKERS SHOW THE FINAL OUTFALL LOCATION TO THE RECEIVING WATER COURSE AND AS SUCH MAY NOT BE DIRECTLY ADJACENT TO PROPOSED DRAINAGE CATCHMENT.
6. ALL SWC WILL REQUIRE FIN DRAINS UNLESS FDR HAVE BEEN PROPOSED.
7. FOR PROPOSED WETLAND SECTION AND LEVELS REFER DRAWINGS NUMBER HE548643-ARC-HDG-SZ-GN000-DE-D-3059 TO 3063.
8. EXISTING MANHOLES AND GULLIES TO BE REINSTATED TO MATCH THE FINAL SURFACE LEVEL.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE NOTES AND LEGEND

Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	NTS
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE | PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-SZ-GN_000-DR-D-3032

100mm on Original

Print Date:

File Path:

LIST OF DRAWINGS

PROPOSED DRAWINGS	
PROPOSED DRAINAGE KEY PLAN	HE548643-ARC-HDG-SZ-GN_000-DR-D-3031
PROPOSED DRAINAGE NOTES AND LEGEND	HE548643-ARC-HDG-SZ-GN_000-DR-D-3032
DRAINAGE LIST OF DRAWINGS	HE548643-ARC-HDG-SZ-GN_000-DR-D-3033
PROPOSED DRAINAGE CATCHMENT PLAN	HE548643-ARC-HDG-SZ-GN_000-DR-D-3034
PROPOSED DRAINAGE PLAN SHEET 1 OF 20	HE548643-ARC-HDG-S1-ML_001-DR-D-3035
PROPOSED DRAINAGE PLAN SHEET 2 OF 20	HE548643-ARC-HDG-S1-ML_002-DR-D-3036
PROPOSED DRAINAGE PLAN SHEET 3 OF 20	HE548643-ARC-HDG-S2-ML_003-DR-D-3037
PROPOSED DRAINAGE PLAN SHEET 4 OF 20	HE548643-ARC-HDG-S3-ML_001-DR-D-3038
PROPOSED DRAINAGE PLAN SHEET 5 OF 20	HE548643-ARC-HDG-S3-ML_002-DR-D-3039
PROPOSED DRAINAGE PLAN SHEET 6 OF 20	HE548643-ARC-HDG-S3-ML_003-DR-D-3040
PROPOSED DRAINAGE PLAN SHEET 7 OF 20	HE548643-ARC-HDG-S3-ML_004-DR-D-3041
PROPOSED DRAINAGE PLAN SHEET 8 OF 20	HE548643-ARC-HDG-S4-ML_001-DR-D-3042
PROPOSED DRAINAGE PLAN SHEET 9 OF 20	HE548643-ARC-HDG-S4-ML_002-DR-D-3043
PROPOSED DRAINAGE PLAN SHEET 10 OF 20	HE548643-ARC-HDG-S5-ML_001-DR-D-3044
PROPOSED DRAINAGE PLAN SHEET 11 OF 20	HE548643-ARC-HDG-S5-ML_002-DR-D-3046
PROPOSED DRAINAGE PLAN SHEET 12 OF 20	HE548643-ARC-HDG-S5-ML_003-DR-D-3047
PROPOSED DRAINAGE PLAN SHEET 13 OF 20	HE548643-ARC-HDG-S5-ML_004-DR-D-3048
PROPOSED DRAINAGE PLAN SHEET 14 OF 20	HE548643-ARC-HDG-S5-ML_005-DR-D-3049
PROPOSED DRAINAGE PLAN SHEET 15 OF 20	HE548643-ARC-HDG-S6-ML_001-DR-D-3050
PROPOSED DRAINAGE PLAN SHEET 16 OF 20	HE548643-ARC-HDG-S6-ML_002-DR-D-3051
PROPOSED DRAINAGE PLAN SHEET 17 OF 20	HE548643-ARC-HDG-S6-ML_003-DR-D-3052
PROPOSED DRAINAGE PLAN SHEET 18 OF 20	HE548643-ARC-HDG-S7-JN_001-DR-D-3053
PROPOSED DRAINAGE PLAN SHEET 19 OF 20	HE548643-ARC-HDG-S8-DT_002-DR-D-3054
PROPOSED DRAINAGE PLAN SHEET 20 OF 20	HE548643-ARC-HDG-S9-DT_001-DR-D-3055
PROPOSED DRAINAGE DETAILS AND SECTIONS	
SURFACE WATER CHANNEL DETAILS 1PAIR INTERMEDIATE	HE548643-ARC-HDG-SZ-GN_000-DE-D-3056
SURFACE WATER CHANNEL DETAILS 2PAIR INTERMEDIATE	HE548643-ARC-HDG-SZ-GN_000-DE-D-3057
SURFACE WATER CHANNEL DETAILS 3PAIR INTERMEDIATE	HE548643-ARC-HDG-SZ-GN_000-DE-D-3058
SURFACE WATER CHANNEL DETAILS 1PAIR TERMINAL	HE548643-ARC-HDG-SZ-GN_000-DE-D-3059
SURFACE WATER CHANNEL DETAILS 2PAIR TERMINAL	HE548643-ARC-HDG-SZ-GN_000-DE-D-3060
SURFACE WATER CHANNEL DETAILS 3PAIR TERMINAL	HE548643-ARC-HDG-SZ-GN_000-DE-D-3061
PROPOSED DRAINAGE PENSTOCK AND OFFICE CHAMBER TYPICAL DETAILS	HE548643-ARC-HDG-SZ-GN_000-DE-D-3062
DRAINAGE STROMEWATER WETLAND 1 PLAN AND SECTION	HE548643-ARC-HDG-SZ-GN_000-DE-D-3063
DRAINAGE STROMEWATER WETLAND 2 PLAN AND SECTION	HE548643-ARC-HDG-SZ-GN_000-DE-D-3064
DRAINAGE STROMEWATER WETLAND 3 PLAN AND SECTION	HE548643-ARC-HDG-SZ-GN_000-DE-D-3065
DRAINAGE STROMEWATER WETLAND 4 PLAN AND SECTION	HE548643-ARC-HDG-SZ-GN_000-DE-D-3066
DRAINAGE STROMEWATER WETLAND STANDARD DETAILS	HE548643-ARC-HDG-SZ-GN_000-DE-D-3067
PLAN AND SECTION FOR PROPOSED CULVERT 1 AT CHAINAGE 1+140	HE548643-ARC-HDG-SZ-GN_000-DE-D-3068
PLAN AND SECTION FOR PROPOSED CULVERT 2 AT CHAINAGE 1+490	HE548643-ARC-HDG-SZ-GN_000-DE-D-3069
PLAN AND SECTION FOR PROPOSED CULVERT 3 AT CHAINAGE 1+795	HE548643-ARC-HDG-SZ-GN_000-DE-D-3070
PLAN AND SECTION FOR PROPOSED CULVERT 4 AT CHAINAGE 2+005	HE548643-ARC-HDG-SZ-GN_000-DE-D-3071
PLAN AND SECTION FOR PROPOSED CULVERT 5 AT CHAINAGE 2+490	HE548643-ARC-HDG-SZ-GN_000-DE-D-3072
PLAN AND SECTION FOR EXISTING CULVERT 7 AT CHAINAGE 4+300	HE548643-ARC-HDG-SZ-GN_000-DE-D-3073
PLAN AND SECTION FOR EXISTING CULVERT 6 AT CHAINAGE 4+350	HE548643-ARC-HDG-SZ-GN_000-DE-D-3074

EXISTING DRAWINGS	
EXISTING DRAINAGE AND SITE CLEARANCE KEY PLAN	HE548643-ARC-HDG-SZ-GN_000-DR-D-3075
EXISTING DRAINAGE AND SITE CLEARANCE NOTES AND LEGEND	HE548643-ARC-HDG-SZ-GN_000-DR-D-3076
EXISTING DRAINAGE AND SITE CLEARANCE CATCHMENT PLAN	HE548643-ARC-HDG-SZ-GN_000-DR-D-3077
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 1 OF 20	HE548643-ARC-HDG-S1-ML_001-DR-D-3078
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 2 OF 20	HE548643-ARC-HDG-S1-ML_002-DR-D-3079
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 3 OF 20	HE548643-ARC-HDG-S2-ML_003-DR-D-3080
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 4 OF 20	HE548643-ARC-HDG-S8-DT_001-DR-D-3081
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 5 OF 20	HE548643-ARC-HDG-S8-DT_002-DR-D-3082
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 6 OF 20	HE548643-ARC-HDG-S8-DT_003-DR-D-3083
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 7 OF 20	HE548643-ARC-HDG-S8-DT_004-DR-D-3084
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 8 OF 20	HE548643-ARC-HDG-S8-DT_005-DR-D-3085
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 9 OF 20	HE548643-ARC-HDG-S7-JN_001-DR-D-3086
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 10 OF 20	HE548643-ARC-HDG-S10-DT_008-DR-D-3087
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 11 OF 20	HE548643-ARC-HDG-S10-DT_009-DR-D-3088
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 12 OF 20	HE548643-ARC-HDG-S6-ML_001-DR-D-3089
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 13 OF 20	HE548643-ARC-HDG-S6-ML_002-DR-D-3090
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 14 OF 20	HE548643-ARC-HDG-S6-ML_003-DR-D-3091
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 15 OF 20	HE548643-ARC-HDG-S9-DT_001-DR-D-3092
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 16 OF 20	HE548643-ARC-HDG-S9-DT_002-DR-D-3093
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 17 OF 20	HE548643-ARC-HDG-S4-ML002-DR-D-3094
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 18 OF 20	HE548643-ARC-HDG-S4-ML002-DR-D-3095
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 19 OF 20	HE548643-ARC-HDG-S5-ML003-DR-D-3096
EXISTING DRAINAGE AND SITE CLEARANCE PLAN SHEET 20 OF 20	HE548643-ARC-HDG-S5-ML006-DR-D-3097

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: DRAINAGE LIST OF DRAWINGS

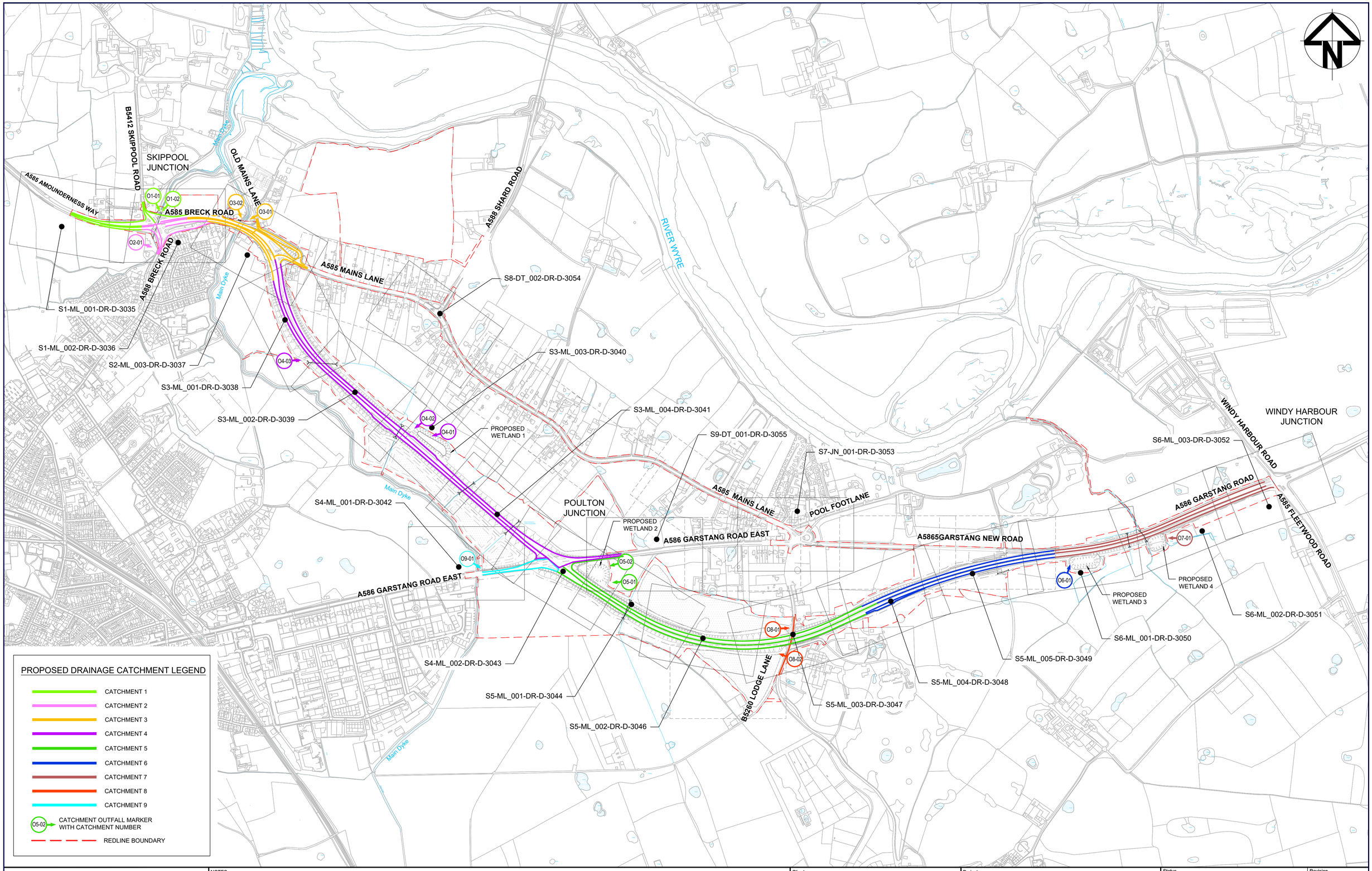
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	NTS
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE548643-ARC-HDG-SZ-GN_000-DR-D-3033

100mm on Original

Print Date:

File Path:



PROPOSED DRAINAGE CATCHMENT LEGEND

- CATCHMENT 1
- CATCHMENT 2
- CATCHMENT 3
- CATCHMENT 4
- CATCHMENT 5
- CATCHMENT 6
- CATCHMENT 7
- CATCHMENT 8
- CATCHMENT 9
- O5-02 CATCHMENT OUTFALL MARKER WITH CATCHMENT NUMBER
- REDLINE BOUNDARY

NOTES

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	[redacted]	[redacted]	[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	[redacted]	[redacted]	[redacted]

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE CATCHMENT PLAN

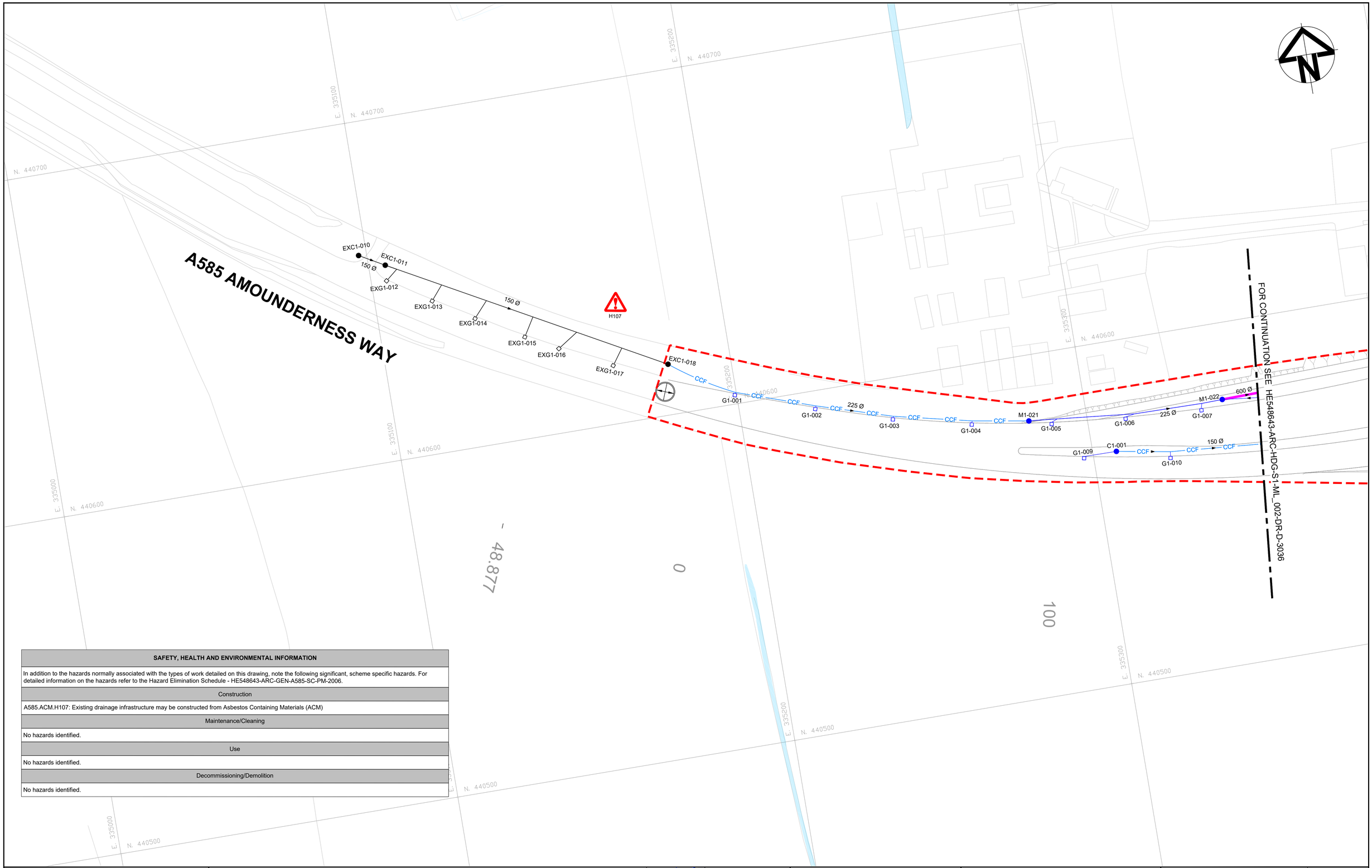
Status: S3 - PRELIMINARY DESIGN
Revision: P02
Scale: NTS
Date: 10JUL2018
Drawn By: G[redacted]
Checked By: A[redacted]
Approved By: N[redacted]
Original Size: A1

Drawing number: HE548643-ARC-HDG-SZ-GN_000-DR-D-3034
(HE PIN | Originator | Volume | Location | Type | Role | Number)

100mm on Original

Print Date:

File Path:



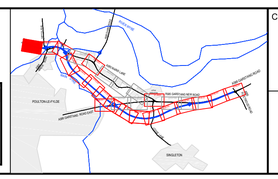
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN_000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 1 OF 20

Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE548643-ARC-HDG-S1-ML_001-DR-D-3035

100mm on Original

Print Date:

File Path:

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.UG.H108: Inundation of flood water
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

B5412 SKIPPOOL ROAD

AMOUNDERNESS WAY

A585 BRECK ROAD

A588 BRECK ROAD

FOR CONTINUATION SEE HE548643-ARC-HDG-S1-ML_001-DR-D-3035

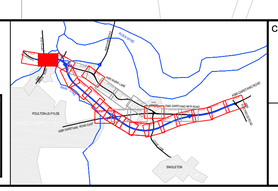
FOR CONTINUATION SEE HE548643-ARC-HDG-S2-ML_003-DR-D-3037

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN_000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 2 OF 20

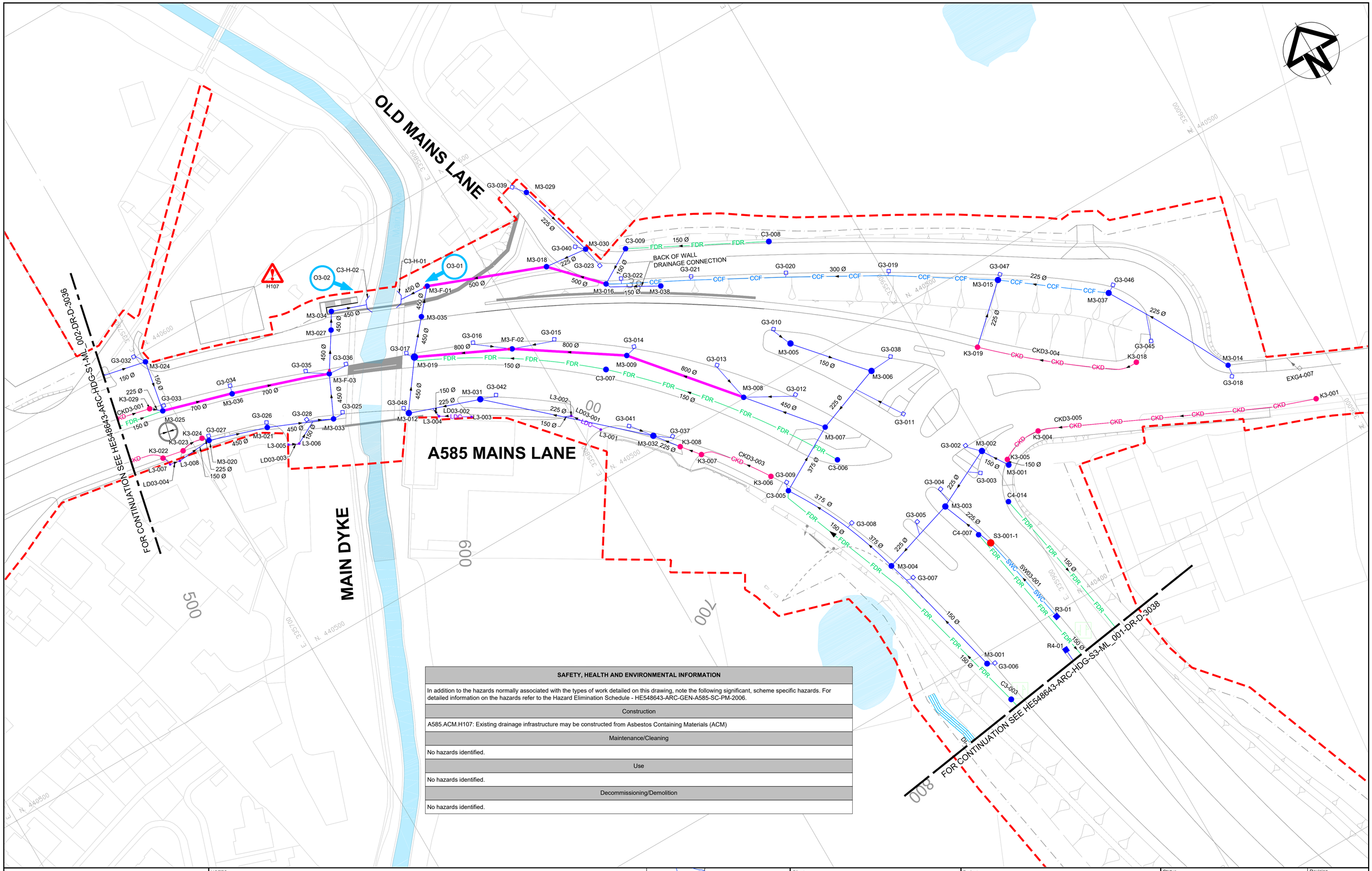
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE548643-ARC-HDG-S1-ML_002-DR-D-3036

100mm on Original

Print Date:

File Path:



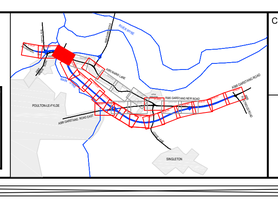
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN_000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 3 OF 20

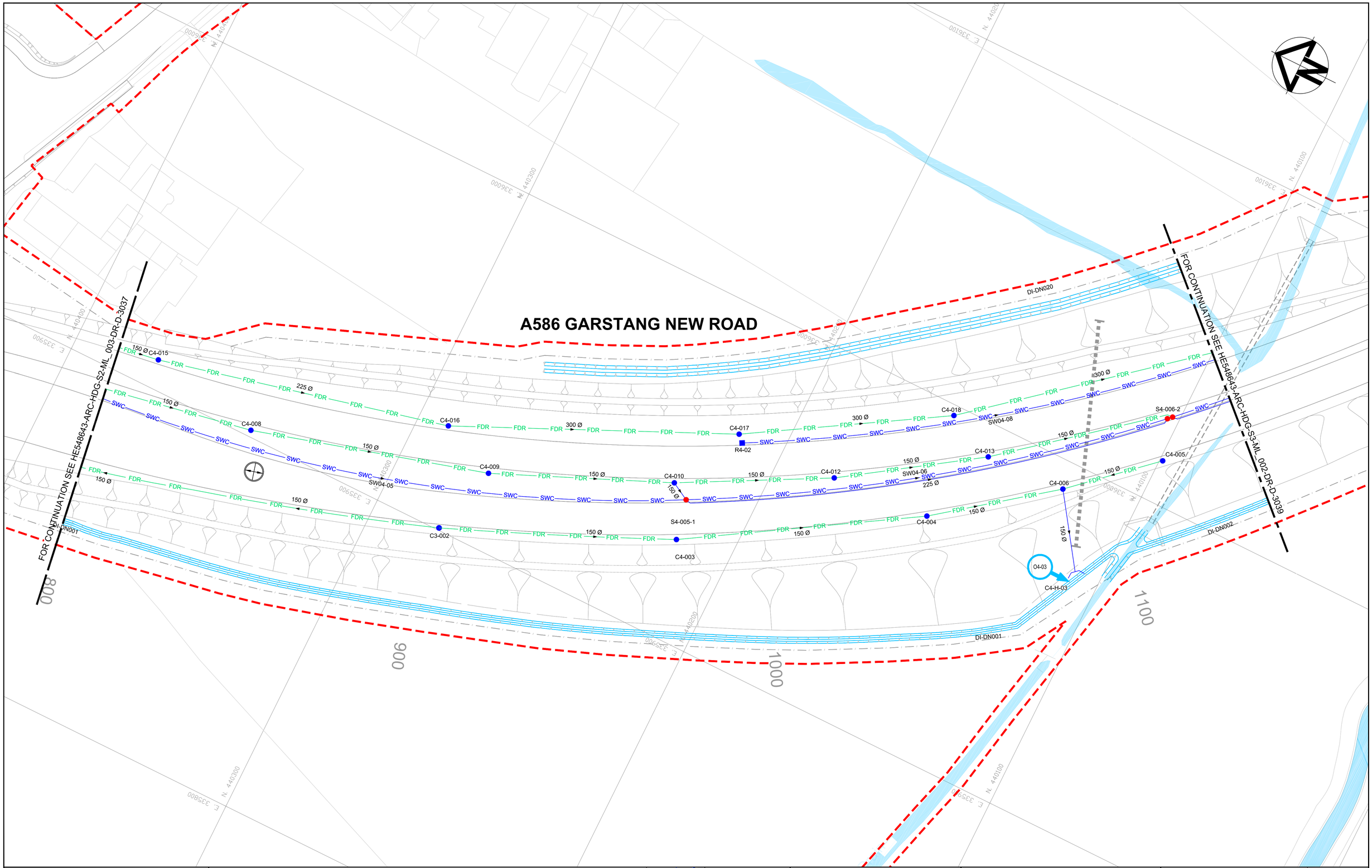
Status: S3 - PRELIMINARY DESIGN
Revision: P02
Scale: 1:500
Date: 10JUL2018
Drawn By: G[redacted]
Checked By: A[redacted]
Approved By: N[redacted]
Original Size: A1

Drawing number HE PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-S2-ML_003-DR-D-3037

100mm on Original

Print Date:

File Path:



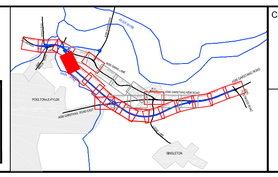
Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN_000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client

highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project

A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title

PROPOSED DRAINAGE PLAN SHEET 4 OF 20

Status: S3 - PRELIMINARY DESIGN

Revision: P02

Scale: 1:500

Date: 10JUL2018

Drawn By: G[redacted]

Checked By: A[redacted]

Approved By: N[redacted]

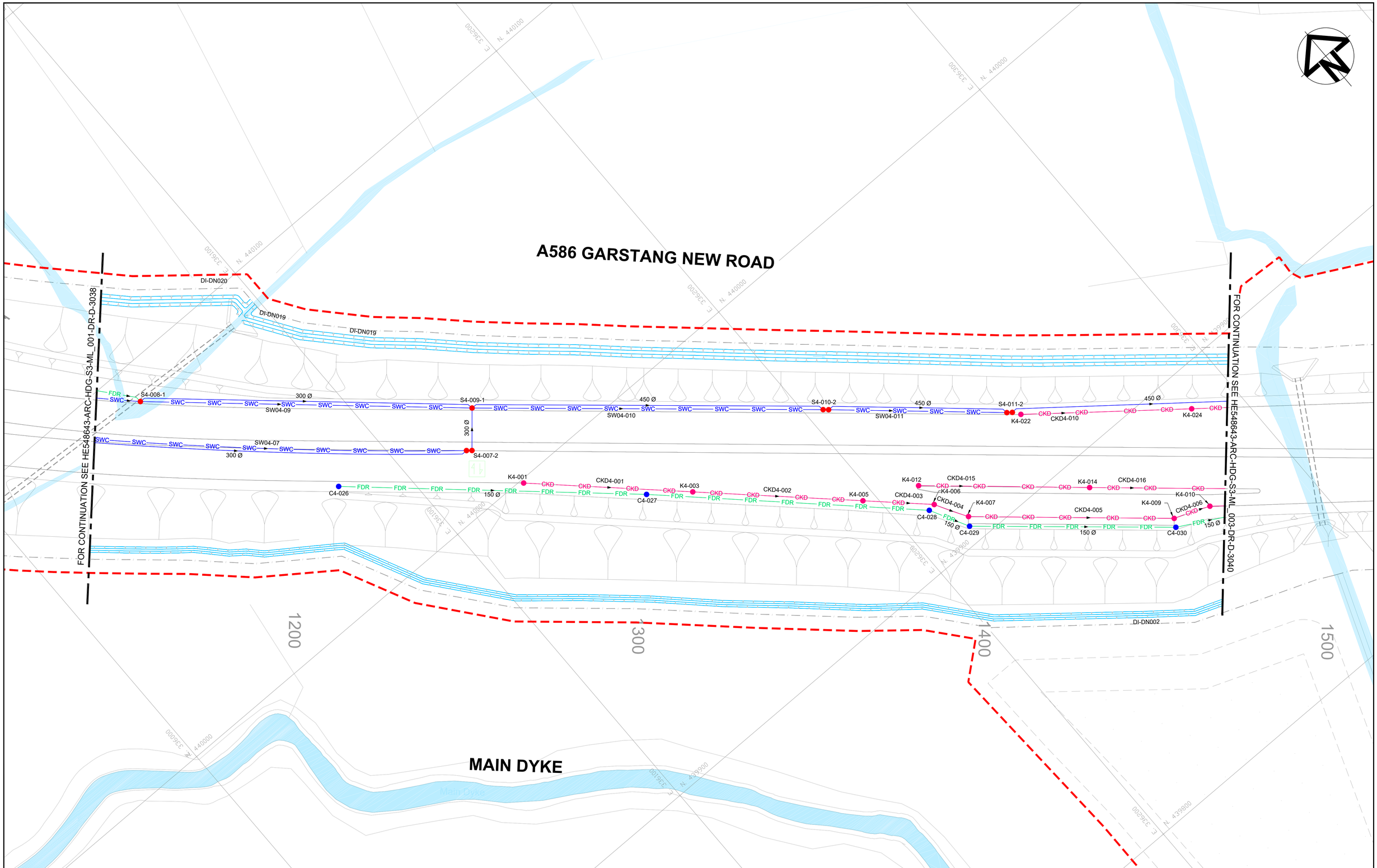
Original Size: A1

Drawing number: HE PIN | Originator | Volume | Location | Type | Role | Number

HE548643-ARC-HDG-S3-ML_001-DR-D-3038

Print Date: 2018-07-14 01:37:30

File Path: \\hc-ukr-hy-fs-10\HY_Proj\Highways\UKR\UB004249-01-A585 Drainage\E-Drawings\Working Drawings\Drawings\PROPOSED\P03\HE548643-ARC-HDG-SZ-GN000-DR-D-3035-3055.dwg

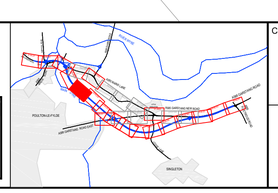


Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 5 OF 20

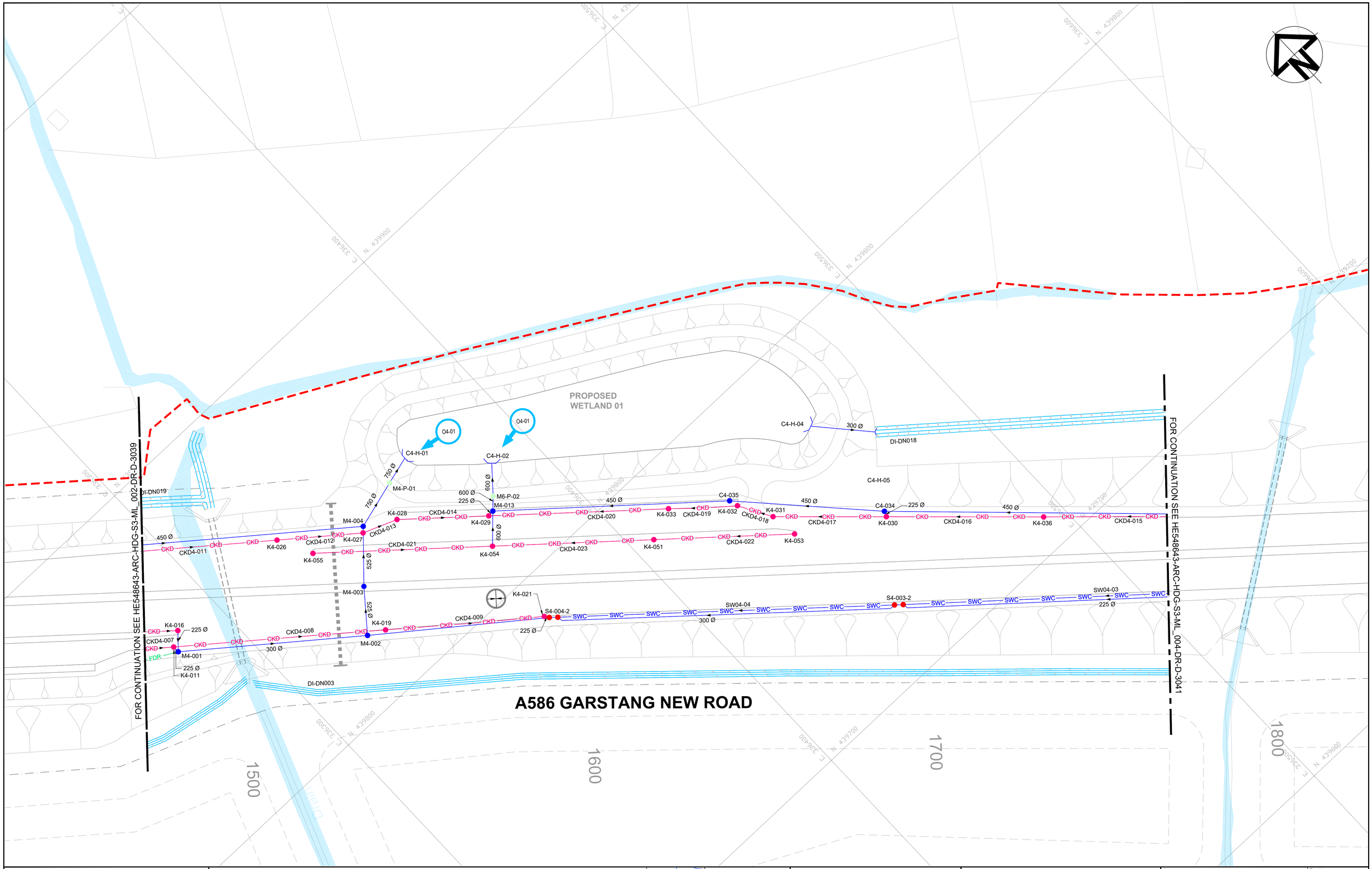
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number HE | PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-S3-ML_002-DR-D-3039

100mm on Original

Print Date:

File Path:



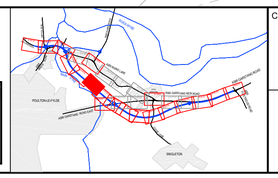
Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client

highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project

A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title

PROPOSED DRAINAGE PLAN SHEET 6 OF 20

Status: S3 - PRELIMINARY DESIGN

Revision: P02

Scale: 1:500

Date: 10JUL2018

Drawn By: G[redacted]

Checked By: A[redacted]

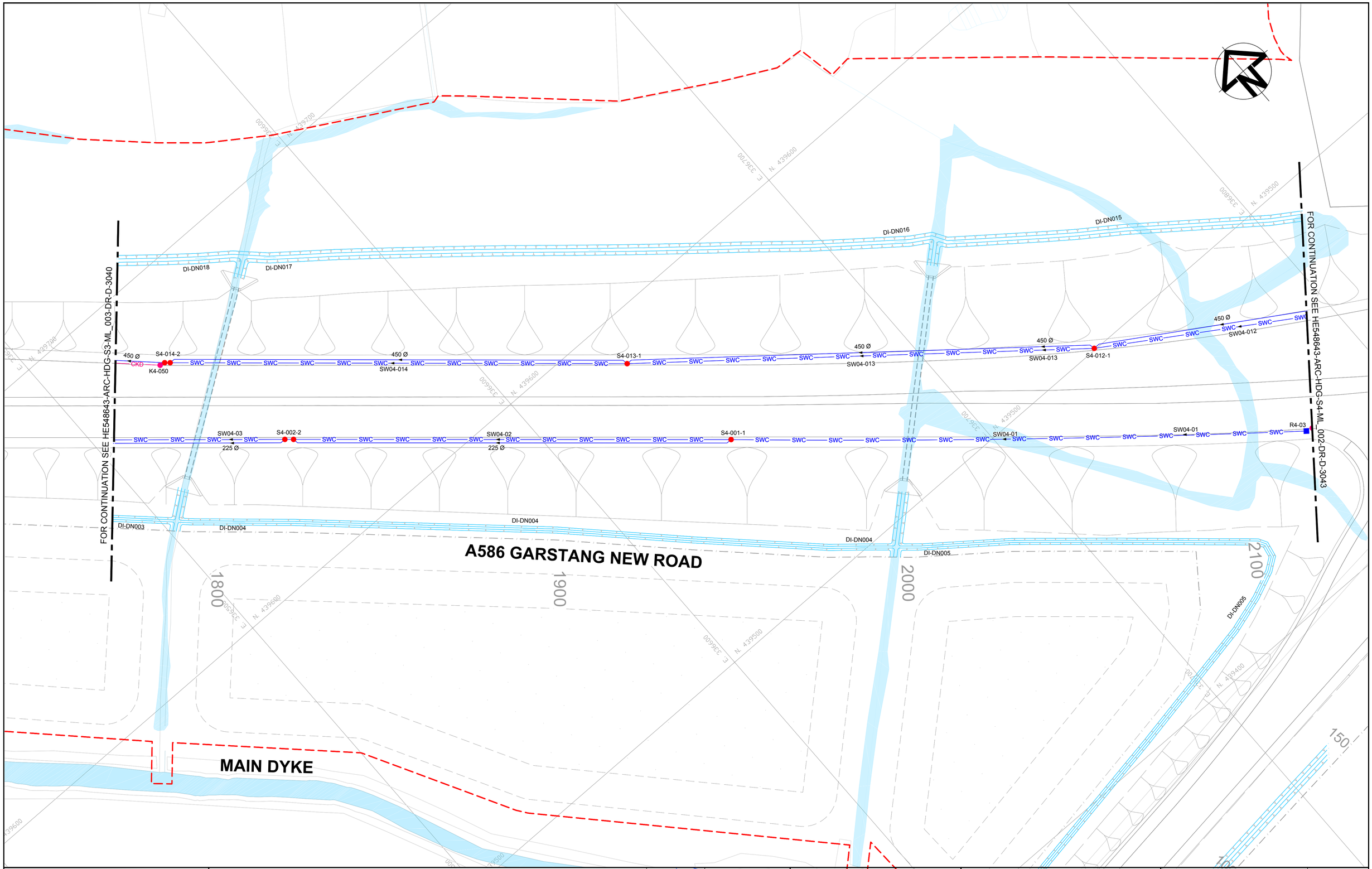
Approved By: N[redacted]

Original Size: A1

Drawing number: HE548643-ARC-HDG-S3-ML_003-DR-D-3040

Print Date:

File Path:

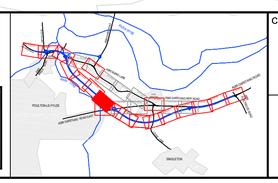


Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 603 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 7 OF 20

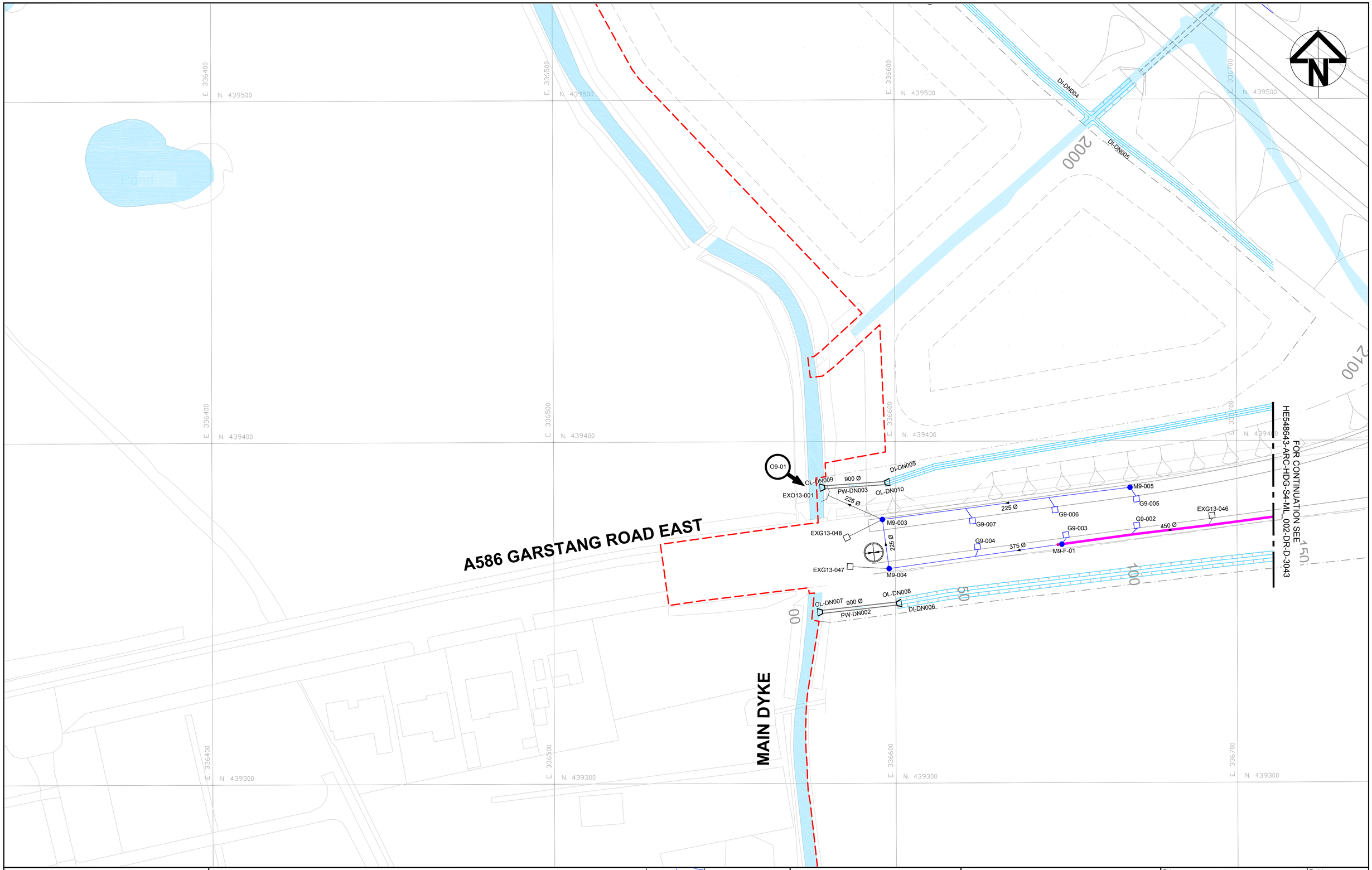
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE548643-ARC-HDG-S3-ML_004-DR-D-3041

100mm on Original

Print Date:

File Path:



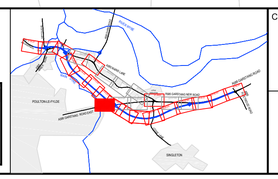
Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Print Date:

File Path:

Client

highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 8 OF 20

Status: S3 - PRELIMINARY DESIGN

Revision: P02

Scale: 1:500

Date: 10JUL2018

Drawn By: G[redacted]

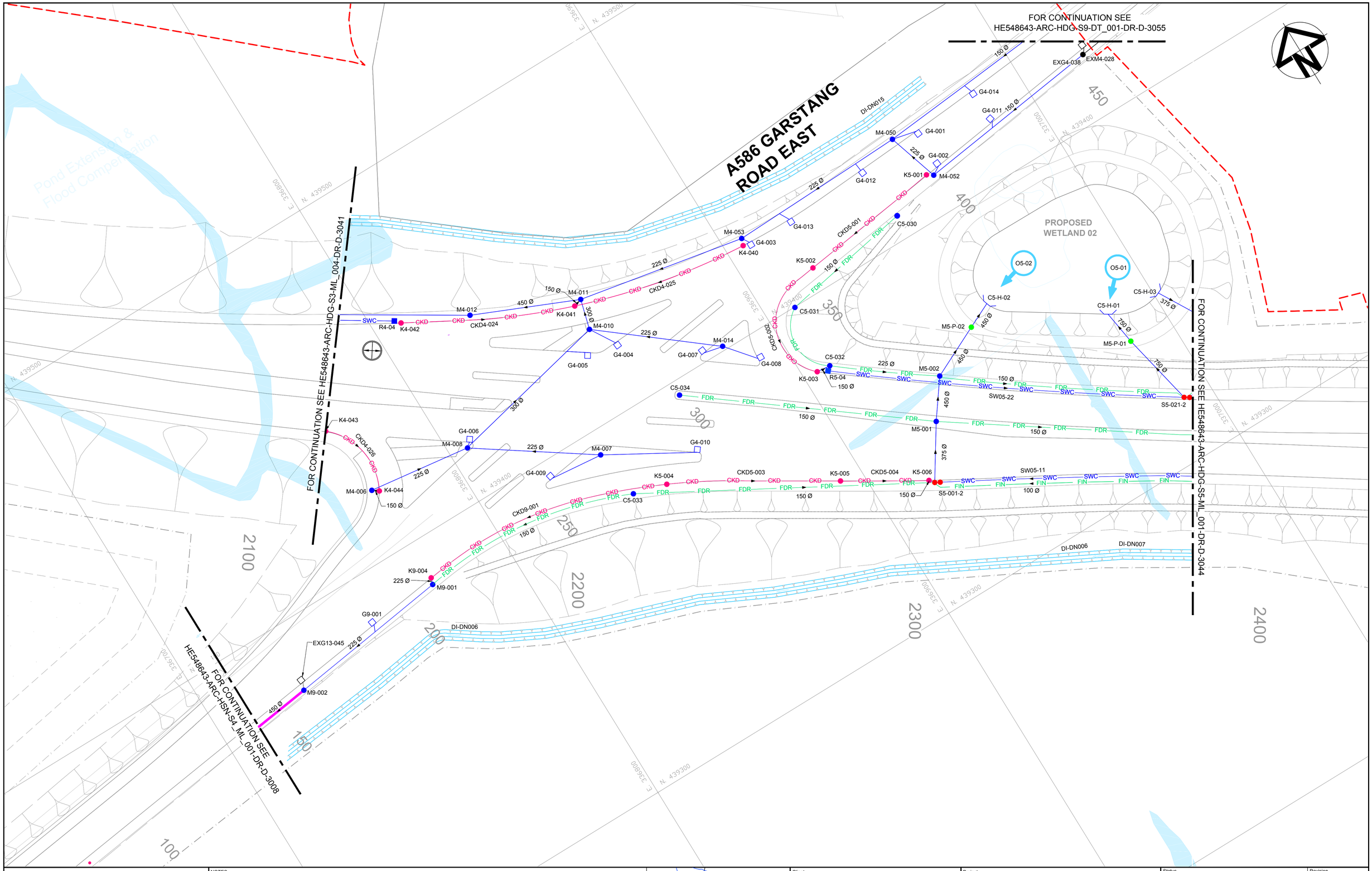
Checked By: A[redacted]

Approved By: N[redacted]

Original Size: A1

Drawing number: HE PIN | Originator | Volume | Location | Type | Role | Number

HE548643-ARC-HDG-S4-ML_001-DR-D-3042



NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 9 OF 20

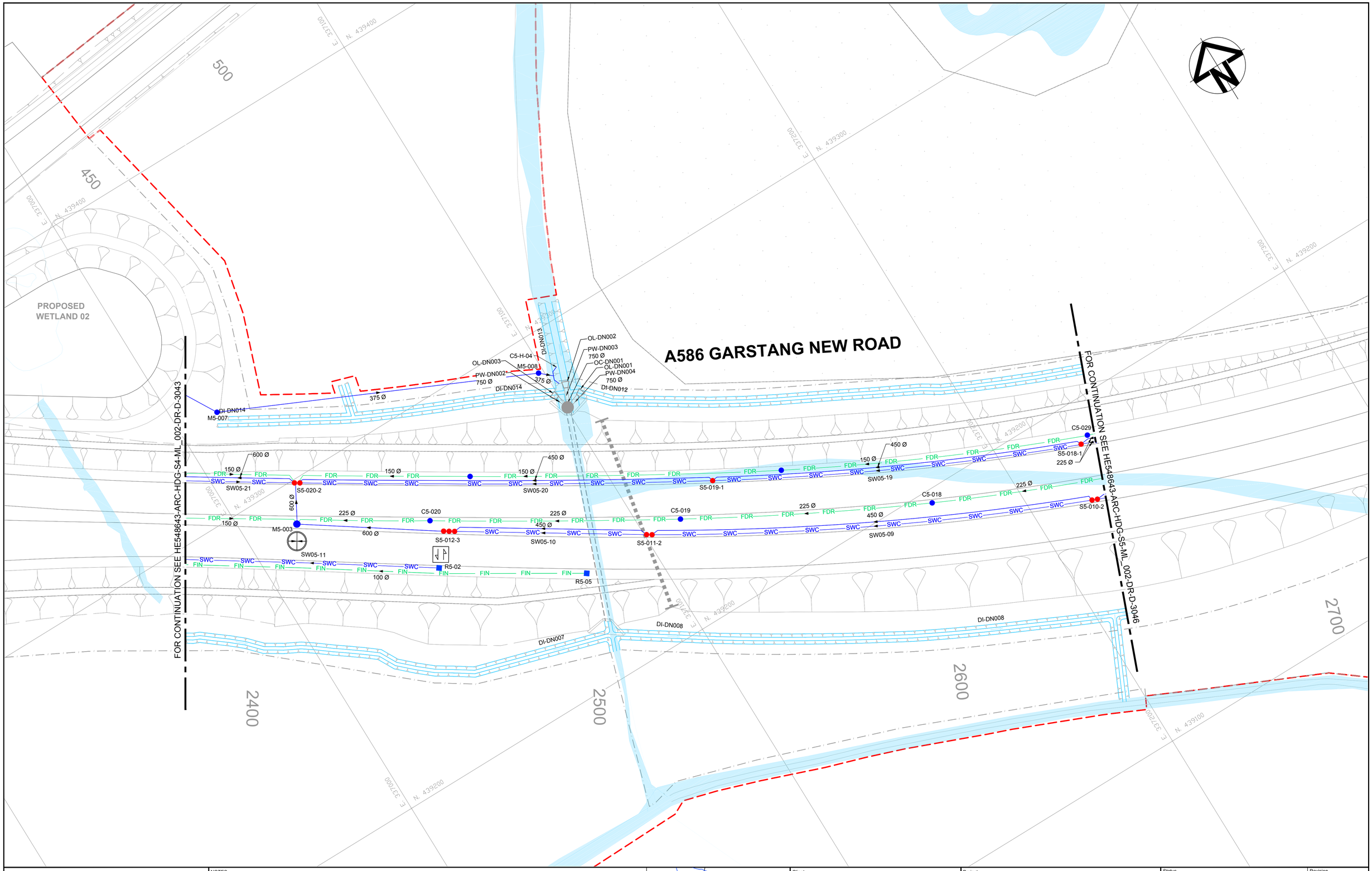
Status: S3 - PRELIMINARY DESIGN
Revision: P02
Scale: 1:500
Date: 10JUL2018
Drawn By: G[redacted]
Checked By: A[redacted]
Approved By: N[redacted]
Original Size: A1

Drawing number: HE548643-ARC-HDG-S4-ML_002-DR-D-3043

100mm on Original

Print Date:

File Path:

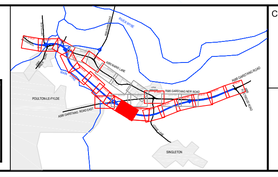


Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 10 OF 20

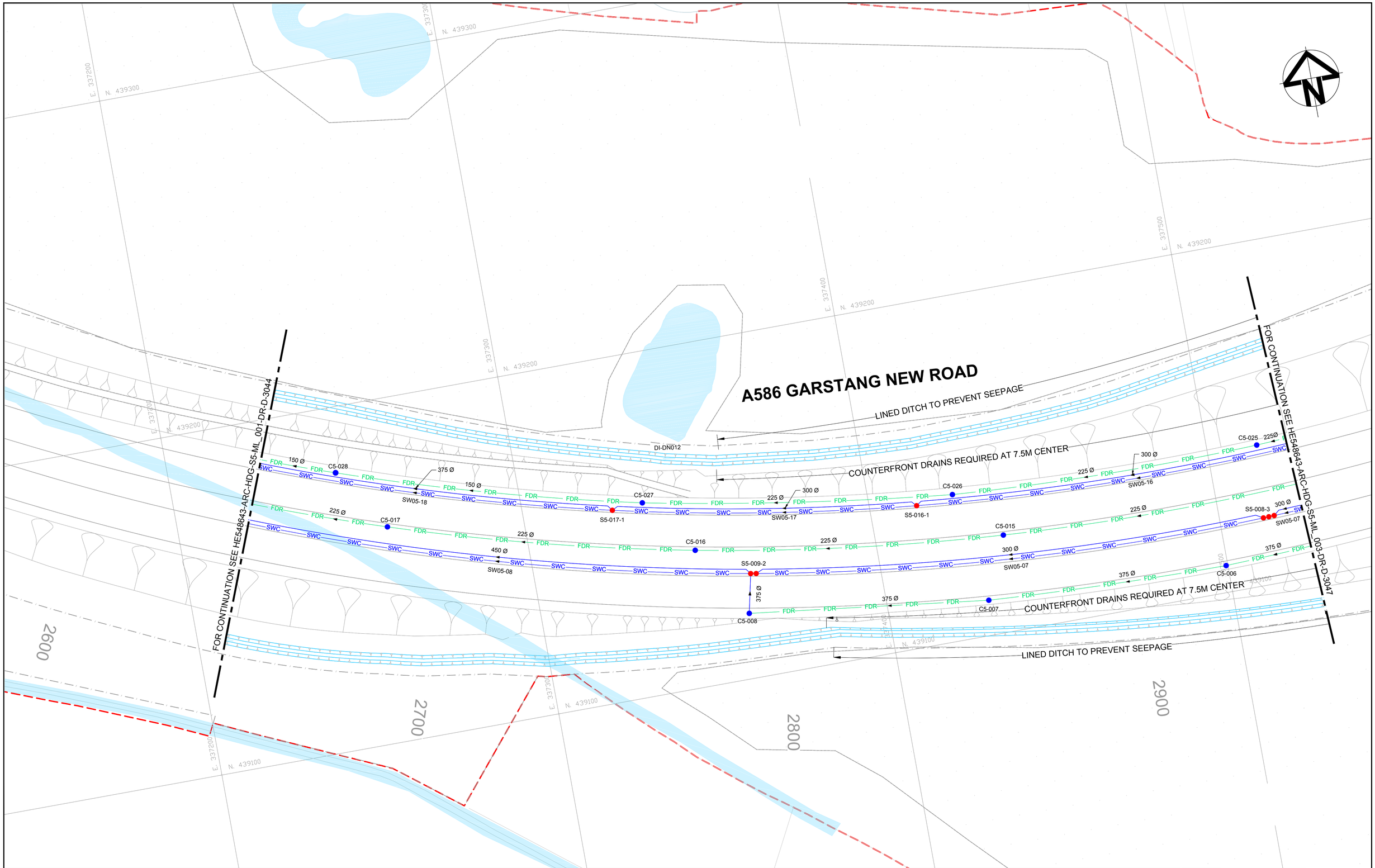
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE548643-ARC-HDG-S5-ML_001-DR-D-3044

100mm on Original

Print Date:

File Path:

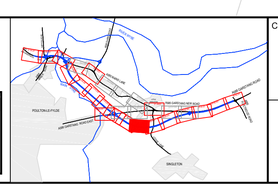


Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 11 OF 20

Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

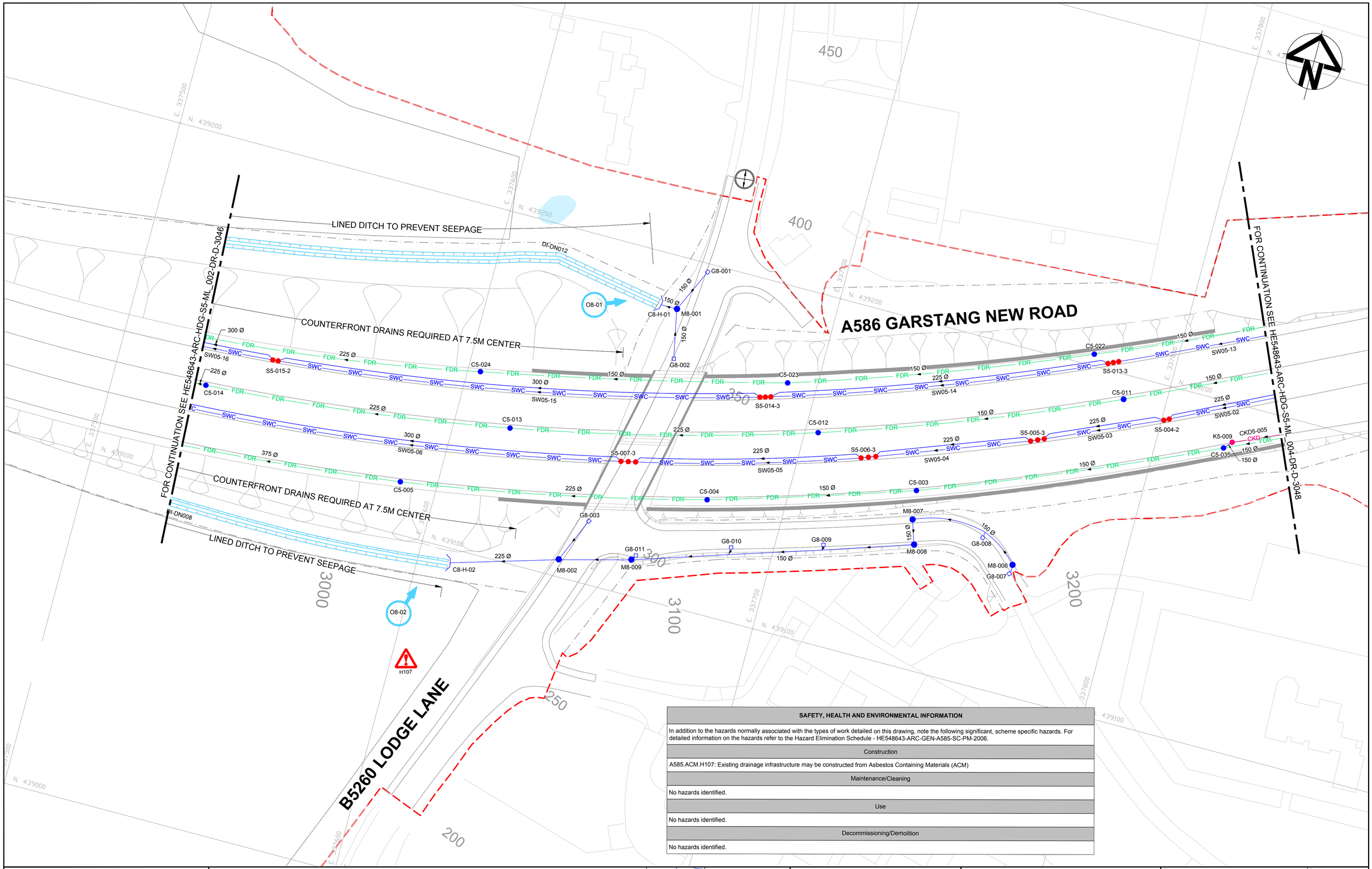
Drawing number: HE | PIN | Originator | Volume | Location | Type | Role | Number

HE548643-ARC-HDG-S5-ML_002-DR-D-3046

100mm on Original

Print Date:

File Path:



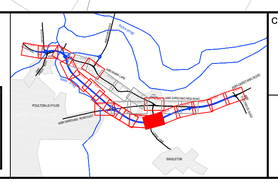
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 12 OF 20

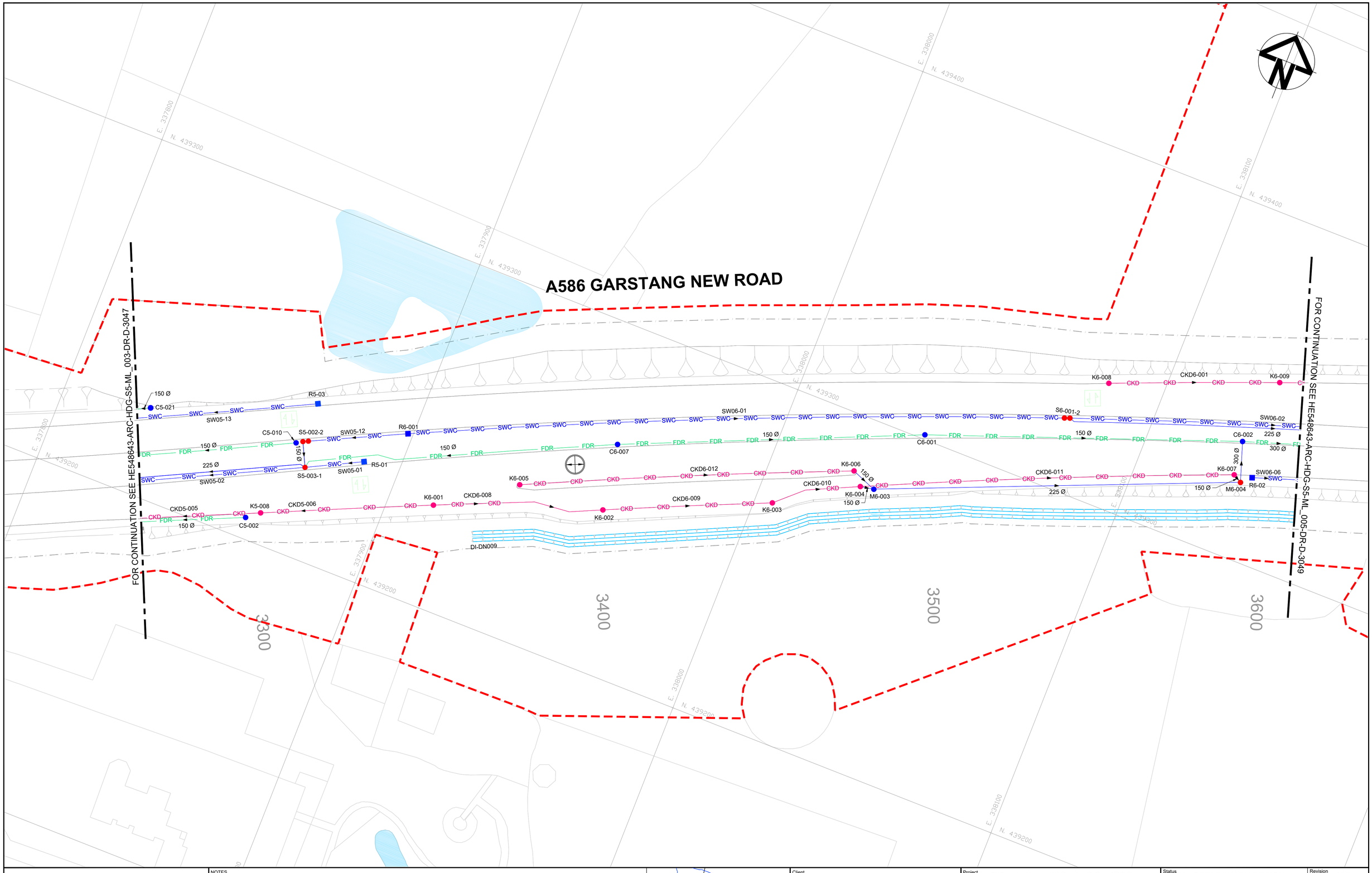
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE548643-ARC-HDG-S5-ML_003-DR-D-3047

100mm on Original

Print Date:

File Path:



NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G. [redacted]	A. [redacted]	N. [redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	G. [redacted]	A. [redacted]	N. [redacted]

100mm on Original

Print Date:

File Path:

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 13 OF 20

Status: S3 - PRELIMINARY DESIGN

Revision: P02

Scale: 1:500

Date: 10JUL2018

Drawn By: G. [redacted]

Checked By: A. [redacted]

Approved By: N. [redacted]

Original Size: A1

Drawing number: HE | PIN | Originator | Volume | Location | Type | Role | Number

HE548643-ARC-HDG-S5-ML_004-DR-D-3048

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

H107

A585 GARSTANG NEW ROAD

FOR CONTINUATION SEE HE548643-ARC-HDG-S5-ML_004-DR-D-3048

FOR CONTINUATION SEE HE548643-ARC-HDG-S6-ML_001-DR-D-3050

3600 3700 3800 3900

E. 338100 E. 338200 E. 338300 E. 338400 E. 338500

N. 439400 N. 439500 N. 439300

CKD6-002 CKD6-003 CKD6-004 CKD6-005 CKD6-006 CKD6-007

K6-010 K6-011 K6-012 K6-013 K6-014 K6-015 K6-016

M6-001 M6-002

150 Ø 225 Ø

SW06-02 SW06-03 SW06-04 SW06-05 SW06-06 SW06-07 SW06-08

S6-002-3 S6-003-2 S6-004-2 S6-006-2 S6-007-2

C6-003 C6-004 C6-005 C6-006

225 Ø 300 Ø 375 Ø

DI-DN009 OL-DN004 OL-DN005 PW-DN001

900 Ø

EXM10-010 EXM10-012 EXM10-01 EXM10-02

EXG10-03 EXG10-04 EXG10-01 EXG10-02

CDR 150 Ø

SWC FDR CKD

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 14 OF 20

Status: S3 - PRELIMINARY DESIGN | Revision: P02

Scale: 1:500 | Date: 10JUL2018

Drawn By: G[redacted]
Checked By: A[redacted]
Approved By: N[redacted]

Original Size: A1

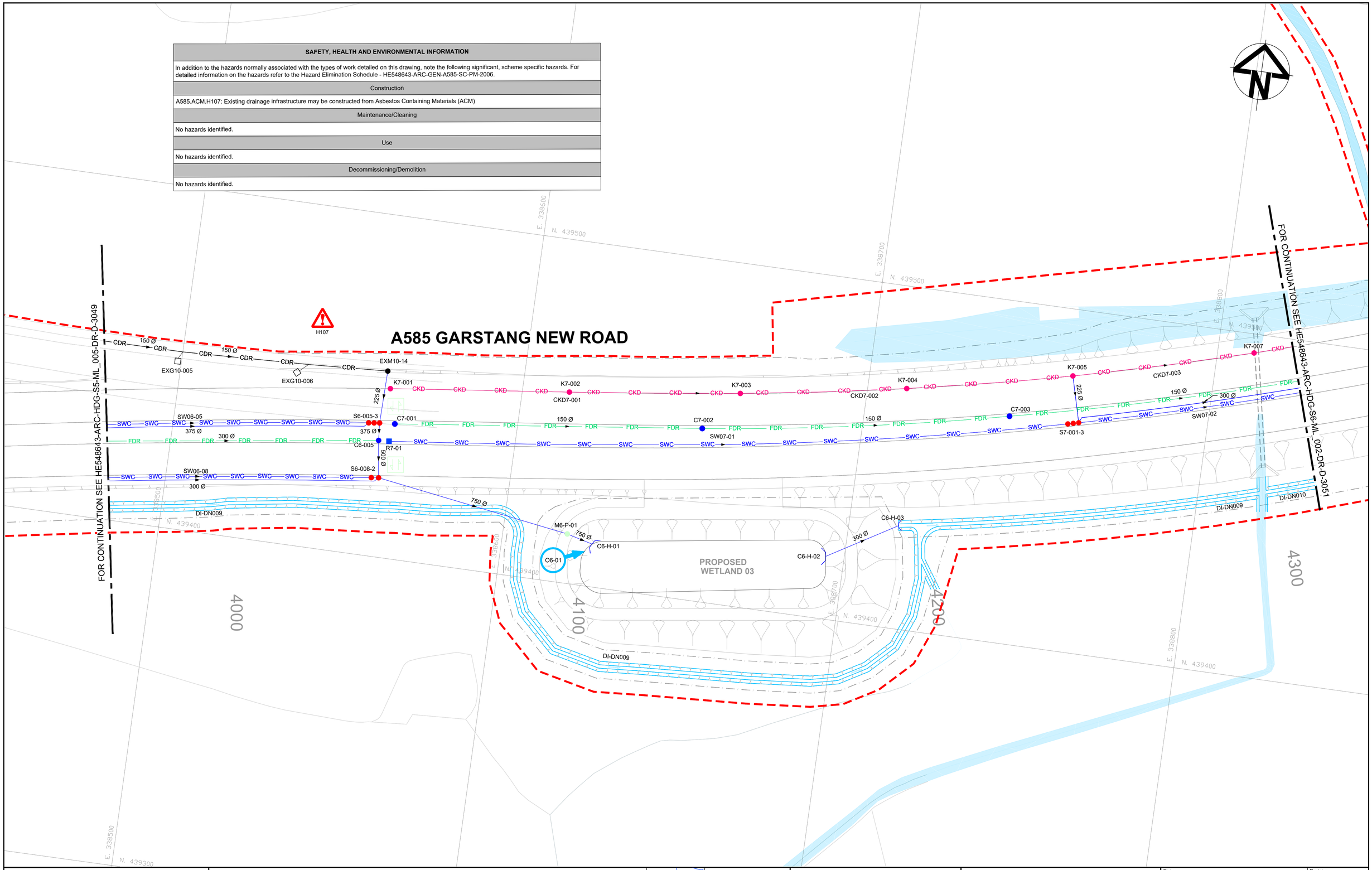
Drawing number: HE | PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-S5-ML_005-DR-D-3049

100mm on Original

Print Date:

File Path:

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.



Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Print Date:

File Path:

Client

highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 15 OF 20

Status: S3 - PRELIMINARY DESIGN

Revision: P02

Scale: 1:500

Date: 10JUL2018

Drawn By: G[redacted]

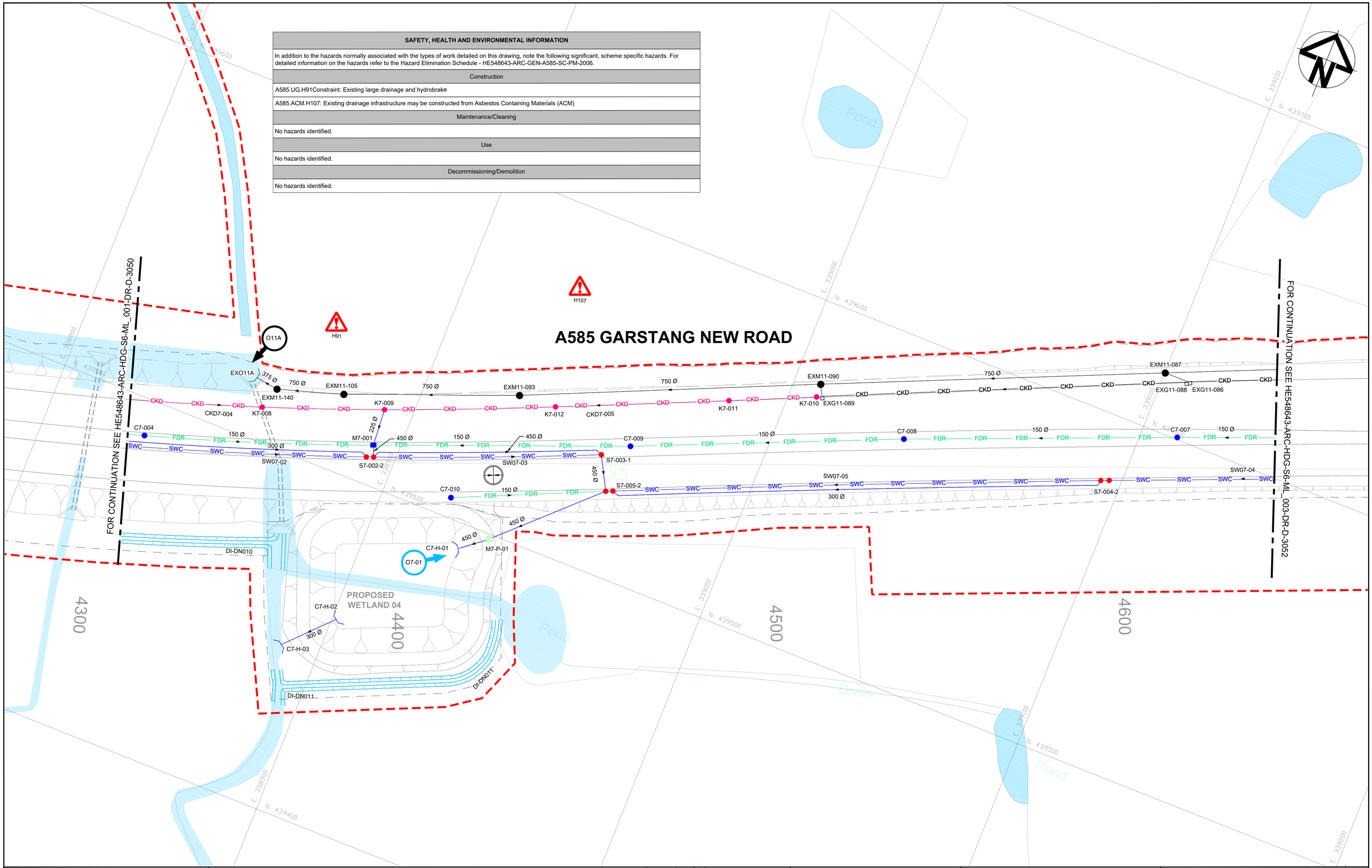
Checked By: A[redacted]

Approved By: N[redacted]

Original Size: A1

Drawing number: HE548643-ARC-HDG-S6-ML_001-DR-D-3050

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.UG.H91Constraint: Existing large drainage and hydrobrake
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.



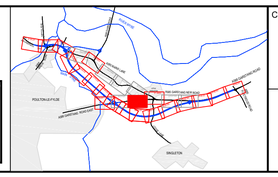
Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client

highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 16 OF 20

Status: S3 - PRELIMINARY DESIGN

Revision: P02

Scale: 1:500

Date: 10JUL2018

Drawn By: G[redacted]

Checked By: A[redacted]

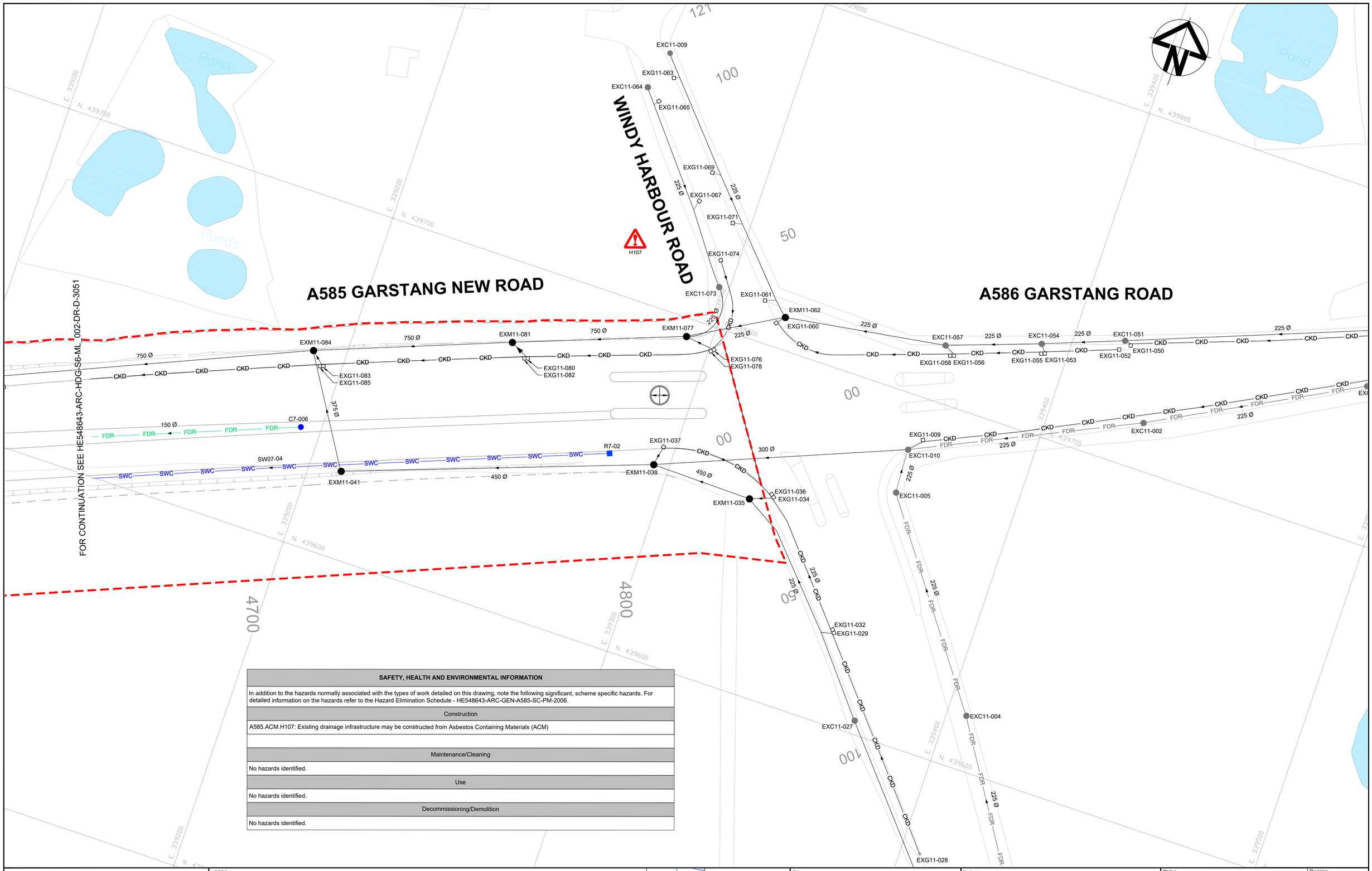
Approved By: N[redacted]

Original Size: A1

Drawing number: HE548643-ARC-HDG-S6-ML_002-DR-D-3051

Print Date:

File Path:



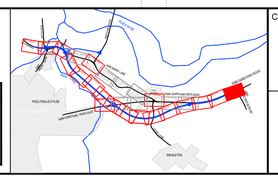
SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
In addition to the hazards normally associated with the types of work detailed on this drawing, note the following significant, scheme specific hazards. For detailed information on the hazards refer to the Hazard Elimination Schedule - HE548643-ARC-GEN-A585-SC-PM-2006.
Construction
A585.ACM.H107: Existing drainage infrastructure may be constructed from Asbestos Containing Materials (ACM)
Maintenance/Cleaning
No hazards identified.
Use
No hazards identified.
Decommissioning/Demolition
No hazards identified.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 17 OF 20

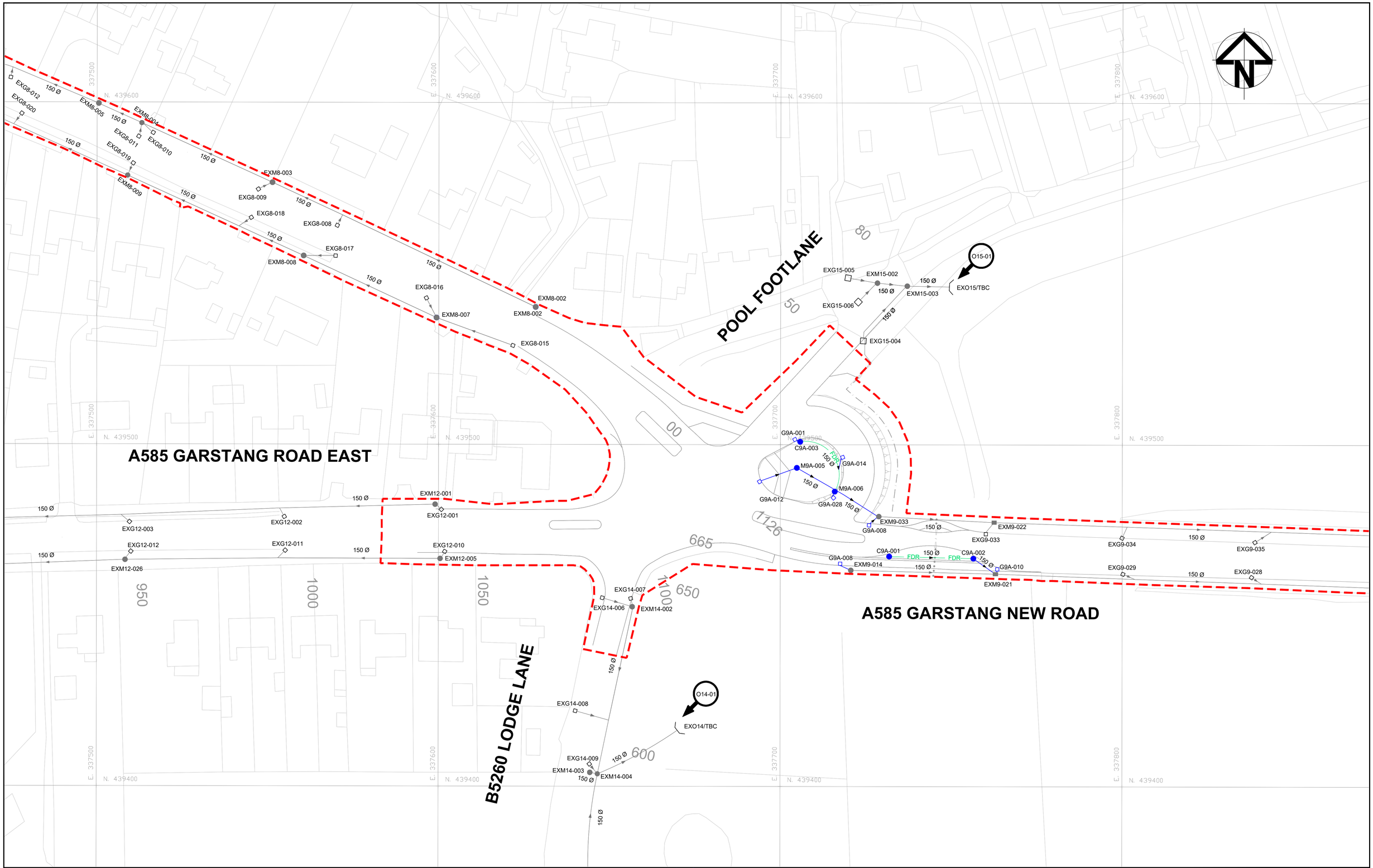
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE548643-ARC-HDG-S6-ML_003-DR-D-3052

100mm on Original

Print Date:

File Path:

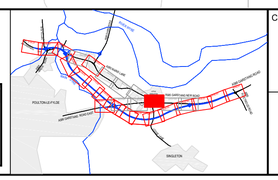


Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	G[redacted]	A[redacted]	N[redacted]

NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 18 OF 20

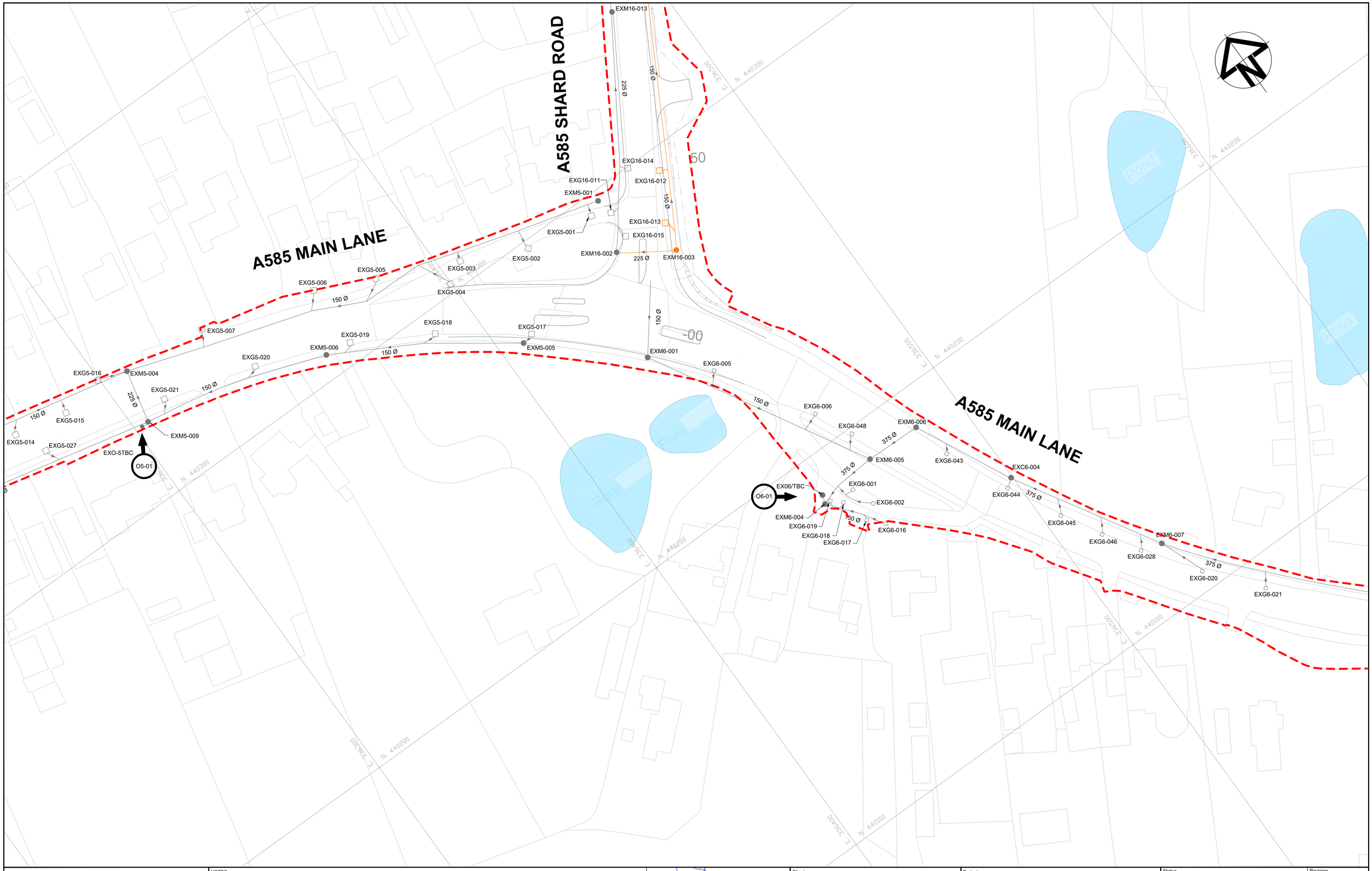
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-S7-JN_001-DR-D-3053

100mm on Original

Print Date:

File Path:



NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3032

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	22DEC2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 19 OF 20

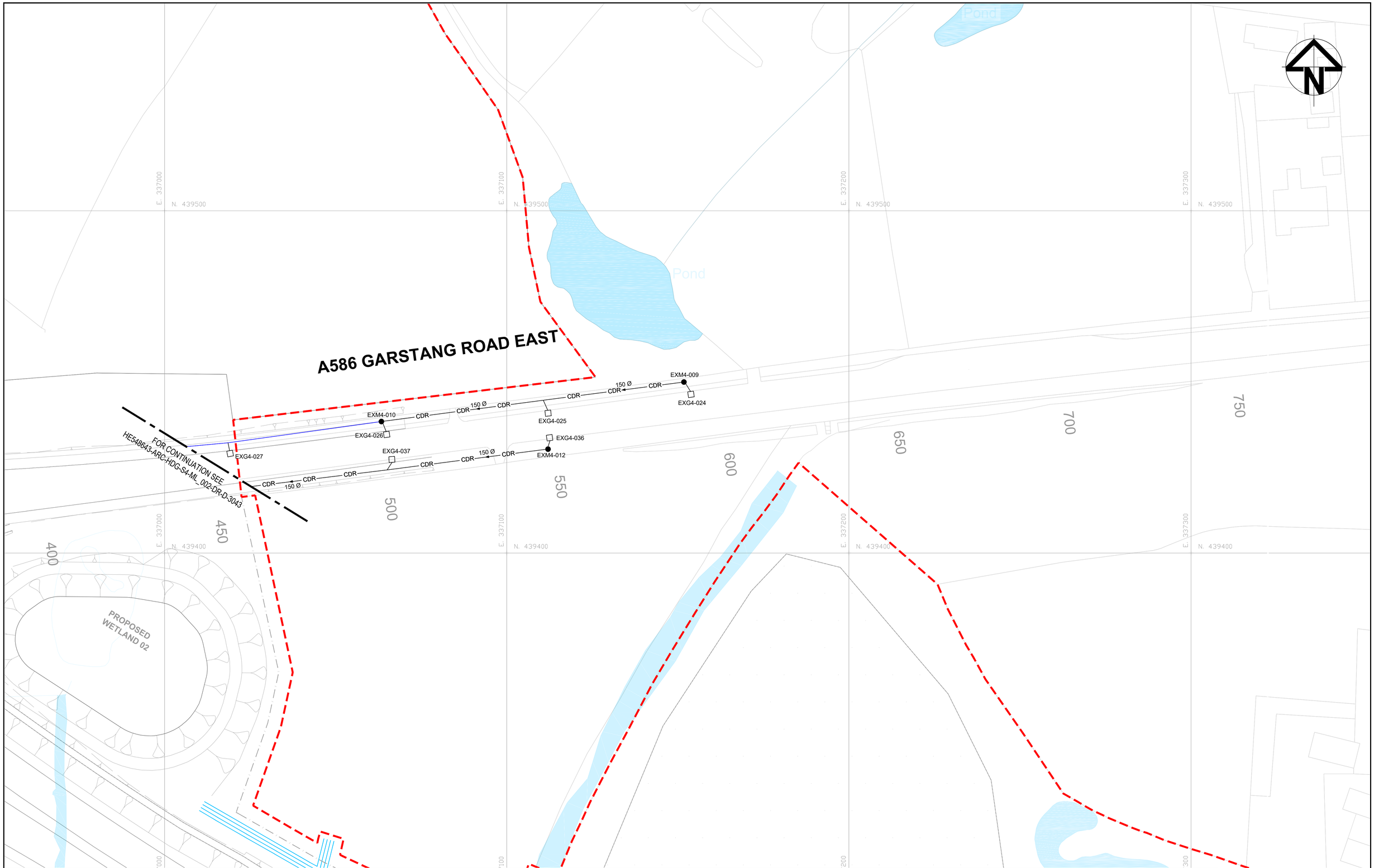
Status: S3 - PRELIMINARY DESIGN
Revision: P02
Scale: 1:500
Date: 10JUL2018
Drawn By: G[redacted]
Checked By: A[redacted]
Approved By: N[redacted]
Original Size: A1

Drawing number: HE548643-ARC-HDG-S8-DT_002-DR-D-3054
(HE PIN | Originator | Volume | Location | Type | Role | Number)

100mm on Original

Print Date:

File Path:

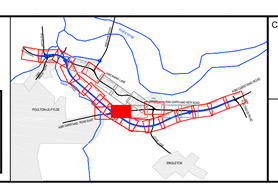


NOTES

1. FOR NOTES AND LEGENDS REFER DRAWING NO : HE548643-ARC-HDG-SZ-GN000-DR-D-3072

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	S3	21FEB2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649



Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PLAN SHEET 20 OF 20

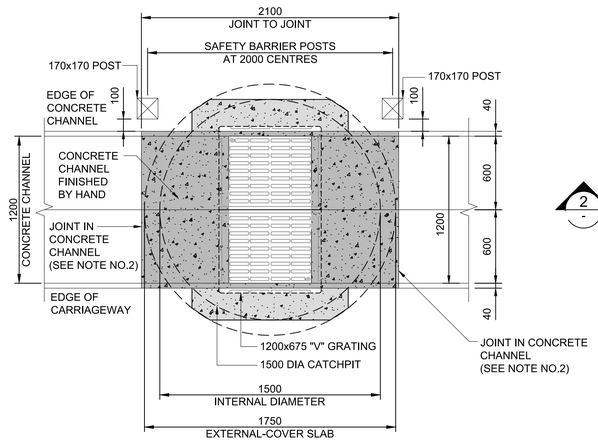
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	10JUL2018
Drawn By	G[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE | PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-S9-DT_001-DR-D-3055

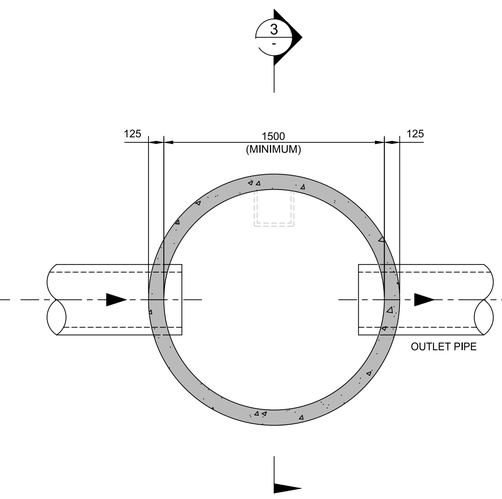
100mm on Original

Print Date:

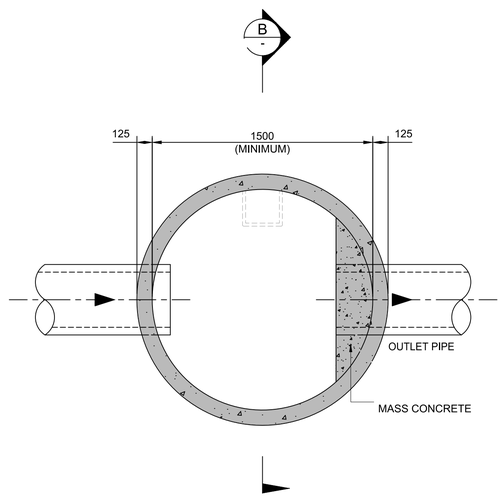
File Path:



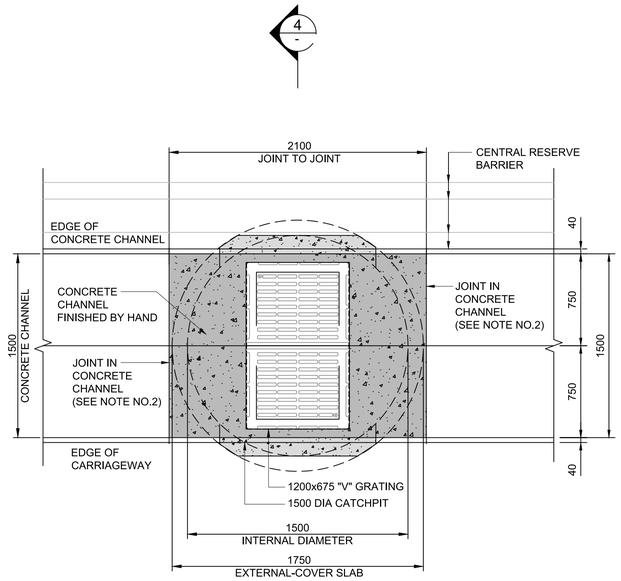
PLAN AT COVER LEVEL
1200 WIDE CHANNEL - VERGE



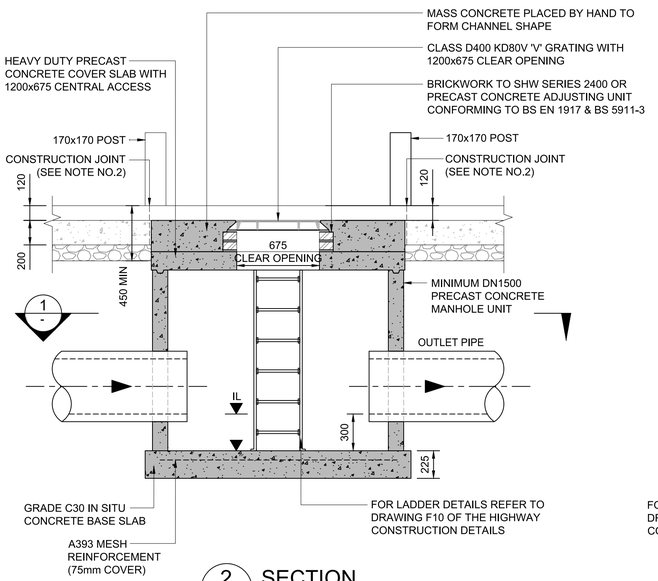
1 SECTION
-



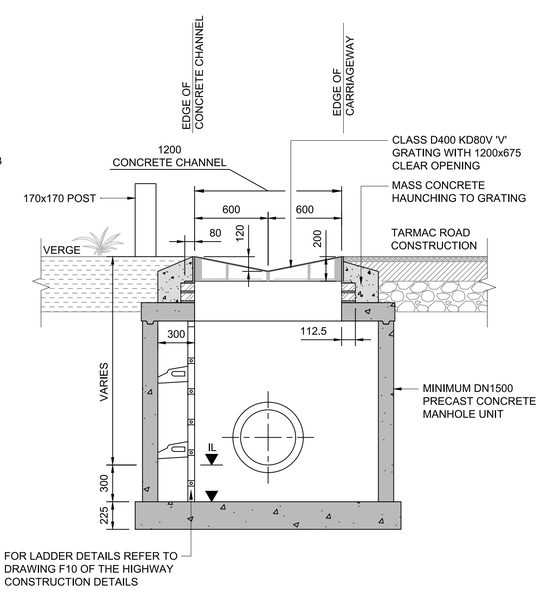
A SECTION
-



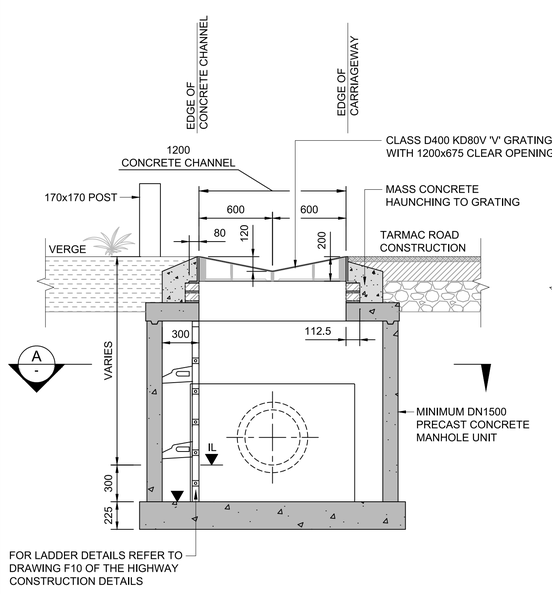
PLAN AT COVER LEVEL
1500 WIDE CHANNEL
CENTRAL RESERVE



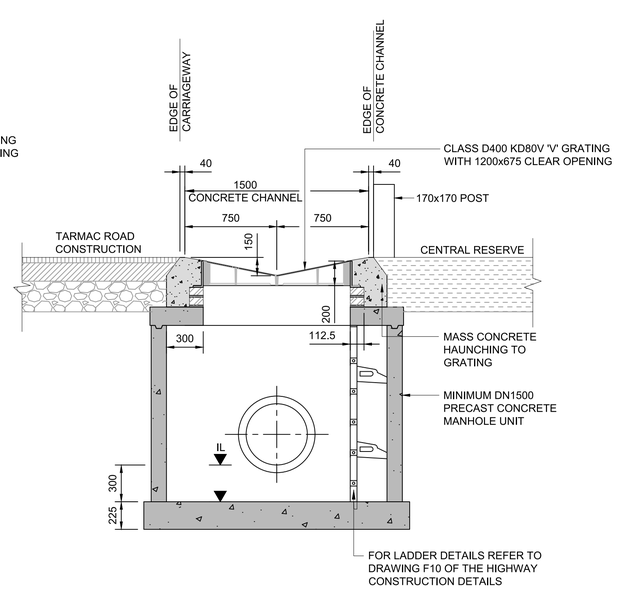
2 SECTION
-



3 SECTION
-



B SECTION
-



4 SECTION
-

NOTES

1. SAFETY CHAINS REQUIRED WHERE OUTLET PIPE IS 600 DIA OR GREATER.
2. CONSTRUCTION JOINT (TRANSVERSE JOINT) BETWEEN THE SLIP FORMED STORM WATER CHANNEL AND HAND-LAID SECTION (APRON SLAB) SHALL BE IN ACCORDANCE WITH THE HIGHWAY CONSTRUCTION DRAWINGS (HCD's), F SERIES DRAWINGS, DRAWING F22, NOTE 6.
3. THE DETAIL TO BE READ IN CONJUNCTION WITH PROPOSED DRAINAGE PLANS (HE548643-ARC-HDG-A585-DR-D-3324-3342).
4. ALL DIMENSIONS ARE IN MILIMETRES UNLESS SPECIFIED.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S. [redacted]	A. [redacted]	N. [redacted]

Client: highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: SURFACE WATER CHANNEL DETAILS 1 PAIR INTERMEDIATE

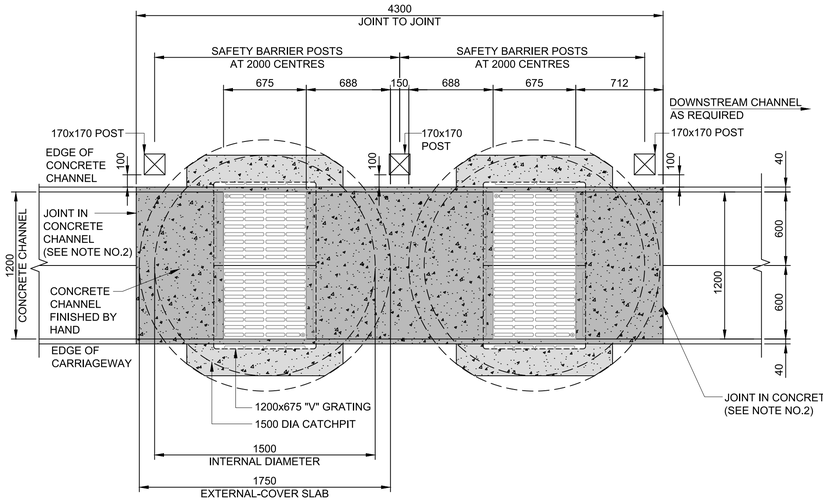
Status	S3-PRELIMINARY DESIGN	Revision P02
Scale	NTS	Date 10JUL2018
Drawn By	S. [redacted]	
Checked By	A. [redacted]	
Approved By	N. [redacted]	
		Original Size A1

Drawing number HE PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-SZ-GN_000-DE-D-3056

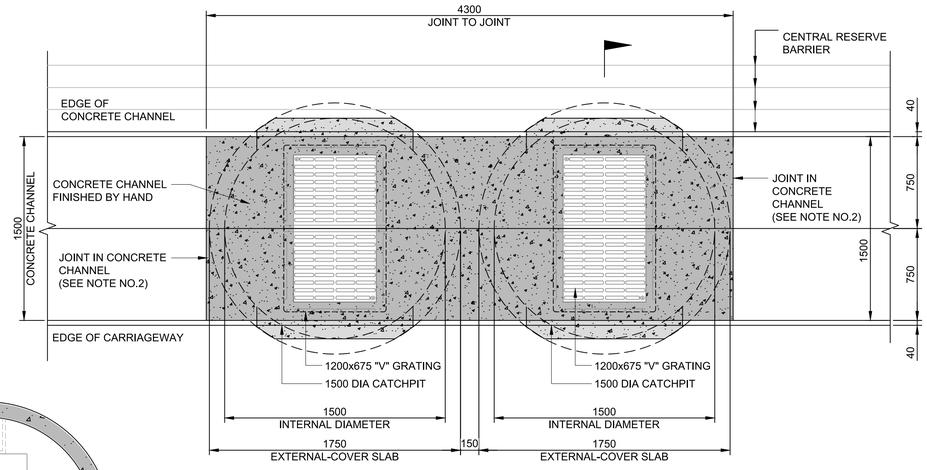
100mm on Original

Print Date: 2018-07-13 15:42:56

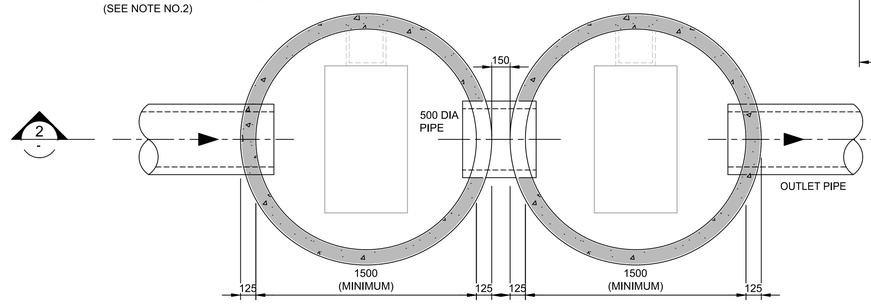
File Path: \\hc-ukr-hy-fs-10\HY_Proj\Highways\UKR\UB004249-01-A585 Drainage\E-Drawings\Working Drawings\Drawings\Standard Details\P03\HE548643-ARC-HDG-SZ-GN_000-DE-D-3056-3061.dwg



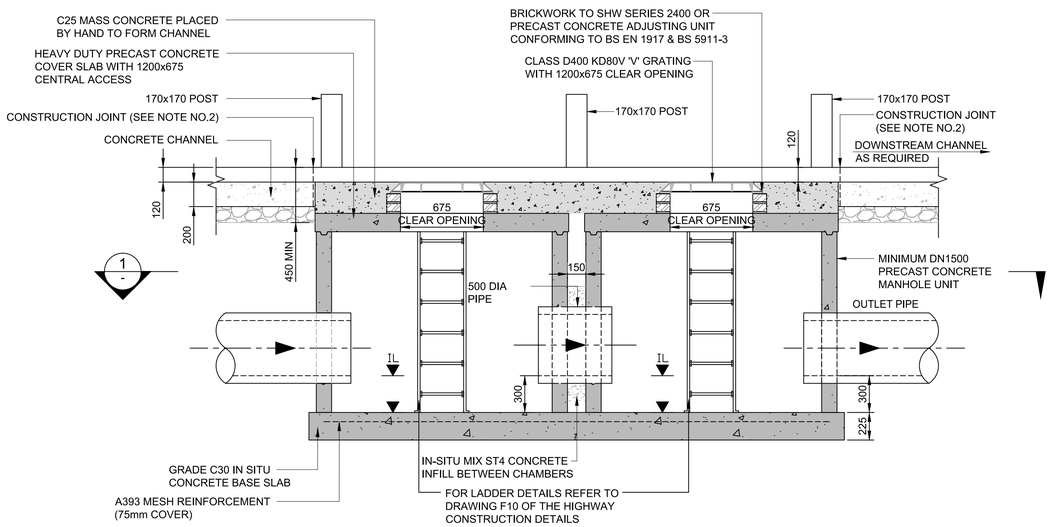
PLAN AT COVER LEVEL
1200 WIDE CHANNEL - VERGE



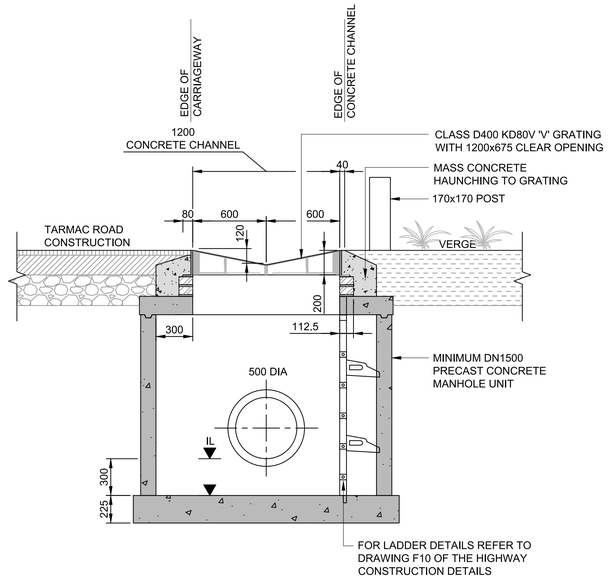
PLAN AT COVER LEVEL
1500 WIDE CHANNEL
CENTRAL RESERVE



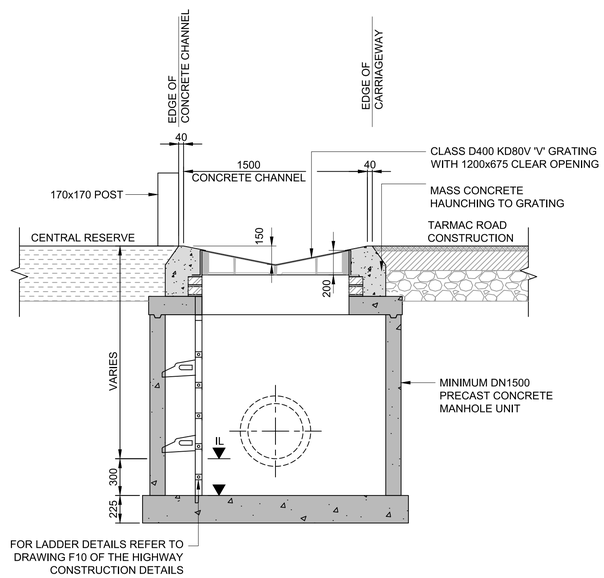
1 - SECTION - 3



1 - SECTION - 2



3 - SECTION



4 - SECTION

NOTES

1. SAFETY CHAINS REQUIRED WHERE OUTLET PIPE IS 600 DIA OR GREATER.
2. CONSTRUCTION JOINT (TRANSVERSE JOINT) BETWEEN THE SLIP FORMED STORM WATER CHANNEL AND HAND-LAID SECTION (APRON SLAB) SHALL BE IN ACCORDANCE WITH THE HIGHWAY CONSTRUCTION DRAWINGS (HCD's), F SERIES DRAWINGS, DRAWING F22, NOTE 6.
3. THE DETAIL TO BE READ IN CONJUNCTION WITH PROPOSED DRAINAGE PLANS (HE548643-ARC-HDG-A585-DR-D-3324-3342).
4. ALL DIMENSIONS ARE IN MILIMETRES UNLESS SPECIFIED.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: SURFACE WATER CHANNEL DETAILS 2 PAIR INTERMEDIATE

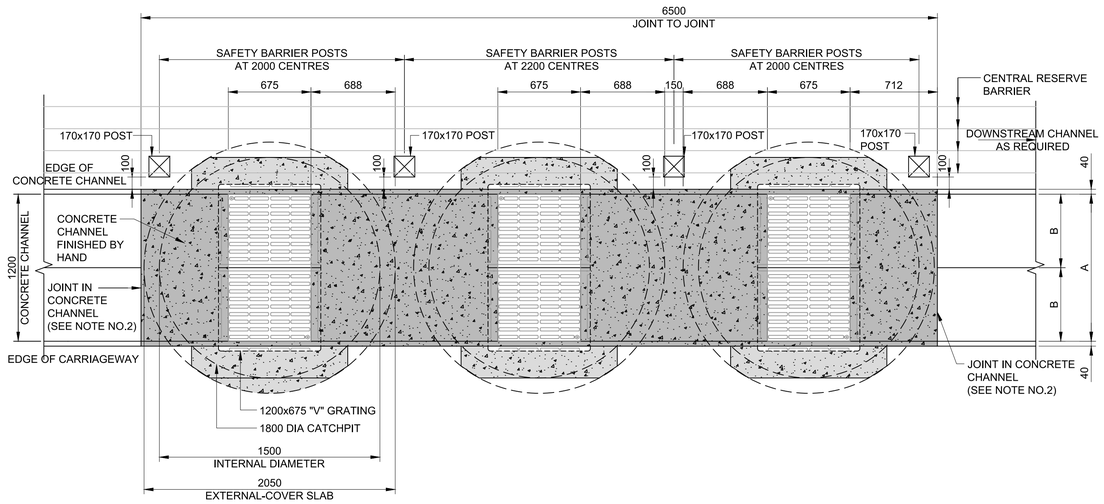
Status	S3-PRELIMINARY DESIGN
Revision	P02
Scale	NTS
Date	10JUL2018
Drawn By	S.[redacted]
Checked By	A.[redacted]
Approved By	N.[redacted]
Original Size	A1

Drawing number: HE548643-ARC-HDG-SZ-GN_000-DE-D-3057

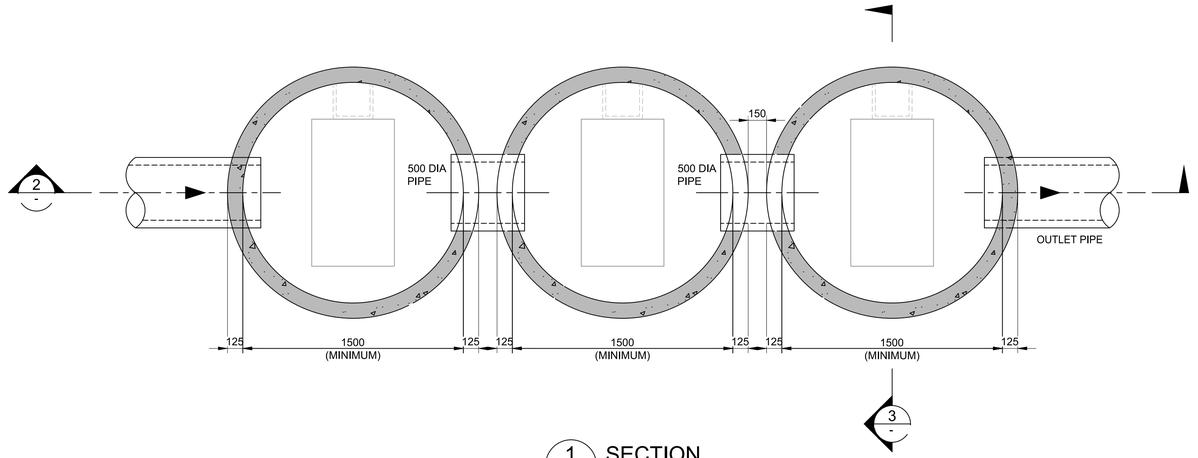
100mm on Original

Print Date: 2018-07-13 15:43:03

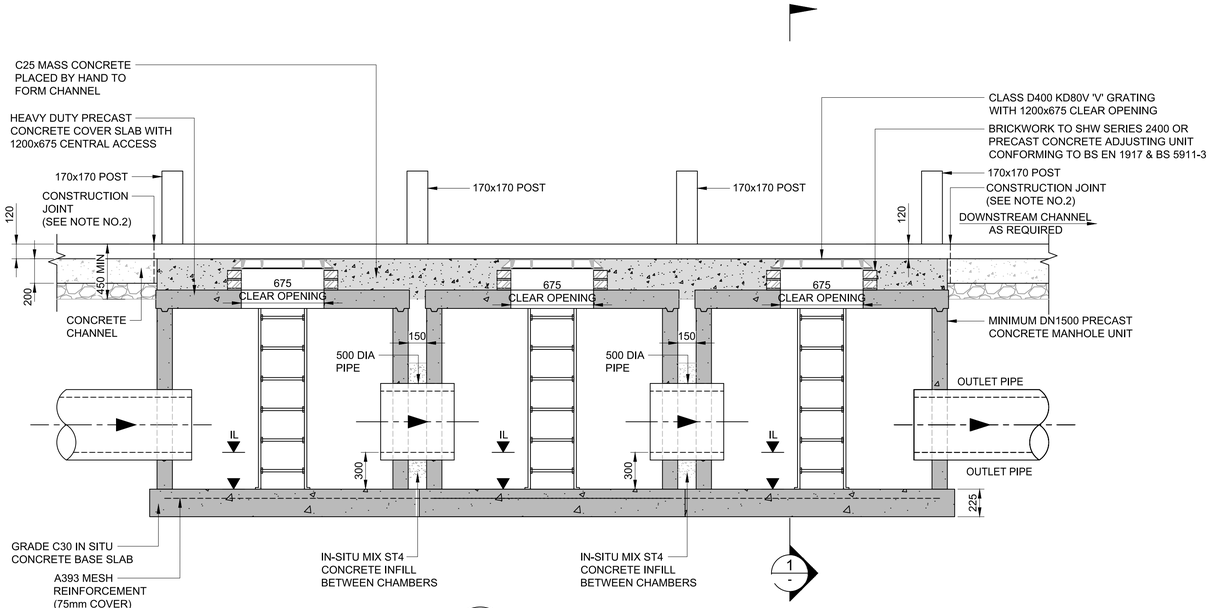
File Path: \\hc-ukr-hy-fs-10\HY_Proj\Highways\UKR\UB004249-01-A585 Drainage\E-Drawings\Working Drawings\Drawings\Standard Details\P03\HE548643-ARC-HDG-SZ-GN_000-DE-D-3056-3061.dwg



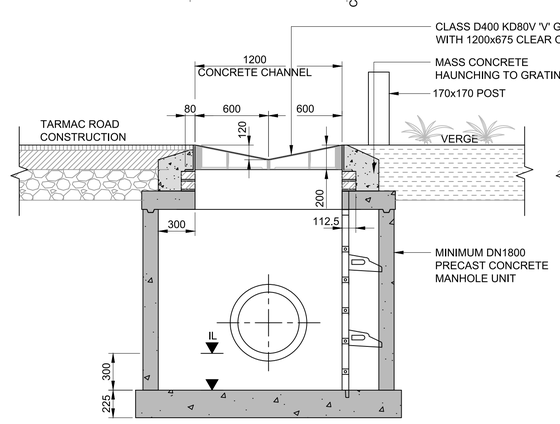
PLAN AT COVER LEVEL



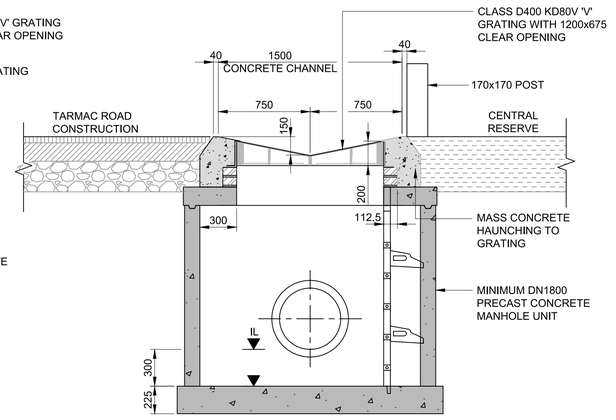
1 - SECTION



2 - SECTION



3 - SECTION



SECTION AT CENTRAL RESERVE

CHANNEL	DIMENSION		LOCATION
	A	B	
1200	1200	600	VERGE
1500	1500	750	CENTRAL RESERVE

NOTES

1. SAFETY CHAINS REQUIRED WHERE OUTLET PIPE IS 600 DIA OR GREATER.
2. CONSTRUCTION JOINT (TRANSVERSE JOINT) BETWEEN THE SLIP FORMED STORM WATER CHANNEL AND HAND-LAID SECTION (APRON SLAB) SHALL BE IN ACCORDANCE WITH THE HIGHWAY CONSTRUCTION DRAWINGS (HCD's), F SERIES DRAWINGS, DRAWING F22, NOTE 6.
3. THE DETAIL TO BE READ IN CONJUNCTION WITH PROPOSED DRAINAGE PLANS (HE548643-ARC-HDG-A585-DR-D-3324-3342).
4. ALL DIMENSIONS ARE IN MILIMETRES UNLESS SPECIFIED.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Client: highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office: Arcadis House, 34 York Way, London, N1 9AB

Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: SURFACE WATER CHANNEL DETAILS 3 PAIR INTERMEDIATE

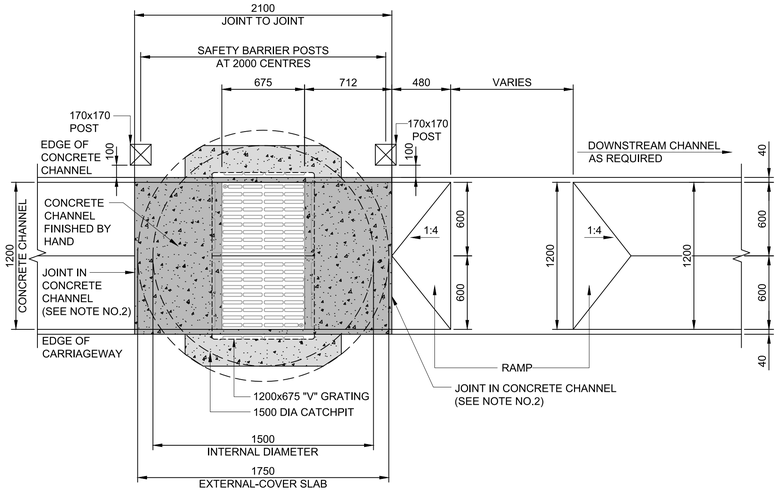
Status	S3-PRELIMINARY DESIGN	Revision	P02
Scale	NTS	Date	10JUL2018
Drawn By	S.[redacted]		
Checked By	A.[redacted]		
Approved By	N.[redacted]		
		Original Size	A1

Drawing number: HE548643-ARC-HDG-SZ-GN_000-DE-D-3058

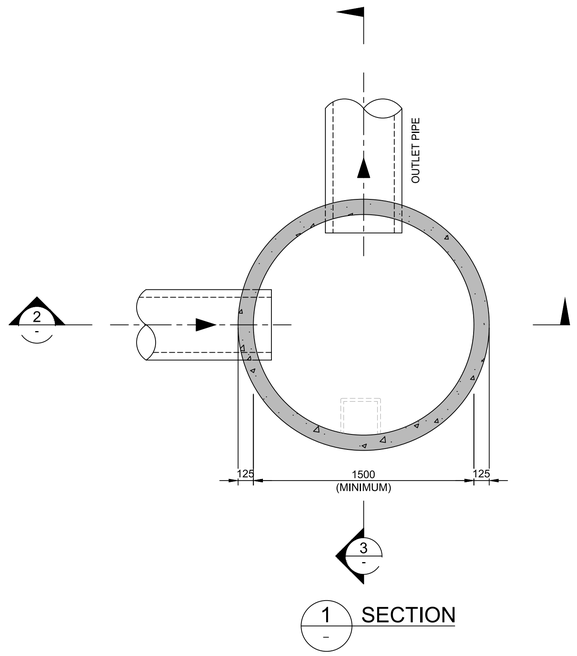
100mm on Original

Print Date: 2018-07-13 15:43:08

File Path: \\hc-ukr-hy-fs-10\HY_Proj\Highways\UKR\UB004249-01-A585 Drainage\E-Drawings\Working Drawings\Drawings\Standard Details\P03\HE548643-ARC-HDG-SZ-GN_000-DE-D-3056-3061.dwg



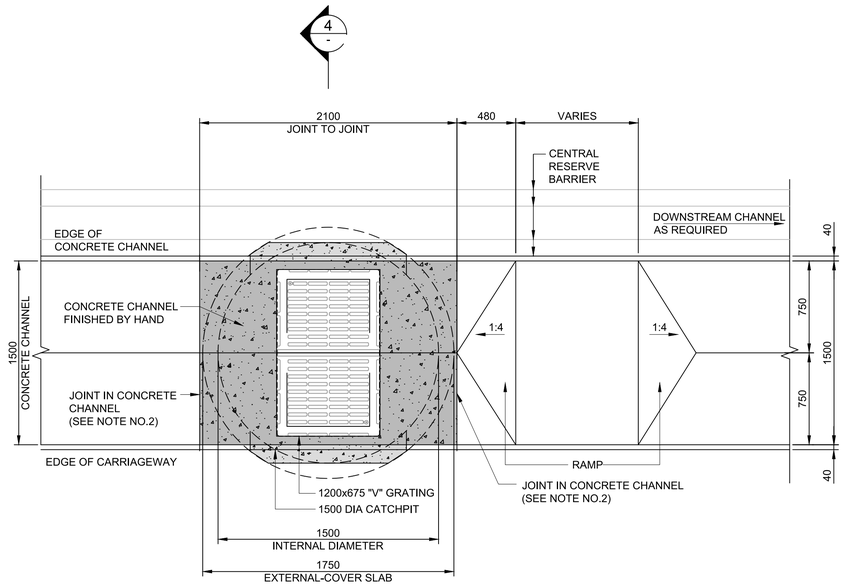
PLAN AT COVER LEVEL
1200 WIDE CHANNEL - VERGE



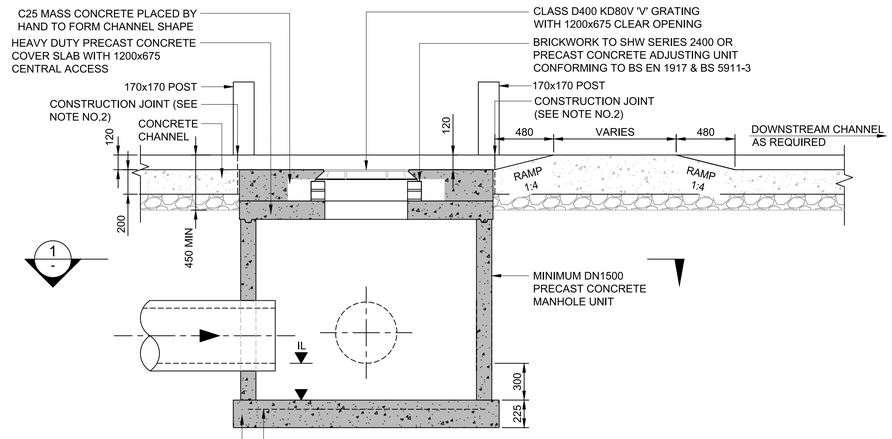
2 – SECTION

3 – SECTION

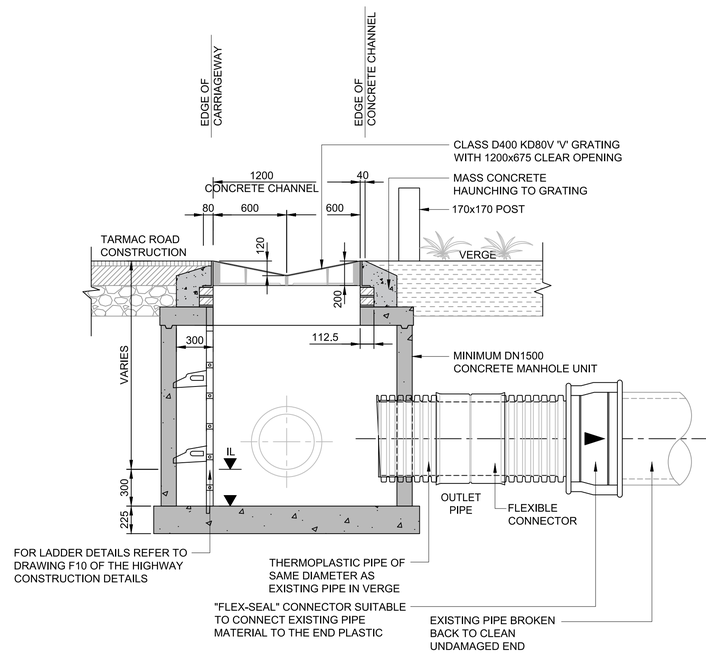
1 – SECTION



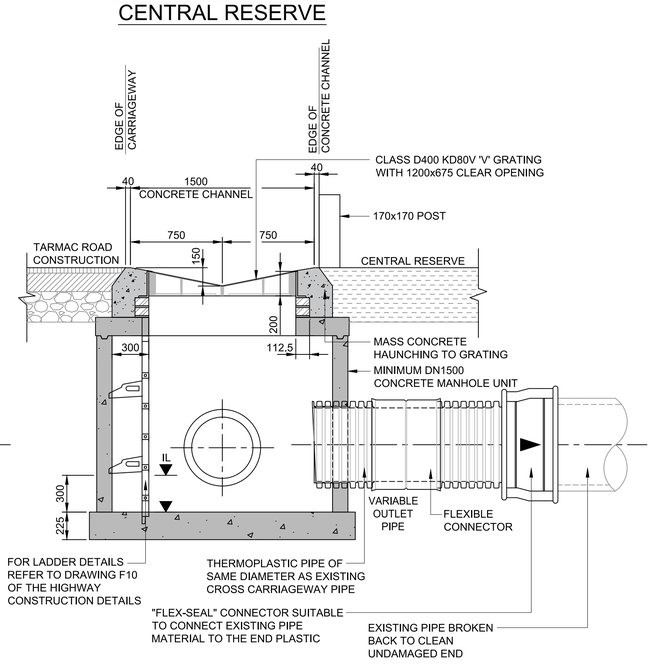
PLAN AT COVER LEVEL
1500 WIDE CHANNEL
CENTRAL RESERVE



2 – SECTION



3 – SECTION



4 – SECTION

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. SAFETY CHAINS REQUIRED WHERE OUTLET PIPE IS 600 DIA OR GREATER.
2. CONSTRUCTION JOINT (TRANSVERSE JOINT) BETWEEN THE SLIP FORMED STORM WATER CHANNEL AND HAND-LAID SECTION (APRON SLAB) SHALL BE IN ACCORDANCE WITH THE HIGHWAY CONSTRUCTION DRAWINGS (HCD's), F SERIES DRAWINGS, DRAWING F22, NOTE 6.
3. THE DETAIL TO BE READ IN CONJUNCTION WITH PROPOSED DRAINAGE PLANS (HE548643-ARC-HDG-A585-DR-D-3324-3342).
4. ALL DIMENSIONS ARE IN MILIMETRES UNLESS SPECIFIED.

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: SURFACE WATER CHANNEL DETAILS 1 PAIR TERMINAL

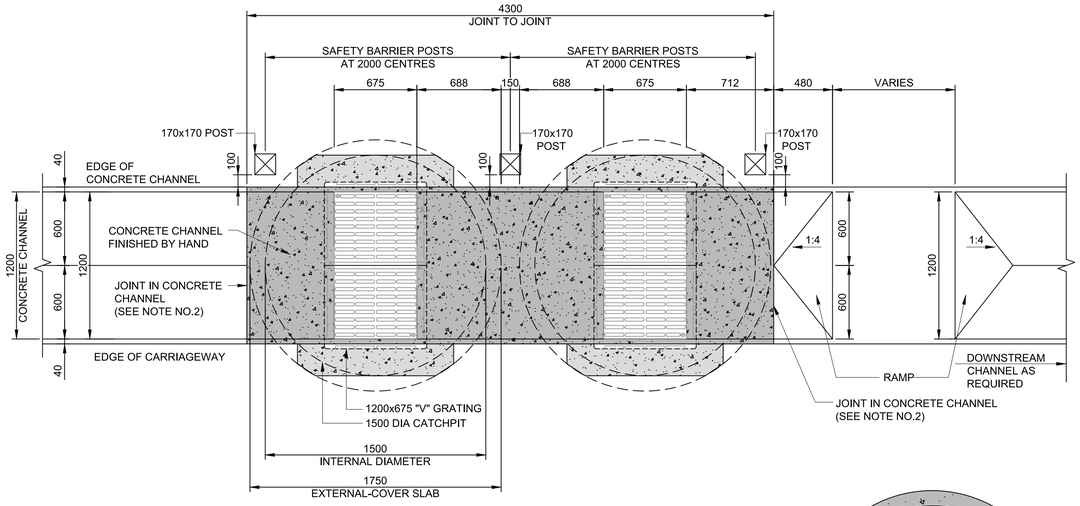
Status	S3-PRELIMINARY DESIGN
Revision	P02
Scale	NTS
Date	10JUL2018
Drawn By	S[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

Drawing number: HE PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-SZ-GN_000-DE-D-3059

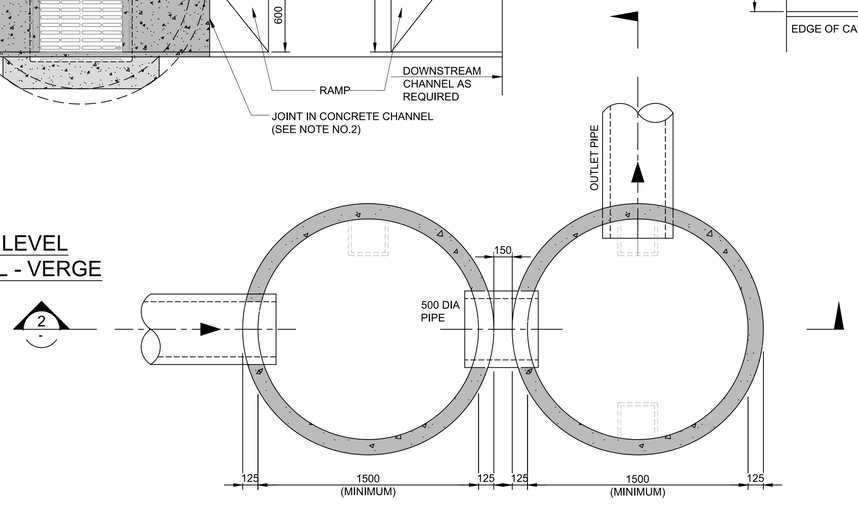
100mm on Original

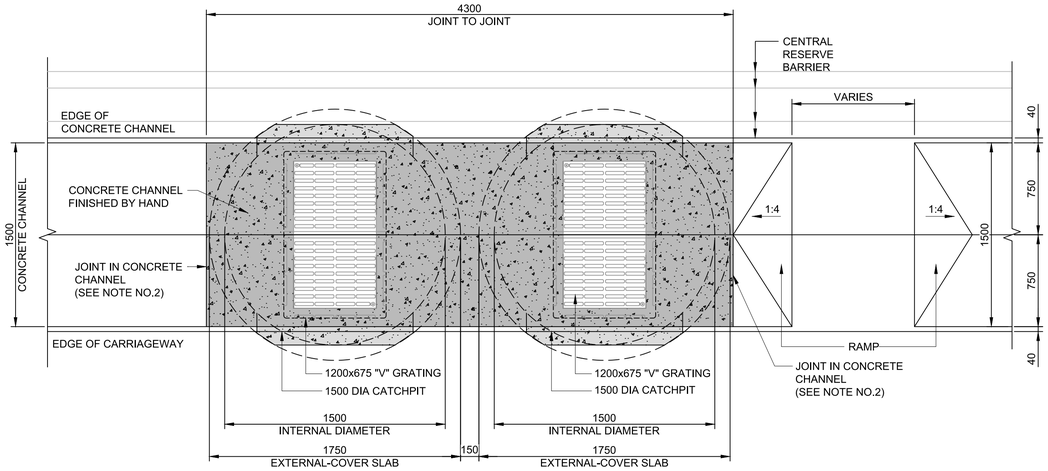
Print Date: 2018-07-13 15:43:13

File Path: \\hc-ukr-hy-fs-10\HY_Proj\Highways\UKR\UB004249-01-A585 Drainage\E-Drawings\Working Drawings\Drawings\Standard Details\P03\HE548643-ARC-HDG-SZ-GN_000-DE-D-3056-3061.dwg

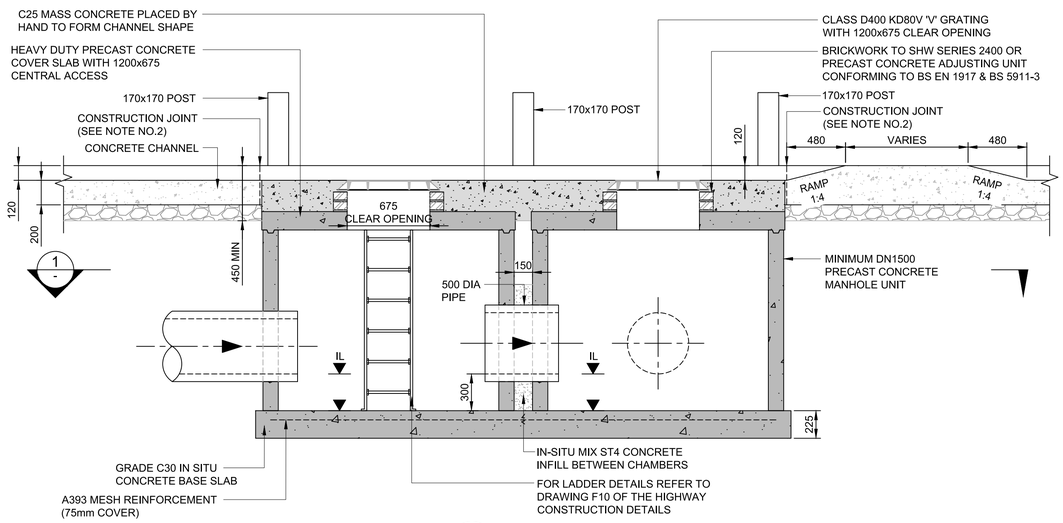


PLAN AT COVER LEVEL
1200 WIDE CHANNEL - VERGE

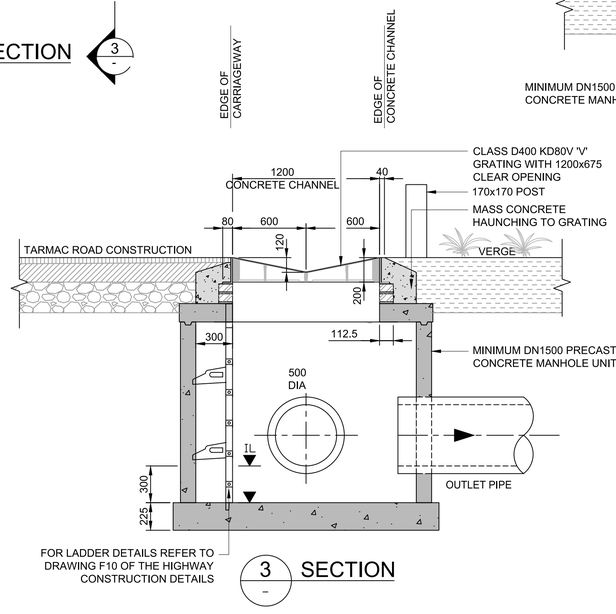




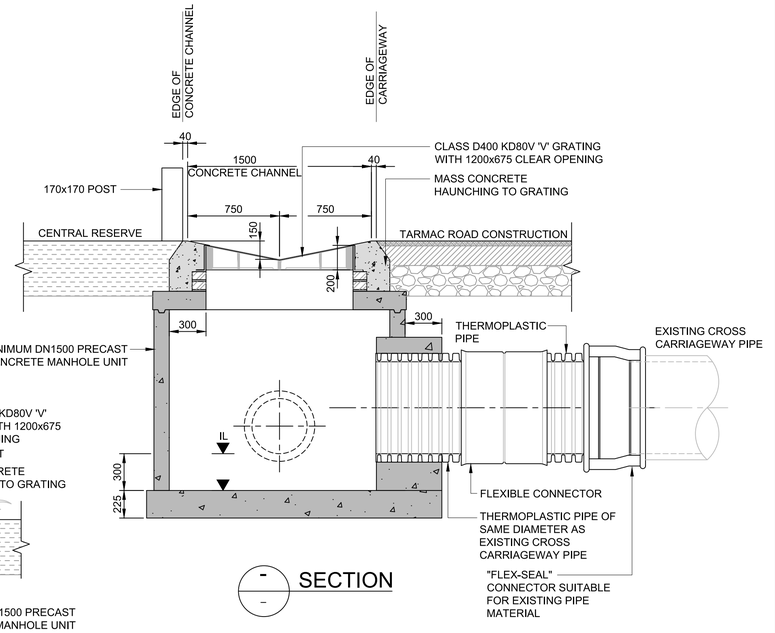
PLAN AT COVER LEVEL
1500 WIDE CHANNEL
CENTRAL RESERVE



2 SECTION



3 SECTION



- SECTION

NOTES

1. SAFETY CHAINS REQUIRED WHERE OUTLET PIPE IS 600 DIA OR GREATER.
2. CONSTRUCTION JOINT (TRANSVERSE JOINT) BETWEEN THE SLIP FORMED STORM WATER CHANNEL AND HAND-LAID SECTION (APRON SLAB) SHALL BE IN ACCORDANCE WITH THE HIGHWAY CONSTRUCTION DRAWINGS (HCD's), F SERIES DRAWINGS, DRAWING F22, NOTE 6.
3. THE DETAIL TO BE READ IN CONJUNCTION WITH PROPOSED DRAINAGE PLANS (HE548643-ARC-HDG-A585-DR-D-3324-3342).
4. ALL DIMENSIONS ARE IN MILIMETRES UNLESS SPECIFIED.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: SURFACE WATER CHANNEL DETAILS 2 PAIR TERMINAL

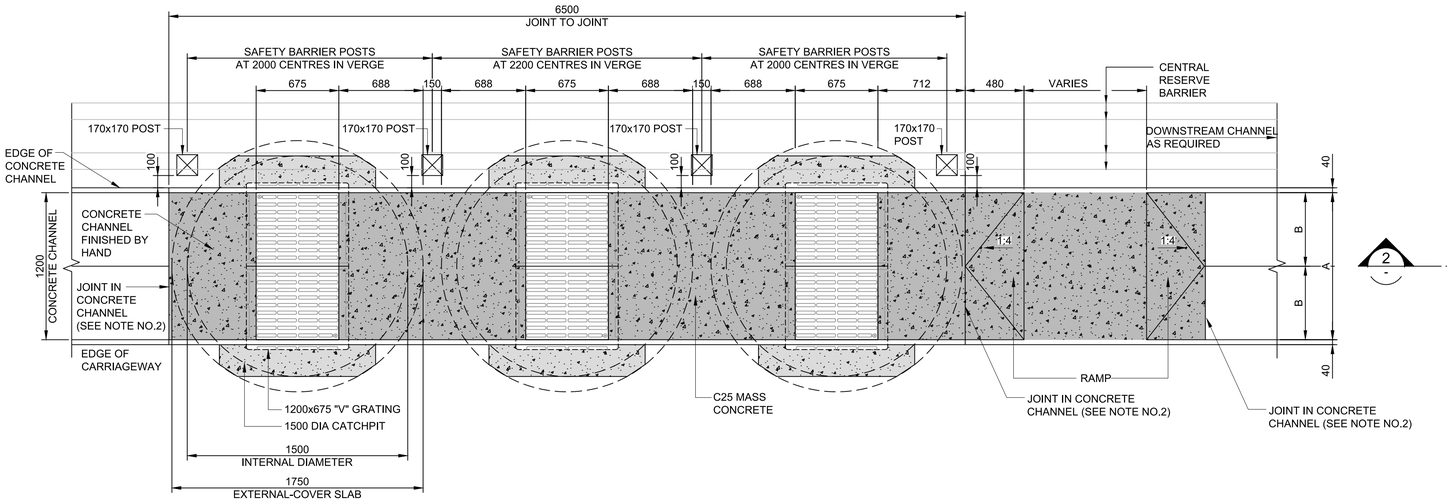
Status	S3-PRELIMINARY DESIGN
Revision	P02
Scale	NTS
Date	10JUL2018
Drawn By	S. [redacted]
Checked By	A. [redacted]
Approved By	N. [redacted]
Original Size	A1

Drawing number: HE HE548643-ARC-HDG-SZ-GN_000-DE-D-3060

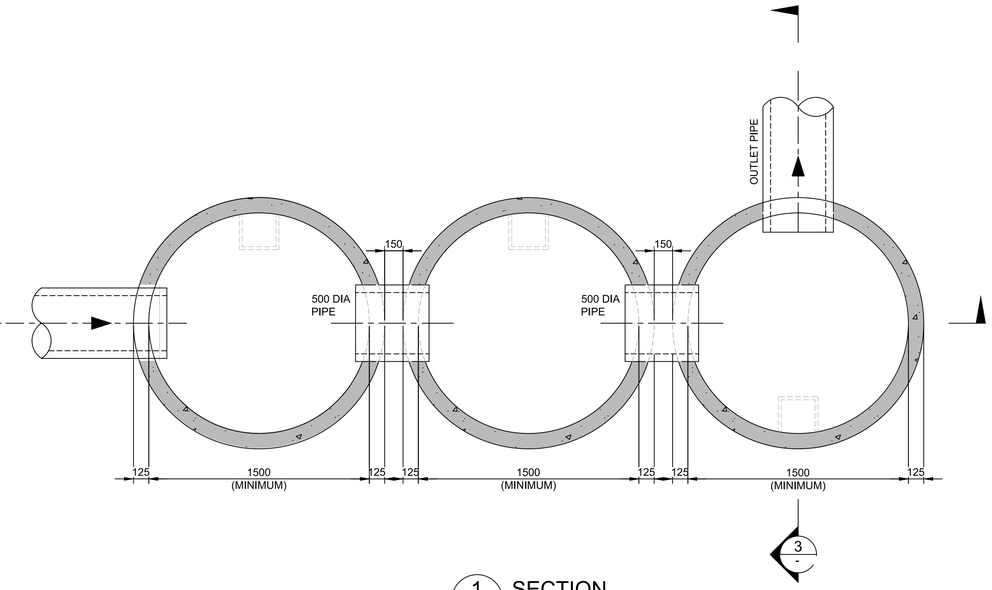
100mm on Original

Print Date: 2018-07-13 15:43:18

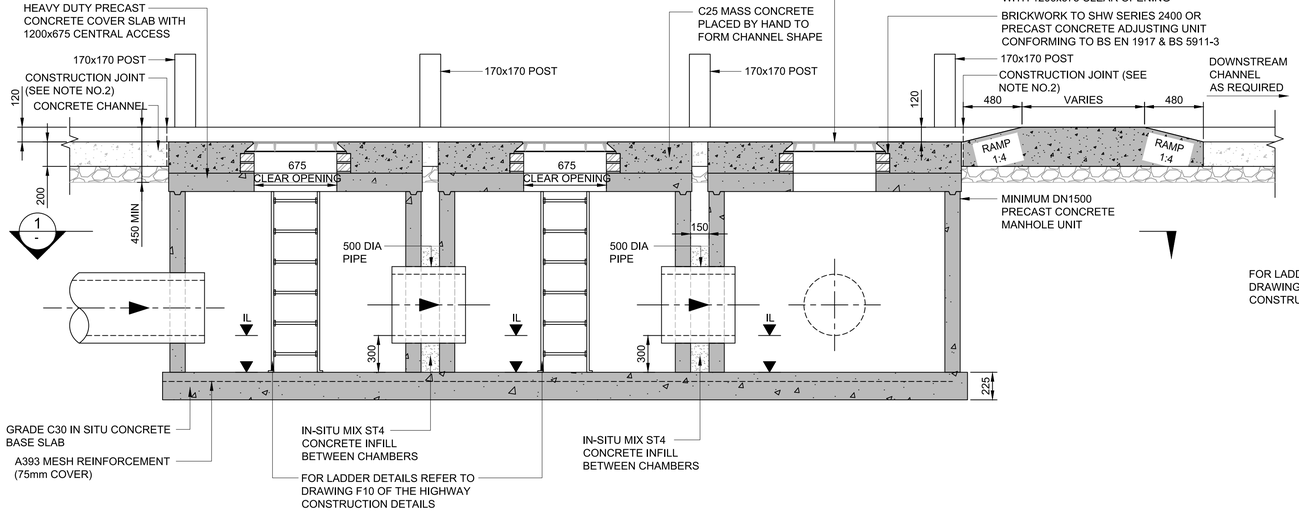
File Path: \\hc-ukr-hy-fs-10\HY_Proj\Highways\UKR\UB004249-01-A585 Drainage\E-Drawings\Working Drawings\Drawings\Standard Details\P03\HE548643-ARC-HDG-SZ-GN_000-DE-D-3056-3061.dwg



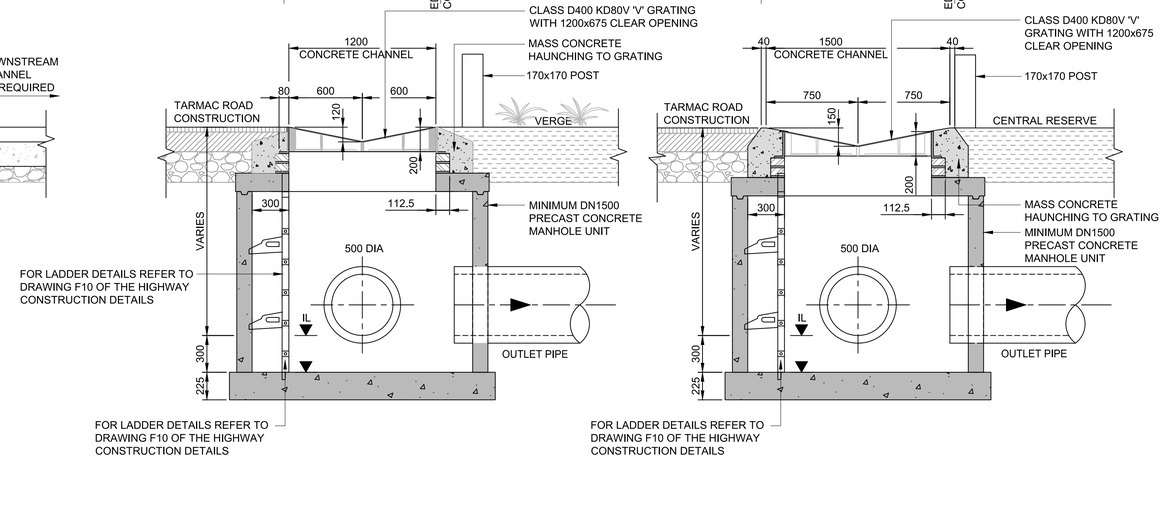
PLAN AT COVER LEVEL



1 SECTION



2 SECTION



3 SECTION

SECTION AT CENTRAL RESERVE

CHANNEL	DIMENSION		LOCATION
	A	B	
1200	1200	600	VERGE
1500	1500	750	CENTRAL RESERVE

NOTES

1. SAFETY CHAINS REQUIRED WHERE OUTLET PIPE IS 600 DIA OR GREATER.
2. CONSTRUCTION JOINT (TRANSVERSE JOINT) BETWEEN THE SLIP FORMED STORM WATER CHANNEL AND HAND-LAID SECTION (APRON SLAB) SHALL BE IN ACCORDANCE WITH THE HIGHWAY CONSTRUCTION DRAWINGS (HCD's), F SERIES DRAWINGS, DRAWING F22, NOTE 6.
3. THE DETAIL TO BE READ IN CONJUNCTION WITH PROPOSED DRAINAGE PLANS (HE548643-ARC-HDG-A585-DR-D-3324-3342).
4. ALL DIMENSIONS ARE IN MILIMETRES UNLESS SPECIFIED.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Client: highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: SURFACE WATER CHANNEL DETAILS 3 PAIR TERMINAL

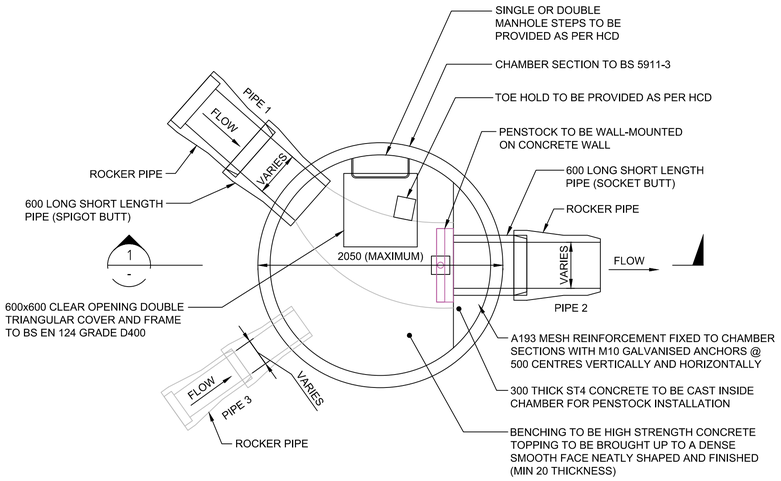
Status	S3-PRELIMINARY DESIGN	Revision	P02
Scale	NTS	Date	10JUL2018
Drawn By	S.[redacted]		
Checked By	A.[redacted]		
Approved By	N.[redacted]		
		Original Size	A1

Drawing number: HE548643-ARC-HDG-SZ-GN_000-DE-D-3061

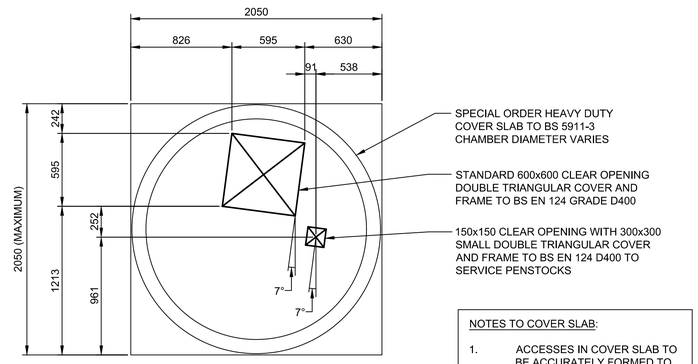
100mm on Original

Print Date: 2018-07-13 15:43:23

File Path: \\hc-ukr-hy-fs-10\HY_Proj\Highways\UKR\UB004249-01-A585 Drainage\E-Drawings\Working Drawings\Drawings\Standard Details\P03\HE548643-ARC-HDG-SZ-GN_000-DE-D-3056-3061.dwg



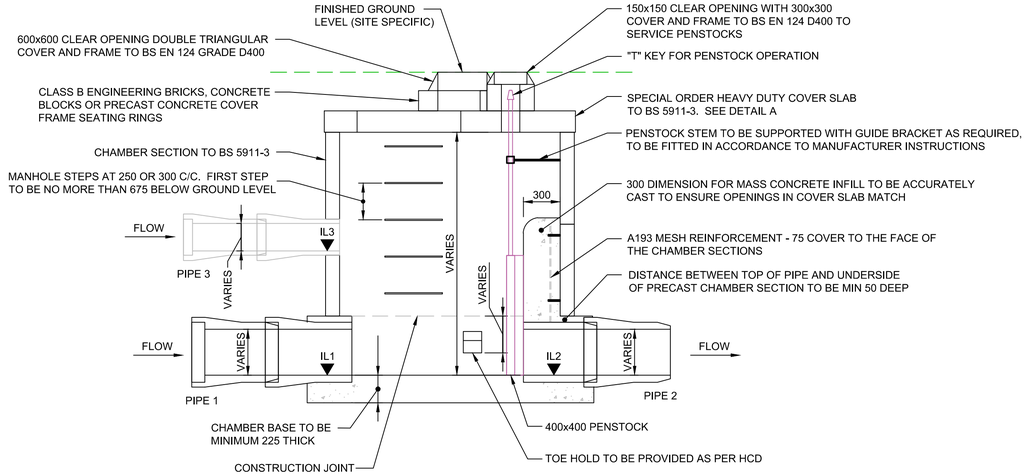
PLAN
SCALE 1 : 25



DETAIL A: COVER SLAB
SCALE 1 : 25

NOTES TO COVER SLAB:

1. ACCESSES IN COVER SLAB TO BE ACCURATELY FORMED TO DIMENSIONS SHOWN TO ENSURE PENSTOCK CAN BE PROPERLY OPERATED THROUGH ACCESS POINT
2. TYPICAL COVER TO ALL REINFORCEMENT TO BE 75



SECTION 1
SCALE 1 : 25

FLOW CONTROL CHAMBER DETAIL

CATCHMENT	CHAMBER NO.	CHAMBER DIA (mm)	ORIFICE DIA (mm)	PIPE (1) PN	PIPE (1) DIA (mm)	PIPE (1) IL (m)	PIPE (2) PN	PIPE (2) DIA (mm)	PIPE (2) IL (m)	PIPE (3) PN	PIPE (3) DIA (mm)	PIPE (3) IL (m)
1	M1-F-01	1800	125	1.018	600	4.405	23.001	150	5.267	-	-	-
	M1-F-02	1500	200	1.026	375	4.224	35.004	450	4.556	-	-	-
	M1-F-04	1500	150	39.001	225	5.144	41.002	450	4.650	-	-	-
2	M2-F-01	2100	100	1.016	600	3.326	30.000	150	4.433	31.000	150	4.103
	M2-F-02	1500	100	32.005	450	3.342	36.001	150	4.669	-	-	-
3	M3-F-01	1500	200	21.021	450	3.998	47.010	500	4.028	-	-	-
	M3-F-02	1800	125	21.018	700	5.251	39.000	150	6.323	40.000	150	6.333
	M3-F-03	1500	150	60.001	450	3.450	65.006	150	3.450	74.000	150	5.018
9	M9-F-01	1200	150	1.005	450	5.486	7.000	150	5.786	-	-	-

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES AND LEVELS IN METRES UNLESS OTHERWISE STATED.
2. REFER TO DRAWING SERIES 0501 DRAINAGE LAYOUT PLANS AND DRAWING SERIES 0500 DRAINAGE SCHEDULE FOR DRAINAGE INFORMATION
3. SPECIFIC PRODUCT DETAILS AND INSTALLATION SHOULD BE IN ACCORDANCE WITH THE MANUFACTURER INSTRUCTIONS.

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED DRAINAGE PENSTOCK AND ORIFICE CHAMBER TYPICAL DETAILS

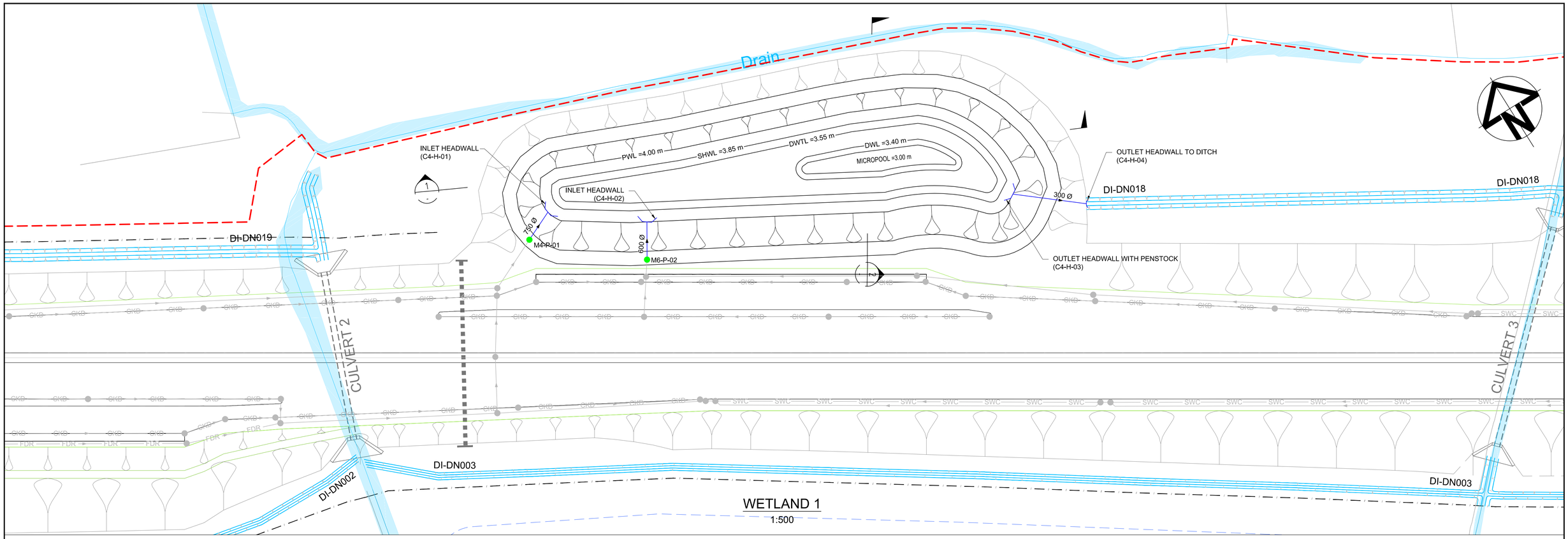
Status	PRELIMINARY DESIGN
Revision	P02
Scale	1:25
Date	10JUL2018
Drawn By	[redacted]LG
Checked By	A.[redacted]
Approved By	N.[redacted]
Original Size	A1

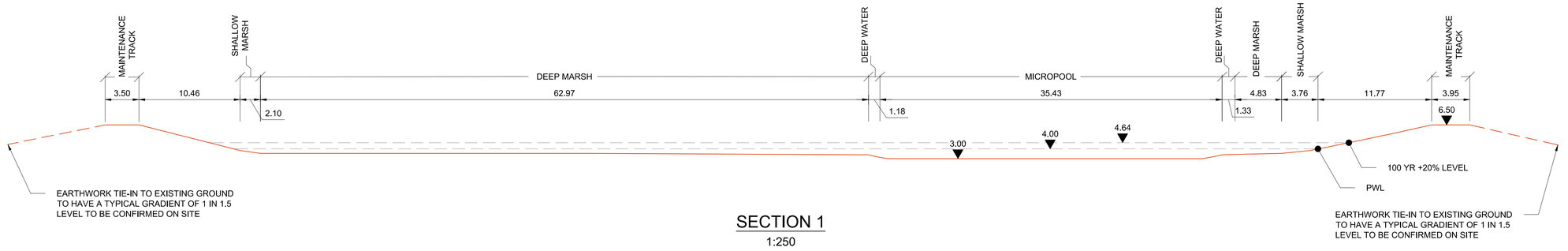
Drawing number: HE PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-SZ-GN_000-DE-D-3062

100mm on Original

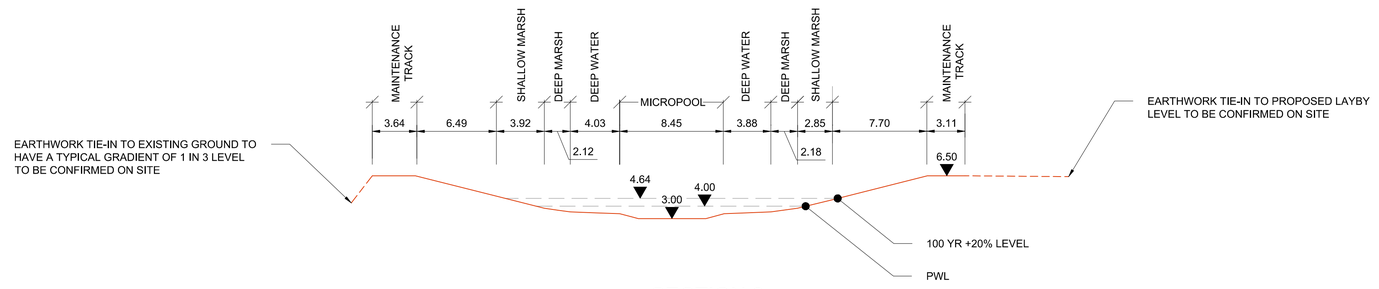
Print Date: 2018-07-13 18:12:27

File Path: K:\Highways\UKR\UB004249-01-A585 Drainage\E-Drawings\Working Drawings\Drawings\Standard Details\P03\HE548643-ARC-HDG-SZ-GN_000-DE-D-3062.dwg





SECTION 1
1:250



SECTION 2
1:250

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	PD	22DEC2017	PRELIMINARY DSIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

REFER TO DRAWING HE548643-ARC-HDG-S1-ML_001-DR-D-3035 TO 3055 FOR PROPOSED DRAINAGE PLAN.

LEGEND

PWL = PERMANENT WATER LEVEL
SHWL = SHALLOW WETLAND
DWTL = DEEP WETLAND
DW = DEEP WATER

Client: highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 603 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: DRAINAGE STORMWATER WETLAND 1 PLAN AND SECTION

Status	S3-PRELIMINARY DESIGN
Revision	P02
Scale	AS SHOWN
Date	10JUL2018
Drawn By	G.[redacted]
Checked By	A.[redacted]
Approved By	N.[redacted]
Original Size	A1

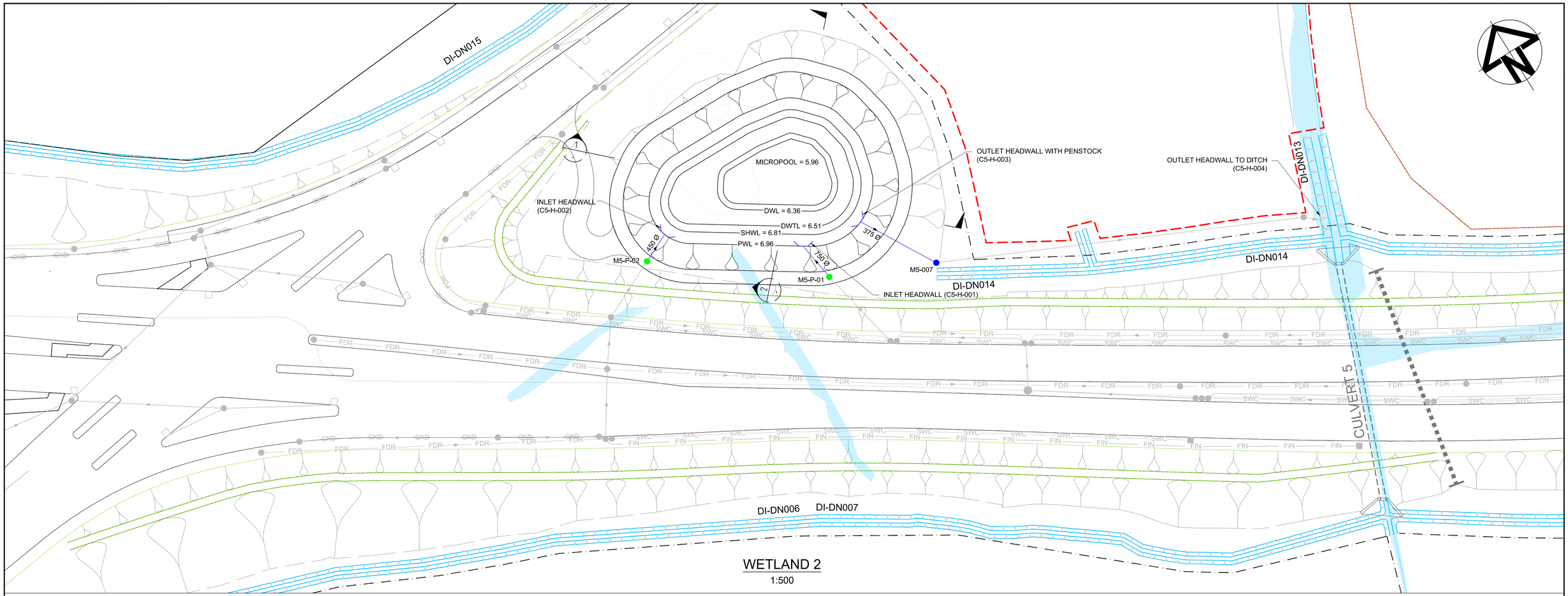
Drawing number: HE548643-ARC-HDG-SZ-GN_000-DE-D-3063

HE PIN | Originator | Volume | Location | Type | Role | Number

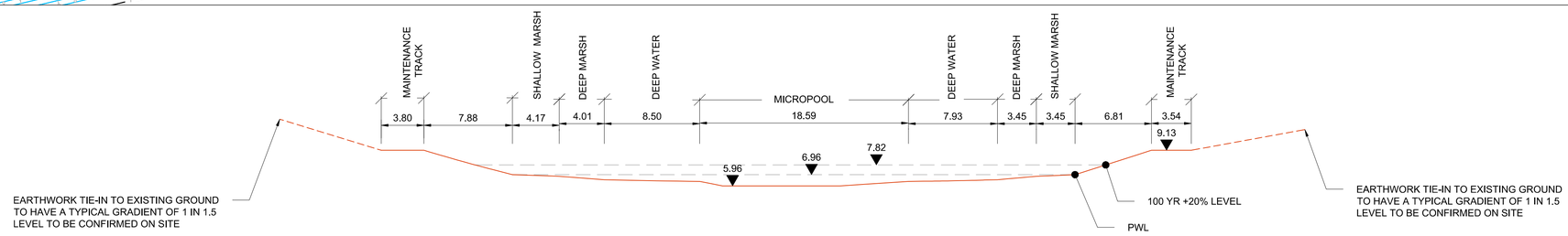
100mm on Original

Print Date: 2018-07-13 20:51:09

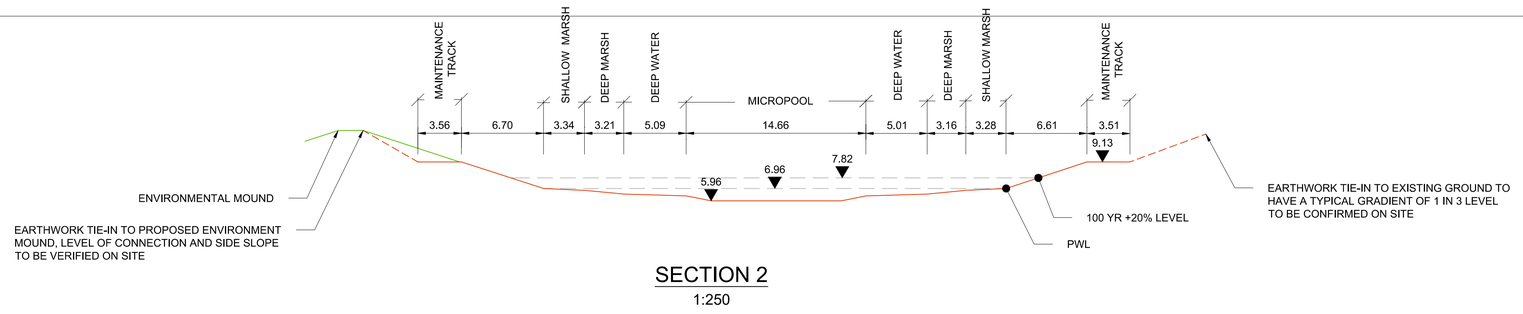
File Path: K:\Highways\UKR\UB004249-01-A585 Drainage\E-Drawings\Working Drawings\Drawings\Standard Details\P03\HE548643-ARC-HDG-SZ-GN_000-DE-D-3063-3066.dwg



WETLAND 2
1:500



SECTION 1
1:250



SECTION 2
1:250

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	PD	22DEC2017	PRELIMINARY DSIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

REFER TO DRAWING HE548643-ARC-HDG-S1-ML_001-DR-D-3035 TO 3055 FOR PROPOSED DRAINAGE PLAN.

LEGEND

PWL = PERMANENT WATER LEVEL
SHWL = SHALLOW WETLAND
DWTL = DEEP WETLAND
DW = DEEP WATER

Client: highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: DRAINAGE STORMWATER WETLAND 2 PLAN AND SECTION

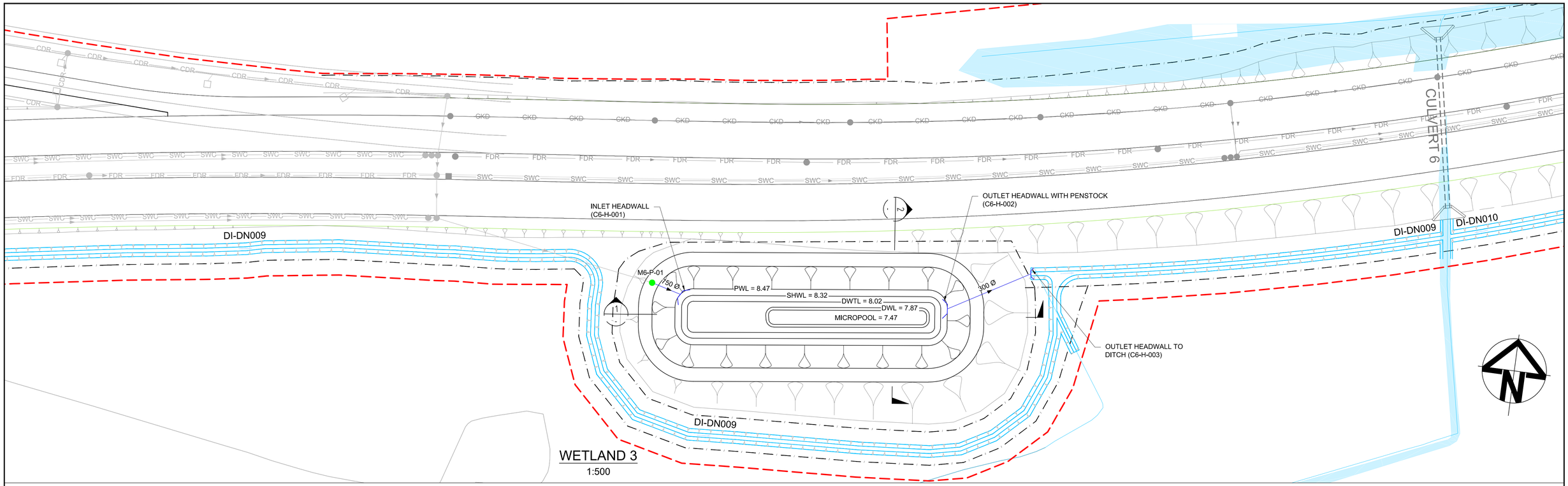
Status: S3-PRELIMINARY DESIGN
Revision: P02
Scale: AS SHOWN
Date: 10JUL2018
Drawn By: G.[redacted]
Checked By: A.[redacted]
Approved By: N.[redacted]
Original Size: A1

Drawing number: HE548643-ARC-HDG-SZ-GN_000-DE-D-3064

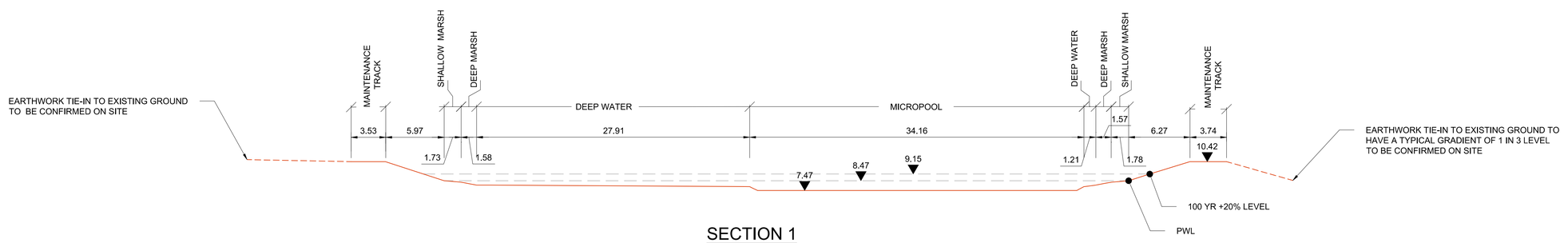
100mm on Original

Print Date: 2018-07-13 21:42:44

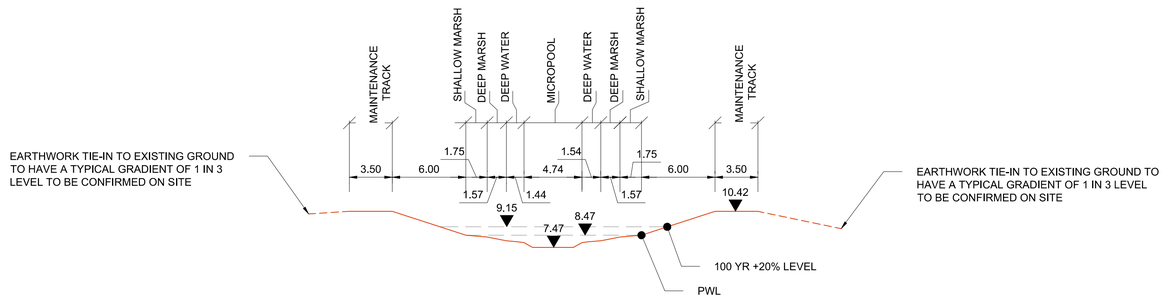
File Path: K:\Highways\UKR\UB004249-01-A585 Drainage\E-Drawings\Working Drawings\Drawings\Standard Details\P03\HE548643-ARC-HDG-SZ-GN_000-DE-D-3063-3066.dwg



WETLAND 3
1:500



SECTION 1
1:250



SECTION 2
1:250

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	PD	22DEC2017	PRELIMINARY DSIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

REFER TO DRAWING HE548643-ARC-HDG-S1-ML_001-DR-D-3035 TO 3055 FOR PROPOSED DRAINAGE PLAN.

LEGEND

PWL = PERMANENT WATER LEVEL
SHWL = SHALLOW WETLAND
DWTL = DEEP WETLAND
DW = DEEP WATER

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: DRAINAGE STORMWATER WETLAND 3 PLAN AND SECTION

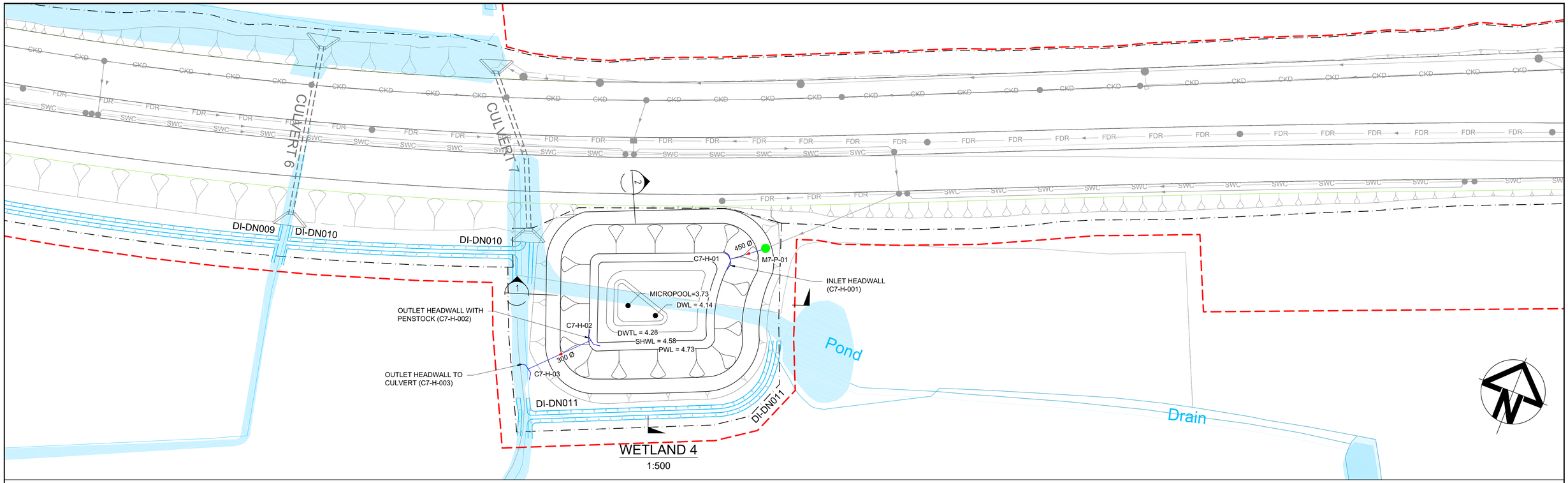
Status	S3-PRELIMINARY DESIGN
Revision	P02
Scale	AS SHOWN
Date	10JUL2018
Drawn By	G.[redacted]
Checked By	A.[redacted]
Approved By	N.[redacted]
Original Size	A1

Drawing number: HE548643-ARC-HDG-SZ-GN_000-DE-D-3065

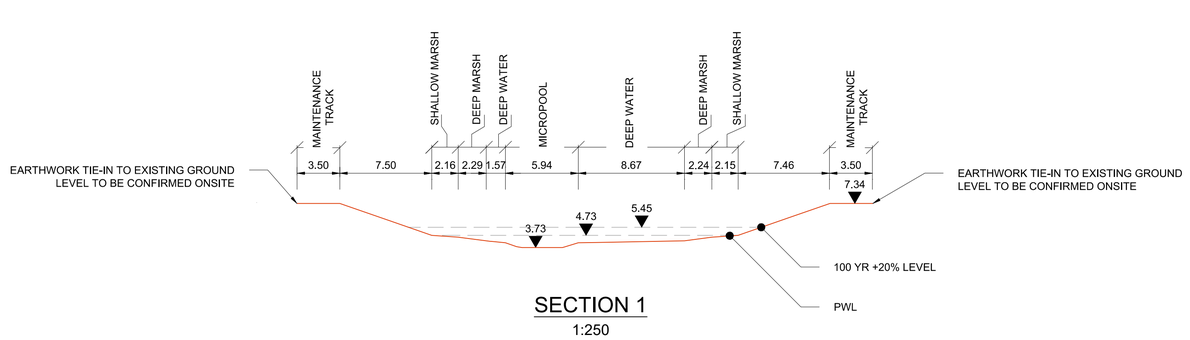
100mm on Original

Print Date: 2018-07-13 21:37:53

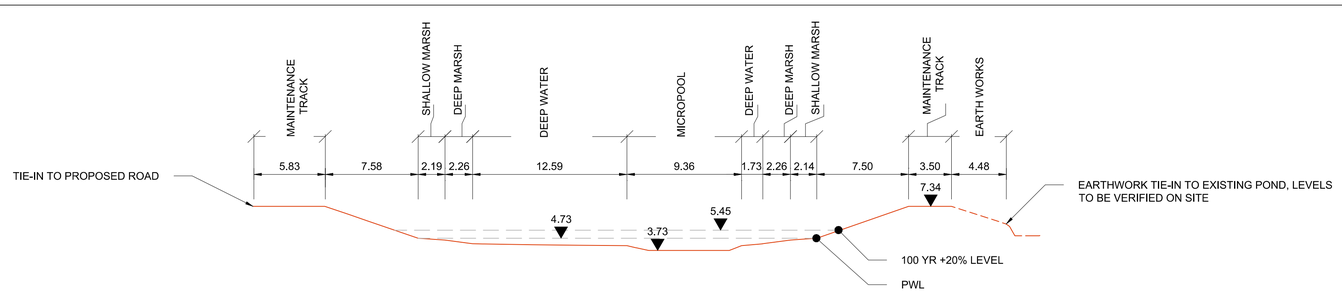
File Path: K:\Highways\UKR\UB004249-01-A585 Drainage\E-Drawings\Working Drawings\Drawings\Standard Details\P03\HE548643-ARC-HDG-SZ-GN_000-DE-D-3063-3066.dwg



WETLAND 4
1:500



SECTION 1
1:250



SECTION 2
1:250

NOTES

REFER TO DRAWING HE548643-ARC-HDG-S1-ML_001-DR-D-3035 TO 3055 FOR PROPOSED DRAINAGE PLAN.

LEGEND

PWL = PERMANENT WATER LEVEL
SHWL = SHALLOW WETLAND
DWTL = DEEP WETLAND
DW = DEEP WATER

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]
P01	PD	22DEC2017	PRELIMINARY DSIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

Client: highways england

ARCADIS Design & Consultancy for natural and built assets

Registered office:
Arcadis House
34 York Way
London
N1 9AB

Coordinating office:
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: DRAINAGE STORMWATER WETLAND 4 PLAN AND SECTION

Status	S3-PRELIMINARY DESIGN
Revision	P02
Scale	AS SHOWN
Date	10JUL2018
Drawn By	G.[redacted]
Checked By	A.[redacted]
Approved By	N.[redacted]
Original Size	A1

Drawing number HE PIN | Originator | Volume | Location | Type | Role | Number

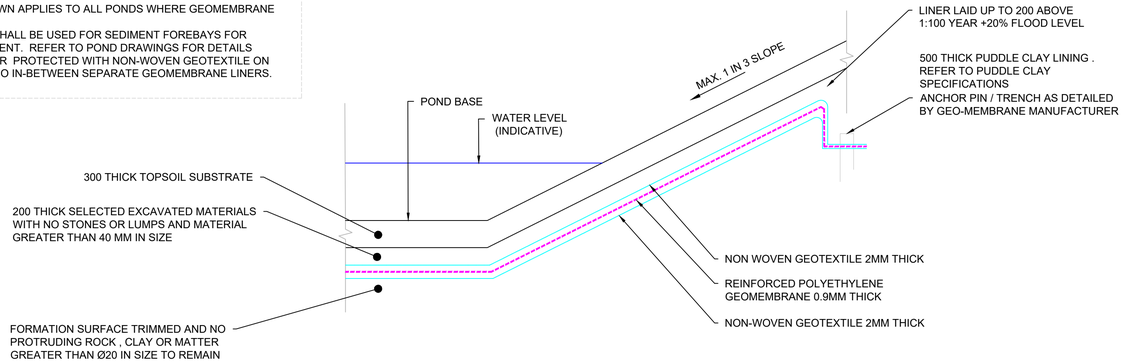
HE548643-ARC-HDG-SZ-GN_000-DE-D-3066

Print Date: 2018-07-13 21:55:20

File Path: K:\Highways\UKR\UB004249-01-A585 Drainage\E-Drawings\Working Drawings\Drawings\Standard Details\P03\HE548643-ARC-HDG-SZ-GN_000-DE-D-3063-3066.dwg

REINFORCED POLYETHYLENE GEOMEMBRANE NOTES:

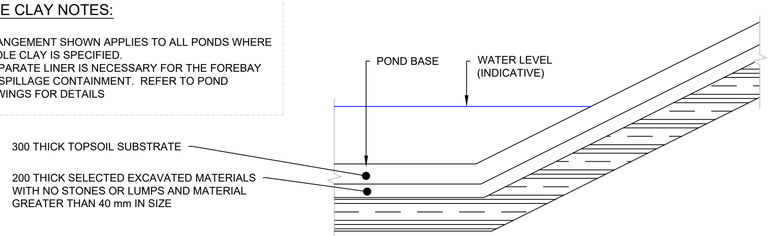
1. ARRANGEMENT SHOWN APPLIES TO ALL PONDS WHERE GEOMEMBRANE LINER IS SPECIFIED.
2. A SEPARATE LINER SHALL BE USED FOR SEDIMENT FOREBAYS FOR SPILLAGE CONTAINMENT. REFER TO POND DRAWINGS FOR DETAILS
3. GEOMEMBRANE LINER PROTECTED WITH NON-WOVEN GEOTEXTILE ON BOTH SIDES AND ALSO IN-BETWEEN SEPARATE GEOMEMBRANE LINERS.



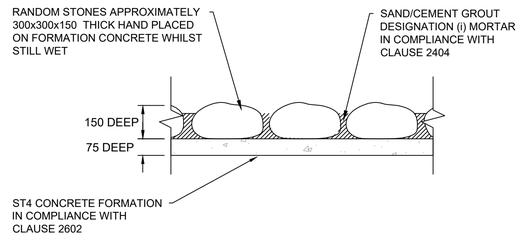
REINFORCED POLYETHYLENE GEOMEMBRANE LINER DETAIL

PUDDLE CLAY NOTES:

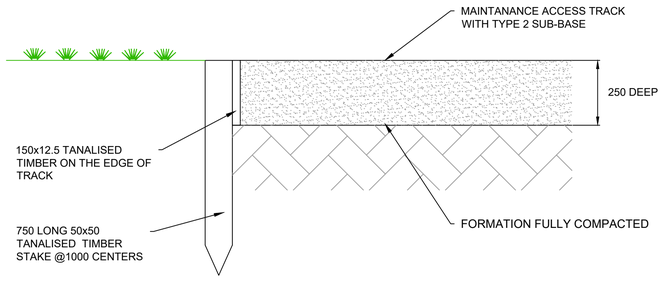
1. ARRANGEMENT SHOWN APPLIES TO ALL PONDS WHERE PUDDLE CLAY IS SPECIFIED.
2. A SEPARATE LINER IS NECESSARY FOR THE FOREBAY FOR SPILLAGE CONTAINMENT. REFER TO POND DRAWINGS FOR DETAILS



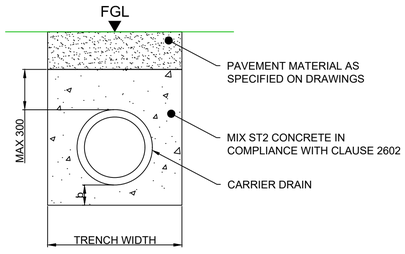
PUDDLE CLAY DETAIL



STONE PITCHING DETAIL



MAINTANANCE ACCESS TRACK DETAILS



CONCRETE BEDDING AND SURROUND DETAIL

CONCRETE BEDDING AND SURROUND NOTES:

1. CONCRETE PROTECTION TO PIPE PROVIDED WHERE COVER TO SOFFIT IS LESS THAN 600
2. TRENCH WIDTH AND DIMENSION "b" SHOULD REFER TO HCD F1

SPECIFICATIONS ON GEOTEXTILE :

GENERAL

1. GEOTEXTILE SYNTHETIC NON-WOVEN. THERMALLY BONDED OR MECHANICALLY NEEDLED FABRIC COMPOSED OF POLYPROPYLENE OR POLYETHYLENE FIBRES.
2. JOINTING OVERLAPPING ONLY AND ALL OVERLAPS HAVE A MINIMUM OF 300mm.

APPLICABLE TO STORMWATER WETLANDS ONLY:

SUBSTRATE OF VARIED DEPTHS :

1. SIDE SLOPES - TOPSOIL.
2. SHALLOW MARSHLAND - 150 TOPSOIL AND WASHED GRAVEL LAID UPON 350 OF SELECTED EXCAVATED MATERIAL WITH NO STONES OR LUMPS OF MATERIAL GREATER THEN 40 N SIZE.
3. DEEP MARSHLAND 150 MIXED TOPSOIL AND GRAVEL LAID UPON 350 OF SELECTED EXCAVATED MATERIAL WITH NO STONES OR LUMPS OF MATERIAL GREATER THEN 40 N SIZE.
4. DEEP WATER - 100 OF COARSE ORGANIC SOIL LAID UPON 400 OF GRAVEL
3. MICROPOOL - 500 OF SELECTED EXCAVATED MATERIAL WITH NO STONES OR LUMPS OF MATERIAL GREATER THEN 40 N SIZE.

FOR DEPTHS FOR SPECIFIC AREA OF WETLAND REQUIRED FOR PLANTING REFER TO LANDSCAPE DRAWING SERIES 3000.

GEOMEMBRANE SPECIFICATIONS:

GENERAL

UNIT WEIGHT (g/m²) = 628
THICKNESS (2 kN/m² PRESSURE) = 0.9mm

MACHINE DIRECTION

TENSILE STRENGTH (kN/m) = 24.7
ELONGATION AT STRAIN (%) = 33
TRAPEZOID TEAR STRENGTH (N) = 545

CROSS DIRECTION

TENSILE STRENGTH (kN/m) = 24.34
ELONGATION AT STRAIN (%) = 31
TRAPEZOID TEAR STRENGTH (N) = 381

STATIC PUNCTURE (CBR)

PUSH-THROUGH FORCE (kN) = 2.2
DISTENSION AT PEAK (mm) = 38
DROP CONE TEST (mm) = 7.4

DURABILITY

OXIDATION RESISTANCE TEST (AGE-%) = 11.58
UV EXPOSURE RESISTANCE = 90%

PUDDLE CLAY SPECIFICATIONS:

1. PUDDLE CLAY PRODUCED FROM A CLAY WITH A LIQUID LIMIT BETWEEN 30 AND 60 AND A PLASTICITY INDEX WHICH IS GREATER THAN THE DIFFERENCE BETWEEN 0.73 TIMES THE LIQUID LIMIT AND 15. IT FREE FROM TOP SOIL, ROOTS, PEAT AND ANY OTHER ORGANIC SOLUBLE MATERIAL. IT SHALL ALSO BE FREE FROM BOULDERS, COBBLES AND GRAVEL EXCEEDING 20MM IN SIZE AND SHALL HAVE A CLAY FRACTION, AS MEASURED IN ACCORDANCE WITH BS1377, GREATER THAN 30%.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	S3	10JUL2018	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS SPECIFIED.

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: DRAINAGE STORM WATER WETLAND STANDARD DETAILS

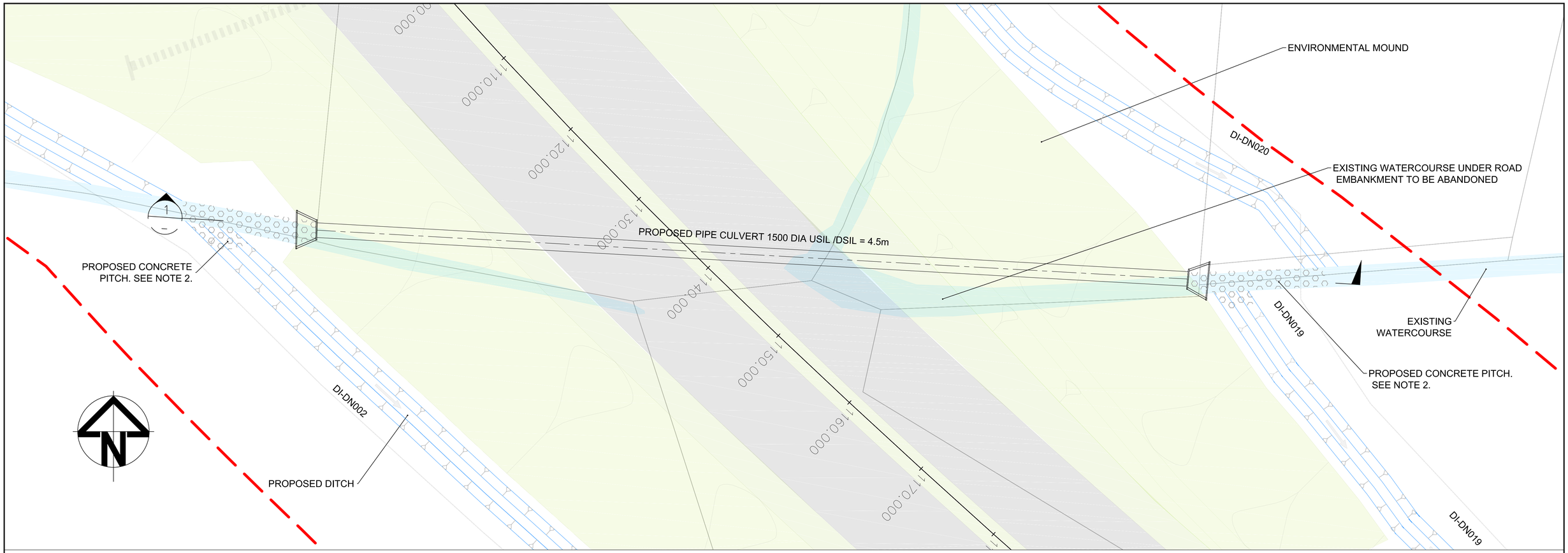
Status	PRELIMINARY DESIGN
Revision	P02
Scale	NTS
Date	10JUL2018
Drawn By	[redacted]LG
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

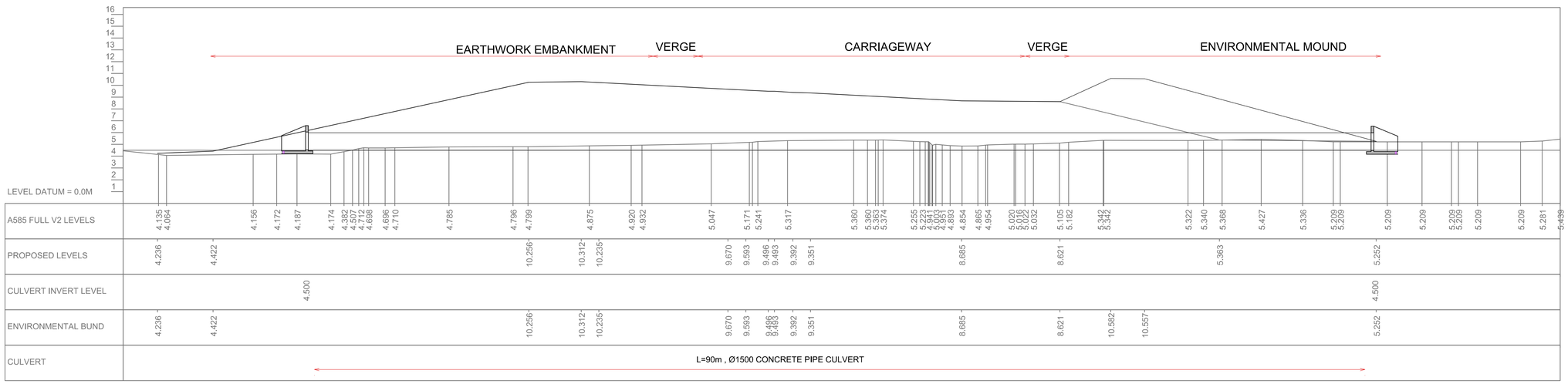
Drawing number HE PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-SZ-GN_000-DE-D-3067

100mm on Original

Print Date: 2018-07-13 15:40:02

File Path: \\hc-ukr-hy-fs-10\HY_Proj\Highways\UKR\UB004249-01-A585 Drainage\E-Drawings\Working Drawings\Drawings\Standard Details\P03\HE548643-ARC-HDG-SZ-GN_000-DE-D-3067.DWG





SECTION 1 / -

NOTES

1. ALL UNITS ARE IN METERS UNLESS STATED OTHERWISE.
2. CONCRETE STONE PITCHING TO BE USED FOR DITCH EROSION PROTECTION. FOR DETAILS SEE DRAWING HE548643-ARC-HDG-SZ-GN_000-DE-D-3067
3. EARTHWORKS TO BE VERIFIED ON SITE .
4. MAMMAL SHELF AND OTTER PASS SHALL BE PROVIDED AT 1 IN 50 YEAR RETURN PERIOD FLUVIAL FLOODING
5. ALL CULVERTS ARE TO BE FORMED FROM PRE-CAST CONCRETE PIPES, AND TO BE ARCHED TO ACCOMMODATE DIFFERENTIAL SETTLEMENT, REFER TO STRUCTURAL OPTIONS REPORT.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	PD	10JULY18	PRELIMINARY DESIGN	L[redacted]	A[redacted]	N[redacted]
P01	PD	22DEC17	PRELIMINARY DESIGN	L[redacted]	A[redacted]	N[redacted]

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED PLAN AND SECTION FOR CULVERT 1 CH 1+140

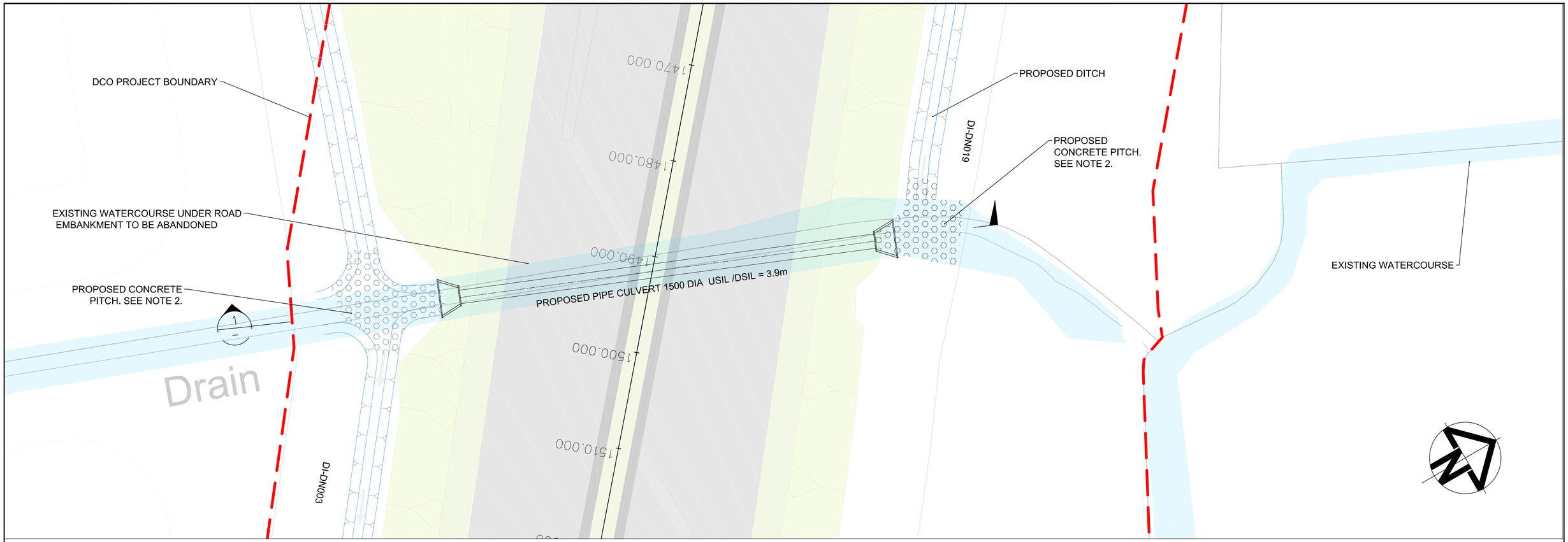
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:200
Date	10JULY18
Drawn By	L[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

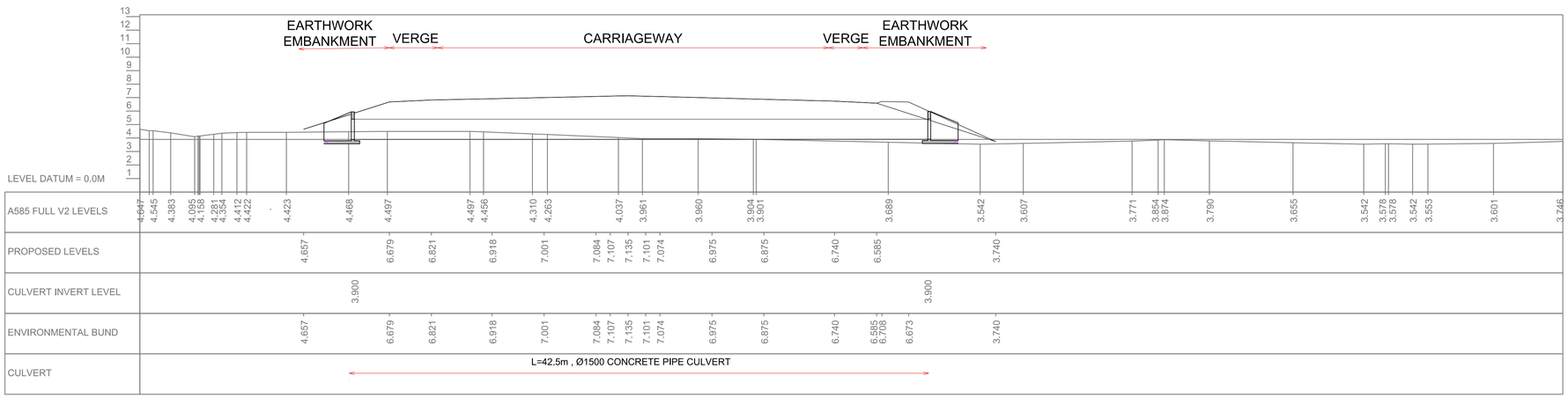
Drawing number: HE HE548643-ARC-HDG-SZ-GN_000-DE-D-3068

100mm on Original

Print Date: 2018-07-13 22:45:09

File Path: C:\Users\ski00451\ARCADIS\UA009921 - A585 Windy Harbour to Skippool - PCF Stage 3 - Dig_Eng_Shared_Models\Culvert_Plan_section V03.dwg





SECTION 1 -

NOTES

1. ALL UNITS ARE IN METERS UNLESS STATED OTHERWISE.
2. CONCRETE STONE PITCHING TO BE USED FOR DITCH EROSION PROTECTION. FOR DETAILS SEE DRAWING HE548643-ARC-HDG-SZ-GN_000-DE-D-3067
3. EARTHWORKS TO BE VERIFIED ON SITE .
4. MAMMAL SHELF AND OTTER PASS SHALL BE PROVIDED AT 1 IN 50 YEAR RETURN PERIOD FLUVIAL FLOODING
5. ALL CULVERTS ARE TO BE FORMED FROM PRE-CAST CONCRETE PIPES, AND TO BE ARCHED TO ACCOMMODATE DIFFERENTIAL SETTLEMENT, REFER TO STRUCTURAL OPTIONS REPORT.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	PD	10JULY18	PRELIMINARY DESIGN	L[redacted]	A[redacted]	N[redacted]
P01	PD	22DEC17	PRELIMINARY DESIGN	L[redacted]	A[redacted]	N[redacted]

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED PLAN AND SECTION FOR CULVERT 2 CH 1+490

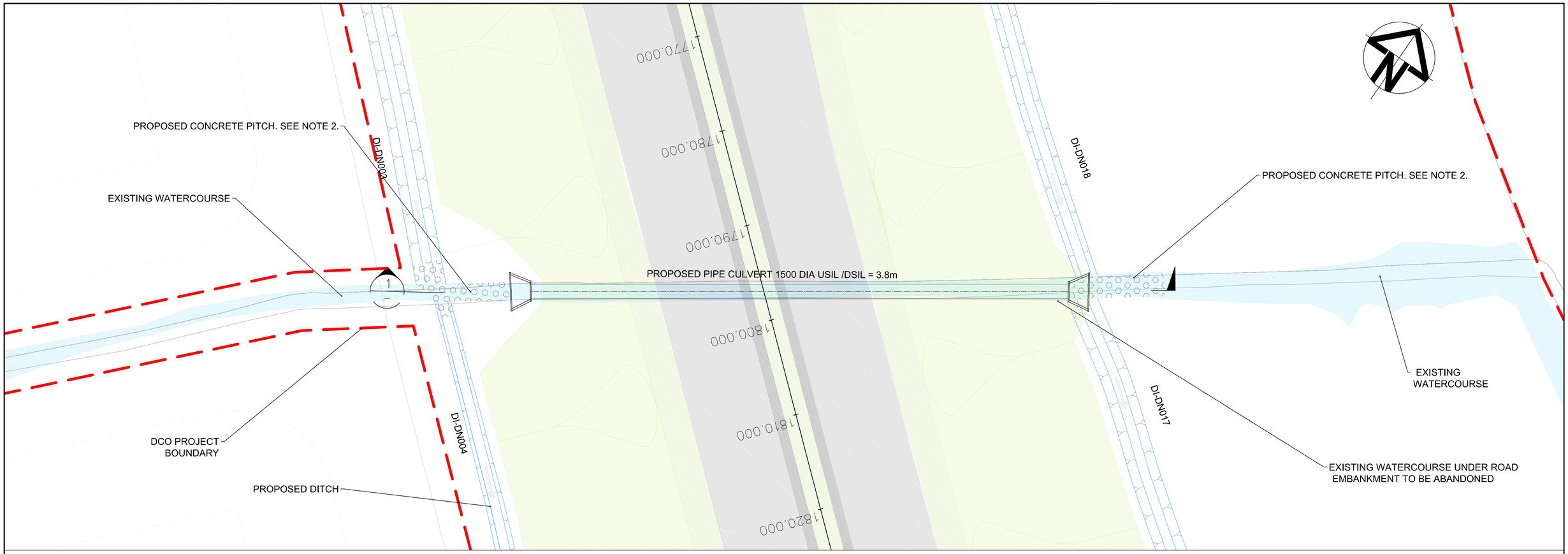
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:200
Date	10JULY18
Drawn By	L[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

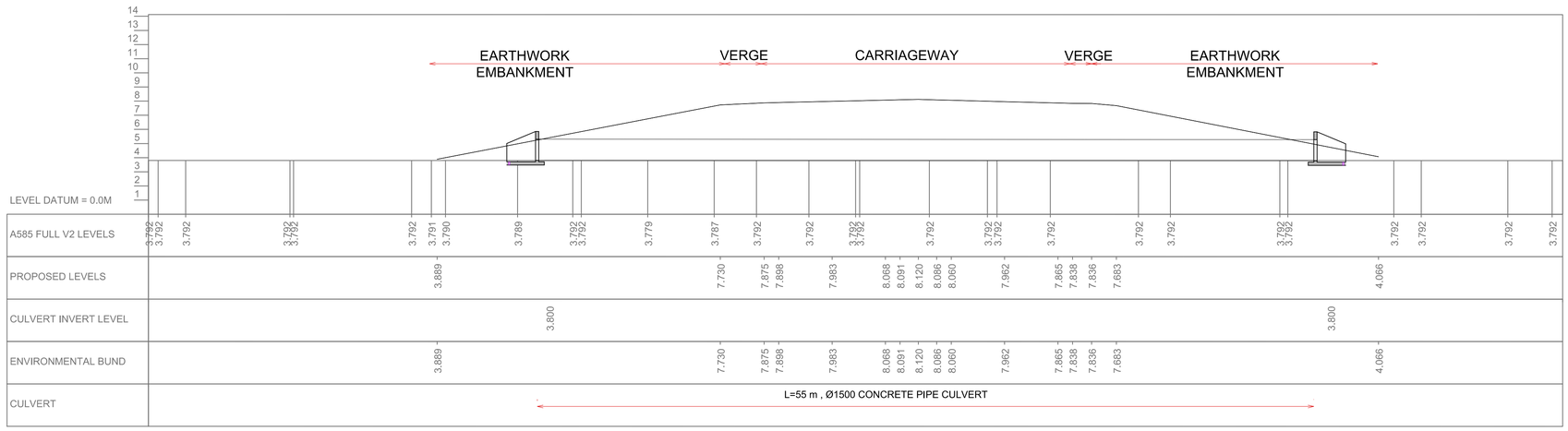
Drawing number: HE548643-ARC-HDG-SZ-GN_000-DE-D-3069

100mm on Original

Print Date: 2018-07-13 22:45:36

File Path: C:\Users\ski00451\ARCADIS\UA009921 - A585 Windy Harbour to Skippool - PCF Stage 3 - Dig_Eng_Shared_Models\Culvert_Plan_section V03.dwg





SECTION 1 -

NOTES

1. ALL UNITS ARE IN METERS UNLESS STATED OTHERWISE.
2. CONCRETE STONE PITCHING TO BE USED FOR DITCH EROSION PROTECTION. FOR DETAILS SEE DRAWING HE548643-ARC-HDG-SZ-GN_000-DE-D-3067
3. EARTHWORKS TO BE VERIFIED ON SITE .
4. MAMMAL SHELF AND OTTER PASS SHALL BE PROVIDED AT 1 IN 50 YEAR RETURN PERIOD FLUVIAL FLOODING
5. ALL CULVERTS ARE TO BE FORMED FROM PRE-CAST CONCRETE PIPES, AND TO BE ARCHED TO ACCOMMODATE DIFFERENTIAL SETTLEMENT, REFER TO STRUCTURAL OPTIONS REPORT.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	PD	10JULY18	PRELIMINARY DESIGN	L[redacted]	A[redacted]	N[redacted]
P01	PD	22DEC17	PRELIMINARY DESIGN	L[redacted]	A[redacted]	N[redacted]

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED PLAN AND SECTION FOR CULVERT 3 CH 1+795

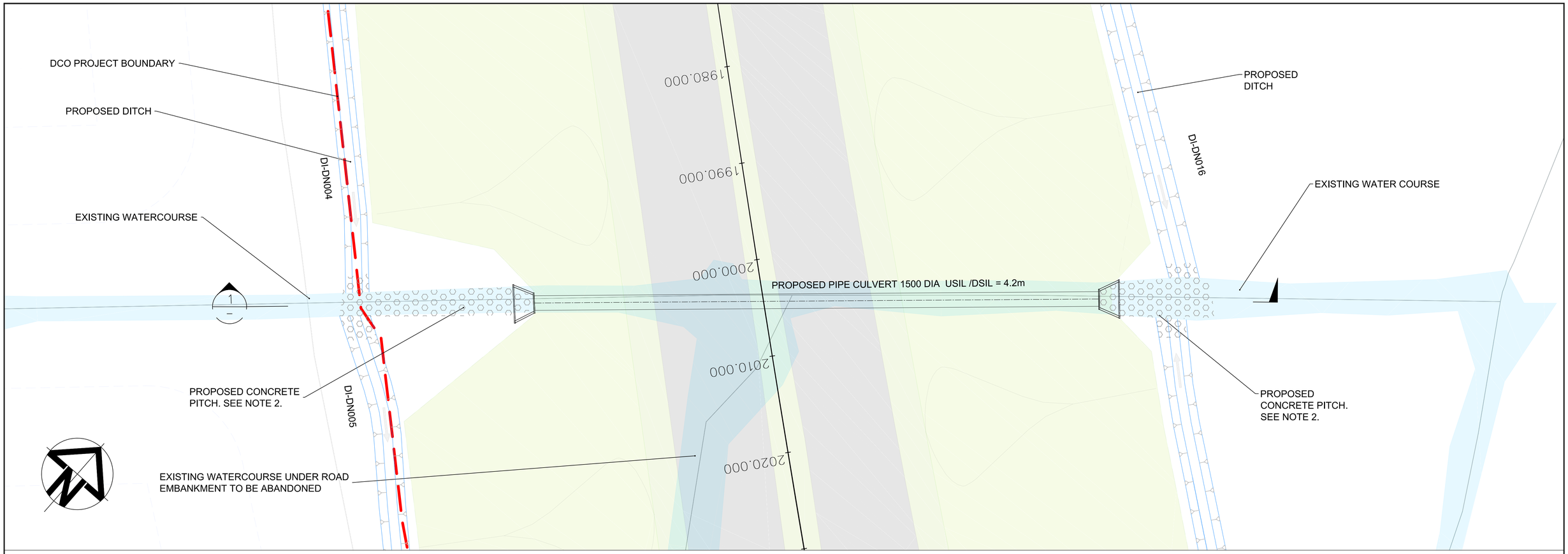
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:200
Date	10JULY18
Drawn By	L[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

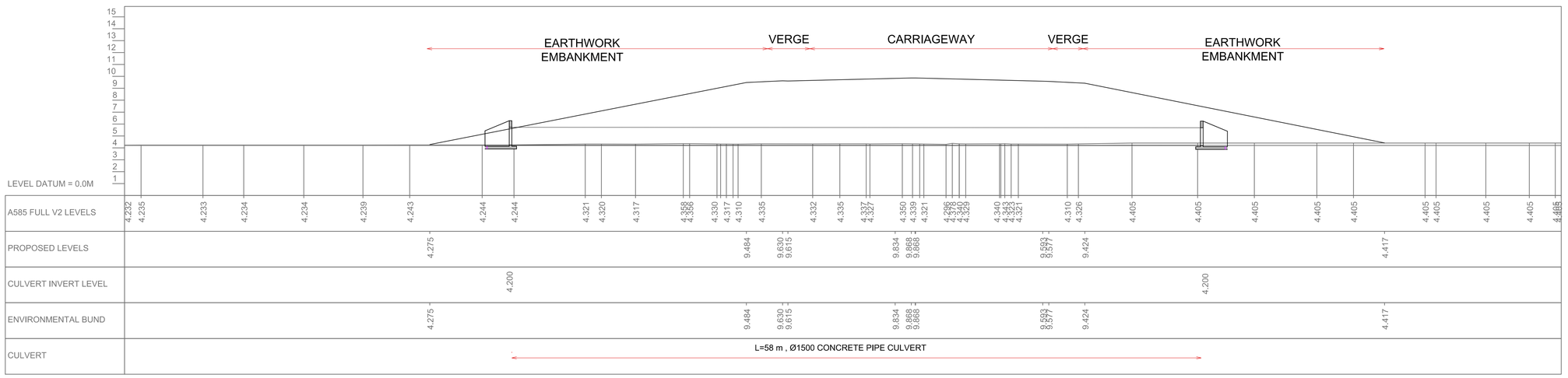
Drawing number: HE548643-ARC-HDG-SZ-GN_000-DE-D-3070

100mm on Original

Print Date: 2018-07-13 22:46:10

File Path: C:\Users\ski00451\ARCADIS\UA009921 - A585 Windy Harbour to Skippool - PCF Stage 3 - Dig_Eng_Shared_Models\Culvert_Plan_section V03.dwg





SECTION 1 –

NOTES

1. ALL UNITS ARE IN METERS UNLESS STATED OTHERWISE.
2. CONCRETE STONE PITCHING TO BE USED FOR DITCH EROSION PROTECTION. FOR DETAILS SEE DRAWING HE548643-ARC-HDG-SZ-GN_000-DE-D-3067
3. EARTHWORKS TO BE VERIFIED ON SITE .
4. MAMMAL SHELF AND OTTER PASS SHALL BE PROVIDED AT 1 IN 50 YEAR RETURN PERIOD FLUVIAL FLOODING
5. ALL CULVERTS ARE TO BE FORMED FROM PRE-CAST CONCRETE PIPES, AND TO BE ARCHED TO ACCOMMODATE DIFFERENTIAL SETTLEMENT, REFER TO STRUCTURAL OPTIONS REPORT.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	PD	10JULY18	PRELIMINARY DESIGN	L[redacted]	A[redacted]	N[redacted]
P01	PD	22DEC17	PRELIMINARY DESIGN	L[redacted]	A[redacted]	N[redacted]

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED PLAN AND SECTION FOR CULVERT 4 CH 2+005

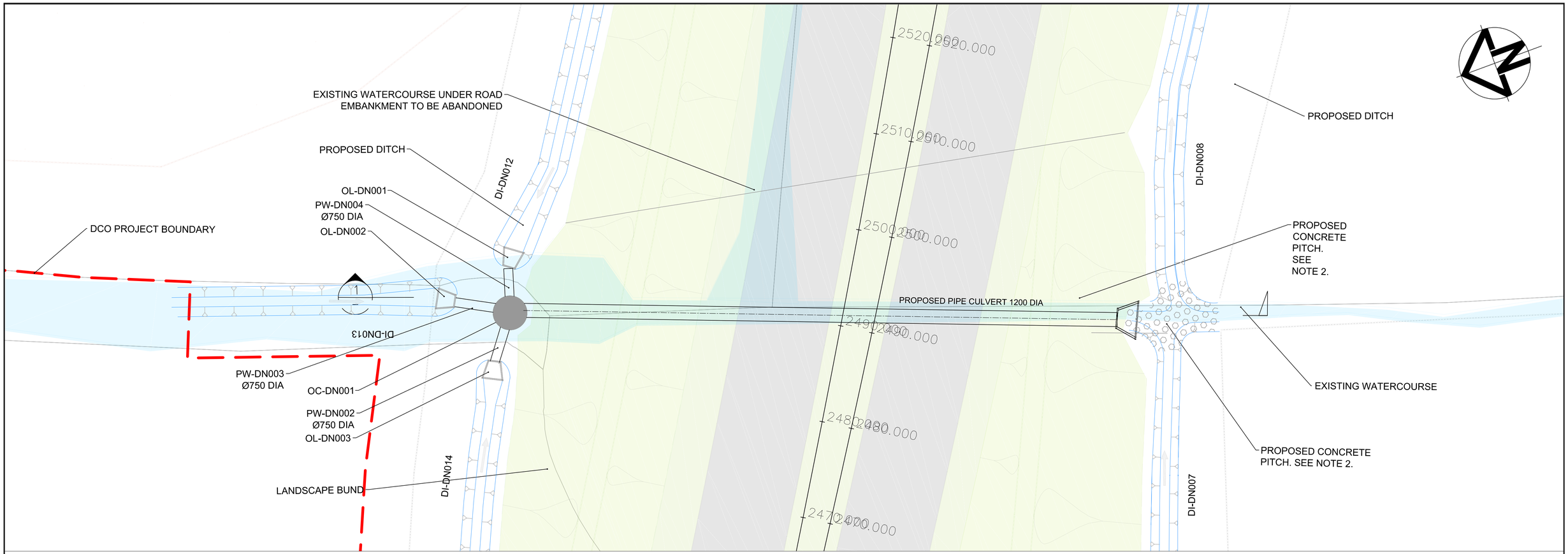
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:200
Date	10JULY18
Drawn By	L[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

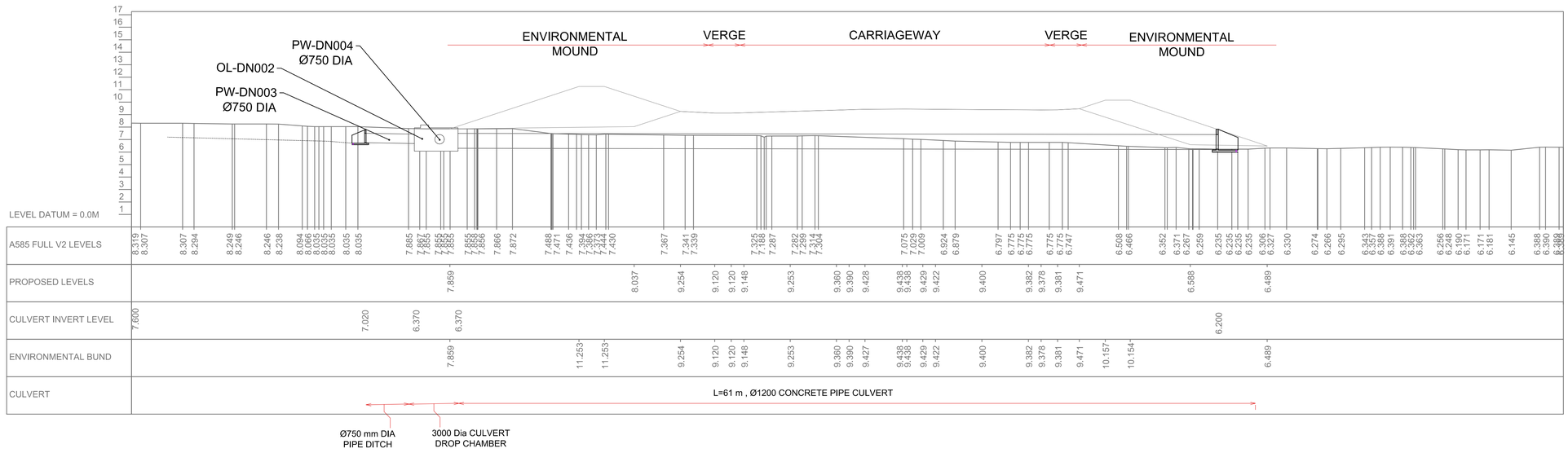
Drawing number: HE PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-SZ-GN_000-DE-D-3071

100mm on Original

Print Date: 2018-07-13 22:46:41

File Path: C:\Users\ski00451\ARCADIS\UA009921 - A585 Windy Harbour to Skippool - PCF Stage 3 - Dig_Eng_Shared_Models\Culvert_Plan_section V03.dwg





SECTION 1 -

NOTES

1. ALL UNITS ARE IN METERS UNLESS STATED OTHERWISE.
2. CONCRETE STONE PITCHING TO BE USED FOR DITCH EROSION PROTECTION. FOR DETAILS SEE DRAWING HE548643-ARC-HDG-SZ-GN_000-DE-D-3067
3. EARTHWORKS TO BE VERIFIED ON SITE .
4. MAMMAL SHELF AND OTTER PASS SHALL BE PROVIDED AT 1 IN 50 YEAR RETURN PERIOD FLUVIAL FLOODING
5. ALL CULVERTS ARE TO BE FORMED FROM PRE-CAST CONCRETE PIPES, AND TO BE ARCHED TO ACCOMMODATE DIFFERENTIAL SETTLEMENT, REFER TO STRUCTURAL OPTIONS REPORT.

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	PD	10JULY18	PRELIMINARY DESIGN	L[redacted]	A[redacted]	N[redacted]
P01	PD	22DEC17	PRELIMINARY DESIGN	L[redacted]	A[redacted]	N[redacted]

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PROPOSED PLAN AND SECTION FOR CULVERT 5 CH 2+490

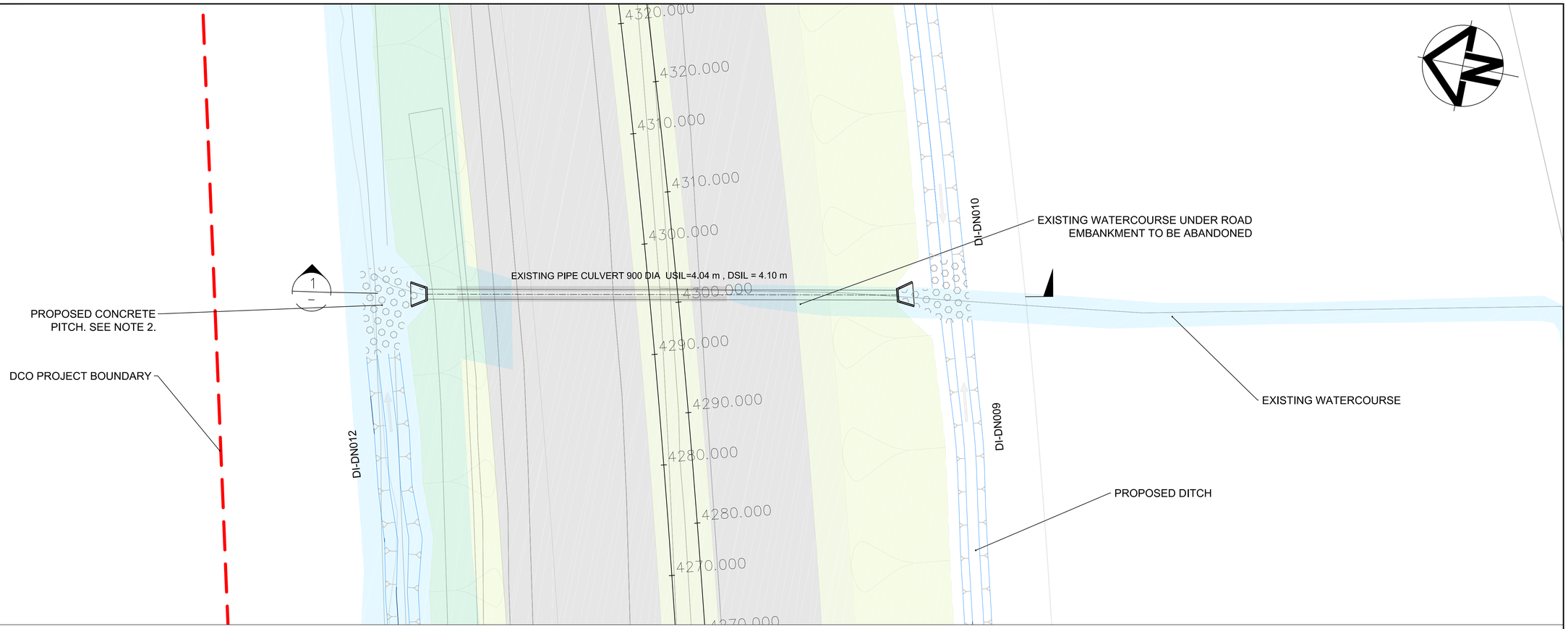
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:200
Date	10JULY18
Drawn By	L[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

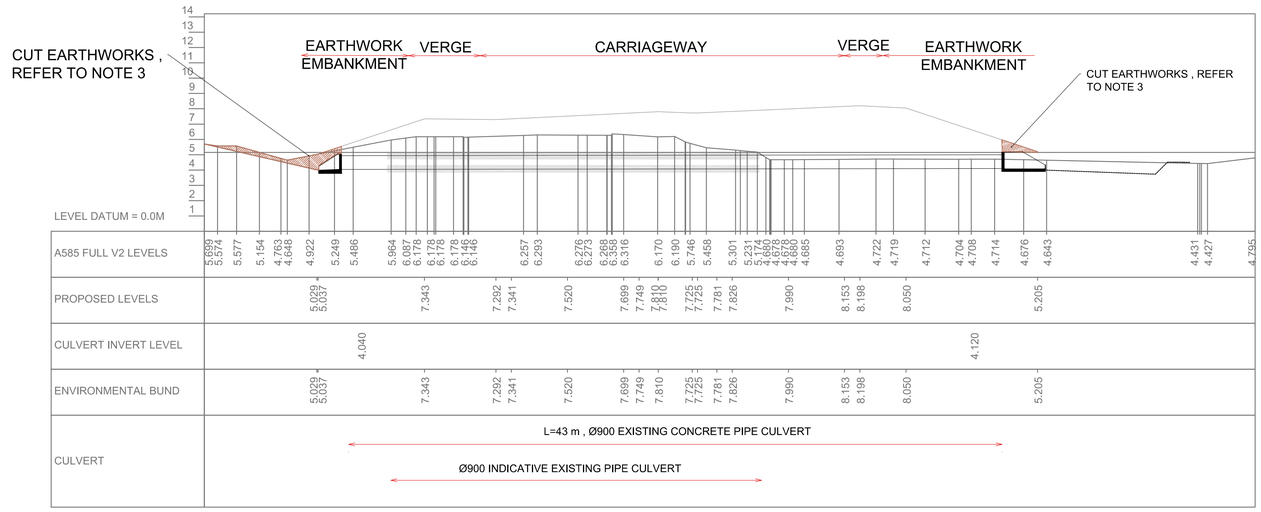
Drawing number: HE548643-ARC-HDG-SZ-GN_000-DE-D-3072

100mm on Original

Print Date: 2018-07-13 22:47:11

File Path: C:\Users\ski00451\ARCADIS\UA009921 - A585 Windy Harbour to Skippool - PCF Stage 3 - Dig_Eng_Shared_Models\Culvert_Plan_section V03.dwg





SECTION 1 -

Rev	Status	Date	Description	Drawn	Chck'd	Apprv'd
P02	PD	10JULY18	PRELIMINARY DESIGN	L[redacted]	A[redacted]	N[redacted]
P01	PD	22DEC17	PRELIMINARY DESIGN	L[redacted]	A[redacted]	N[redacted]

NOTES

1. ALL UNITS ARE IN METERS UNLESS STATED OTHERWISE.
2. CONCRETE STONE PITCHING TO BE USED FOR DITCH EROSION PROTECTION. FOR DETAILS SEE DRAWING HE548643-ARC-HDG-SZ-GN_000-DE-D-3067
3. EARTHWORKS TO BE VERIFIED ON SITE .
4. MAMMAL SHELF AND OTTER PASS SHALL BE PROVIDED AT 1 IN 50 YEAR RETURN PERIOD FLUVIAL FLOODING
5. ALL CULVERTS ARE TO BE FORMED FROM PRE-CAST CONCRETE PIPES, AND TO BE ARCHED TO ACCOMMODATE DIFFERENTIAL SETTLEMENT, REFER TO STRUCTURAL OPTIONS REPORT.
6. LENGTH OF EXISTING CULVERT IS INDICATIVE , TO BE VERIFIED WITH FURTHER CCTV AND ASSET SURVEY DURING STAGE 5. NO CCTV INFORMATION AVAILABLE AT THIS STAGE , REFER TO EXISTING DRAINAGE AND SITE CLEARANCE DRAWINGS HE548643-ARC-HDG-SZ-GN_000-DR-D-3075-3097

This map is based upon Ordnance Survey material by Arcadis Consulting (UK) ltd on behalf of Highways England, with the permission of the Controller of her Majesty's Stationery Office. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. © Crown copyright and database rights 2016 OS Licence number 100030649

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL IMPROVEMENT SCHEME

Drawing title: PLAN AND SECTION FOR EXISTING CULVERT 6 CH 4+300

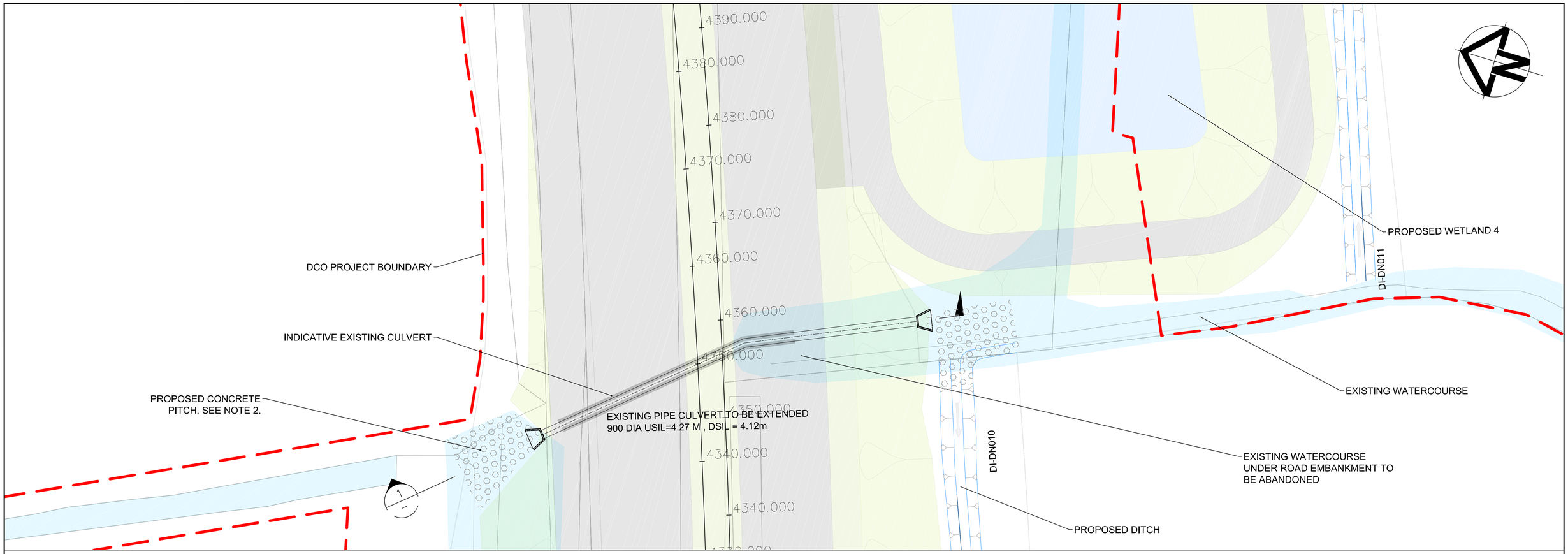
Status	S3 - PRELIMINARY DESIGN
Revision	P02
Scale	1:200
Date	10JULY18
Drawn By	L[redacted]
Checked By	A[redacted]
Approved By	N[redacted]
Original Size	A1

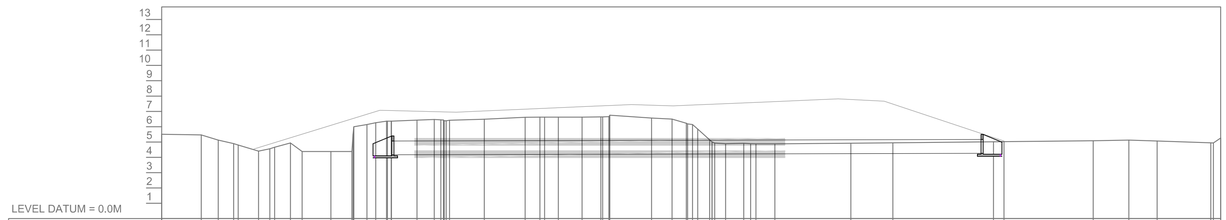
Drawing number HE PIN | Originator | Volume | Location | Type | Role | Number
HE548643-ARC-HDG-SZ-GN_000-DE-D-3073

100mm on Original

Print Date: 2018-07-13 22:47:44

File Path: C:\Users\ski00451\ARCADIS\UA009921 - A585 Windy Harbour to Skippool - PCF Stage 3 - Dig_Eng_Shared_Models\Culvert_Plan_section V03.dwg





LEVEL DATUM = 0.0M

| | | |

Appendix H – Water quality assessments

MEMO

ARCADIS Design & Consultancy for natural and built assets

SUBJECT
A585 Windy Harbour to Skippool Highway Drainage Outfalls Assessment

DATE
12 December 2017

DEPARTMENT
Water Management and Resilience

COPIES TO
[redacted]

TO
Alan Cope

PROJECT NUMBER
10013463

FROM
[redacted]

Author	[redacted]	[redacted]
Checker	[redacted]	
Approver	[redacted]	

1. Introduction

An assessment has been undertaken to quantify the potential impacts of the discharge of routine runoff from the Scheme to receiving watercourses, namely the Horsebridge Dyke, the Main Dyke and the Pool Foot Creek. The Highways Agency Water Risk Assessment Tool (HAWRAT) has been used, as prescribed in Method A of the Design Manual for Roads and Bridges Volume 11, Section 3, Part 10, - Road Drainage and the Water Environment (DMRB HD45/09).

In accordance with the methodology a tiered approach to the assessment has been followed, with results reported at each step. Proposed outfalls have been assessed individually and cumulatively:

- for soluble pollutants where outfalls discharge within 1km along a river reach
- for sediment – bound pollutants where outfalls discharge within 100m along a river reach

2. Input Data

The HAWRAT requires data that have been collected from a number of sources, briefly summarised below and document in more detail in the accompanying A585 HAWRAT Input Data document:

- Climatic region: Cold/Wet and Standard Annual Average Rainfall: Warrington
- Q95 flow – derived from Centre of Ecology and Hydrology LowFlow software
- BFI – extracted for relevant catchments from the FEH web-service
- Designated Areas – searched online Nature on the Map
- Water Hardness – no local data available so a conservative assumption (Low) was adopted
- River Width – measured blue line thickness on OS mapping

3. Individual Outfall Assessment Results

The table below summarises the results of the individual outfall assessments.

Outfall No. & Receiving Watercourse	Step 1	Step 2	Step 3	Comments
Ca.1 Horsebridge Dyke	Runoff Fails Toxicity Test	Copper (0.04ug/l) and Zinc (0.13ug/l) PASS. Sediment accumulating: Yes (0m/s), Extensive: No (24).	No mitigation required. N/A	Stage 1: Fail Stage 2: Metals – Pass Sediment – Pass with alert D/S Protected Area
Ca.2 Horsebridge Dyke	Runoff Fails Toxicity Test	Copper (0.03ug/l) and Zinc (0.10ug/l) PASS Sediment accumulating: Yes (0.01m/s), Extensive: No (27).	No mitigation required. N/A	Stage 1: Fail Stage 2: Metals – Pass Sediment – Pass with alert D/S Protected Area
Ca.3 Main Dyke	Runoff Fails Toxicity Test	Copper (0.03ug/l) and Zinc (0.12ug/l) PASS Sediment accumulating: Yes (0.02m/s), Extensive: No (45).	No mitigation required. N/A	Stage 1: Fail Stage 2: Metals – Pass Sediment – Pass with alert D/S Protected Area
Ca.4 Main Dyke	Runoff Fails Toxicity Test	Copper (0.09ug/l) and Zinc (0.31ug/l) PASS. Sediment accumulating: Yes (0.03m/s), Extensive: Yes (121).	Sediment accumulating yes (0.03m/s), extensive no (99).	Stage 1: Fail Stage 2: Fail (sediments only). Stage 3: Metals – Pass Sediment – Pass
Ca.5 Main Dyke	Runoff Fails Toxicity Test	Copper (0.07ug/l) and Zinc (0.25ug/l) PASS. Sediment accumulating: Yes (0.03m/s), Extensive: No (99).	No mitigation required. N/A	Stage 1: Fail Stage 2: Metals – Pass Sediment - Pass
Ca.5b Main Dyke	Runoff Fails Toxicity Test	Copper (0.01ug/l) and Zinc (0.04ug/l) PASS. Sediment accumulating: Yes (0.03m/s), Extensive: No (16)	No mitigation required. N/A	Stage 1: Fail Stage 2: Metals – Pass Sediment – Pass
Ca.6	Runoff Fails	Copper (0.85ug/l) and Zinc (2.89ug/l) FAIL.	Copper (0.57ug/l) and	Stage 1: Fail

Pool Foot Creek	Toxicity Test	Sediment accumulating: Yes (0.03m/s), Extensive: Yes (455).	Zinc (1.94ug/l) PASS. Sediment accumulating (0.03m/s), extensive no (91).	Stage 2: Fail Stage 3: Metals – Pass Sediment – PASS with alert D/S Protected Area
Ca.7 Pool Foot Creek	Runoff Fails Toxicity Test	Copper (0.79ug/l) and Zinc (2.69ug/l) FAIL Sediment accumulating: Yes (0.03m/s), Extensive: Yes (409).	Copper (0.55ug/l) and Zinc (1.89ug/l) PASS. Sediment accumulating (0.03m/s), extensive no (98).	Stage 1: Fail Stage 2: Fail Stage 3: Metals – Pass Sediment – PASS with alert D/S Protected Area
Ca.8 Main Dyke	Runoff Fails Toxicity Test	Copper (0.00ug/l) and Zinc (0.01ug/l) PASS. Sediment accumulating: Yes (0.10m/s), Extensive: No (2)	N/A	Stage 1: Fail Stage 2: Metals – Pass Sediment - Pass

The results indicate that discharges from drainage catchments 1, 2 and 3 all pass at Step 2 for both solubles and sediments, albeit with an alert for sediments to flag that there is a protected area (the Wyre Estuary SSSI) downstream of these outfalls. Water quality treatment measures are not therefore required at these outfalls.

The outfall discharging catchment 4 fails at Step 2 for sediments, with the results indicating the potential for extensive sediment accumulative downstream of the outfall. Settlement of sediments is therefore required, with 18% settlement needed to achieve a PASS at Step 3. A wetland with a vortex grit separator is proposed at this location. Data presented in HD33/16 for the treatment efficiencies of various treatment system types shows that vortex grit separators can achieve 40% removal of suspended solids and the removal percentage for wetlands is 60%. These proposed treatment measures would therefore comfortably provide the level of settlement necessary at this outfall.

The outfalls draining catchments 5 and 5B both pass at Step 2 for solubles and sediment and whilst no treatment measures are required the drainage design includes for a wetland and vortex grid separator.

Outfalls from catchments 6 and 7 both discharge to the Pool Foot Creek, which is a small watercourses that drains a corresponding small catchment areas, hence the available dilution is limited. As a result both of these outfalls fail at Step 2 for both solubles and sediment and treatment/settlement measures are required. 33% treatment for solubles and 80% settlement for suspended solids is required at outfall 6 and 30% treatment for solubles and 76% for settlement for suspended solids is necessary at outfall 7. Wetland and vortex grid separator systems are proposed at both outfalls. In combination these measures offer settlement efficiencies of up to 100% (60%/40% respectively) and soluble treatment efficiencies of up to 65% for Zinc and 30% for Copper. These proposed treatment measures would therefore provide the levels of settlement and solubles reduction necessary at these outfalls.

The outfall draining catchment 8 passes at Step 2 for solubles and sediment and no treatment measures are required, nor are proposed at this outfall.

4. Cumulative Outfall Assessments

The table below summarises the results of the cumulative outfall assessments undertaken.

Outfalls	Step 1	Step 2	Step 3	Comments
Ca.1 and Ca.2	Runoff Fails Toxicity Test	Copper (0.06ug/l) and Zinc (0.22ug/l) PASS. Sediment accumulating: Yes (0.00m/s), Extensive: No (43)	N/A	Stage 1: Fail Stage 2: Metals – Pass Sediment – Pass with alert D/S Protected Area
Ca.4, Ca.5 and Ca.5B	Runoff Fails Toxicity Test	Copper (0.16ug/l) and Zinc (0.57ug/l) PASS	N/A	Stage 1: Fail Stage 2: Metals - Pass
Ca.6 and Ca.7	Runoff Fails Toxicity Test	Copper (1.29ug/l) and Zinc (4.31ug/l) FAIL. Sediment accumulating: Yes (0.03m/s), Extensive: Yes(865)	Copper (0.62ug/l) and Zinc (2.07ug/l) PASS Sediment accumulating: Yes (0.03m/s), Extensive: Yes (95)	Stage 1: Fail Stage 2: Fail Stage 3: Metals – Pass Sediment – PASS with alert D/S Protected Area

The results indicate that the cumulative discharges from drainage catchments 1 and 2 passes at Step 2 for both solubles and sediments, albeit with an alert for sediments to flag that there is a protected area (the Wyre Estuary SSSI) downstream of these outfalls. Water quality treatment measures are not therefore required at these outfalls.

The cumulative outfall discharging catchments 4, 5 and 5B pass at Step 2 for solubles and sediment and whilst no treatment measures are required the drainage design includes a wetland for catchments 4 and 5.

Cumulative outfalls from catchments 6 and 7 discharge to the Pool Foot Creek, as above it is a small watercourse that drains the two catchment areas. The cumulative assessment shows that Step 2 is failed for both solubles and sediment and treatment/settlement measures are required. 52% treatment for solubles and 89% settlement for suspended solids is required for the cumulative outfall. Wetland and vortex grid separator systems are proposed at both outfalls. In combination these measures offer settlement efficiencies of up to 100% (60%/40% respectively) and soluble treatment efficiencies of up to 65% for Zinc and 30% for Copper. These proposed treatment measures would therefore provide levels of settlement necessary at these outfalls. However, as we are approaching or exceeding our soluble treatment efficiencies we would recommend that more detailed assessment using Method B is undertaken or further measures in the treatment train are investigated.

Appendix I – Accidental spillage containment assessments

Probability calculation Summary

$P_{inc} = P_{SPL} \times P_{POL}$

Outfall location	P_{SPL}	P_{POL}	P_{inc}	%
1	0.000322085	0.6	0.00019325	0.019
2	0.000345008	0.6	0.00020701	0.021
3	0.002382296	0.6	0.00142938	0.143
4	0.00050705	0.6	0.00030423	0.030
5	0.004037841	0.6	0.00242270	0.242
5b	0.000361461	0.6	0.00021688	0.022
6	0.000198486	0.6	0.00011909	0.012
7	0.000247538	0.6	0.00014852	0.015
8	-	0.6	-	
9	0.000113291	0.6	0.00006797	0.007

Where P_{inc} is less than 1%, no further spillage prevention measures are required to reduce the risk of a serious pollution incident.

All of our outfalls therefore 'Pass', with no need for spillage prevention measures.

Appendix J – Technical note (TN22) – Drainage CCTV asset and condition survey review

ARCADIS Design & Consultancy for natural and built assets

working on behalf of

highways england

Technical Note 22

Project	**A585 Windy Harbour to Skippool**	Date	23 MAY 2018
Subject	**Drainage CCTV Asset and Condition Survey Review**	Ref	**HE548643-ARC-HDG-A585-TN-D-3022 Version 1.0**

Author [redacted]

Table of Contents

1	**Introduction**	**1**
1.1	Background	1
1.2	Survey requirements	1
1.3	Survey length	1
1.4	De-scoped works	1
1.5	Contractor CCTV Survey	1
2	**Survey Data Review**	**3**
2.1	Survey data specification	3
2.2	Information received	3
2.3	Feedback on received data	3
2.4	Outstanding data	3
2.5	Conclusion	4
Appendix A – Hand marked up CCTV plans		**1**

Prepared by	[redacted]	Date	22/05/2018
Checked by	[redacted]	Date	23/05/2015
Approved by		Date	

Revision Status	Amendments	Date
V 1.0	First Issue	27/06/2018

1 Introduction

1.1 Background

1.1.1 During the Preliminary Design (Stage 3) existing as-built records and drainage data for the existing A585 trunk road has been obtained from Highways England Drainage Data Management System (HADMMS).

1.1.2 As-built drainage data has also been received from Enterprise Mouchel (Area 13) for the newly constructed Windy Harbour Junction (Drawing number: 780003/501z & 502z).

1.1.3 No data has been received from Lancashire County Council (LCC) for the local drainage networks which connect to the existing A585 trunk road. LCC stated during a walk over survey on the 30/11/2017 that no formal data is available.

1.1.4 This information has been used to determine the existing drainage collector, carrier systems and outfalls serving the existing A585 within the study area.

1.1.5 From a desk top gap analysis study of the available data it became clear that additional asset survey would be required to fill the gaps in the missing asset data.

1.2 Survey requirements

1.2.1 During the desk top study existing drainage gap analysis plans (CCTV asset and condition survey requirements) where produced to identify areas where addition asset and condition data was required. These areas where split into three categories on the plans (document numbers HE548643-ARC-HDG-A585-DR-D-3301 to 3312):

- Existing drainage to be removed – CCTV asset and condition survey not required;
- Existing drainage to be retained – CCTV asset and condition survey required; and
- Existing drainage to be removed – asset survey required (no CCTV condition survey).

1.3 Survey length

1.3.1 The existing drainage gap analysis plans estimated that 8.8km of existing drainage needed be surveyed, of which:

1. 6.3km is categorised as “existing drainage to be retained – CCTV asset and condition survey required”; and
2. 2.5km is categorised as “existing drainage to be removed – asset survey required (no CCTV condition survey)”.

1.4 De-scoped works

1.4.1 The proposed CCTV asset and condition survey works were de-scoped by Highway England on the 18/02/2018. The descoping was due the original survey programme taking 6 weeks which would of meant it clashing with road closes being but in place for another Highways England Scheme. In addition, further survey information was received from the maintainer prior to the works commencing.

1.4.2 The survey was descoped on the understanding that the remaining drainage asset would be surveyed at design stage 5 to inform the de-trunking works.

1.4.3 The revised descoped plans were issued to Highways England on the 19/02/2018.

1.5 Contractor CCTV Survey

1.5.1 The risk of not having data for 6.3km of drainage asset was raised via an Early Warning Notice and entered onto the Project Risk Register. As a result, Highways England instructed the CCTV asset and condition survey to be undertaken during Stage 3.

1.5.2 This Technical Note captures the results of this further additional survey and its impact on the current design.

2 Survey Data Review

2.1 Survey data specification

2.1.1 A CCTV Asset and Condition Specification - Appendix 90/1 (document number HE548643-ARC-HDG-A585-SU-D-3000) along with a Schedule or Rates (SoR) was issued to Highways England in October 2017. This specification outlined the scope of works, pre-cleansing, traffic management issues, and the required deliverables.

2.2 Information received

2.2.1 The original survey programme supplied by Highways England's CCTV asset and condition supplier Interserve stated that the survey works would start in 16/02/2018 and would be completed by the end of 09/03/2018 (4weeks). However, the survey was delayed, by 10 day and started on the 26/02/2018 and finished on 23/03/2018, with the final report received on 30/04/2018

2.2.2 The CCTV data was issued to Arcadis via WeTransfer and Table A in Appendix A summarises the CCTV asset and condition data.

2.3 Feedback on received data

2.3.1 4 No. files were received in the WeTransfer, these being:

- 1no. Access database file;
- 1no. drawing AutoCAD file;
- 1no. PDF file of the drawings; and
- 1no. CCTV report

2.3.2 The survey information received is generally in compliance with the specification. However, the following deliverables required by the specification have not been provided:

- WinCan inspection report;
- Detailed report on departures from drainage drawings;
- Marked up drawings and AutoCAD files showing the location of major defects; and
- Marked up drawings and AutoCAD files showing the defect mitigation recommendations.

2.4 Outstanding data

2.4.1 The SoR estimate 6.3km of existing pipework needed CCTV asset and condition survey and 2.5km required asset survey only (total 9km).

2.4.2 We have received 6.3km of data, of which some of the data is outside of the scope of works as shown on a set of hand marked up plans in Appendix A. The plans have been highlighted to show:

- No CCTV asset and condition survey available (yellow highlight);
- CCTV asset and condition survey available (Blue highlight); and
- CCTV asset and condition survey in complete (Green highlight).

2.4.3 Other elements break down as below:

- Estimated chambers = 147, surveyed = 131

- Estimated gullies = 176, surveyed = 211

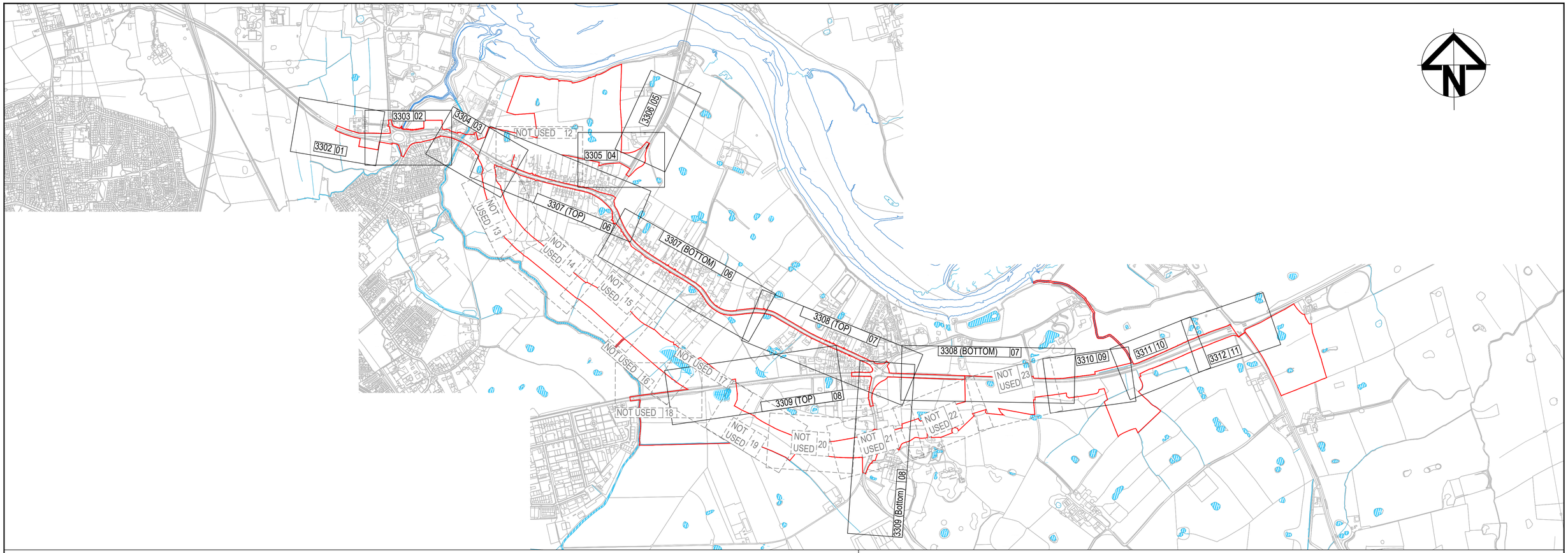
2.4.4 Consequently, there is still a minimum of 2.5km of outstanding data, based on the de-scoped survey works.

2.5 Conclusion

The received CCTV asset and condition data helps clarify some of the existing drainage assets and their condition, but there are still large areas were the data is incomplete or missing and we will have to make assumptions to fill in the gaps

The deliverables are partially in compliance with the specification.

Appendix A – Hand marked up CCTV plans



DRAINAGE LEGEND :

- PROPOSED REDLINE BOUNDARY
- 225 Ø — EXISTING DRAINAGE TO BE REMOVED - CCTV ASSET AND CONDITION SURVEY NOT REQUIRED
- 225 Ø — EXISTING DRAINAGE TO BE RETAINED -CCTV ASSET AND CONDITION SURVEY NOT REQUIRED
- 225 Ø — EXISTING DRAINAGE TO BE RETAINED - CCTV ASSET AND CONDITION SURVEY REQUIRED
- 225 Ø — EXISTING DRAINAGE TO BE REMOVED - ASSET SURVEY REQUIRED (NO CCTV CONDITION SURVEY)
- EXISTING DRAINAGE GULLY POT WITH CONNECTIONTO BE REMOVED - CCTV ASSET AND CONDITION SURVEY NOT REQUIRED
- EXISTING DRAINAGE GULLY POT WITH CONNECTION TO BE RETAINED - CCTV ASSET AND CONDITION SURVEY REQUIRED
- EXISTING DRAINAGE GULLY POT WITH CONNECTION TO BE RETAINED -CCTV ASSET AND CONDITION SURVEY NOT REQUIRED
- M1A-001/C1A-001 — EXISTING DRAINAGE MANHOLE/CATCHPITTO BE REMOVED - CCTV ASSET AND CONDITION SURVEY NOT REQUIRED
- M1A-001/C1A-001 — EXISTING DRAINAGE MANHOLE/CATCHPIT TO BE RETAINED - CCTV ASSET AND CONDITION SURVEY REQUIRED
- M1A-001/C1A-001 — EXISTING DRAINAGE MANHOLE/CATCHPIT TO BE REMOVED - ASSET SURVEY REQUIRED (NO CCTV CONDITION SURVEY)
- M1A-001/C1A-001 — EXISTING DRAINAGE MANHOLE\CATCHPIT TO BE RETAINED -CCTV ASSET AND CONDITION SURVEY NOT REQUIRED
- EXISTING DRAINAGE TO BE RETAINED -CCTV ASSET AND CONDITION SURVEY NOT REQUIRED
- NO EXISTING DRAINAGE DATA AVAILABLE - LOCATE EXISTING DRAINAGE ASSETS AND UNDERTAKE CCTV ASSET AND CONDITION SURVEY
- Pond — EXISTING WATERBODIES
- ASSUMED EXISTING HEADWALL / OUTFALLL LOCATION
- PROPOSED ROAD LAYOUT
- ORDNANCE SURVEY
- EXISTING ROAD
- 3311 | 10 — SHEET NO. / DRAWING NO.

DRAINAGE GENERAL NOTES :

1. ALL PIPE SIZES ARE IN MILLIMETERS AND LEVELS ARE IN METERS UNLESS STATED OTHERWISE.
2. WRITTEN SCALES (EG. 1:1000, 1:500, ETC.) APPLY TO DRAWINGS AT A1 PAPER SIZE UNLESS NOTED OTHERWISE.
3. DO NOT SCALE DIRECTLY FROM DRAWINGS, USE FIGURED DIMENSIONS ONLY.
4. REFER TO CCTV ASSET SPECIFICATION HE-548643-ARC- HDG-A585-RP-D-3037.
5. CCTV ASSET AND CONDITION SURVEYS ARE TO BE UNDERTAKEN ON ALL IDENTIFIED AND UNIDENTIFIED DRAINAGE ASSET AS HIGHLIGHTED ON THESE PLANS.
6. SHEET NO. 12 TO 23 NOT TO BE REFERRED FOR THIS PACKAGE.

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Notes

LOCATION PLAN

Client: highways england

ARCADIS Design & Consultancy for natural and built assets
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) KEY PLAN

Status	PRELIMINARY DESIGN
Revision	P02
Scale	NTS
Date -	21FEB2018
Drawn By	[redacted].G
Checked By	A[redacted]
Approved By	N[redacted]
Project No.	UA008015
PIN	HE548643
Originator	ARC
Original Size	A1
Drawing number	HE548643-ARC-HDG-A585-DR-D-3301

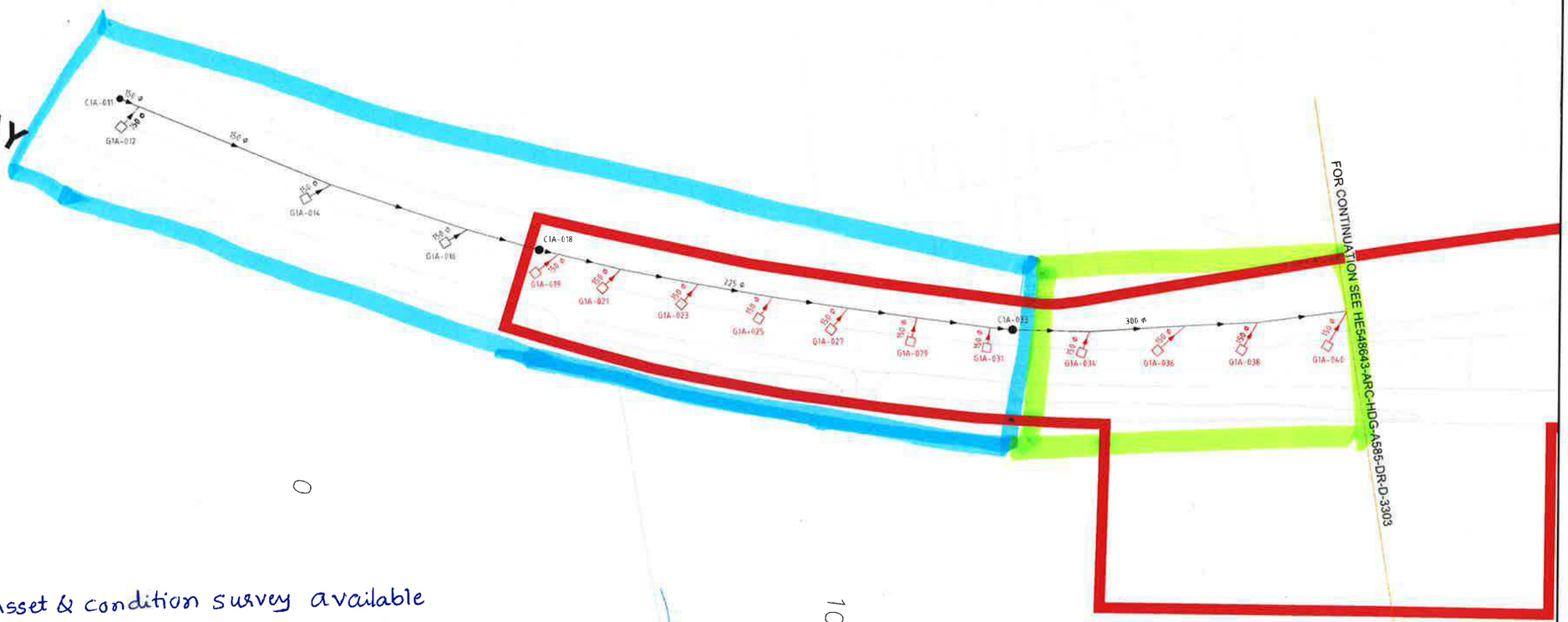
Volume | Location | Type | Role | Number

100mm on Original

Print Date:

File Path:

A585 AMOUNDERNESS WAY



NO CCTV Asset & condition survey available

CCTV Asset & condition survey available

CCTV Asset & condition survey is incomplete

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S	A	N
P01	PD	26OCT2017	PRELIMINARY DESIGN	S	A	N

Notes

1. FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 1 OF 11

Status: PRELIMINARY DESIGN | Revision: P02

Scale: 1:500 | Date: 21FEB2018

Drawn By: [redacted]G

Checked By: A[redacted]

Approved By: N[redacted]

Project No: UA008015 | HA PIN: HE548643 | Originator: ARC | Original Size: A1

Drawing number: Volume | Location | Type | Role | Number: HE548643-ARC-HDG-A585-DR-D-3302

100mm on Original

Print Date:

File Path:

B5412 SKIPPOOL ROAD

A585 BRECK ROAD

A588 BRECK ROAD

DRAINAGE ASSETS ON SKIPPOOL ROAD (B5412) TO BE IDENTIFIED AND A CCTV ASSET AND CONDITION SURVEY TO THE OUTFALL IS TO BE UNDERTAKEN

STRUCTURAL CONDITION SURVEY REQUIRED, METHODOLOGY TO BE CONFIRMED WITH SPECIALIST SUPPLIER

OUTFALL CATCHMENT-02A DETAILS TBC

OUTFALL CATCHMENT-01A DETAILS TBC

OUTFALL CATCHMENT-02B DETAILS TBC

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3302

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3304

E 440600

E 440500

No CCTV asset & condition survey available

CCTV Asset & condition survey available

CCTV asset & condition survey is incomplete

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Notes

1. FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS

Registered office: Arcadis House, 34 York Way, London N1 9AB

Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 2 OF 11

Status	PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date :-	21FEB2018
Drawn By	[redacted] G
Checked By	A [redacted]
Approved By	N [redacted]
Project No	HA PIN: UA008015
Originator	ARC
Original Size	A1
Drawing number	Volume | Location | Type | Role | Number: HE548643-ARC-HDG-A585-DR-D-3303

100mm on Original

Print Date:

File Path:

OLD MAINS LANE

A585 MAINS LANE

Main Dyke

OUTFALL CATCHMENT-03A DETAILS TBC

OUTFALL CATCHMENT-04A DETAILS TBC

G3A/TBC

G4A/TBC

C4A-035

G4A-034

G4A-032

G4A-030

G4A-028

G4A-026

G4A-024

G4A-022

C4A-021

G4A-019

G4A-017

G4A-015

C4A-014

G3A-051

G3A-031

G3A-029

G3A-027

G3A-025

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3303

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3307 (TOP)

500

600

700

800

Pond

No CCTV asset & condition Suevey available

CCTV & asset & condition suevey available

CCTV asset & condition suevey is incomplete

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	P0	21FEB2018	REDUCED SURVEY SCOPE	S	A	N
P01	P0	26OCT2017	PRELIMINARY DESIGN	S	A	N

Notes

1 FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS

Registered office: Arcadis House, 34 York Way, London, N1 9AB

Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 3 OF 11

Status: PRELIMINARY DESIGN

Revision: P02

Scale: 1:500

Date: 21FEB2018

Drawn By: [redacted]G

Checked By: A[redacted]

Approved By: N[redacted]

Project No: UA008015

HA: HE548643

PIN:

Originator: ARC

Volume | Location:

Type | Role | Number:

Original Size: A1

Drawing number: HE548643-ARC-HDG-A585-DR-D-3304

100mm on Original

Print Date:

File Path:

Pond

E 440590

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3306

A588 SHARD ROAD

DRAINAGE ASSETS ON A588 TO BE IDENTIFIED AND A CCTV ASSET AND CONDITION SURVEY TO THE OUTFALL IS TO BE UNDERTAKEN

E 440400

No CCTV asset & condition Survey available

CCTV asset & condition survey available

CCTV asset & condition Survey is incomplete

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3307 (TOP)

Pond

Pond

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chk'd	Appr'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

Print Date:

File Path:

Notes

1 FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS
Registered office: Arcadis House, 34 York Way, London N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel +44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 4 OF 11

Status: PRELIMINARY DESIGN

Revision: P02

Scale: 1:500

Date: 21FEB2018

Drawn By: [redacted]G

Checked By: A[redacted]

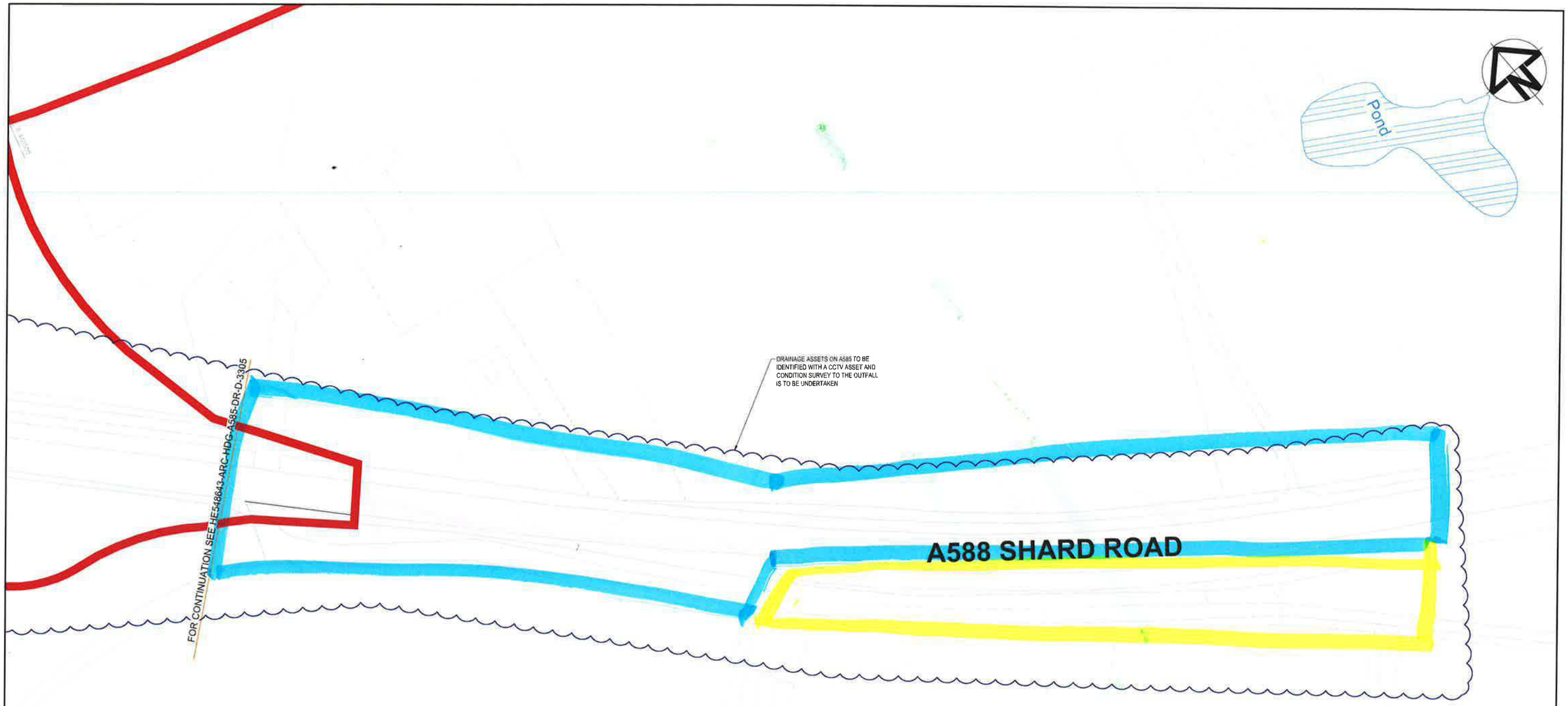
Approved By: N[redacted]

Project No: UA008015 | HA PIN: HE548643 | Originator: ARC

Original Size: A1

Drawing number: Volume | Location | Type | Role | Number

HE548643-ARC-HDG-A585-DR-D-3305



NO CCTV asset & condition Survey available

CCTV asset & condition survey available

CCTV asset & condition survey is incomplete

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Notes:

1 . FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS
Registered office: Arcadis House 34 York Way London N1 9AB
Coordinating office: The Surrey Research Park 10 Medawar Road Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 5 OF 11

Status: PRELIMINARY DESIGN | Revision: P02

Scale: 1:500 | Date: 21FEB2018

Drawn By: [redacted]G

Checked By: A[redacted]

Approved By: N[redacted]

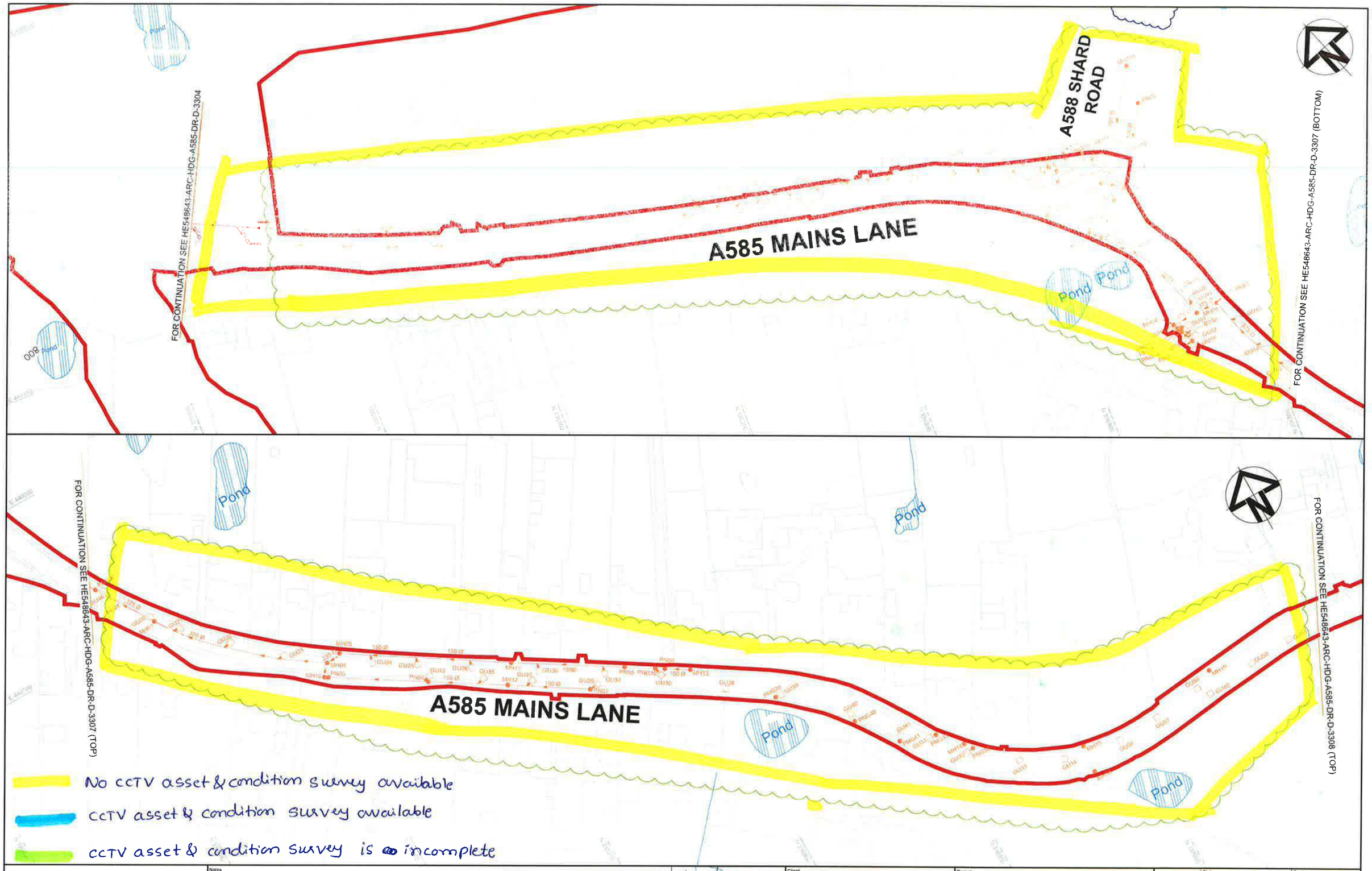
Project No: UA008015 | HA PIN: HE548643 | Originator: ARC | Original Size: A1

Drawing number: Volume | Location | Type | Role | Number
HE548643-ARC-HDG-A585-DR-D-3306

100mm on Original

Print Date:

File Path:



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Notes

1 . FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS

Registered office: Arcadis House 34 York Way London N1 9AB

Coordinating office: The Surrey Research Park 10 Mediawrr Road Guildford GU2 7AR Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 6 OF 11

Status: PRELIMINARY DESIGN | Revision: P02

Scale: 1:1000 | Date: 21FEB2018

Drawn By: [redacted]G

Checked By: A[redacted]

Approved By: N[redacted]

Project No: UA008015 | HA: HE548643 | PIN | Originator: ARC | Original Size: A1

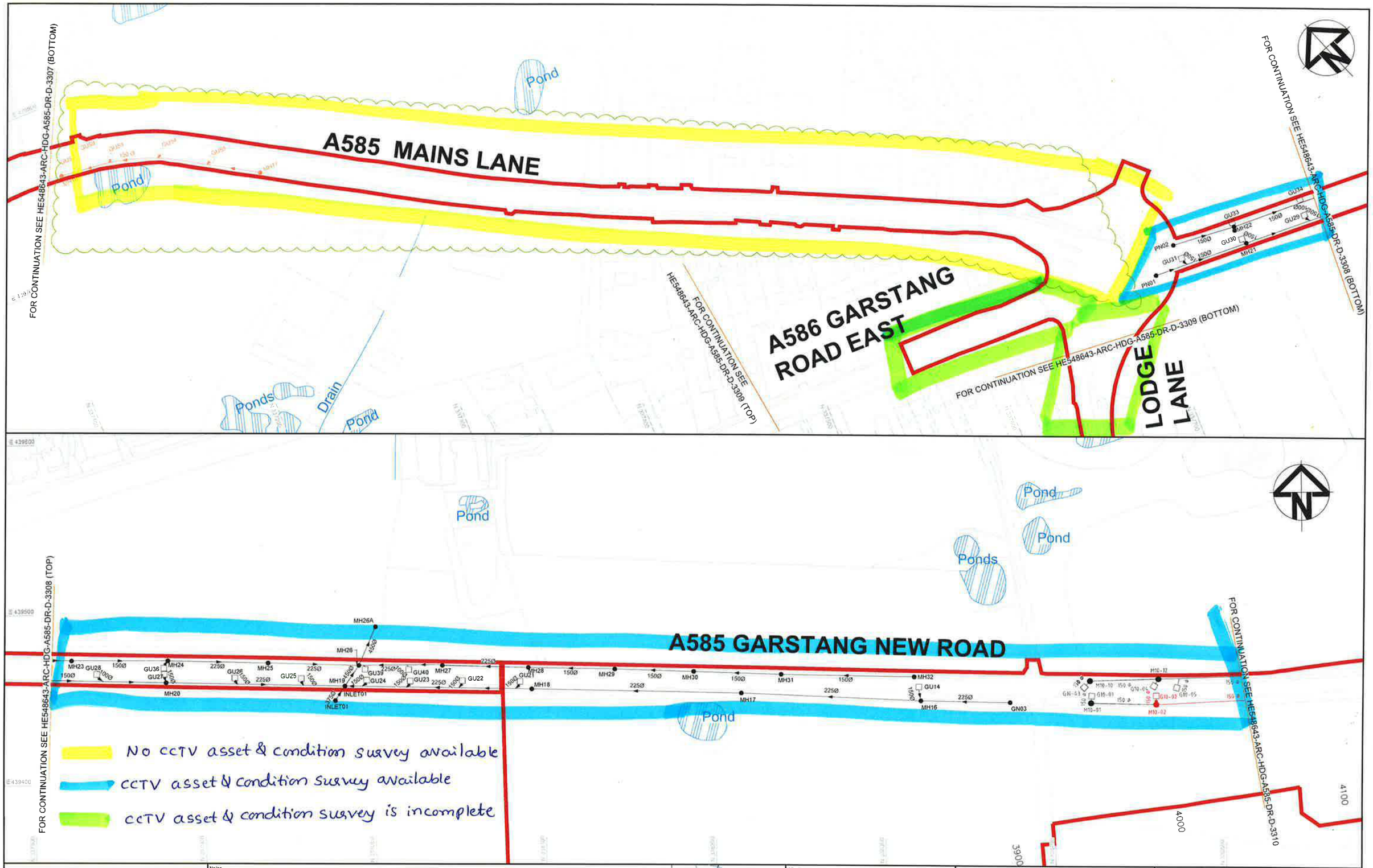
Drawing number: Volume | Location | Type | Role | Number

HE548643-ARC-HDG-A585-DR-D-3307

100mm on Original

Print Date:

File Path:



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chk'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Notes

1 . FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS
Registered office: Arcadis House, 34 York Way, London N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel: +44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

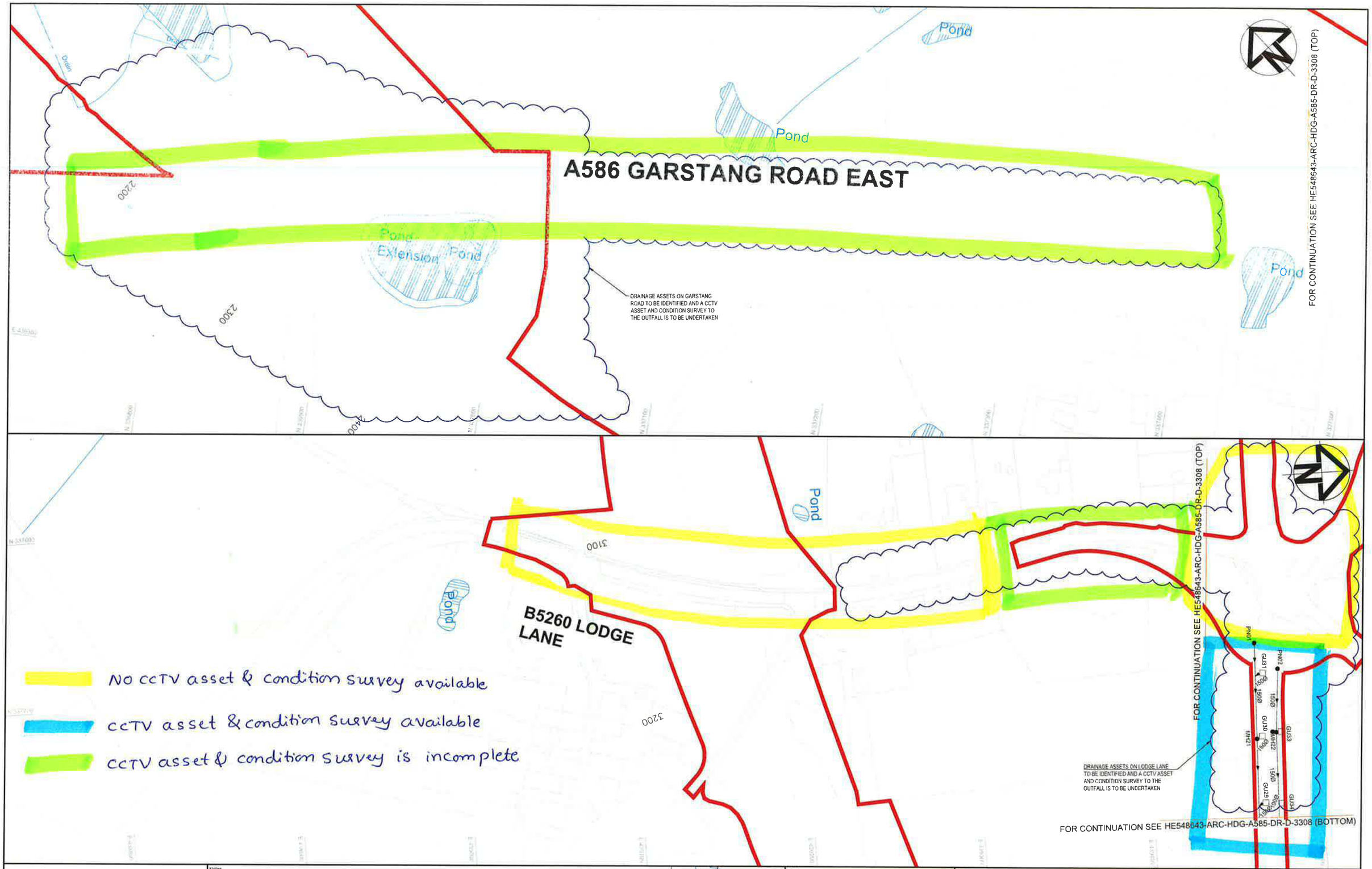
Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 7 OF 11

Status	PRELIMINARY DESIGN
Revision	P02
Scale	1:1000
Date	21FEB2018
Drawn By	[redacted] G
Checked By	A[redacted]
Approved By	N[redacted]
Project No.	UA008015
HA PIN	HE548643
Originator	ARC
Original Size	A1
Drawing number	HE548643-ARC-HDG-A585-DR-D-3308
Volume | Location | Type | Role | Number	

100mm on Original

Print Date: [redacted]

File Path: [redacted]



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

100mm on Original

Notes

1 . FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client

highways england

ARCADIS

Registered office: Arcadis House, 34 York Way, London, N1 9AB

Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel 44 (0)1483 803 000

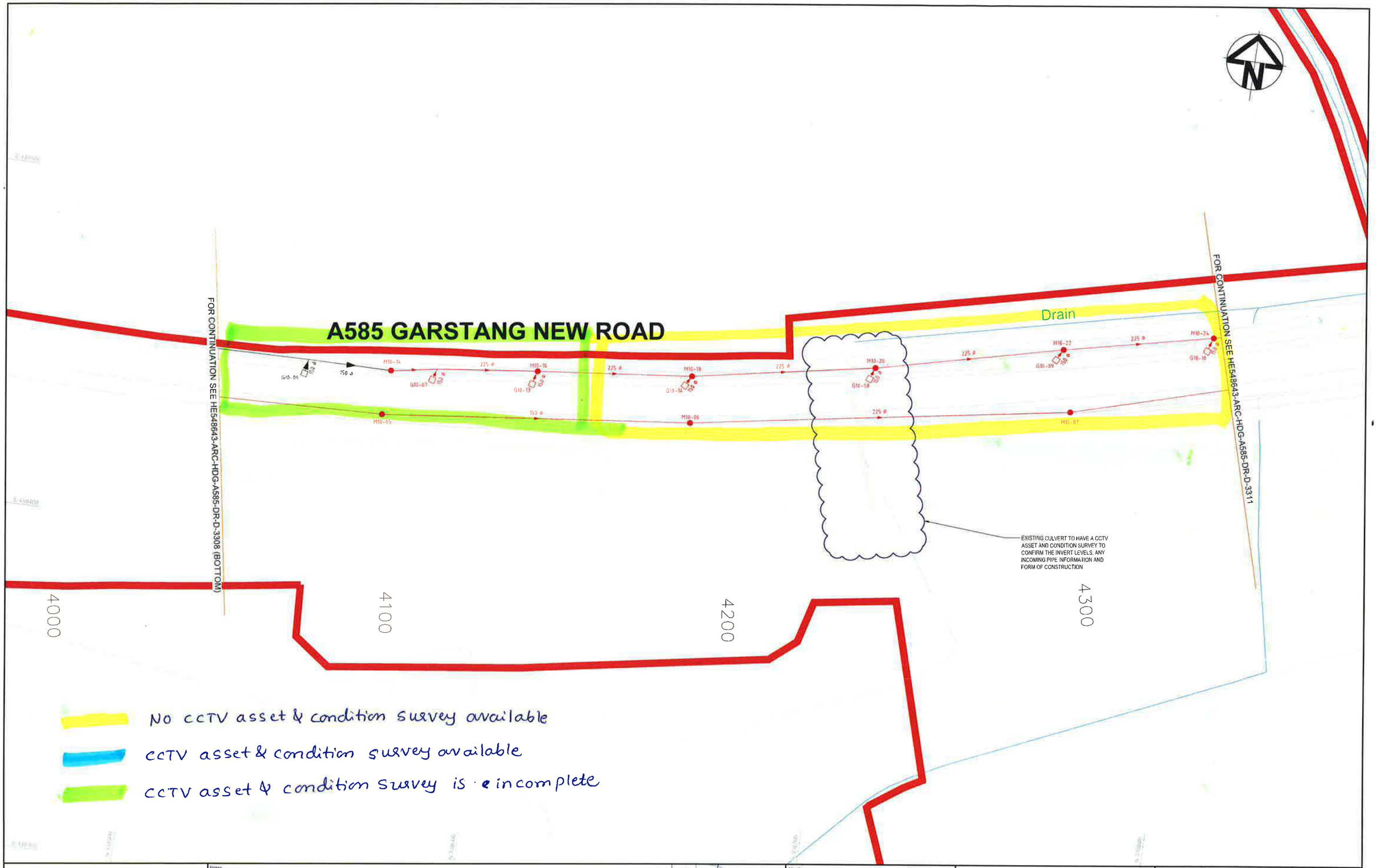
Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 8 OF 11

Status	PRELIMINARY DESIGN
Revision	P02
Scale	1:1000
Date	21FEB2018
Drawn By	[redacted]G
Checked By	A[redacted]
Approved By	N[redacted]
Project No	UA008015
HA PIN	HE548643
Originator	ARC
Original Size	A1
Drawing number	HE548643-ARC-HDG-A585-DR-D-3309

Print Date:

File Path:



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Notes

1 . FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS
Registered office
Arcadis House
34 York Way
London
N1 9AB
Coordinating office
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL
STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 9 OF 11

Status: PRELIMINARY DESIGN | Revision: P02

Scale: 1:500 | Date: 21FEB2018

Drawn By: [redacted]G
Checked By: A[redacted]
Approved By: N[redacted]

Project No: UA008015 | HA PIN: HE548643 | Originator: ARC | Original Size: A1

Drawing number: HE548643-ARC-HDG-A585-DR-D-3310

Volume | Location | Type | Role | Number

100mm on Original

Print Date: [redacted]

File Path: [redacted]

A585 GARSTANG NEW ROAD

EXISTING CULVERT TO HAVE A CCTV ASSET AND CONDITION SURVEY TO CONFIRM THE INVERT LEVELS, ANY INCOMING PIPE INFORMATION AND FORM OF CONSTRUCTION

Outfall Catchment - G10 & G11A

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3310

FOR CONTINUATION SEE HE548643-ARC-HDG-A585-DR-D-3312

EXISTING CULVERT TO HAVE A CCTV ASSET AND CONDITION SURVEY TO CONFIRM THE INVERT LEVELS, ANY INCOMING PIPE INFORMATION AND FORM OF CONSTRUCTION

Pond

Pond

Drain

Pond

4400

4500

4600

4700

NO CCTV asset & condition survey available

CCTV asset & condition survey available

CCTV asset & condition survey is incomplete

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S[redacted]	A[redacted]	N[redacted]
P01	PD	26OCT2017	PRELIMINARY DESIGN	S[redacted]	A[redacted]	N[redacted]

Notes

1. FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301

LOCATION PLAN

Client: highways england

ARCADIS

Registered office
Arcadis House
34 York Way
London
N1 9AB

Coordinating office
The Surrey Research Park
10 Medawar Road
Guildford GU2 7AR
Tel: 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 10 OF 11

Status	PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	21FEB2018
Drawn By	[redacted]G
Checked By	A[redacted]
Approved By	N[redacted]
Project No.	HA PIN I Originator
	UA008015 HE548643 ARC
Original Size	A1
Drawing number	Volume I Location I Type I Role I Number
	HE548643-ARC-HDG-A585-DR-D-3311

100mm on Original

Print Date:

File Path:



Rev	Status	Rev. Date	Purpose of revision	Drawn	Chckd	Apprvd
P02	PD	21FEB2018	REDUCED SURVEY SCOPE	S	A	N
P01	PD	26OCT2017	PRELIMINARY DESIGN	S	A	N

Notes
1. FOR NOTES AND LEGENDS REFER DRAWING NO :HE548643-ARC-HDG-A585-DR-D-3301
2. ALL GULLY OUTLET PIPES ARE 150mm DIAMETER UNLESS SPECIFIED.

LOCATION PLAN

Client: highways england

ARCADIS
Registered office: Arcadis House, 34 York Way, London, N1 9AB
Coordinating office: The Surrey Research Park, 10 Medawar Road, Guildford GU2 7AR, Tel 44 (0)1483 803 000

Project: A585 WINDY HARBOUR TO SKIPPOOL STAGE - 3 PRELIMINARY DESIGN

Drawing title: EXISTING DRAINAGE GAP ANALYSIS PLANS (CCTV ASSET AND CONDITION SURVEY REQUIREMENTS) SHEET 11 OF 11

Status	PRELIMINARY DESIGN
Revision	P02
Scale	1:500
Date	21FEB2018
Drawn By	[redacted] G
Checked By	A [redacted]
Approved By	N [redacted]
Project No	UA008015
PIN	HE548643
Originator	ARC
Original Size	A1
Drawing number	HE548643-ARC-HDG-A585-DR-D-3312

Volume | Location | Type | Role | Number

100mm on Original

Print Date:

File Path:

Appendix K – Maintenance operations

DRAINAGE MAINTENANCE SCHEDULE										
Ref	**Group Item**	**Tasks**	**Frequency**	**Traffic Management Measures**	**Assumed Means of Safe Access**	**Assumed Safe Method of Maintenance Work**	**Impact on Day-to-Day Operations**	**Impacts on Current Maintenance Activities**	**Scheme Specific Safety Measures and Risks**	**Remarks**
1	Surface water drainage systems	Inspection, litter/debris removal for drainage elements at ground level, including: gullies, combined kerb drain units, Linear drain units, Grated "u" channels, all chambers.	Regular	Partial lane closures for underpasses and roads where no footpaths exist.	• Access is via the existing road network. Operate under lane closure. • Avoid entry to chamber where possible. (Confined space entry)	• All operations are carried out above ground. • Conduct as part of the general highways maintenance for the scheme	Some disruption to road users during lane closure.	Increased. More drainage elements and variety in the area.	• Working near live traffic / NMUs. • Surface water channels / Combined drainage and kerb units and linear drainage systems are prone to rapid build-up of silt and debris in flat areas.	• Proposed drainage is designed with self-cleaning velocity to minimise blockage. • Silt and other solids arising from emptying and cleaning operations may cause pollution, and should therefore be disposed of in a suitable manner in accordance with local regulations. • Maintenance should be avoided in bad weather / heavy rainfall. • Tasks that are classed as non-urgent repairs should wait for lane closure to be carried out.
2		Emptying and cleaning drainage systems such as gullies, combined kerb/drainage, linear drain systems, catch pits.	Regular (every 12 months or after each major storm)	Lane closure to allow access for purpose built vehicles.		• Access to the combined kerb/drainage, linear systems is via its rodding access and/or outlet units. • Using standard vacuuming and jetting equipment.	Some disruption to road users during lane closure.		• Working near live traffic / NMUs. • Combined kerb/drainage, linear systems access units are located along the system to provide effective maintenance points.	
3		Inspection on all carrier drains / grated "u" Channels (below ground)	Occasional (every 10 years)	Lane closure to allow access for purpose built vehicles.		• CCTV survey should be used where possible. No man-entry required. • Task can be done in conjunction with flushing.	Some disruption to road users during lane closure.		• Working near live traffic / NMUs.	
4		Surface water drainage pipe network cleaning (blockage, emergency)	Remedial / Reactive (when required)	Lane closure to allow access for purpose built vehicles.		• Conventional methods (e.g. high/low pressure jetting / suction). Depend on the extent of works required.	Some disruption to road users if lane closure is required.		• Working near live traffic / NMUs. • Emergency may involve flooding on roads, accidental spillages etc.	
5		Surface water drainage pipe rehabilitation	Remedial (when required)	Lane closure to allow access for purpose built vehicles.		• Methods depending on types of repair required. • Trenchless pipe lining techniques available so no major excavation required.	Some disruption to road users during lane closure. Trenchless techniques minimise disruption to road users.		• Working near live traffic / NMUs.	
6		Clearing and cleaning culverts. De-silting.	Occasional (determined by routine inspection)	Lane closure to allow access for purpose built vehicles. (If off-road site is unavailable)		• Conventional methods (e.g. high/low pressure jetting / suction). Depend on the extent of works required.	Some disruption to road users if lane closure is required.		• Working near shallow ditches that may contain water. • Task frequency can be reduced by fitting inlets/outlets with trash screens and routine debris removal.	
7		Emptying and cleaning vortex grit separators	Regular (every 12 months or after each major storm)	Lane closure to allow access for purpose built vehicles.		• Access to the vortex grit separator via chamber cover – non-man entry. • Using standard vacuuming and jetting equipment.	Some disruption to road users during lane closure.		• Working near live traffic.	

DRAINAGE MAINTENANCE SCHEDULE										
Ref	**Group Item**	**Tasks**	**Frequency**	**Traffic Management Measures**	**Assumed Means of Safe Access**	**Assumed Safe Method of Maintenance Work**	**Impact on Day-to-Day Operations**	**Impacts on Current Maintenance Activities**	**Scheme Specific Safety Measures and Risks**	**Remarks**
8	Wetlands	Inspection to identify any areas of the wetlands that is not operating correctly. Litter/debris removal that is detrimental to the operation of the wetland	Regular (monthly or after each major storm)	Wetlands with off network access do not require TM. Single lane closure to allow access to wetlands of offline by-pass	• Offline maintenance track provides easy and safe access for people and vehicles to the Wetland. • Maintenance access track is provided around the Wetland to provide close access to Wetland and all associated structures/features. • The existing Wetland is fenced for security. • The existing Wetland has side slopes of less than 1:3.	• All structures can be easily inspected without entering the structures. • All structures apart from the PCD chamber are of an open design. • See 'Safety Measures and Risks'.	None. Wetland locate away from carriageways.	None – current operating as a Wetland	• Need to work on gentle side slopes (1 in 3 or less) • Maintenance should be avoided in bad weather / heavy rainfall.	• Silt and other solids arising from emptying and cleaning operations may cause pollution, and should therefore be disposed of in a suitable manner in accordance with local regulations. • Maintenance should be avoided in bad weather / heavy rainfall.
9		Weed invasive, plant control for the Wetland.	Regular			• Conduct as part of the landscape maintenance for the scheme. • Operatives must wear appropriate clothing and PPE			• Maintenance should be avoided in bad weather / heavy rainfall.	
10		Sediment management for the Wetland	Occasional (determined by routine inspection)			• The operation involves using a vacuum tanker which requires no man-handling of possible contaminated silt. • Entry to structure should be avoided where possible. • Most sediment is designed to be trapped in the Wetland.				
11		Repair eroded areas	Remedial (when required)			• Immediate working area to be cleared.			• Block water from the working area and reinstate after remedial work.	
12	Flow Control Device	Inspect and remove any obstructions	Regular (monthly or after each major storm)	Single lane closure to allow access to chamber	• Access is via the road network. Operate under lane closure. • Avoid entry to chamber where possible. (Confined space entry)	• All operations are carried out above ground. (where possible) • Maintenance activity in confined space to use safe systems of working	Some disruption to road users during lane closure.	Increased	• Working near live traffic. Confined space entry	

APPENDIX F – MEETING MINUTES

Page Left Intentionally Blank

MINUTES

ARCADIS Design & Consultancy for natural and built assets

MEETING TITLE
A585 Windy Harbour to Skippool Improvement Scheme

DATE
30 April 2018

TIME
10:00 AM

LOCATION
EA Office Bamber Bridge

CHAIR PERSON
[redacted]

ORGANISER
[redacted]

COPIES TO
[redacted] – Highways England
[redacted] – Highways England
[redacted] – Arcadis
[redacted] – Arcadis
[redacted] – Arcadis
[redacted] – Arcadis

PARTICIPANTS
[redacted] – Arcadis
[redacted] – Arcadis
[redacted] – Arcadis
[redacted] – EA
[redacted] – EA
[redacted] – EA
[redacted] - EA

APOLOGIES

ACTION	WHO	WHEN
1. Introductions and Aims of the Meeting		
1.1 CG outlined that we would like to discuss each of the agenda items which are focused on each of the EA comments received on the submitted FRA report and hydraulic models.		
1.2 CG asked that where a comment was linked to a query on the hydraulic model could she liaise directly with the EA model reviewer. PS stated that this is not their preferred approach and that communications should continue to be channelled via AH.		
2. Feedback on current FRA		
2.1 Use of 2015 LiDAR - CG stated that Arcadis checks have not identified any recent (post 2015) significant development within the model domain that could affect model predictions. PS confirmed that the EA are in agreement with this conclusion and this comment is closed out. No further action required.		
2.2 Approach to modelling buildings – CG re-iterated that the adopted approach (increased roughness) is standard practice for fluvial modelling and has been accepted by the EA in several other studies. PS said that he would discuss further with the EA model reviewer to close this out.	PS/AH	5/11/18
2.3 Model Extent – PS confirmed that sufficient justification has now been provided by Arcadis for the chosen model extent. This should be documented in the FRA Technical Annex. This comment is closed out.	CG	
2.4 Tidal Boundary - PS confirmed that sufficient evidence has now been provided by Arcadis. This should be documented in the FRA Technical Annex. This comment is closed out	CG	

ACTION	WHO	WHEN
3. Modelling Annex		
3.1 CG shared a draft modelling annex. PS stated that he was happy with the content and structure of the annex. CG confirmed that this would be completed and submitted as part of the revised FRA.	CG	Revised FRA submission
4. Flood Risk During Construction		
4.1 LD outlined that the works required to mitigate for temporary increases in fluvial flood risk during the construction phase would be secured by being included in the Record of Environmental Actions and Commitments, as well as the Outline Construction Environment Management Plan (CEMP), both of which are certified documents. DH explained that inclusion in these DCO documents would bind the contractor to putting the measures in place. The flood compensation area would also be secured within the DCO itself through 'Schedule 1 - The Authorised Development' and also within the Works Plans (a certified document). PS confirmed that the EA were satisfied with this approach.	CG	Revised FRA submission
4.2 Compensation storage – latest modelling results. CG described that the representation of the compensation provision in the model has been refined. CG shared a series of images that mapped out the change in depth (relative to baseline results) for a range of storm events (1% AEP plus 30% CC to 10% AEP) under 3 scenarios: During Construction, During Construction with Mitigation, Scheme Completion. The model results show that the mitigation is successful in reducing flood depths. In the largest event modelled (1% AEP plus 30% for climate change), increases in flood depth are limited to within the range of +3 to +4cm. PS confirmed that the ranges of impacts would be deemed acceptable by the EA. PS and PH requested that further information is included in the FRA report about how the storage areas would work in practice, e.g. how they would fill and empty, and how the flood hydrograph is changed.		
5. Tidal Flood Risk		
5.1 Impacts to the Scheme – LD clarified the 2 locations along the Scheme that are potentially at risk of tidal flooding. The vertical alignment of the design in the eastern area of risk is not constrained so has been raised above the 0.5% + CC tidal flood level. At the second location at Skippool junction, the Scheme has to tie into the existing road network, which poses a significant constraint to the vertical alignment. As a result, it is not practical to raise the road above the 0.5% AEP flood level (300mm depth of flooding predicted, increasing to 700mm when CC allowance is applied to year 2115). LD outlined that the risk would be managed by the operator, issuing warnings and enforcing road closures as necessary on receipt of EA flood warnings. PS confirmed that provided that the design constraints and the rationale behind the strategy for managing tidal flood risk to the scheme are clearly described in the FRA, this would be acceptable to the EA.	LD	Revised FRA submission
5.2 Impacts of the Scheme on Third Party Tidal Risk – the EA confirmed that the key location for scrutiny is around the Skippool junction as this		

ACTION	WHO	WHEN
area has a history of flooding and there are sensitive receptors. CG stated that the proposed replacement of the Horsebridge Dyke culvert has not yet been represented in the tidal model. Once we have updated model results Arcadis will provide the EA with detailed information for this area for further discussion.		
5.3 CG asked if the EA had any photographs of past flooding events in this area. PH will check.	PH	
6. Appendix D – Mapped Flood Extents		
6.1 CG outlined the reasoning behind the coverage of the maps provided in Appendix D of the FRA. PS said that a footnote should be added to the appendix to provide the reader with the explanation. CG confirmed this would be added to the updated FRA. Comment closed out.	CG	
7. Skippool Bridge Soffit Level		
7.1 CG outlined that due to design constraints on the vertical alignment of the road of the new bridge location the soffit level of the new structure would not be above the 1% AEP plus 70% climate change flood level (soffit level – 5.02mAOD flood level – 5.20mAOD). CG queried the acceptability of the design and PS confirmed this this was acceptable. Comment closed out.	CG	
8. Permitting		
8.1 DH shared the Consents and Agreements Position Statement (CAPS) and talked through some of the permits and consents we thought may be required and the timescales involved in each. PH confirmed that for a FRAP the EA have a determination period of 8 weeks once they have all information required. Once an application is submitted they can stop the clock to request further information. PH stated that a FRAP has a lifespan of 3 years. PS suggested that a future meeting with a focus on consents and permits is arranged. AH suggested Arcadis send the CAPS to him so that he can advise further.	DH	
9. Protective Provisions	DH	
9.1 DH outlined that these form part of Schedule 10 of the Development Consent Order. We have provisions prepared for the scheme. DH advised that they would be shared with the EA during the Examination period and there would be opportunities or the EA to review and tweak wording of provisions. DH to forward provisions to AH.		
10. Draft Statement of Comment Ground (SoCG)	DH	
10.1 Arcadis have prepared a working draft of a SoCG. DH explained the purpose of the document and that we would be sharing this with the EA so that we can begin to develop it further. DH to send working draft to AH.		

ACTION	WHO	WHEN

11. AOB

None

A585 Windy Harbour to Skippool Improvement Scheme – Meeting to Discuss Outstanding Matters (Water Environment)

Monday 1 April 19/ 11:00 AM
Environment Agency (EA) Offices,
Bamber Bridge

Attendees:

[redacted] – Arcadis
[redacted] – Arcadis
[redacted] – Arcadis
[redacted] – Environment Agency (EA)
[redacted] – EA
[redacted] – EA

Apologies:

None

Item no.	Notes/actions	Action owner and target dates for completion
1.0	**Introductions and Aims of the Meeting**	
1.1	LD outlined that we would like to discuss each of the agenda items which are focused on key issues not yet agreed, as outlined in the EAs Relevant Representation and supplementary comments, draft Statement of Common Ground (SoCG) and tidal model review.	
2.0	**Overview of the Examination Period**	
2.1	KB highlighted upcoming key deadlines as set out in the draft examination timetable included in the Rule 6 letter: • Deadline 2 – 17 May 2019 – Highways England (HE) to submit updated application documents, including the updated Flood Risk Assessment (FRA). ***Post meeting update: We propose to submit the updated FRA prior to Deadline 2 for comment / agreement. Then following comments from the EA, update the FRA and submit to the Planning Inspectorate at Deadline 2 – 17 May 2019.*** • Deadline 2 – 17 May 2019 – Highways England required to submit the Draft SoCG to the Planning Inspectorate and the EA are required to submit their Written Representation. • 4 July 2019 reserved for issue specific hearings (if required). • 12 September reserved for a further issue specific hearing (if required). • 9 October the Examination period ends. AH queried if these deadlines were set by Highways England. KB confirmed that they were defined by the Planning Inspectorate and that the final examination timetable would be published shortly after the preliminary meeting on 9 April 2019.	
2.2	KB also highlighted that the Inspectors initial assessment of the principal issues includes the Water Environment and the following sub-topics: • Surface and groundwater effects. • Drainage. • Marine Environment. • Flood Risk. KB also noted that the Inspector has specified that the SoCG must contain an item to cover our position on the draft Development Consent Order (DCO). AH highlighted that the EA	

	may seek to add requirements to the d DCO linked to the FRA and delivery of the temporary floodplain compensation storage areas on the Main Dyke. **KB to add an item in to the draft SoCG cover the draft DCO.**	**KB 12/4/19**
3.0	**Relevant Representation and Supplementary Comments**	
3.1	Fluvial flood risk – outstanding matters. LD summarised key issues still under discussion: Temporary floodplain compensation area (FCA) – LD highlighted that whilst the EA are seeking detailed design information, this cannot be provided as the project is not yet in the detailed design phase (KB noted the contractor is likely to be on board from June). PS confirmed that the EA are seeking comfort that the FCA would able to be consented. LD suggested we could write into the Outline Construction Environmental Management Plan (CEMP), Record of Environmental Actions and Commitments (REAC) and FRA commitments regarding: maintaining EA access – 8m easement from river bank, ensuring bank stability, maintaining levels / avoiding sudden dips in ground levels etc. The contractor would be bound by these commitments. CG also noted that we have sought the opinion of a Reservoirs Engineer and will add details to the FRA. PS confirmed that this approach would be acceptable. **LD/CG to update FRA and KB to update the REAC and Outline CEMP.** Third party impacts and Main Dyke tidal gates **–** CG explained that the project is having no influence on the current operation of the tidal gates and whilst a small increase in baseline water levels are predicted with the Scheme in place, these are in channel increases, with no detriment to baseline flood risk (and significant benefits further upstream). Also the gates are not mechanised but controlled by water level conditions. PH was unsure of the origin of the EA comment on working in partnership to improve operation of the gates and PH/PS could think of no real practical interventions. **CG to add a note to the FRA to confirm that the flaps are in EA ownership and that they will continue to maintain these. The Scheme will have no impact on any current maintenance and operation regimes**. **PH to confer with colleagues to clarify where this comment came from. Assume no further action for HE and that we can move towards a status of 'Agreed' on this matter**.	**LD/CD/KB** **CG** **PH – 12/04/19**
3.2	Horsebridge Dyke culvert. CG shared the design teams responses to the EAs comments on the information submitted surrounding the replacement culvert design. PH outlined that the key concerns for her are managing the potential for scour/erosion and subsequent blockage risks (particularly given the angle between the culvert inlet and upstream channel), and ensuring that the design is resilient to the tidal flow conditions at the downstream end. PH noted that the EA had done a lot of works to this asset recently, including replacing flaps, and have plans for further works e.g. providing safer access with new steps. PH is keen to understand the reasoning behind the design decisions that have been taken to date and would like documented who will have maintenance responsibility for the various parts of the asset, our design also needs to ensure that EA access is maintained. (Note: the downstream tidal outfall/headwall is in private ownership but maintained by the EA, this needs to be resolved). **LD suggested that HE provide a technical note to the EA that covers the above aspects**. PH also requested that invert levels be specified in the FRA. CG agreed to add these into the modelling annex for the culvert inlet and outlet. **CG to add to the FRA.**	**Design Team – 12/4/19** **CG**
3.3	UKCP18 CG explained her approach to determining the scale of tidal uplift required to represent UKCP18 predictions for the Wyre (0.85m applied in a sensitivity test run of the model) and explained that the effect is significantly dissipated along the estuary, such that effects are very small at the Scheme location (approx. 0.04m). CG queried the acceptability of this approach, given that there is as yet no official published guidelines. PS welcomed the work that Arcadis had done in the absence of any guidance	

	from the EA. PS outlined there had been many conversations at the EA over the past week and said that he thinks that the applied uplift is a little under what it should be and may not stand up to scrutiny. CG asked if the EA could confirm the allowance that we should use so that a further run of the tidal model can be completed and reported on in the updated FRA. **PS to confirm appropriate UKCP18 uplift. CG to run tidal model and report in FRA.** ***Post meeting update: UKCP18 uplift confirmed by AH 03/04/19.***	**PS/CG**
3.4	Haul roads and site compounds – the EA stated they require further details of where these elements of the Scheme have the potential to interact with floodplains and Main Rivers. LD suggested specific measures / commitments could be included within the Outline CEMP / REAC. The EA were in agreement with this approach. **LD to add further details to the FRA report and KB to add commitments to the Outline CEMP re set back distances, boundary fencing types etc.**	**LD/KB**
4.0	**Tidal Modelling**	
4.1	CG and PS discussed the tidal model review comments. PS noted that CG responses had resolved many of the comments. CG noted that she had sent some further data (Cloud Point survey, 1D FMP dat file and 2d_bc file for linking proposed culverts beneath the Scheme embankment) to the model reviewer as requested and had done another run of the tidal model with Garstang Road opened up. **CG agreed to issue complete formal responses to the model review and to liaise directly with the model reviewer to resolve outstanding matters.** ***Post Meeting Note: formal responses submitted to Ben Meredith 03/04/19.*** **When confirmation is received from the model reviewer that all comments have been satisfactorily addressed, AH to review draft SoCG to update the status of relevant comments.**	**CG – 12/4/19** **AH – 19/4/19**
4.2	Tidal flood risk impacts and mitigation LD described the dwarf walls that have been added to the Scheme design to mitigate impacts to properties situated off Breck Road, showing their location and explaining their need. CG explained that the walls have been added to the tidal model and referenced the tidal model results memo submitted to the EA on 15 February and asked for feedback. PH/PS had not yet reviewed the memo. **PH/PS to review the memo and confirm if the modelled effects of the scheme are acceptable in terms of changes to baseline flood risk on third party land.** **LD/CG to check that the walls have no effect on any EA assets**	**PH/PS/AH – 12/4/19** **LD / CG**
4.3	Tidal flood risk to the Scheme LD explained that a Flood Warning and Evacuation Plan (FWEP) is being prepared to manage residual tidal flood risk to the operational scheme. The draft Plan can be shared with the EA for comment. PS welcomed this, but noted that the Local Authorities (emergency planning teams) should be the key consultee. **LD share draft of the FWEP.**	**LD – 12/4/19**
5.0	**Works potentially classified as Flood Risk Activities**	
5.1	LD and PH discussed the submitted plans and EA comments on them, requesting further clarity/detail at a finer resolution/scale. To help in understanding what works will be situated close to EA assets (and to help in future permitting of these works) LD agreed to send drawing files in Arc GIS compatible format. **LD to submit package of GIS shape files to AH to include:** Draft Order Limits (Scheme red line boundary)	**LD – 12/4/19**

	8m and 16m buffer zones (measured from the top of bank of the Main Dyke, Horsebridge Dyke and Wyre) Drainage outfall/headwall locations and drainage ponds Temporary floodplain storage areas Main dyke crossing Horsebridge Dyke replacement culvert alignment, plus inlet/outlet structures the dwarf walls	
6.0	**Draft SoCG**	
	LD ran through the draft SoCG matters noted as Under Discussion. All of the topics have been covered in this meeting and the actions agreed and recorded above, should allow the status of the matters to be updated to 'Agreed' against all points. **LD to provide a revised SoCG to AH (including new entry to cover the draft DCO) for EA review and update.**	**LD – 12/4/19**
6.0	**Any Other Business**	
6.1	Consents and Agreements Position Statement / General Permitting LD confirmed that the purpose of the Consents and Agreements Position Statement was to identify consents and permits likely to be required from the EA to construct the Scheme and to gain an assurance from the EA that, subject to submission of permit applications by the Contractor, supported by all necessary information, there would be no obvious show stoppers to obtaining the consents required for the Scheme. **AH understood why this assurance from the EA was being asked for. However, he said he would take this away and to see if they could agree in principal, there are no show stoppers. If so this could be added to the draft SoCG.**	**AH – 12/4/19**

Gibson, Claire

From: NWNorthPlanning [redacted]
Sent: 13 November 2018 14:19
To: [redacted]
Cc: [redacted]
Subject: RE: A585 Windy Harbour to Skippool

Hello Lisa,

We have reviewed the revised minutes (emailed to us 6 November) and we accept them as an accurate record.

Our response to our actions from the meeting, as mentioned in the minutes:

- 2.2 – Approach to modelling buildings – having further considered this we are satisfied that increased roughness is suitable for this project.
- 5.3 – We were unable to find any photos of flooding for the Skippool Bridge area. We suggest that Arcadis carry out an internet search / check local newspaper websites.

We have recently become aware (through an unofficial route) that the DCO has been submitted to PINS, who have 28 days to validate the submission. However, we understand that there is an outstanding tidal model review. Is this still the case?

Emily's surname is Woods. She attended the meeting for personal development purposes as she is a new starter. There will be no cost recovery charge for her attendance.

We will provide any comments on the Consents and Agreements Position Statement and draft Protective Provision in due course.

Best regards,

Alex

[redacted]

[redacted]

Working in partnership to enable sustainable growth and create better places for people and wildlife

Follow us on Twitter @EnvAgencyNW
Visit the website - https://www.gov.uk/environment-agency
Visit our blog - https://environmentagency.blog.gov.uk/

From: [redacted], Lisa [redacted]
Sent: 06 November 2018 12:55
To: [redacted], Alex [redacted]; NWNorthPlanning [redacted]
[redacted]>
Cc: [redacted] Claire <[redacted]>; [redacted] Kate [redacted]; [redacted] David [redacted]
Subject: FW: A585 Windy Harbour to Skippool

MINUTES

ARCADIS Design & Consultancy for natural and built assets

MEETING TITLE
A585 Windy Harbour to Skippool Improvement Scheme

DATE
30 April 2018

TIME
10:00 AM

LOCATION
EA Office Bamber Bridge

CHAIR PERSON
[redacted]

ORGANISER
[redacted]

COPIES TO
[redacted] – Highways England
[redacted] – Highways England
[redacted] – Arcadis
[redacted] – Arcadis
[redacted] – Arcadis

PARTICIPANTS
[redacted] – Arcadis
[redacted] – Arcadis
[redacted] – Arcadis
[redacted] – EA
[redacted] – EA
[redacted] – EA

APOLOGIES
[redacted] – EA

ACTION	WHO	WHEN

1. Introduction to the Scheme / Work Completed to Date

1.1 SP gave an overview of the Scheme

1.2 CG gave an overview of the current status of the FRA / hydraulic modelling

2. Construction Phasing

2.1 SP ran through the construction phasing of the Scheme and how the bypass will be built. SP explained that it would not be feasible for the new Skippool Bridge to be constructed and in place before the road embankments for the new bypass, which cross the Main Dyke floodplain are in place. This is because the embankments require a settlement period and therefore the work on this aspect needs to start first with the construction of the bridge started after. The works need to be constructed in parallel.

2.2 SP explained that it would take 9 months for the first phase of the new Skippool Bridge to be replaced, the new larger culvert in place and all utilities diverted. Overall construction period of the Scheme would be 2 years.

2.3 PH and AH stated that there is a need to mitigate for any increases in flood risk to third parties during construction for all events up to and including 1% AEP plus 30% for climate change. Note that we only need to consider a 30% allowance for climate change as the construction phase only lasts for 9 months. Therefore, the FRA needs to identify and provide additional mitigation within the red line boundary to allow the Scheme to be constructed / phased the way it needs to be.

SP 16/05/2018

ACTION	WHO	WHEN
2.4 AH asked if there were any schematics they could be sent of the new Skippool Bridge. SP said there are draft drawings and he would email them to AH.		
2.5 PH stated that there are significant issues with PR / local community flooding and awareness would need to be considered.		
3. Tidal Modelling		
3.1 CG provided background to the tidal model and asked the EA about acceptable tolerances [CG also noted that it appears the central reserve at Skippool Junction (locally known as the River Wyre Junction after the pub) is controlling tidal flooding]		
3.2 PH / AH and PS said there wasn't a simple answer to this and that they would have to take this query away and look at reasonable tolerances.	AH	As part of the FRA review process.
3.3 CG to liaise with the EA over tolerances for increases in levels – i.e. what would be considered a detriment and what is acceptable within the bounds of model / data accuracy.	CG	As part of the FRA review process.
4. Flood Risk During Construction		
4.1 PH stated that flood risk during construction should be covered within the FRA and that detail of site compounds and haul roads should be provided.		
4.2 Arcadis noted that they have site compound locations but are awaiting the appointment of a buildability consultant to confirm haul roads.		
4.3 AH outlined the FRA needs to consider any temporary changes in ground levels in relation to site compounds / haul roads.		
4.4 PH and PS stated that the FRA needs to consider key receptors and their vulnerabilities and to ensure there would be no detriment to third parties and that run off is controlled.		
5. Timescales		
5.1 KB gave a brief overview of the DCO submission timescales and queried the EAs review timescales. PS confirmed that the EA would need 6 weeks for model reviews (to be carried out by external consultants on behalf of the EA).		
5.2 PS also said he was happy for the EA to review the model and would be easier to work with us. PS stated a preference to receiving everything all at once rather than being drip fed. **Post note – AH has agreed that CG can send just the baseline and with scheme fluvial models prior to completing the mitigation model.**		
5.3 AH said anything that is being submitted though to the EA should go through him as the first point of contact.		
5.4 PH Suggested that the EA could also offer permitting advice.		

ACTION	WHO	WHEN

6. AOB

6.1 Future Planning Applications – PH noted there are a lot of development proposed in this area therefore it is critical to take account of this in the FRA i.e. what is rural land now may not be in future. KB noted she maintains a register of potential cumulative developments which is regularly updated.

6.2 The EA noted left bank of Horsebridge Dyke (just by the ‘d’ in Breck Road on OS opensource mapping) there is an application for ‘agricultural access’ (Wyre Council ref. 18/00243/FUL) and it is likely this may be a precursor to future housing development.

6.3 The EA noted there should be no drainage ponds in FZ3 – and this needs to clearly be identified in the FRA.

6.4 SP outlined the preliminary drainage design. New outfalls are designed in accordance with current standards. There are 2 general designs for new outfalls, first of which discharges to wetlands before discharging to highway ditches and ultimately into local watercourse. Arcadis have gained agreement with Lancashire County Council for this. Wetlands have been designed to accommodate a 1 in 100-year storm with 40% climate change allowance. Second discharges directly into watercourse, consents/permits for these will be sought at detail design stage.

6.5 SP stated where existing outfalls will be maintained and re-used, the design has maintained the existing 1 in 5-year discharge rate by providing attenuation and water quality mitigation.

Gibson, Claire

From: NWNorthPlanning [redacted]
Sent: 18 May 2018 09:30
To: [redacted] Claire
Cc: [redacted] Pippa; [redacted] Paul; [redacted] Kate; [redacted] Sucha; [redacted] Lisa
Subject: RE: A585: Notes from EA Meeting

Hello Claire,

We have checked the minutes and we are satisfied with them. Please note, though, that I am listed as an Arcadis employee.

For your information, the planning application referred to in 6.2 is Wyre Council ref: 18/00243/FUL.

Best regards,

Alex

[redacted]

[redacted] | Lutra House, Dodd Way, Off Seedlee Road, Walton Summit, Bamber Bridge, Preston, PR5 8BX

Working in partnership to enable sustainable growth and create better places for people and wildlife

Follow us on Twitter @EnvAgencyNW
Visit the website - https://www.gov.uk/environment-agency
Visit our blog - https://environmentagency.blog.gov.uk/

From: [redacted] Claire [redacted]
Sent: 16 May 2018 10:27
To: NWNorthPlanning [redacted]
Cc: [redacted], Pippa [redacted], Paul [redacted] Kate [redacted] Sucha [redacted] Lisa [redacted]
Subject: FW: A585: Notes from EA Meeting

Hi Alex / Pippa / Paul,

Please find attached the minutes from our meeting on 30th April. Please can you confirm that you are happy that these are an accurate summary of the discussions had. We would then like to send them to Highways England for their information.

Thanks,

Claire

[redacted]

www.arcadis.com

Click here for more information on Flood Resilience in Arcadis

ARCADIS Design & Consultancy for natural and built assets

Be green, leave it on the screen.

Arcadis Consulting (UK) Ltd
Arcadis Consulting (UK) Limited is a private limited company registered in England & Wales (registered number 02212959). Registered office at Arcadis House, 34 York Way, London, N1 9AB. Part of the Arcadis Group of Companies along with other entities in the UK.

This email and any files transmitted with it are the property of Arcadis and its affiliates. All rights, including without limitation copyright, are reserved. This email contains information that may be confidential and may also be privileged. It is for the exclusive use of the intended recipient(s). If you are not an intended recipient, please note that any form of distribution, copying or use of this communication or the information in it is strictly prohibited and may be unlawful. If you have received this communication in error, please return it to the sender and then delete the email and destroy any copies of it. While reasonable precautions have been taken to ensure that no software or viruses are present in our emails, we cannot guarantee that this email or any attachment is virus free or has not been intercepted or changed. Any opinions or other information in this email that do not relate to the official business of Arcadis are neither given nor endorsed by it.

This message has been scanned and no issues were discovered.
Click here to report this email as spam

Information in this message may be confidential and may be legally privileged. If you have received this message by mistake, please notify the sender immediately, delete it and do not copy it to anyone else.

We have checked this email and its attachments for viruses. But you should still check any attachment before opening it.
We may have to make this message and any reply to it public if asked to under the Freedom of Information Act, Data Protection Act or for litigation. Email messages and attachments sent to or from any Environment Agency address may also be accessed by someone other than the sender or recipient, for business purposes.
Click here to report this email as spam